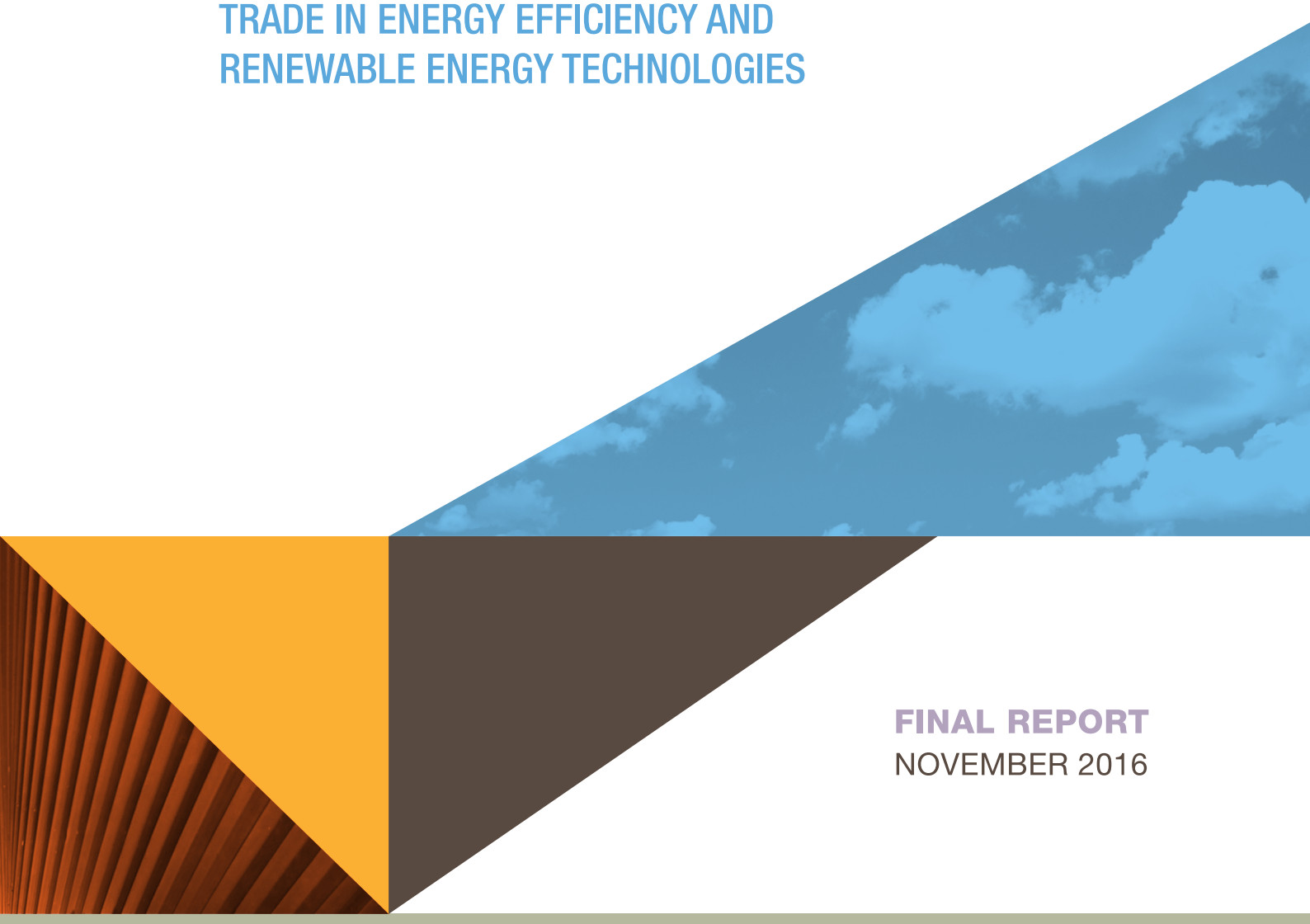
SCOPING STUDY ON INTRA-ASEAN VALUE CHAIN COOPERATION AND TRADE IN ENERGY EFFICIENCY AND RENEWABLE ENERGY TECHNOLOGIES



FINAL REPORT

NOVEMBER 2016

This report has been produced as part of the ASEAN SHINE program. ASEAN SHINE is an initiative implemented by the International Copper Association, in partnership with United Nations Environment Programme (UN Environment), Scientific and Industrial Research Institute of Malaysia (SIRIM), the Research Center for Energy and Environment of Vietnam (RCEE), the Electrical and Electronics Institute of Thailand (EEI), and the Institute of Integrated Electrical Engineers of the Philippines (IIEE)

Program ID:

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

Funded by European Union, SWITCH Asia program

Grant amount 1,749,099.90 EUR

Contract ref. DCI-ASIE 2012/291-458

Name of beneficiary European Copper Institute

Partners

- United Nations Environment Programme, Economy Division
- International Copper Association Southeast Asia
- Electrical and Electronics Institute
- SIRIM QAS International
- Integrated Institute of Electrical Engineers
- Research Center for Energy and Environment

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

November 2016

Disclaimer: This document has been produced with the financial assistance of the European Union. The contents of this document are the sole responsibility of the authors and can in no way be taken to reflect the views of the European Union.

ACKNOWLEDGEMENTS

The report was commissioned by the United Nations Environment Programme's Environment and Trade Hub. It is a key output of the Environment and Trade Hub's work programme on enhancing trade and investment in environmentally sound technologies in 2016. The report received important contributions from UN Environment experts, as acknowledged here.

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Pierre Cazelles and Jean-Marc Alexandre (International Copper Association) in partnership with Chitra Priambodo (Castlerock Consulting) undertook this study. Research was based on extensive desk research and literature review of reports of government and industry associations, interviews with key informants and analysis of data on trade and other relevant variables.

The project was managed by Anja von Moltke, Head of the Environment and Trade Hub (UN Environment), under the overall guidance of Steven Stone, Chief of the Resources and Markets Branch (UN Environment). Substantive contributions were provided by Lennart Kuntze, Taylor Clayton, Sara Castro de Hallgren and Emily McQualter (UN Environment).

Administrative support during the publication process was provided by Désirée Leon (UN Environment). UN Environment is grateful for the support of Ashley Petry, UN Online Volunteer mobilized through www.onlinevolunteering.org. The final layout was designed by Satuorn Thamsongsana (International Copper Association) and Weerana Talodsuk (Professional Artwork and Graphic Designer).

UN Environment and the authors would like to thank the European Commission for the financial support provided for this publication and project.

Any errors or omissions are the sole responsibility of the authors.

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LIST OF ABBREVIATIONS

AC	Alternating Current
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
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
EE&C-SSN	Energy Efficiency and Conservation Sub-Sector Network
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
FIT	Feed-in Tariff
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
R&D	Research and Development
RAC	Room Air Conditioner
RE	Renewable Energy

LIST OF ABBREVIATIONS

RE-SSN	Renewable Energy Sub-Sector Network
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 (newly UN Environment)
VAT	Value Added Tax
WCO	World Custom Organization
WTO	World Trade Organization

LIST OF EXHIBITS

LIST OF EXHIBITS

EXECUTIVE SUMMARY

The countries of the Association of Southeast Asian Nations (ASEAN) 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), EE and RE 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 EE, ASEAN member countries are progressively adopting Minimum Energy Performance Standards (MEPS) with EE standard and labelling programs. ASEAN member countries coordinate their energy policies through the ASEAN Energy Efficiency & Conservation Sub-Sector Network (EE&C-SSN) and the Renewable Energy Sub-Sector Network (RE-SSN). Both are composed of government agencies acting as program coordinators, and report to the Senior Officials Meeting on Energy (SOME) and the ASEAN Ministers on Energy Meeting (AMEM).

Under the broader umbrella of the Association of Southeast Asian Nations Standards Harmonization Initiative for Energy Efficiency (ASEAN SHINE) program, a scoping study was initiated. This study aimed to foster understanding among ASEAN policymakers (ministries in charge of energy, trade, commerce, industry, etc.) of 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 reviews the existing intra-ASEAN trade in selected EE and RE technologies, and identifies the potential to further enhance intra-ASEAN supply chain integration for these technologies. Key findings of this scoping study are delineated below.

PERFORMANCE TESTING STANDARDS

Concerning energy performance testing standards for 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 the ASEAN SHINE[1] program.

The international standard for testing the energy performance of refrigerators, which is applied in the majority of ASEAN's big economies (the Philippines, Indonesia, Malaysia and Singapore), is IEC 62552; Vietnam is currently working on aligning its national standard to IEC 62552. Hence, adoption of IEC 62552 in ASEAN countries as the common testing standard is the recommended way forward from the perspective of regional harmonization.

[1] ASEAN SHINE is an activity funded by the EU-SWITCH program; it aims to increase the market share of more highly efficient air conditioners in ASEAN by harmonizing test methods and energy-efficiency standards, adopting common Minimum Energy Performance Standards, and changing consumer purchasing attitudes in favour of energy-efficient air conditioners.

National standards for testing the energy performance of alternating current (AC) induction motors in ASEAN countries are found in Indonesia, Malaysia, Thailand and Vietnam, with these standards moving towards alignment with the IEC 60034-2 standard. As a next step, a detailed analysis of the gaps between IEC 60034-2 and the existing national standards would be useful, as it would help prepare detailed roadmaps for harmonization in ASEAN.

IEC 60076-1 (distribution transformers) is mostly used by ASEAN electric utilities to meet their loss reduction targets. However, this standard is not mandatorily applied by the commercial-industrial sectors at the national level.

Exhibit ES 1. Summary of applied performance testing standards for selected technologies in ASEAN

Country	National Energy Performance Testing Standard			
	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 with 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 (aligned with IEC 60034-2)
Malaysia	Aligned with ISO 5151 (old version)	MS IEC 62552-3:2016 (Aligned with IEC 62552-3:2015)	Apply IEC 60076-1 (Electric utilities)	Aligned with IEC 60034-2
Myanmar	N/A	N/A	N/A	N/A
Philippines	(1) Aligned with ISO 5151-PNS ISO 5151:2014 (2) 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 with ISO 5151	Aligned with 62552-3:2007	Apply IEC 60076-1 (Electric utilities)	N/A
Thailand	Aligned with ISO 5151 (old version)	TIS 455-2537 and TIS 2186-2547	Apply IEC 60076-1 (Electric utilities), and TIS 384-2453	TIS 867-2550-2007 (Aligned with IEC 60034-2)
Vietnam	Aligned with ISO 5151 (old version)	TCVN 7829:2016 (ongoing) aligned with IEC 62552 (1/2/3)	TCVN 6301-1:2015 aligned with IEC 60076-1:2011	TCVN 6627-2-1:2010 aligned with IEC 60034-2-1:2007

MINIMUM ENERGY PERFORMANCE STANDARDS (MEPS)

Exhibit ES 2 provides an overview of the MEPS applied in ASEAN for selected technologies.

Indonesia, Malaysia, Singapore, Thailand and Vietnam already apply mandatory MEPS for air conditioners.

Malaysia, Singapore, Thailand and Vietnam are far ahead of other ASEAN countries in developing and implementing MEPS for refrigerators. Nonetheless, meaningful discrepancies exist in the methods used by these countries to define energy performance. On one hand, Malaysia and the Philippines apply an Energy Efficiency Factor (EEF). On the other hand, Singapore, Thailand and Vietnam apply a linear energy consumption estimation, based on adjusted capacity. A discrepancy analysis between these two methods would clarify the potential for harmonization, thus paving the way for the establishment of a regional MEPS target.

At present, Vietnam is the only ASEAN country with mandatory MEPS for electric motors and distribution transformers. In Malaysia and Thailand, efforts to promote EE for electric motors have been initiated through voluntary programs. Vietnam has moved steps ahead in terms of applying regulations and standards for energy efficiency. Transferring experience and knowledge from Vietnam to other ASEAN countries would enhance these countries' capacity in formulating and implementing standards to promote EE.

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

LABELLING

Exhibit ES 3 provides an overview of the labelling programs for selected technologies in ASEAN. The labelling programs in Malaysia, Singapore, Thailand and Vietnam follow a five-star/tick rating system. Indonesia is developing a labelling program based on a four-star rating system. For all countries, the higher the number of stars/ticks, the higher the performance; however, the methods of assigning the ratings and the requirements for labels vary between countries. Currently, no process for the adoption of a regional label is underway.

Exhibit ES 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 - voluntary - 1-4 stars	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	Mandatory label	Mandatory 1-5 star rating, pending implementation	None	None
Singapore	Mandatory - comparative label, 1-5 rating	Mandatory 1-4 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

In addition to the technologies mentioned above, another study conducted under the guidance of ASEAN SHINE, with the support of the UN Environment *en.lighten* initiative (Coyne et al., 2016), has identified linear fluorescent lamps and LED lamps as important products to target. This is because:

- Linear fluorescent lamps command a large market share, with stable annual sales across the ASEAN region. In addition, there are major differences between existing MEPS levels in Malaysia, the Philippines, Thailand and Vietnam. Therefore, there are significant opportunities for harmonization, both in terms of realising energy savings and in terms of regional trade.
- LED lamps have a small but fast-growing market share across the ASEAN region, and only two countries (Malaysia and Singapore) have existing MEPS. Indonesia, the Philippines and Thailand are currently considering developing their MEPS. Through relatively modest policy interventions, the latter countries could enjoy significant gains in energy security and energy savings; in today's market LED lamps tend to have higher efficiency levels than those required by regulations. This aspect of LED technology therefore presents the ASEAN Member States with an opportunity to establish a short-term efficiency requirement that is higher and could be harmonized across the region (Coyne et al., 2016).

Energy Performance Standards for Renewable Energy Technologies

Solar PV and solar thermal: Current solar PV standards in ASEAN are mostly related to connecting the solar PV system to the grid, the Balance of System (BoS), and the safety of installation. This situation may persist, 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 mass-produced in the region; at present this technology is still heavily imported. Despite growing interest in this technology, 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.

The Proposed Approach: Facilitate the Identification and Recognition of EE and RE Products

The six-digit HS code does not differentiate EE and non-EE products: The analysis of trade-flow provides only a single trade value (in US$ thousands) that includes both EE and non-EE products classified under a single six-digit HS code. Thus, if there is no performance standard as defined by regulation, all products are treated as the same for import purposes (e.g., no differentiation of energy-efficient vs. non-efficient by HS code for tariff). 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 “classification” to distinguish energy efficiency technologies be introduced to support intra-regional trade of EE technologies. In terms of recognizing EE and RE products, no regional labelling currently distinguishes EE/RE products. Having such regional labels in place would facilitate and further simplify intra-ASEAN trade of such technologies and their recognition by end users.

Tariff Barriers

In line with the ASEAN Trade in Goods Agreement (ATIGA), ASEAN countries apply mostly “tariff free” rates for the technologies covered by this study. Hence, for these technologies, tariffs are no longer a significant barrier to intra-ASEAN trade. From the same perspective, the impact of the Environmental Goods Agreement (EGA) on intra-ASEAN trade is expected to be limited. The EGA could benefit ASEAN countries by enhancing their potential to trade with other countries or economic regions, but specific opportunities should be investigated on a country-by-country basis rather than on a regional one.

For products that are mostly imported from non-ASEAN countries, such as electric motors, tariffs could still play a role. For example, such products could be imported to Singapore and then re-exported to other ASEAN countries. This would have an indirect impact on intra-ASEAN trade. Singapore is a trading hub for ASEAN, with the lowest average MFN tariff; for most products under study, tariffs applied in Singapore are set at zero.

Non-tariff Barriers

In this study, possible non-tariff barriers are explored through a review of the trade policies and existing EE and RE promotion policies of each ASEAN member country.

In terms of trade policy and regulations, all ASEAN member countries already 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 for EE and RE technologies. Limitations on RE investments, notably concerning local content requirements, are only observed in Indonesia, Malaysia and Myanmar.

Six ASEAN countries have already set EE and RE targets in their national energy policies. However, for the private sector, the perception remains that regulatory and policy frameworks for electricity are unstable, that the existing roadmaps and action plans to reach the EE and RE targets are unclear, and that there is a lack of direction in implementing EE and RE policies. This creates doubts and reinforces the risk perception of potential foreign investors who wish to develop EE and RE projects.

Case Study of Solar PV in Vietnam

A case study on solar PV development in Vietnam was undertaken to analyse non-tariff barriers that impede the adoption of solar PV technology. The key findings from the case study show that the development of solar PV projects has been slow in Vietnam because of roadblocks such as policy and institutional barriers, issues with economic and financial resources, and the lack of adequate data and information.

Solar PV technology currently available in Vietnam has mostly been imported, with large numbers of existing solar PV panels and components coming from China. Components are also imported from Korea and some European countries where quality is higher, yet for a cost that is still reasonable. A limited number of local companies and research institutions are starting to play a role in the solar PV industry. The infrastructure of the power sector has not yet developed to meet the requirements of solar PV integration. For example, the infrastructure for rooftop net metering is not available in Vietnam.

The existing policy framework provides limited support for solar PV in Vietnam. 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. However, there are still no action plans for these policies. The underdeveloped policy framework, as well as the inadequate nature of current support mechanisms, cast doubt on the government's commitment to solar PV development.

As suggested above, the Vietnamese market for solar PV is not yet mature. In the absence of a competitive solar power market, the financial feasibility of solar PV projects relies heavily on the state budget. In this context, investors find it difficult to make cash flow projections,

mobilize financing and make loan arrangements with banks.

No comprehensive geospatial map of Vietnam's solar resources, nor a master plan for Vietnam's solar PV development, have been published. There is therefore an overall lack of information, and solar PV developers and investors have a limited understanding of proper investment procedures. To obtain permissions, they must guess their way through many procedural steps, as pertaining to investment certificates, construction permissions and electricity operation licenses.

CONCLUSIONS AND RECOMMENDATIONS

Based on the review of tariff and non-tariff barriers, the interest of ASEAN countries in participating in the EGA negotiations can be better understood from a global perspective than from a regional one. This is because 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 (Indonesia, Malaysia, the Philippines, Singapore, Thailand and Vietnam). In that regard, a lack of harmonization affects energy performance testing methods, MEPS and labelling:

- MEPS and labelling requirements vary greatly across the region.
- Enforcement of those requirements is limited, even in countries that have developed and implemented MEPS.
- Across the technologies studied, labelling is still in its initial stages, even in the six largest ASEAN countries.

This results in limited potential for the mutual recognition of energy performance when technologies are traded between countries. This lack of mutual recognition directly influences the potential for increasing intra-ASEAN trade in EE technologies.

In line with the above, two key strategies are recommended for EE technologies.

The first recommended strategy consists of harmonizing standards aimed at testing the energy performance of EE equipment. Not all ASEAN countries reference their national standards to the relevant international standard. Alignment of national standards to an international standard has been achieved for air conditioners, where the reference used is ISO 5151:2010. This is not the situation for the other household appliances in this study (refrigerators and linear fluorescent and non-directional LED lighting), or for other EE equipment used in industry (electric motors and transformers).

The second strategy consists of adopting and harmonizing MEPS from the perspective of progressively phasing out inefficient equipment from the market. The rationale for this second strategy is that technologies with a lower efficiency usually have a lower initial price and limit

market opportunities for more efficient equipment. Hence, MEPS set a minimum standard for entering the market, creating a barrier for continuous penetration of inefficient products.

For RE technologies (solar PV and solar thermal), the study suggests that general approaches cannot be applied because the situation in each ASEAN country is unique. For these technologies, the study recommends employing technology-specific approaches, including by improving the policy framework for solar PV and increasing the market understanding of solar thermal technologies.

01

INTRODUCTION

1.1 BACKGROUND AND OBJECTIVES

1.1.1 Background

Intra-ASEAN Trade on Energy Efficiency and Renewable Energy Technologies

ASEAN is among the world's most dynamic regions, with accelerated economic performance in recent years. Economic growth can notably be attributed to regional cooperation and integration initiatives that have been carried out during the past two decades. Gross domestic product (GDP) in the region nearly doubled between 2007 and 2015, with a combined GDP of over US$ 2.5 trillion. In parallel, average GDP per capita has grown by almost 80% to more than US$ 4,000 (The ASEAN Secretariat, 2015). ASEAN has also become 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 the AFTA is to increase the ASEAN region's competitive advantage as a production base for the world's market. A crucial 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 provide ASEAN consumers with wider choices, higher-quality products and competitive prices. ASEAN has therefore introduced the ASEAN Trade in Goods Agreement (ATIGA), in which most tariffs for goods in the region are geared toward zero. Nonetheless, there is still much work to be done to effectively remove non-tariff barriers. Initiatives and ideas for further enhancement of economic and trade cooperation are regularly raised and discussed in annual ASEAN Economic Minister (AEM) meetings. In 2015, ASEAN members formed the ASEAN Economic Community (AEC), marking the formal establishment of an integrated economic region.

To fulfil their global commitment on climate change, ASEAN countries have been very active in promoting energy efficiency (EE) and renewable energy (RE) technologies. For example, feed-in tariffs (FITs) have been adopted in Thailand and Malaysia and are being developed in the Philippines. The liberalization of electricity markets has greatly contributed to an increased share of RE in the regional energy mix. Concerning energy efficiency, countries are progressively adopting Minimum Energy Performance Standards (MEPS) and labelling programs. Energy efficiency and renewable energy are also key program areas of the ASEAN Plan for Action for Energy Cooperation 2016-2025 (APAEC). As described in the APAEC, ASEAN member countries coordinate their energy policies through the ASEAN Energy Efficiency & Conservation Sub-Sector Network (EE&C-SSN) and the Renewable Energy Sub-Sector Network (RE-SSN), which are composed of government agencies acting as program coordinators. The EE&C-SSN and RE-SSN report to the Senior Officials Meeting on Energy (SOME) and the ASEAN Ministers on Energy Meeting (AMEM).

The present study explores the potential for a better integration of the value chains of selected EE and RE technologies through trade and technical cooperation among ASEAN members.

Trade of Environmental Goods and Services: A 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 a green economy. EE and RE technologies are a sub-set of EGS because of 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, the Friends of EG group, composed of WTO members including Canada, Chinese Taipei, Japan, New Zealand, the United States, European Union (EU) countries, Norway and Switzerland, submitted a list of environmental goods to the WTO Committee on Trade and 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 5% 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. It excluded certain WTO key players, in particular the 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 have allowed nomination of 340 products in 10 environmental categories. With the exception of Singapore, no ASEAN country has joined the EGA negotiations.[2] Therefore, the potential for ASEAN countries to join the EGA negotiations is one of the particular areas to be explored in the framework of the present scoping study.

1.1.2 Objectives

Under the broader umbrella of the ASEAN SHINE[3] program, the present scoping study aims to analyse the potential for increasing intra-ASEAN value-chain cooperation and trade in the field of energy efficiency and renewable energy technologies. In line with this objective, the study aims to identify and document the potential benefits and issues for ASEAN countries. This study focuses on a selection of seven clean energy 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 to increase the market share of more efficient air conditioners in ASEAN by harmonizing test methods and energy efficiency standards, adopting common Minimum Energy Performance Standards, and changing consumer purchasing attitudes to favour energy-efficient air conditioners.

The study also aims to improve understanding among ASEAN policymakers (the ministries in charge of energy, trade and commerce) of the aforementioned benefits and issues. The results have therefore been presented and discussed at two regional stakeholder consultation workshops.

1.1.3 Selected Technologies

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

- **Electricity consumption:** Electricity usage in residential and industrial sectors contributes significantly to energy consumption in ASEAN countries. For example, air conditioners, refrigerators and lighting account for more than 50% of electricity usage in the residential sector, while electric motors account for about 65% of electricity consumption in the industrial sector (UN Environment, 2014).
- **Potential for energy savings:** Air conditioners, motors, refrigerators, lighting and transformers hold an important potential for electricity saving in ASEAN countries. This is associated with substantial potential reductions in GHG emissions (notably CO_2).
- **Policy priorities:** The ASEAN Plan of Action for Energy Cooperation (APAEC) recommends the harmonization and promotion of energy efficiency standards and labelling for various kinds of energy-related products. At present, the prioritized focus includes room air conditioners and lighting.
- **Projected growth:** It is expected that by 2035 installed capacity of solar PV technologies in ASEAN countries will reach 9.9 GW, accounting for 6.6% of total renewable installed capacity in the region [ASEAN Centre for Energy (ACE), 2015]. Moreover, price decreases in solar PV technology have made the implementation of this technology more affordable in ASEAN developing countries.

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, MEPS and Labelling:** To facilitate trade in the selected technologies mentioned in section 1.1.3, it is important to harmonize standards and practices among ASEAN countries. In line with the ASEAN Plan for Action in Energy Cooperation 2016-2025, it is also appropriate to promote cooperation among ASEAN member countries, notably towards the utilization of International Standards. For energy efficiency technologies (RACs, refrigerators, electric motors and distribution transformers) the focus is placed on the following:

    Focus 1. Moving the national standards for performance testing methods towards the relevant international standard(s).

Focus 2. Defining and adopting a regional benchmark level for MEPS.
Focus 3. Harmonizing labelling practices to facilitate recognition among end users and authorities.

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

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

Activity 1.1. Review of standards on performance testing methods, MEPS and labelling. The review was conducted to determine whether 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(s).
Activity 1.2. Review of the existing labelling program in each ASEAN member country.
Activity 1.3. Regional analysis to identify the trend towards and gap between international standards for performance testing methods and MEPS.
Activity 1.4. Identification of barriers to the implementation of MEPS, performance testing standards and labelling, and assessment of how these barriers influence intra-ASEAN economic integration.
Activity 1.5. Identification of potential energy savings that could be achieved by 2025 and 2030 for selected EE technologies, based on analysis conducted in the U4E program.[4] The analysis of potential energy savings uses CLASP's[5] and LBNL's[6] Policy Analysis Modelling System (PAMS) to forecast the impact 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.

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 policies and regulations that 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; in other countries such financial incentives are not in place, despite the need for such technologies.

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

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

Activity 2.1. A review of the EE and RE policy and regulatory frameworks in ASEAN countries. This review covered EE and RE promotion policies, MEPS and labelling policies, RE-based feed-in-tariff (FIT) policies, and policies providing financial incentives and/or fiscal instruments for EE and RE development.

Activity 2.2. An analysis of the positive and negative impacts of the above policies and regulations, with regard to trade flows.

3. **Value chain analysis of supply and demand in the context of intra-ASEAN trade:** While looking at the trade benefits of intra-ASEAN cooperation, one important aspect is the identification of potential value chain integration of EE and RE technologies. 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 the following activities:

   Activity 3.1. Illustration of the value chain for selected EE and RE technologies, including key components and products (supply side) and application(s) (demand side).

   Activity 3.2. Identification of the six-digit harmonization code (HS) of the product and key components for selected EE/RE technologies. (Further background information on the definition and application of HS codes is provided in Exhibit 1.1).

   Activity 3.3. Market analysis for the selected EE and RE technologies in ASEAN countries, with particular emphasis on the demand side (the application).

   Activity 3.4. Analysis of trade flows based on the six-digit HS code export data for the selected EE and RE technologies manufactured in ASEAN. When selected EE and RE manufacturing sectors were not available within ASEAN, the import data was not taken into consideration.

   Activity 3.5. 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 for 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:** To formulate further steps to enhance intra-ASEAN value chain integration, existing tariff and non-tariff barriers for these technologies must also be assessed.

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

Activity 4.1.1. Review of tariffs applied in the trade flow analysis in ASEAN countries of the selected EE and RE technologies, based on six-digit HS codes. 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.

Activity 4.1.2. Review of proposed commitment to preferential tariffs[7] in ASEAN countries for selected RE and EE technologies, particularly in the ATIGA. This review was also based on six-digit HS codes.

Activity 4.1.3. Review of the tariff data on six-digit HS codes for selected EE and RE technologies from the World Trade Organization (WTO) website from Most-Favoured 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.

Activity 4.1.4. Comparative analysis of the reviews conducted in activities 4.1.1, 4.1.2 and 4.1.3, to compare the actual tariff implementation of selected EE and RE technologies in ASEAN with the preferential tariff commitment made under ATIGA.

Activity 4.1.5. Analysis of possible implications that the Environmental Goods Agreement would bring to intra-ASEAN economic integration, based on the comparative analysis conducted above.

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.

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

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 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

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

Activity 4.2.1. Review of existing non-trade barriers for selected EE and RE technologies, of which several key factors were assessed:

- Protection of national industry through local content requirements.
- Limitation of foreign direct investment.
- Financial barriers, such as restricted access to financing.
- 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.

Activity 4.2.2. 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 technologies, and their impact on 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. Primary data sources include:

- Meetings with the ASEAN Secretariat/officials to obtain information relevant to regional ASEAN trade initiatives on economic integration and to ascertain their views 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.Singapore, for comparative analysis with interview results from Vietnam.

The secondary data sources were:

- Literature and past studies conducted by ICA, UN Environment, the International Energy Agency (IEA), and other credible institutions and EE/RE programs at the 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 EE and RE 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).
    - Minimum Energy Performance Standards (MEPS).
    - Existing certification in certain RE and EE technology installations, 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 and RE in ASEAN countries, such as regulations on fiscal/incentives on EE and RE standards and labelling, and FIT.
- Background information on the EGA.
- Information on harmonization codes.

1.3 SCOPE AND LIMITATIONS OF THIS STUDY

The studied EE technologies are widely used and are characterized by a generally low level of efficiency. They are presumed to offer important potential in terms of market development. In turn, the energy saving and emissions-reduction potential associated with these technologies are expected to be significant. This study focuses on the most promising technologies with regard 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 (RACs)
- refrigerators
- electric motors
- transformers
- lighting

Renewable Energy:

- solar PV
- solar Thermal

The above technologies were selected based on 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 regional value chain integration. The sections below briefly define the technologies, as well as the scope and limitation of each technology included in this study.

1.3.2 Room Air Conditioners (RACs)

RACs are used to cool and dehumidify a room/space. They can be of the split type (single-split type or multi-split type) or the window type,[8] the latter which is found only in a few ASEAN countries. A split-type system is composed of an outdoor unit and one or more indoor units. The outdoor unit consists of a compressor, condenser and cooling fans. The indoor units consist of an evaporator and expansion control, and possibly air circulation fans, air filters, a drainage arrangement (sometimes including a pump) and a humidifier. Single- and multi-split RACs can be either with or without an inverter. The inverter technology is the latest evolution of technology concerning the electric 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 a split RAC have increased efficiency in contrast to traditional air conditioners, extending the life of their parts and eliminating sharp fluctuations in the load.

[8] The wall type is not considered in this study.

Single-split RAC: A single-split RAC features only one evaporator/indoor unit for every remote condensing unit and compressor.

Multi-split RAC: A multi-split RAC includes more than one indoor unit for every remote condensing unit and compressor.

Window-type RAC: This type of RAC is supplied and installed as a single item (the 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 suitable only for single rooms and limited to an approximate maximum of 6kW cooling.

RACs consume a significant share of the electricity in the residential and commercial sectors, so EE improvement in RACs in the selected ASEAN economies could lead to great energy savings. This justifies the inclusion of RACs as a key focus of this study.

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

- **HS 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 litres. The appliances on which this study focuses 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 refrigerators, 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 purposes, and with 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 products reviewed in this study for trade flow and tariffs are:

- **HS 8418.21** – Refrigerators for household use, vapour-compression-type.
- **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 (input power rating ≤ 0.75 kW) 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 and 375 KW), manufactured in large volumes and having low voltage. These are sold to original equipment manufacturers or sold as stand-alone motors that the final customer then integrates into a specific application on site.
- Large-sized motors (input power rating above 375 kW). These 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 accounts for about 70% of electricity used by electric motors globally (Waide, Paul, et al., 2011), this study focuses solely on medium-sized, low-voltage alternating current (AC) induction motors. Accelerated deployment of energy-efficient motors in this category would result in significant energy savings throughout the region.

The harmonized systems for this product are:

- **HS 8501.52:** AC motors, multi-phase, of an output exceeding 750 W but not exceeding 75 kW.
- **HS 8501.53:** 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 transfer alternating current (AC) 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) networks. 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, 70% occur in distribution transformers. In line with this situation, 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 1.4 shows the type of distribution transformers and their general usage.

Exhibit 1.4 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:

- **HS 8504.21** – Liquid dielectric transformers, not exceeding 650kVA.
- **HS 8504.22** – Liquid dielectric transformers, power-handling capacity 650-10,000kVA.
- **HS 8504.90** – Transformer parts (including the cores of transformers).

1.3.6 Solar Photovoltaic (Solar PV) Power System

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

The main component of a solar 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 ranging from 50 to 200 watts. 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.

A 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 the energy performance of a solar PV system are inverters and the battery/energy storage. Inverters are used to convert the variable DC output of solar PV panels into AC that can be fed into the national grid 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 for solar PV covered in this study is:

- **HS 8541.40** – PV module, wafer, cells.

1.3.7 Solar Thermal

The basic principle of a solar water heating (SWH) system is the absorption of solar radiation by a 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 purposes. SWH systems are gaining popularity in ASEAN, as concerns over environmental sustainability and energy use grow.

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 that contain a dark absorber plate located under a transparent cover. Flat-plate solar collectors contain an air gap between the absorber and the 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 solar collectors in many ways.

Evacuated heat pipe tube systems eliminate convection and heat losses. They are also less likely to fail because they allow regulation of the maximum working temperature, which flat-plate collectors do not provide. Evacuated heat pipe tube systems are also lighter and easier to install, and they require far less maintenance.[9] This study covers solar thermal systems, both flat plate and evacuated heat pipe tube, used to heat water intended for residential and/or commercial use, given the prevalence of the former and the practicality of the latter.

The six-digit HS code for solar thermal water heating considered in this study is:

- **HS 8419.90** – Solar flat plate collector and solar evacuated tube collector, including parts.

1.3.8 Lighting

This study focuses on two types of lighting products:

- Linear fluorescent lamps: They command a large market share in the ASEAN market. Several ASEAN countries (Malaysia, the Philippines, Thailand and Vietnam) have mandatory MEPS for this product. However, there are significant differences in the four countries' MEPS. Hence, the harmonization of MEPS would positively affect energy savings in the region, offering a unique departure point for further analysis.
- LED lamps: They have a small but fast-growing market share across the ASEAN region. Only two countries have existing MEPS, while three countries are considering/developing such MEPS. It is therefore expected that through modest policy intervention, significant gains in energy security and energy savings could be achieved for this product.

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

The specific six-digit HS codes for linear fluorescent and LED lamps are not available. Hence, the analysis of trade flow and tariffs is based on:

- **HS 9405.10** – Chandelier and other electric ceiling or all lighting fittings, excluding those used for lighting public open space or thoroughfares.

02

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

This section provides an overview of ASEAN policy and regulatory frameworks that directly and indirectly influence intra-ASEAN integration in EE and RE technologies. This chapter begins by discussing the standards for testing energy performance, as well as existing minimum energy performance standards (MEPS) and labelling schemes. Harmonization in these three fields will facilitate intra-ASEAN trade of EE and RE technologies. An overview of EE and RE policies and incentives is given in this chapter, and a summary of national and regional trade policies is also provided.

2.1 TESTING & ENERGY PERFORMANCE STANDARDS & LABELLING

This section comprises stocktaking on existing energy performance standards and labelling programs for selected EE and RE technologies in ASEAN countries. This analysis also highlights whether the energy performance standards are mandatory or voluntary in ASEAN countries and identifies 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 a whole, the adoption of national testing standards that refer to international standards, the adoption of similar minimum requirements on energy performance, and the implementation of 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 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 EE and RE technologies. Tables summarizing the detailed information of standards for energy performance testing methods, MEPS and labelling are provided in Appendix A.1.

Notably, MEPS are not relevant assessment indicators for solar PV and solar thermal, as these technologies generate energy rather than consume it.

2.1.1 Air Conditioners

Energy performance testing method: The six biggest economies (Indonesia, Malaysia, the Philippines, Singapore, Thailand and Vietnam) are aligned with ISO 5151. However, Singapore is the only country already aligned with the most updated version of ISO 5151, issued in 2010. Through ASEAN SHINE[10] all ASEAN countries have agreed to the gradual adoption of ISO 5151 2010 as the common testing standard by 2020.

[10] ASEAN SHINE is an activity funded by the EU-SWITCH program; it aims to increase the market share of more highly efficient air conditioners in ASEAN by harmonizing test methods and EE standards, adopting common MEPS, and changing consumer purchasing attitudes in favour of energy-efficient air conditioners.

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

The labelling programs in Malaysia, Singapore, Thailand and Vietnam all follow a five-stars/ticks rating system, while Indonesia has a four-stars rating system. In all these countries, 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 the adoption of a regional label is underway.

Appendix A.1 provides a summary of existing standard/testing methods and 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) or by 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 methods adopted in the 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 its national standard with IEC 62552. Thailand has national standards that differ from international standards. Because most of the big economies in ASEAN have applied IEC 62552, adoption of this standard in ASEAN countries as the standard for testing energy performance of refrigerators 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 and the Philippines, and the linear energy consumption estimation, based on adjusted capacity, used in Indonesia, Singapore, Thailand and Vietnam. The ASEAN Big Six countries (Indonesia, Malaysia, the Philippines, Singapore, Thailand and Vietnam) lead in the development and implementation of MEPS for residential refrigerators. However, MEPS for refrigerators are only mandatory in the Philippines, Singapore, Thailand and Vietnam, whereas in Indonesia the MEPS for refrigerators are still being drafted, with plans for implementation as a mandatory regulation.

The standards on 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 testing the energy performance of AC induction motors is the IEC 60034-2 (Rotating Electrical Machines Part 2: Methods for Determining Losses and Efficiency of Rotating Electrical Machinery from Tests). In ASEAN, national standards for the energy performance testing method for AC induction motors are found in Indonesia, Malaysia, Thailand and Vietnam, with these standards moving towards alignment with the IEC 60034-2 standard. A detailed gap analysis between IEC 60034-2 and

existing national standards would be useful to help prepare detailed roadmaps for harmonization in ASEAN.

MEPS and Labeling: The IEC 60034-30-1-2014 standard 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 to determine MEPS for AC induction motors.

Vietnam, Thailand, Malaysia and Indonesia have national regulations for MEPS for AC induction motors. Vietnam's reference level is IE1 on a mandatory basis. Thailand aims to implement MEPS on a voluntary basis, with embedded tax benefits for installation of motors with an efficiency class corresponding to IE3 for two, four, six and eight pole motors with an output range from 0.73kW – 185kW. However, at present Thailand's MEPS correspond to IE2 and are implemented on a voluntary basis. Malaysia's reference level is IE2, on a voluntary basis. Indonesia has recently adopted IE1 as the reference MEPS level on a mandatory basis. In other countries, MEPS for AC induction motors are still being discussed and are 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 on testing methods for measuring performance, labelling and MEPS for AC induction motors are provided in Appendix A.3.

2.1.4 Distribution Transformers

Energy Performance Testing Method: The international standard for testing the energy performance of distribution transformers is IEC 60076-1. It is applied mostly as a standard to comply with electric utility requirements in Malaysia, the Philippines, Singapore and Thailand. Indonesia's utility (PLN) has its own standard (S-PLN) for distribution transformers that is aligned with IEC 60076-1. However, only Vietnam has a mandatory national standard aligned with IEC-60076-1. This shows that the current application of IEC 60076-1 is primarily to meet the electric utilities' requirements, not to enforce measurement of energy performance at the national level.

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

The standards on 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: For linear fluorescent lighting, ASEAN countries diversely apply IEC 60969/1988[11] and IEC 60081, while for non-directional LED lighting Malaysia and Singapore apply IEC 62612/2013. In ASEAN, programs and measures regarding harmonization standards are quite advanced for compact fluorescent lamps (CFLs), but not for linear fluorescent lamps and non-directional LED lighting. Appendix A.5 provides a summary of current energy performance testing methods for linear fluorescent lamps and non-directional LED in ASEAN countries.

MEPS and labelling: Based on a study conducted under the ASEAN SHINE lighting program, with the support and guidance of the UN Environment en.lighten initiative (Coyne et al., 2016), linear fluorescent lamps and LED lamps are 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, the Philippines, Thailand and Vietnam (although there are variations on tube diameter, colour temperature, phosphor type and lumen output). This provides a significant opportunity, both for harmonization and to realise energy savings and 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 tend to have higher efficiency 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 efficiency 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 ASEAN Big Six countries concerning solar PV energy systems. Fifty-three of these standards are aligned with IEC standards. Most of the standards applied by ASEAN countries are for non-concentrating solar PV (Ansay, G., 2015). The situation with regard to the adoption of international standards varies greatly:

- Indonesia has 17 SNI/RSNI solar PV national standards, of which six are aligned with IEC standards.
- Malaysia has 22 MS IEC national solar PV standards, of which 20 are aligned with IEC standards. Most of these standards relate to guidelines for decentralized rural electrification (DRE).
- The Philippines has 14 national solar PV standards, all of which are aligned with IEC standards. Most of the standards are related to non-concentrating modules.

[11] 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).

- Singapore has ten national solar PV energy system standards aligned with IEC standards, most of which relate to non-concentrating modules.
- Thailand has three national standards, of which two are aligned with IEC standards.
- Vietnam has three TCVN national standards, only one of which is aligned with IEC standards.

Most solar PV standards currently applied in ASEAN are related to connecting the solar PV system to the grid, the Balance of System (BoS), and safety of installation. This situation may continue, 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 need for standards applying to the energy performance of modules/cells may become more important in the future, when solar PV is mass-produced in the region. However, at present, solar PV modules and cells 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 consume it.

2.1.7 Solar Thermal

At this stage, information regarding existing national standards for solar thermal is 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; in general, existing products follow the aforementioned ISO standards.

2.2 POLICIES/ REGULATORY FRAMEWORK TO PROMOTE RE AND EE

This section covers key trade and energy policies in the ASEAN countries. Policies are approached on a broad scale, i.e., they are not presented on a technology-by-technology basis. Energy policies play an important role in the development of markets (for example, by providing incentives), 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 Electricity Act of 1973 and the Electricity Act (Amendment) Order of 2002 govern the electric industry in Brunei. 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 moving to reduce the country's dependence on fossil fuels, the Government of Brunei is exploring ways to increase renewable energy usage and reduce carbon emissions. These efforts include investigation of the feasibility 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 development 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. However, there is no specific target for the RE share of the total energy mix, and there is 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 South 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 enhance capacity in Cambodia to enforce national standards for energy efficiency technologies. To avoid creating barriers to trade, these standards should be geared towards alignment with ASEAN and international standards.

2.2.3 Indonesia

An extensive legal framework, including policies to promote EE&C and RE, is already in place in Indonesia. Law No. 30/2007 concerning energy provides the overall umbrella for energy management and utilization of renewable energy resources and energy conservation.

To support the above priorities, there are specific regulations for promoting green investment in Indonesia, including:

- Direct incentives (development of feed-in tariffs for electricity generated from renewable resources, including solar PV power generation, and regulation by the government to provide incentives for energy conservation measures).
- 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 is not communicated transparently and widely, with the result that 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 EE standard or mandatory label exists in Lao PDR. The country also has no substantial manufacturing capacity for EE and RE equipment and relies on imports. 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

As a result of the development of energy-intensive industries beginning in 2000, energy demand has grown faster than GDP. Hence, there is a clear need to promote efficient uses of energy to ensure domestic energy security, requiring sound energy efficiency policies backed

by good strategies and implementable programs. To support these, the Malaysian Government has issued policies, including incentives, regarding the development of energy efficiency and renewable energy technologies. The following are key policies now in force:

- Efficient Management of Electrical Energy Regulation (2008).
- Feed-in tariffs under the Renewable Energy Act of 2011 (last updated in 2015), under the authority of the Ministry of Energy, Green Technology and Water.[12]
- Incentives to encourage the generation of renewable energy, under the Promotion of Investment Act 1986 (application extended in 2015), which includes an exemption from income tax (on 100% of statutory income for 10 years) and an investment tax allowance.
- Additional import duty and sales tax exemptions for renewable energy. Companies generating RE can also apply for import duty and sales tax exemptions on imported machinery, equipment, materials, spare parts and consumables used directly in the generation process, if those materials 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 budget, with the aim of promoting EE projects through the provision of investment tax allowances, accelerated capital allowances, import duty exemptions and sales tax exemptions for energy efficiency products.
- The Malaysian Government has set a target for renewable energy to account for 24% of the total national energy mix by 2050.

The incentives stated above will facilitate the market development of, 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. In this document, sectorial programs and activities have been recommended, including the development of local manufacturing 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 a 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 technologies.

[12] Feed-in tariffs notably apply to solar energy.

2.2.7 The Philippines

The Philippines has the highest electricity tariff among ASEAN countries. In parallel, imported oil and coal each represent more than 40% of the energy mix. In response to this, the Government of the Philippines has prioritized development of energy efficiency and renewable energy, and the country has put in place an extensive list of incentives for RE developers and business/ commercialization. These incentives include, among others, income tax holidays, tax and duty exemptions 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 in 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 to promote energy efficiency and conservation (EEC) and 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, 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 careers as energy managers, equipping them with a thorough understanding of the key energy issues in the building and industrial sectors. 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 technology, and to invest in energy-saving equipment, with the capital expenditure on the qualifying equipment being written off 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 directed not only at its industry and infrastructure but also towards the country's human resources, with an emphasis on increasing skills and awareness regarding energy efficiency.

2.2.9 Thailand

The basis for energy efficiency measures and deployment of renewable energy in Thailand is the Thailand Integrated Energy Blueprint, which is built upon three pillars: national energy security, economical use of energy and environmentally sustainable use of energy.

Thailand's Alternative Energy Development Plan (AEDP 2012-2021) sets 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, develop R&D in Thailand, and to increase the competitiveness of Thai technologies in the global market (DEDE, 2012).

To enhance the implementation of energy efficiency and conservation activities, the Government of Thailand also introduced financial incentives (Egkamol, 2013), such as:

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 projects to private companies (max 3 million Baht), and for EE equipment for government buildings.
- ESCO fund: Co-investing with private investors through benefit sharing for energy efficiency measures.
- Tax incentives in purchasing EE products and developing EE businesses.
- EE loans that encourage banks to offer loans for EE projects based on the success of revolving fund programs.

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

2.2.10 Vietnam

Vietnam has put in place comprehensive regulations and policies and established a national program on energy efficiency and energy savings. 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, dated 3 September 2003, which requires the Ministry of Industry and Trade (MOIT) to undertake energy efficiency and energy-conservation programs.

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

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

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 EE technologies, across ASEAN countries.[13] The savings potential assumes MEPS will be implemented in 2020 at a level equivalent to the best global MEPS currently implemented at present (2015).

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

No.	Country	Room Air Conditioners (GWh)		Refrigerators (GWh)		Motors (GWh)		Transformers (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	Lao PDR	28.8	59.9	5.3	11.8	24.7	68.4	31.5	61.7
4	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

2.4 TRADE POLICIES INFLUENCING INTRA-ASEAN INTEGRATION

This section provides a summary of selected trade policies that potentially influence intra-ASEAN integration in selected EE and RE technologies. It also provides an analysis of the impact of energy policies described in the previous section on 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 tariffs and MFN tariffs among ASEAN countries. Except in Brunei and Singapore, ASEAN countries' average MFN tariffs are higher than 5%. This means that ASEAN countries are still relatively protective of their economies in terms of imports, except for preferential trade zones, such as ATIGA, that apply preferential tariffs.

For most ASEAN countries, the gap between the overall bound tariff and average MFN tariff (binding overhang) is also quite large, which reflects a certain unpredictability of trade policies in most ASEAN nations.[14]

[13] U4E initiatives: www. United4efficiency.org

[14] 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

ASEAN Trade in Goods Agreement (ATIGA): This agreement aims to achieve a free flow of goods in the region, resulting in fewer trade barriers and deeper economic linkages among Member States, lower business costs, increased trade, a larger market, and economies of scale for businesses. Through ATIGA, Brunei, Indonesia, Malaysia, the Philippines, Singapore and Thailand have committed to eliminate intra-ASEAN import duties on 99.65% 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 to 5% on 98.86% of their tariff lines.

High average MFN rates in ASEAN member countries may not affect EE and RE technologies that are regionally produced and have existing trade-flows among ASEAN nations. However, they 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% tariff rates for all ASEAN countries.

Exhibit 2.2: Overall bound tariff, average MFN 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
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 10 minutes to a maximum of three days, and there is no restriction/prohibition seen for EE and RE technologies. Limitations on RE investments and local content requirements are only found in Indonesia, Malaysia and Myanmar. However, regional labelling is not yet in place; 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 and 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 customs declaration to customs clearance	Import restriction/ prohibition/ special permit for EE/RE	Limitation of foreign investment in EE/RE measures	Local content requirement for EE/RE products/ 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 government for certain RE products, 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
Myanmar	Yes	N/A	3 days	No restriction/prohibition but most goods need licence to enter Myanmar	Power generation projects 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 analysing the differences in value chain parts among countries. The market analysis of each technology across 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 analysed based on the six-digit HS code relevant to the technology. Identification of existing trade flow suggests that 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 should be noted: the environmental characteristics of EE products are not reflected in the six-digit HS code. For example, inverter and non-inverter air conditioners are classified under the same six-digit HS code (HS 8415.10). This condition limits the analysis of the trade flow information in this chapter 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 situation.

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 average tariff applied, are compared to see whether tariffs are still a barrier for each technology in intra-ASEAN integration. The most common non-tariff barriers found in ASEAN member countries are discussed, including how they would affect 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 the supply and demand side. In addition, the market situation of each technology in ASEAN is presented. The trade flow is also discussed to create a better understanding of the potential of each ASEAN member country with regard to production, manufacturing and assembly of the selected EE and RE technologies, as well as the potential export of products to other ASEAN member countries.[16]

3.1.1 Distribution Transformer

Value Chain

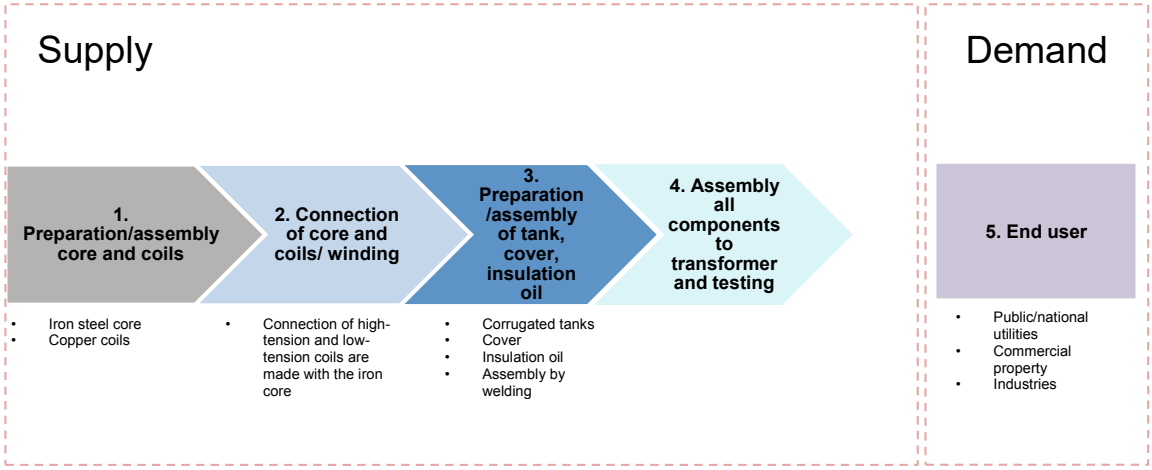
Exhibit 3.1 illustrates the simplified value chain of a distribution transformer (wet-type, also referred to as liquid type). On the supply side, the components are the iron steel core, the copper coils, the tank and the cover. Other transformer parts installed after the assembly of the core-coil, integrated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

[16] All trade flow information provided in exhibits in this chapter, including export data for all six-digit HS codes, is sourced from the International Trade Centre (ITC) website, www.trademap.org.

On the demand side, the major end users of wet-type distribution transformers in ASEAN are national/public utilities and power companies. Dry-type transformers being less flammable, the end users are limited mostly to those industries prone to fire hazards, and to large commercial properties.

The supply chain shown in Exhibit 3.1 illustrates the traditional manufacturing process of a distribution transformer. However, today manufacturers increasingly outsource the supply of transformer parts and sub-assemblies because it has become more cost effective, allowing transformer manufacturers to focus their skill set on design and assembly expertise.

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



Market in ASEAN

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

- The Philippines, Indonesia, Myanmar and Vietnam lack sturdy electricity grids (*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 rural electrification programs 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 increase electric demand through the construction of new shopping malls, offices, shops, hotels and data centres. Moreover, both residential and commercial infrastructure development in large and mid-sized cities in Indonesia, Vietnam and the Philippines is expected to increase the 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	Lao PDR	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)**[17]

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 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 wet-type (HS 8504.21 and HS 8504.22) distribution transformers in ASEAN countries. Thailand's export value for wet-type distribution transformers (both HS 8504.21 and HS 8504.22) ranks the highest in ASEAN, followed by Singapore. Major export destinations for Thailand's wet-type distribution transformers are ASEAN countries sharing boundaries with Thailand, such as Cambodia, Lao PDR, Malaysia and Myanmar. In addition, Singapore is also importing significant quantities of wet-type transformers from Thailand with a power-handling capacity of more than 650 KVA but not exceeding 10,000 kVA.

[17] The analysis is limited to wet-type transformers because of their prevalence compared to dry-type transformers in the power systems market in ASEAN.

- **Transformer parts**

Transformer parts, such as corrugated tanks, bushings, tap chargers, and high-tension and low-tension coils, are all classified under a six-digit HS code 8504.90 (definition: parts of electric transformers, static converters and inductors). Exhibit 3.5 illustrates the intra-ASEAN exports of transformer parts. 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, the Philippines, Singapore and Thailand.

Exhibit 3.3: : Export from transformer-producing countries in ASEAN to their ASEAN counterparts (HS 8504.21, liquid dielectric transformers having a power-handling capacity not exceeding 650 kVA)

HS 841821 Exporter	Importer (US$ Thousands)										Total export value among producers in ASEAN, US$ Thousands (2015)
	Brunei Darussalam	Cambodia	Indonesia	Lao PDR	Malaysia	Myanmar	Philippines	Singapore	Thailand	Vietnam	
Indonesia	30				259		47	317			653
Malaysia			72					473		8	553
Philippines											0
Singapore	200		1,182		461	1,296	342		72	3	3,556
Thailand	122	2,946	29	975	546	311	16			91	5,036
Vietnam			355		55		427	31	83		951

Exhibit 3.4: Export from transformer-producing countries in ASEAN to their ASEAN counterparts (HS 8504.22, 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	Lao PDR	Malaysia	Myanmar	Philippines	Singapore	Thailand	Vietnam	
Indonesia	106				246		1,011	1,054		3,926	6,343
Malaysia			2				1,366	685	197		2,250
Philippines											0
Singapore			1,163		1,230	174	347		235	1,431	4,580
Thailand	572	829	302	725	4,572	2,697	514	3,299		463	13,973
Vietnam			1,121		191		2,324	299	88		4,023

Exhibit 3.5: Export from transformer-part-exporting countries in ASEAN to their ASEAN counterparts (HS 8504.90, parts)

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	
Malaysia	43		8,420			18	419	13,223	4,121	863	27,107
Singapore	120	25	23,589	4	29,715	3,314	4,632		14,658	11,473	87,530
Philippines		73	49		792	3		1,085	4,902	75	6,979
Thailand	16	83	2,712	3,011	4,037	385	1,762	2,649		2,570	17,225

3.1.2 Room Air Conditioners (RACs)

Value Chain

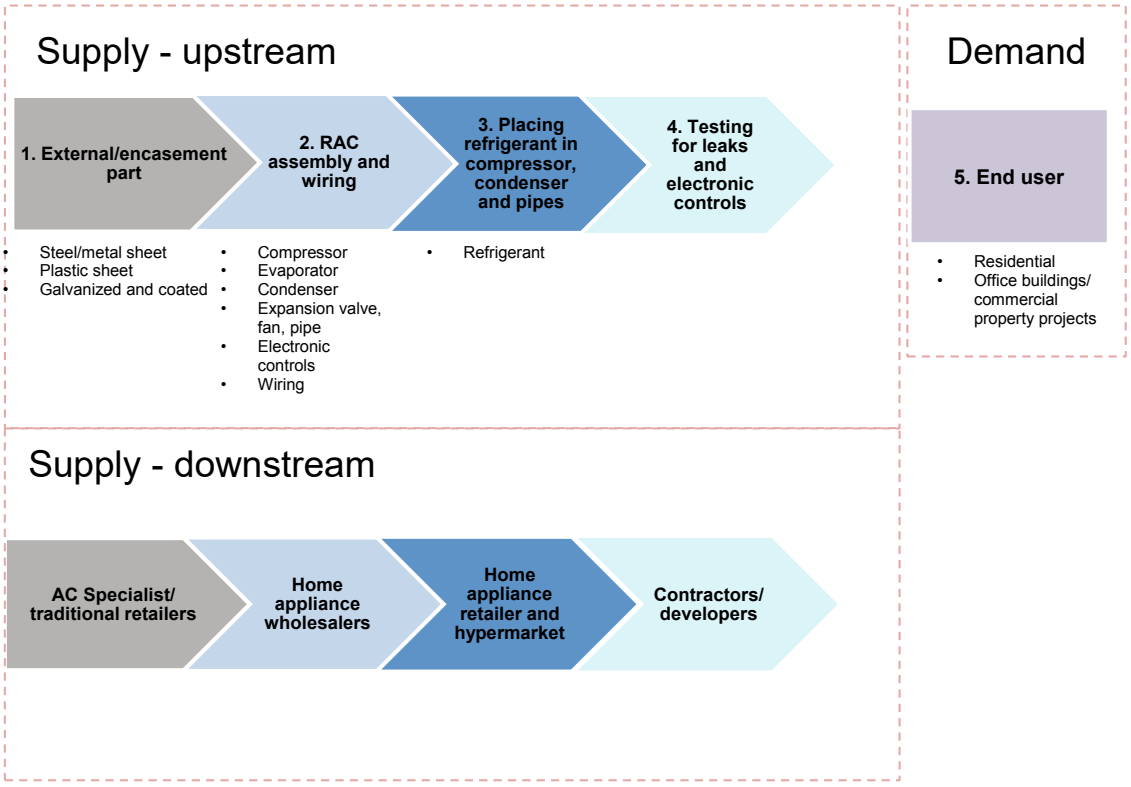
The simplified value chain of a RAC is given in Exhibit 3.6. On the supply side, the upstream section shows the manufacturing process.

Once the encasement parts are made, the RAC is ready for assembly. The compressor, evaporator, condenser and other supporting parts, such as pipes, expansion valves and fans, are then installed. Often these parts are pre-built. The evaporator and condenser are connected to the compressor via a copper wire. 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. Testing for refrigerant leaks and electronic controls is done at the end of the manufacturing process.

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

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

Exhibit 3.6: Simplified value chain of a room air conditioner



Market in ASEAN

The market value (is US$ million) for RACs in the ASEAN Big Six countries in 2012[18] is illustrated in Exhibit 3.7 (BSRIA, 2012). The window-type RACs only exist in quantity in the Philippines, while the multi-split type are only prevalent in Singapore.

In Singapore, the penetration of RACs with inverters is higher than the penetration of non-inverter RACs; electricity prices for residential users in Singapore are relatively high compared to other ASEAN countries. As a result, consumers are better positioned to choose more efficient technologies that reduce monthly electricity bills.

In Indonesia, Thailand, Malaysia and Vietnam, impulse buying for cheaper products, without considering the lower operating cost and energy consumption, means that non-inverter RACs still dominate the market. In certain cases, a higher installation cost for RACs with inverters and a lack of fully trained and willing installers also reduce the popularity of inverter RACs.

Enforcement of labelling and MEPS, in addition to the removal of electricity subsidies, would help to increase the growth of RACs with higher energy efficiency, including RACs with inverters.

[18] Data for ASEAN Big Six countries is officially available.

Exhibit 3.7: Market for RACs 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 the share of distribution channels in each country. In Indonesia and Thailand, RAC specialist/traditional retailers and home-appliance wholesalers have the highest market share in terms of distribution, while in Vietnam, the Philippines and Singapore, hypermarkets and home-appliance retailers have taken over the sales channels.

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

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

Distribution channels	Share of market volume distribution (% volume)					
	Indonesia	Thailand	Malaysia	Vietnam	Philippines	Singapore
AC specialist/ traditional retailers	65%	60%	30%	10%	25%	30%
Home-appliance wholesalers		0%	25%	30%	0%	0%
Home-appliance retailers/ hypermarkets	25%	15%	0%	40%	60%	40%
Others (contractors, developers)	10%	25%	35%	20%	15%	30%

The share of local production and imported RACs is given in Exhibit 3.9. The Philippines and Singapore import all RACs, while the Thai and Malaysian markets are still dominated by local products. The Indonesian and Vietnamese share of local products are still below 25% when compared to imports.

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 window, wall-type and self-contained RACs (HS 8415.10) in ASEAN countries. Thailand's export value for window and wall-type RACs ranks the highest in ASEAN. Amongst ASEAN countries, Vietnam has the most significant import value of RACs, specifically from Thailand and Malaysia.

The major export destinations of RAC products from Malaysia, the second biggest exporter in ASEAN, are Vietnam, Singapore and Thailand.

Exhibit 3.10: Export flow of RACs (HS 8541.40)

HS 841510 Exporter	Importer (US$ Thousands)										Total export value among producers in ASEAN, US$ Thousands (2015)
	Brunei Darussalam	Cambodia	Indonesia	Lao PDR	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	336,240
Philippines					9			136		9	154
Singapore	1,147	29,516	2,990	209	1,246	9,041	187		893	14,566	59,795
Thailand	1,112	13,490	165,029	13,587	60,005	7,618	29,687	138,766		257,472	686,766
Vietnam			52		8		12,602	3	2,556		15,221

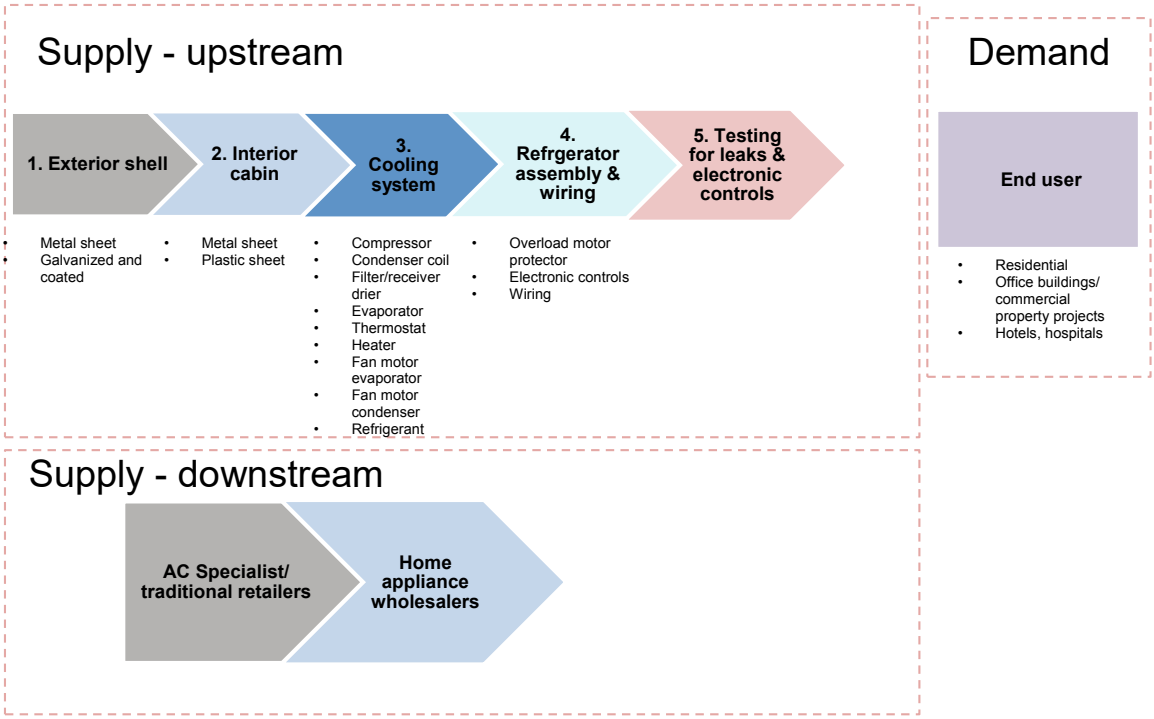
3.1.3 Refrigerators

Value Chain

Exhibit 3.11 illustrates the simplified refrigerator value chain. On the supply side, the upstream section shows the manufacturing process.

The downstream section of the supply side illustrates the distribution channel prior to utilization by the 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 B2B transactions for residential and commercial property projects, and for projects such as hotels and hospitals.

Exhibit 3.11: Simplified value chain of a refrigerator



Market in ASEAN

In ASEAN, production and manufacturing of household refrigerators takes place in Indonesia, Malaysia, the Philippines, Singapore, Thailand and Vietnam, yet most countries do not use local brands. According to the Asia Research Report (Kabe, 2012), the market for refrigerators in the main ASEAN countries (Indonesia, Malaysia, the 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 five 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

A local brand in the Philippines has a substantial market share of about 25%.[19] However, this situation appears to be the exception in the ASEAN region.

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

Thailand has become a hub for refrigerator manufacturing by foreign brands in the ASEAN region. It was estimated that of all Japanese brands manufactured in ASEAN, 80% are manufactured in Thailand (Kabe, 2012). Similarly, of all Korean brands manufactured in ASEAN, 40% are manufactured in Thailand. Japanese, South Korean, Chinese and European brands are competing to increase production of various household appliances, including refrigerators, through the establishment of local manufacturing facilities in Thailand.

This situation is evolving rapidly as Vietnam's labour cost is becoming cheaper than Thailand's. This has started to attract foreign investors looking for an alternative location to establish manufacturing facilities. It is therefore likely that Vietnam will increasingly appear as a competitor for Thailand and other ASEAN countries as a refrigerator-manufacturing base.

Flow of trade in ASEAN

Exhibits 3.13 and 3.14 show the export flow of household refrigerators, compression-type and others (HS 8418.21 and HS 8418.29) in ASEAN countries. Thailand dominated the export of household refrigerators in ASEAN, especially for HS 8418.21, at about 88% of total ASEAN exports. Thailand exports household refrigerators to all ASEAN countries, but mostly to Vietnam, Malaysia and the Philippines.

For HS 8418.29, Thailand's export value is also the highest in ASEAN, being the major export destination for Myanmar and Lao PDR.

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

Exhibit 3.13: Export from refrigerator-producing countries in ASEAN to their ASEAN counterparts (HS 8418.21, household refrigerators, compression-type and others)

HS 841821 Exporter	Importer (US$ Thousands)										Total export value among producers in ASEAN, US$ Thousands (2015)
	Brunei Darussalam	Cambodia	Indonesia	Lao PDR	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											0
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-producing countries in ASEAN to their ASEAN counterparts (HS 8418.29, household refrigerators, other types)

HS 841829 Exporter	Importer (US$ Thousands)										Total export value among producers in ASEAN, US$ Thousands (2015)
	Brunei Darussalam	Cambodia	Indonesia	Lao PDR	Malaysia	Myanmar	Philippines	Singapore	Thailand	Vietnam	
Indonesia					1	655	621	1	73	33	1,384
Malaysia	6							23	34	1,156	1,219
Philippines											0
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

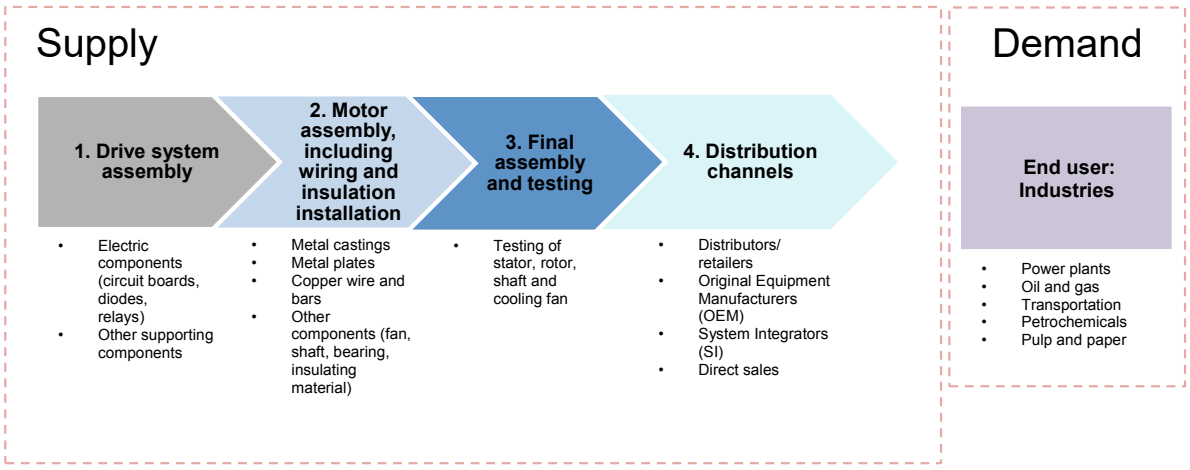
3.1.4 Electric Motors

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 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., the 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: distributors/retailers, original equipment manufacturers (OEMs), system integrators (SIs) and direct sales. As illustrated by exhibit 3.15, the main end users include the power generation industry, the oil and gas industry, the transportation industry, the chemical and petrochemical industry, and the pulp and paper industry. To a lesser extent, the food and beverage industry, and the water and wastewater industry are other notable end users of electric motors.

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). The market size is significant in Indonesia and Thailand and is expected to continue increasing as a result of the sustained 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$ Millions) 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), as well as in 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 of the aforementioned sectors.

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)	Machinery in ship-building, automotive and other transportation sectors	19%
Heating, ventilation and air conditioning (HVAC)	Fans and pumps in climate-control operations of residential and commercial buildings	17%
Oil and gas	Fans and pumps in upstream and downstream and machinery 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%

Industrial sectors	Application in the sectors	Share of low-voltage electric motor market (2010)
Water and wastewater	Pumps in municipal water supply/distribution, municipal wastewater treatment, industrial wastewater treatment, desalination, sewage treatment	13%
Chemicals and petrochemicals	Machinery and pumps in agrochemicals, pharmaceuticals, polymers, paints and oleo chemicals	12%
Food and beverage	Various food and beverage machinery. Filling, mixing, grinding and bottling	11%

The following are key drivers of low-voltage electric motors in ASEAN countries and are related to the characteristics of each country's industrial growth (Frost and Sullivan, 2012):

- The key driver of low-voltage motor growth in Indonesia is the 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, due largely to the oil and gas and power sectors, which continue to spur the market for motors. Meanwhile, Indonesia's food and beverage and packaging industries seem to grow in tandem.
- In Malaysia, there is rapid growth in the market for low-voltage motors in the oil and gas industry, owing to well-developed infrastructure and an abundance of this resource. The presence of foreign direct investment in the petrochemical and chemical sector also boosts the low-voltage motor market in this country. A major contributing factor is the business-friendly environment, which is provided and supported by the government. 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 motors in the Philippines. Steady growth of the market for low-voltage motors is seen in the food and beverage sector, in the chemical industry, and in 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 motor demand from the HVAC, oil and gas, and water and wastewater sectors.
- Singapore's low-voltage motor demand arises from three industrial sectors: power, water and wastewater, and chemicals. Most of the major market participants have distributors in the country. Compared to other ASEAN countries, customers in Singapore tend to be more willing to adopt EE 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 motor market demand. Since Vietnam joined the WTO in 2007, there has been steady growth in all end user industries, aided by a favourable investment

environment and conditions provided by the government for foreign manufacturers. Hence, motor manufacturers are looking to shift their production base to Vietnam because of its competitive advantages, such as low wages and a relatively strong base of skilled workers.

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

Distribution channels: In ASEAN, retailers/distributors account for 55% of the total market distribution channel for low-voltage motors. The OEMs follow with about 18% market share. About 12% of the market is channelled through SIs. Engineering procurement construction contributes to both OEMs and SIs in turnkey projects and greenfield investments. Direct sales, which constitute about 15% of the total market, is a less preferred mode of procurement because the major motor manufacturers are international brands that typically operate through large distributor networks. The proportion of direct sales is likely to be caused by 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. Exhibits 3.18 and 3.19 illustrate export flows of electric motors (HS 8501.52) in ASEAN and show that, for these products, Singapore's export value is highest. The majority of electric motor products (HS 8501.52) 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 8501.53 electric motors (AC motors, multi-phase, of an output exceeding 750 W) shows a pattern similar to HS 8501.52 for Singapore. Hence, we could observe that Singapore's export values are the highest, most likely due to its positioning as a hub for ASEAN trade, with very low or no import tariffs and efficient custom and trade procedures.

Exhibit 3.18: : Export from electric-motor-producing countries in ASEAN to their ASEAN counterparts (HS 8501.52, 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	Lao PDR	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 8501.53, AC motors, multi-phase, of an output exceeding 75 kW)

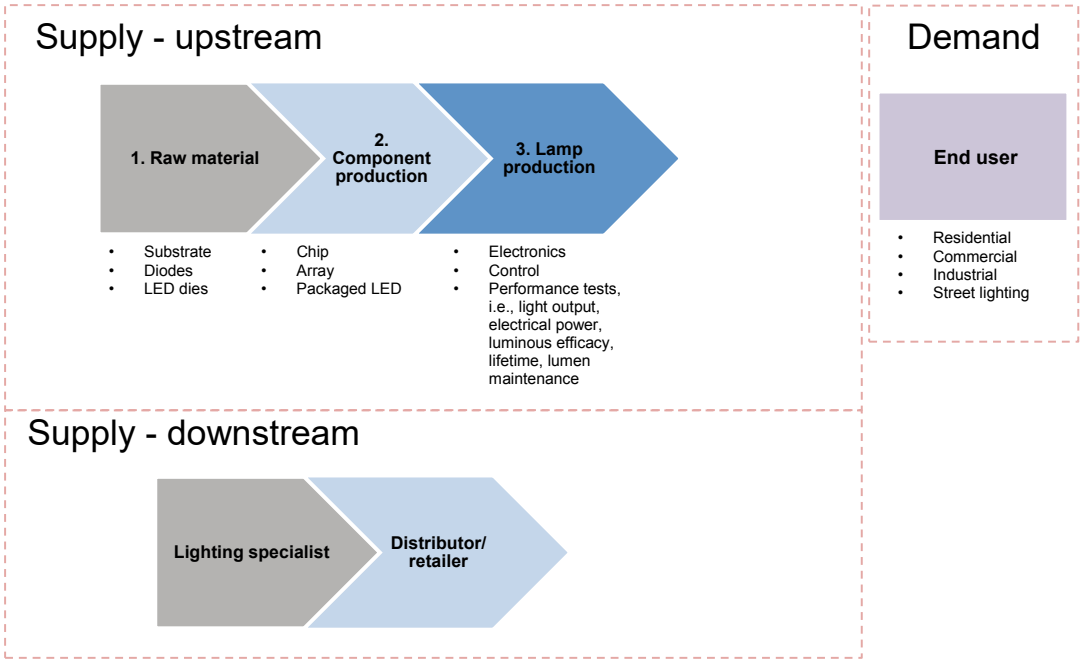
HS 850153 Exporter	Importer (US$ Thousands)										Total export value among producers in ASEAN, US$ Thousands (2015)
	Brunei Darussalam	Cambodia	Indonesia	Lao PDR	Malaysia	Myanmar	Philippines	Singapore	Thailand	Vietnam	
Indonesia								475			475
Malaysia	31		96				8	178	33	214	560
Philippines			190		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

A simplified view of the LED value chain is provided in Exhibit 3.20. On the upstream supply side, the process consists of preparation of raw materials, followed by component production and lamp production. One of the raw materials of LED is diodes, which are 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) and gallium arsenide phosphide (GaAsP), and different impurities and result in different colours of light being emitted by the LED. The main process of making LEDs involves cutting the wafers into 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 for LED lighting

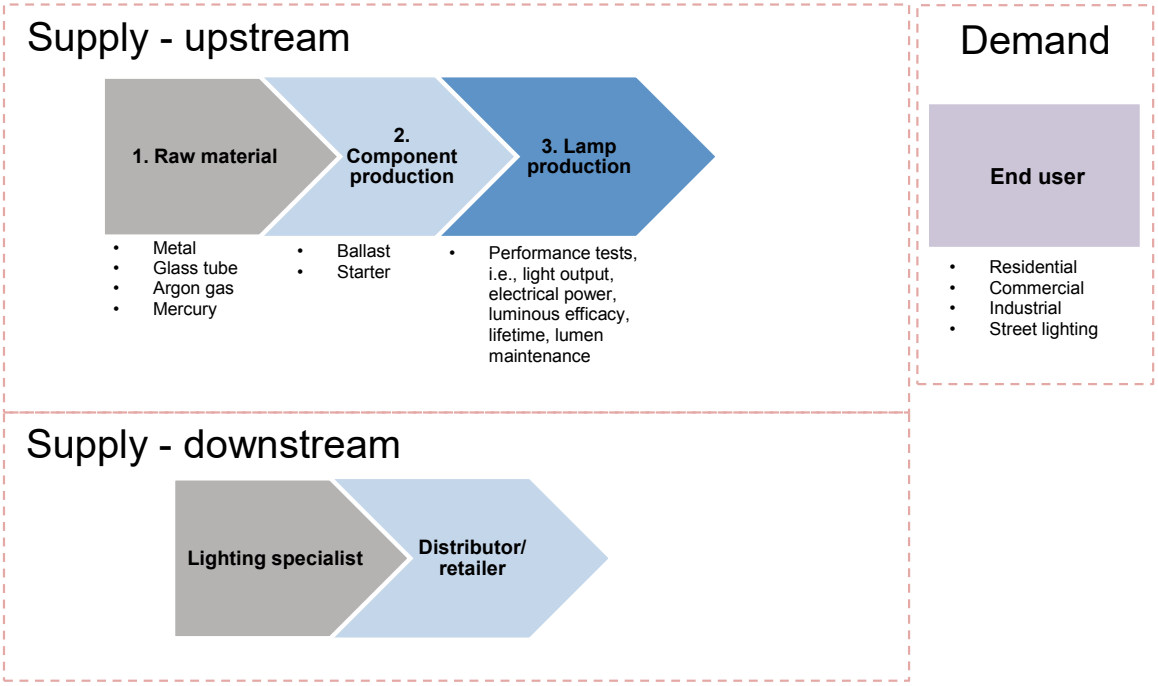


To complete the device, it is necessary to bring electricity, thus, wires must be attached to the substrate. These wires must stick to the semiconductor well and be strong enough to withstand subsequent processing, such as soldering and heating. LEDs are encased in transparent plastic. The wires and 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.

A simplified view of the value chain of a linear fluorescent lamp is provided 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 the phosphors that coat the inside of the lamp, giving off visible light.

Before the lighting product is sent to the market, several performance tests are run to ensure that the product will work properly. Performance tests are normally run on light output, electrical power required to operate the lamp, and luminous efficiency. Performance tests usually involve “lifetime”, which is the total time a lamp can operate 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 for linear fluorescent lighting



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

The end users of lighting can be divided into four groups: namely, the residential sector, industrial customers, the commercial sector (hotels, malls and hospitals), and specific users for streetlights.

Market in ASEAN

Exhibit 3.22 shows the total annual sales of lamps, and the fraction corresponding to linear fluorescent and LED lamps in ASEAN countries (Coyne, S. et al., 2016). Linear fluorescent lights are still more common than LEDs. Although LED is a more energy-efficient technology, it has just recently entered the market, and its price is still higher than for linear fluorescent lamps. However, the market share of LED is expected to gradually increase over the next few years.

Exhibit 3.22: Annual sales of lamps for all ASEAN member states (UN Environment, 2016)

Country	Annual Sales (Mio)	Annual Sales (%)	
	All lighting types	Linear Fluorescent	LED
Brunei Darussalam	NA	NA	NA
Cambodia	75	50	NA
Indonesia	100	NA	NA
Lao PDR	2	65	1
Malaysia	50	33	NA
Myanmar	31	NA	NA
Philippines	113	23	NA
Singapore	25	50	NA
Thailand	97	46	10
Vietnam	150	NA	NA

Flow of trade in ASEAN

Trade data for lighting appliances does not specify the HS codes for different types of lighting, such as linear fluorescent or LED. Therefore, in the present analysis, both HS 9405.10 (chandelier and other electric ceiling or all lighting fittings, excluding those of a kind used for lighting public open space or thoroughfares) and HS 9405.40 (electric lamps and lighting fittings) are considered. These HS codes are assumed to cover all types of lighting appliances, including linear fluorescent and LED.

Exhibit 3.23 shows the exports from lighting-producing countries in ASEAN to their ASEAN counterparts for HS 9405.10. Malaysia dominates the export to ASEAN countries, followed by Thailand. Most of these products (about 70%) are exported to Singapore. The majority of products from Thailand are exported to Myanmar. For lighting products under HS 9405.40, seen in Exhibit 3.24, Singapore's export value ranks first amongst ASEAN countries, with its products mostly exported to Indonesia and Malaysia. Singapore's total exports account for 66% of the total export value in ASEAN.

Exhibit 3.23: Export from lighting-producing countries in ASEAN to their ASEAN counterparts (HS 9405.10, 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	Lao PDR	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-producing countries in ASEAN to their ASEAN counterparts (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	Lao PDR	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 systems is presented in Exhibit 3.25. The manufacturing process starts with the making of ingots and wafers. Poly-silicon, which is made of metallurgical-grade silicon, is melted into poly-crystalline silicon ingots. These ingots are then sliced into wafers. These wafers are etched and cleaned, and they 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 they can collect electrons for electricity. Once the coating is done, the PV cells are sorted and checked for quality.

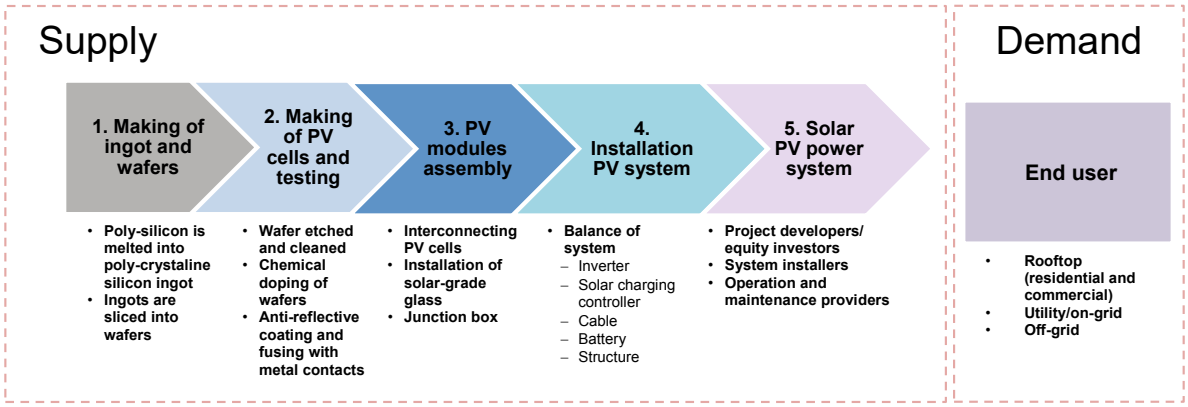
PV modules are assembled from PV cells. At this stage, the solar cells are laid out on a back sheet and interconnected. Solar-grade glass, which constitutes the bulk of the module's mass, is added atop the cells and back sheet. A junction box is added, allowing for electricity interconnections. If the 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 applications (on-grid connections), solar PV rooftop arrays in residential or commercial properties, and off-grid applications, often in remote areas where grid extension does not exist or cannot be built economically.

For the supply of solar PV cells/modules and components, the following are brief observations made in the ASEAN Big Six countries:

- Although some local companies claim to produce solar PV modules in Indonesia, they are actually importing the PV cells, and local activities are limited to the encapsulation and framing of the modules. Most of the BoS components, such as the inverter, structure and battery, 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 companies are owned by foreign investors, one from Korea and the other from Japan. Manufacturers of solar PV cells are available locally (about eight companies), and a few of them have 100% local ownership. "Local" production of BoS mostly originates from companies with foreign direct investment.
- In Thailand, both local and foreign players are present in the market for solar PV modules/cells and BoS. However, there is no local production of metallurgical-grade silicon.
- Local manufacturers of solar PV modules, cells and wafers are found in the Philippines and Singapore. Locally available BoS are imported.
- In Vietnam, PV companies are mostly importing PV cells and assembling modules. Most of the BoS components, such as the inverter, structure and battery, are imported.

The key actors in solar PV power system development are project developers and equity investors, system installers, and service providers for operation and maintenance. These actors play a "distribution channel" role in driving solar PV market growth in ASEAN.

Exhibit 3.25: Simplified solar PV value chain



Market in ASEAN

No updated and detailed information was found on the value of production of solar PV modules. In addition, as solar PV modules are integrated into solar PV systems, the development of this industry can be appreciated through the actual implementation of solar PV systems. In turn, the study uses installed capacity (kW) to assess the solar PV market. Compared to its potential, the installed capacity of solar PV generation in ASEAN countries is limited (see Exhibit 3.26). Higher growth in this market will require 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*	REVE - Wind Energy and Electrical Vehicle Magazine, 2015 (http://www.evwind.es/2015/07/21/cambodia-has-big-renewable energy-potential/53444)
3	Lao PDR	1	ADB, 2012
4	Malaysia	166.1	SEDA, 2015
5	Myanmar	N/A	N/A

No.	Country	Installed capacity (MW), 2014	Source
6	Indonesia	61.6*	Abdul Rosyid, 2015
7	Philippines	219.2	PV Magazine, 2016.(http://www.pv-magazine.com/news/details/beitrag/conergy-completes-201-mw-of-solar-pv-in-the-philippines_100023945/#axzz4AI2L7cjQ)
8	Singapore	26.5*	Energy Market Authority, 2017. (http://www.ema.gov.sg/statistic.aspx?sta_sid=20140730tzT7HYFaefda)
9	Thailand	945	Energy Market Authority, 2017 (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

Exhibit 3.27 describes the trade flows for solar PV (HS 8541.40) in ASEAN. This table shows that Malaysia accounts for more than 60% of the total export value of the ASEAN Big Six member states. The majority of solar PV (HS 8541.40) from Malaysia is exported to Singapore and Thailand. Thailand is also the main recipient of Singapore's exports.

Exhibit 3.27: Export from solar PV-producing countries in ASEAN to their ASEAN counterparts (HS 8541.40, photosensitive semiconductor devices, including photovoltaic cells whether or not assembled in modules or made up into panels; light-emitting diodes)

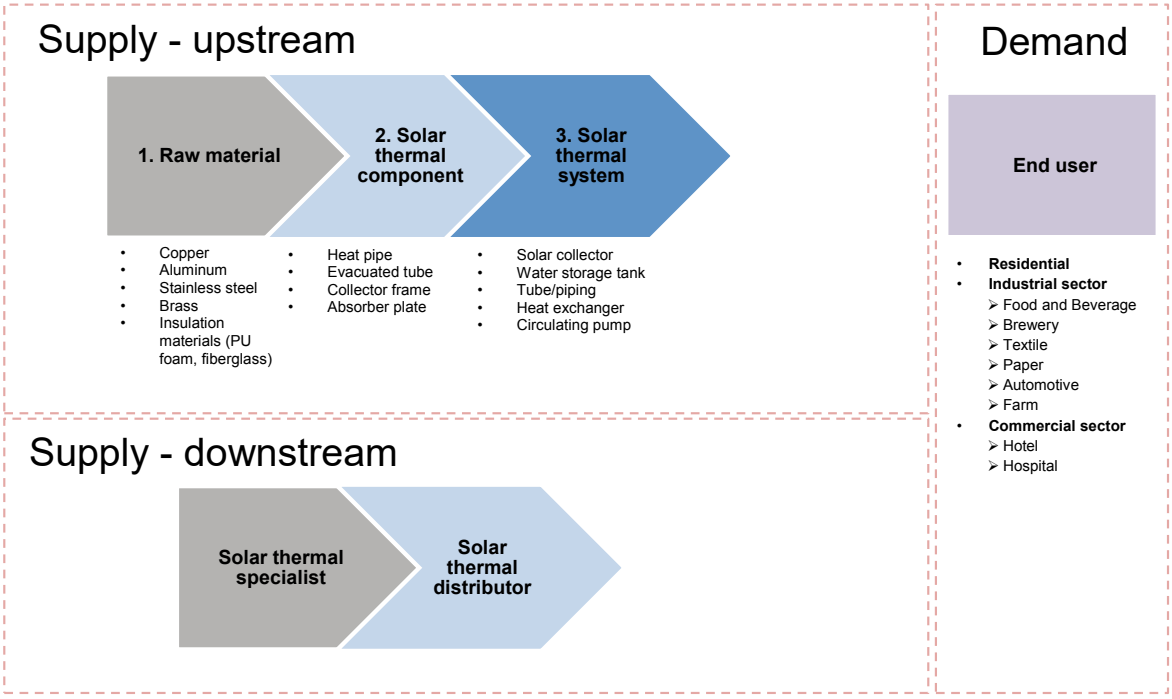
HS 854140 Exporter	Importer (US$ Thousands)										Total export value among producers in ASEAN, US$ Thousands (2015)
	Brunei Darussalam	Cambodia	Indonesia	Lao PDR	Malaysia	Myanmar	Philippines	Singapore	Thailand	Vietnam	
Indonesia					102		5,741	21,465	1,547		28,855
Malaysia	2	11	501	54			79,102	154,062	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 needed to manufacture solar thermal system components include essential metals such as copper, aluminum, stainless steel and brass, and also insulation materials, such as polyurethane foam (PU foam) and fiberglass.

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 the heat pipe, evacuated tube, collector frame and absorber plate. In some cases suppliers provide pre-made 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 users. In general, a solar thermal specialist provides extensive services, which include design, implementation and maintenance. Solar thermal distributors often have their own solar thermal specialists to assist project owners with effective installation.

The end users of solar thermal systems can be divided into three categories: the residential sector; industrial customers, such as food and beverage companies, breweries, textile companies, paper industries, and 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 the Philippines, Vietnam and Thailand. There is little information available regarding the market and distribution channels of solar thermal systems in other ASEAN countries.

In the Philippines, the application of solar thermal appliances is specific to solar water heating (SWH). Typical end users include high-income residential consumers, hotels, hospitals and the tourism industry (IIEC, 2011). By 2001, more than 433 solar water heaters had been installed, particularly in resorts, sport 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 water heating systems usually ranges from 200 to 400 litres (prefabricated systems) for residential customers; these residential customers represent 75% of the 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 market share. In Ho Chi Minh City, the annual growth rate of SWH installations has been 40 to 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 in terms of SWH installations. Solar collectors 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. In 2012, 43% of the market was met through local production, while 57% was sourced from imports (Ipsos Business Consulting, 2013). SWHs are mostly installed in the residential sector via two sources: households either 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 sell flat-plate solar collectors. These are typically inefficient, but evacuated tube collectors are more fragile and require more maintenance after installation. By 2012, Thailand had a total of 20,815 m2 of solar collectors in operation. The market has experienced substantial annual growth, with an expansion rate of 17.4%, mainly as a result of the Thai Government's solar thermal subsidy program, which provided 30% financial support to project owners who used the technology over the 2008-2012 period (Ipsos Business Consulting, 2013).

Flow of trade in ASEAN

The trade flow of solar thermal (HS 8419.90) in ASEAN is shown in Exhibit 3.29. Singapore has the highest exports, followed by Malaysia. Thailand is another major exporter within the ASEAN region, but, interestingly, Thailand's total exports represent only 30% of Singapore's exports to other ASEAN countries. This suggests that there are significant imports of solar thermal products from outside ASEAN, which are then re-exported to other ASEAN countries from Singapore. This country appears to serve as a trading hub.

Exhibit 3.29: Export from solar-thermal-producing countries in ASEAN to their ASEAN counterparts (HS 8419.90, solar flat plate collector and 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	Lao PDR	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

Differences in tariff regimes can restrict market access, representing a barrier to trade and inhibiting the deployment of EE and RE technologies in ASEAN countries. However, tariffs are not the only issue to consider from the perspective of market transformation. The following section discusses the relevance of both tariff and non-tariff barriers.

3.2.1 Tariff Barriers

The analysis of tariff barriers provided in this section is based on the six-digit HS codes for selected EE and RE technologies, on the MFN tariff, and on the preferential tariff. The preferential tariffs, i.e., the tariffs actually applied by ASEAN countries, are identified based on the ITC Trade Map[20] and compared with the MFN tariff for each technology.

A. Transformers

- **Six-digit HS code(s) covered:** HS8504.21, HS8504.22, HS8504.33, HS 8504.90.
- **MFN tariff:** In Cambodia, Indonesia, the Philippines and Vietnam, MFN tariffs are higher than 5%.
- **Preferential tariff:** There are no records in the ATIGA preferential tariff schedule. However, the 2015 ITC Trade Map indicates that Cambodia and the Philippines apply regional tariffs. Cambodia applies a tariff of 2% to 5%, while the Philippines applies a tariff of 1.7% to 5%.

B. Room air conditioners

- **Six-digit HS code(s) covered:** HS 8415.10.
- **MFN tariff:** Malaysia and Thailand apply the highest ASEAN MFN tariff at 30%, followed by Vietnam at 25%. Indonesia, the Philippines, Cambodia and Lao PDR also apply relatively high MFN tariffs, ranging from 10% to 20%. In contrast,

[20] www.trademap.org

Singapore applies a 0% MFN tariff, and Myanmar and Brunei Darussalam only apply 1% and 5% tariffs, respectively.

- **Preferential tariff:** The Philippines and Vietnam both apply a preferential tariff of 5%, despite an agreed 0% rate under ATIGA.

C. *Refrigerators*

- **Six-digit HS code(s) covered:** HS 8418.21, HS 8418.29.
- **MFN tariff:** Malaysia, Thailand and Vietnam still apply relatively high MFN tariffs, ranging from 25% to a maximum of 35%. Brunei Darussalam and Singapore apply tariffs of only 5% and 0%, respectively. Indonesia, Lao PDR, Myanmar and the Philippines all apply a 10% MFN tariff, and Cambodia a 15% MFN tariff.
- **Preferential tariff:** Cambodia, the Philippines and Vietnam still apply a 5% tariff for refrigerators.

D. *Electric motors*

- **Six-digit HS code(s) covered:** HS 8501.51, HS 8501.52, HS 8501.53.
- **MFN tariff:** Malaysia, MFN tariffs are applied diversely for the different HS codes, but the general situation is that, with the exception of Singapore, these tariffs are higher than 5%.
    - *HS 8501.51*: Vietnam, Indonesia, Thailand and Cambodia apply relatively high MFN tariffs (between 9% and 15%). Both Brunei Darussalam and Lao PDR apply an MFN tariff of 5%, and Myanmar and the Philippines apply a 1% tariff. Malaysia and Singapore have reached zero tariffs.
    - *HS 8501.52*: All ASEAN countries apply similar MFN tariffs to the tariffs applied for HS 8501.51, except Malaysia (tariff of 15%) and Vietnam (tariff of 4.3%).
    - *HS 8501.53*: Indonesia and Cambodia apply relatively high MFN tariffs (10% and 15%, respectively), while Malaysia, Singapore and Vietnam apply 0%. Myanmar, the Philippines and Thailand apply a 1% MFN tariff, and Brunei Darussalam and Lao, 15%.
- **Preferential tariff:** Cambodia applies a 5% tariff for all motors. Vietnam applies a 4% tariff for HS 8501.51 only, and Myanmar a 1% tariff for HS 8501.53.

E. *Lighting*

- **Six-digit HS code(s) covered:** HS 940510, HS 940540.
- **MFN tariff:**
    - *HS 9405.10:* Most ASEAN member states apply 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%, respectively).
    - *HS 9405.40:* Half of ASEAN member states still apply tariffs above 5%, while Singapore, Myanmar and the Philippines apply relatively low tariffs of 0%, 1% and 4%, respectively.
    - Brunei Darussalam and Lao PDR apply a 5% MFN tariff for both types of lighting products.
- **Preferential tariff:** Tariffs remain, notably in Cambodia and the Philippines, where they range from 3.1% to 5%.

F. Solar PV

- **Six-digit HS code(s) covered:** HS 8541.40.
- **MFN tariff:** With the exception of Myanmar (7.5%), Cambodia (7%) and Lao PDR (5%), ASEAN member states apply low MFN tariffs (less than 1%) for solar PV.
- **Preferential tariff:** Cambodia applies a tariff of 1% to other ASEAN countries.

G. Solar thermal

- **Six-digit HS code(s) covered:** HS 841990.
- **MFN tariff:** The tariff is usually less than 5%. However, Lao PDR, Malaysia and Cambodia still apply relatively high MFN tariffs (10%, 13.8% and 15%, respectively).
- **Preferential tariff:** Cambodia still applies a 1% tariff to other ASEAN member states.

Key findings on tariff barrier analysis:

The previous section compared MFN tariffs (applied by ASEAN countries to their non-ASEAN trade partners) and preferential tariffs (the ones actually applied among ASEAN countries). The analysis reveals 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, the MFN tariffs are usually higher than the preferential tariffs. This results in protecting domestic and regional ASEAN markets. It can also contribute to intra-ASEAN trade and, thus, intra-ASEAN value chain cooperation for these products.

Air conditioners and refrigerators with higher EE could take advantage of this trade environment, provided that it is possible to manufacture the EE technologies in ASEAN member countries. RACs and refrigerators are already manufactured in the ASEAN Big Six countries. Hence, the potential for technology transfer of EE could be realized, notably by bringing in international experts to build the capacity of the local manufacturing supply chain.

As described before, ASEAN countries mostly import electric motors. Because Singapore has both 0% MFN tariffs and preferential tariffs for this equipment, there is an opportunity for this country to serve as a trading hub to support the deployment of higher-efficiency motors at reduced cost.
Despite the commitment to apply zero tariffs under the ATIGA, several countries continue to impose low tariffs. Hence, ASEAN countries may need to work further on enforcing ATIGA.

3.2.2 Non-tariff Barriers

The study found that the protection of national industries through local content requirements and limitations on foreign direct investment still takes place in a few ASEAN countries where there are no tariff barriers. For example, this scenario occurs in Indonesia's solar PV sector. Such requirements and limitations impede access to low-cost, legitimate products in these countries, despite the low tariff under ATIGA and efficient custom processes.

There are also limitations on investment in RE technologies in Indonesia, Malaysia and Myanmar. Because ownership restrictions of RE power generation apply to foreign investors,

the amount of financing available for these technologies is restricted to a smaller pool of capable local investors. This condition creates a barrier for market growth that will indirectly influence the growth of intra-ASEAN integration in RE technologies. In addition, despite the official ASEAN regional cooperation on Rules of Origin and Mutual Recognition Agreement on Safety Standards, there is no identifiable effort underway to promote regional labelling that would facilitate recognition of EE products based on their EE performance. Non-tariff barriers and their implications are further discussed in Chapter 4.

04

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

This chapter provides a high-level analysis of the impact of existing EE and RE trade policies and regulatory frameworks introduced in Chapter 2, offering 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 for EE and RE equipment and identifies the market and trade barriers that exist in various value chains, based on the value chain assessments carried out in Chapter 3.

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

4.1.1 Energy performance standards, MEPS and labelling

The markets for RACs, refrigerators and lighting cover a wide range of applications and end users. These products can usually be used indistinctively in the residential, commercial and/or business sectors. These products are mostly sold in the retail market and require little design customization to meet end users' needs. Setting up standards for these products is thus easier than for those products with more tailored specifications and narrower targeted markets, such as electric motors and distribution transformers.

As a result, the study identifies more countries putting in place national standards and/or adopting international standards for energy performance for RACs, refrigerators and lighting, as opposed to standards for distribution transformers and AC induction electric motors. Setting up standards for widely produced products is simply easier. In turn, some "low-hanging fruit" are identified for immediate action – for example, by replacing conventional RACs, refrigerators and lighting with more energy-efficient ones in the ASEAN region.

Indonesia, Malaysia, the Philippines, Singapore, Thailand and Vietnam clearly lead the way in setting up national standards for testing energy performance and in adapting their national standards to international standards. These countries' work has been particularly fruitful for RACs, refrigerators and lighting. In parallel, these countries have also made significant effort to adopt MEPS and labelling, demonstrating their awareness of, and commitment to, market transformation. So far, however, ASEAN countries have been able to move their individual commitments to collective ones only for RACs, through the adoption of a regional roadmap supporting the deployment of energy-efficient air conditioners. For other technologies, the study found that:

- MEPS and labelling requirements vary considerably across the region.
- There is a lack of enforcement of MEPS (for electric motors, lighting, refrigerators and distribution transformers), even for countries that have developed and implemented their MEPS.
- Labelling is still at a preliminary stage in most countries.

This lack of regional integration of the standards, MEPS and labelling processes hinders development of a mutually recognized regional framework, thus creating significant non-tariff barriers to intra-ASEAN trade. It should be noted, however, that all the issues mentioned above were also faced by the ASEAN SHINE program for air conditioners. The harmonization path followed for RACs could therefore serve as a reference to extend the market transformation to other EE technologies.

In regard to solar PV in ASEAN, no national standards have been issued, nor international standards adopted, on energy performance testing methods for solar PV cells and modules. The standards that have been 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 ratings for modules/cells may, however, become important when solar PV modules/cells are produced at scale in the region.

4.1.2 Policies/Regulatory Framework to Promote EE and RE

Exhibit 4.1 summarizes the status of key EE and RE policies and regulatory frameworks and of incentives for EE and RE technologies across the region. Malaysia, Indonesia, the Philippines, Singapore, Thailand and Vietnam all have EE policies and a regulatory framework, including MEPS and labelling, although the level of detail and enforcement vary. Fiscal incentives, such as tax exemptions for importing EE/RE products, exist in Indonesia, Singapore, the Philippines and Thailand.

These regulations and incentives facilitate the market growth of EE and RE technologies, giving indirect support to intra-ASEAN trade 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 market development will always depend on how the electricity market is regulated, and in the ASEAN region the electricity market is heavily policy-regulatory driven.

The enforcement of regulations and implementation of incentives, however, is not enough. Importers of RE products still face difficulties with customs clearing, despite existing incentives and tax facilities for “environmentally friendly” or sustainable products. For example, in Indonesia, RE project developers often spend considerable time in customs clearance because of the failure of the system to recognize the environmental characteristics of the products, despite existing regulations on customs tax exemptions for RE technologies. Establishment of a regional labelling system for EE/RE technologies would thus facilitate market access, notably through trade in these technologies.

Exhibit 4.1 Summary of existing status of key EE and RE policies and regulatory frameworks and incentives for EE and RE technologies in ASEAN countries

Country	Key energy efficiency and renewable energy policies and regulations		Key energy efficiency and renewable energy incentives/taxes	
	Energy efficiency and energy conservation policy/regulation/law	Renewable energy target	Feed-in tariff for solar PV	Fiscal incentives (tax exemptions, subsidies, etc.)
Brunei Darussalam	No, under development	Yes, 10% power generation by 2035	No	No
Cambodia	No, under development	No	No	No
Lao PDR	No, under development	Yes	No	No
Indonesia	Yes	Yes, 23% of energy mix by 2025	Yes	Yes, but underutilized
Malaysia	Yes	Yes, 24% of 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 the value chains for selected technologies conducted in Chapter 3, the following observations can be made:

- Local manufacturing and intra-regional trade flows are available for RACs, refrigerators, lighting and distribution transformers. Electric motors are mostly imported, as is most of the solar PV value chain, with the exception of the assembly of solar modules and panels. Manufacturers of solar cells in ASEAN are found only in Malaysia, the Philippines and Singapore.
- For air conditioners, refrigerators and lighting, because the local markets and intra-ASEAN trade flows are already firmly established, the promotion of higher energy efficiency could focus on consumers and be carried out through existing marketing channels and established distributors.
- In Indonesia, Thailand, Malaysia and Vietnam, the most common consumer behaviour is buying the product with the lowest price, without considering the operational and energy costs incurred during the product's life cycle. Notably, this explains why non-inverter RACs continue to dominate most ASEAN air-conditioner markets.
- The utilization of energy efficiency technologies is sometimes further hindered due to the lack of local skills to install the equipment properly. For example, in Indonesia, inverter RACs have difficulty penetrating the market because most technicians do not know the correct installation procedures for inverter RACs.
- 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 labour costs relative to Thailand and Indonesia. This illustrates that different strategies can be adopted by ASEAN countries, depending on their particular situation. It is therefore recommended that ASEAN countries work together to identify each country's potential "positioning role" from the perspective of intra-ASEAN trade integration.

4.2.1 Tariff and Non-tariff Barriers to Trade

For the technologies covered in this study, the ASEAN preferential rate under the ATIGA is to apply mostly "tariff free" rates for all products. Only a few countries (such as Cambodia and the Philippines) still apply tariffs to their ASEAN counterparts, although these tariffs are relatively low (less than 5%). 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 are still significant. For motors, Singapore could help to facilitate intra-ASEAN trade, because the country has the lowest average MFN tariff, while ASEAN preferential tariffs for these products are already set at zero.

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

these countries (such as Thailand, Malaysia and Vietnam) can be understood only from a global perspective (rather than from a regional one). Discussions with the 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 unstable electricity regulatory and policy frameworks and the lack of targets and direction in implementing EE and RE. This creates doubts and imposes risks for foreign investors. Furthermore, there is no regional labelling yet in place that distinguishes EE/RE products, creating challenges for recognition. 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 that 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 (FITs) 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, the installed capacity of solar PV power generation has reached 945 MW in Thailand (Tongsopit, S., et al., 2015), 166 MW in Malaysia (SEDA, 2015) and about 61 MW in Indonesia (Rosyid, A., 2015).[21] From a regional perspective, the ASEAN Plan for Action in Energy Cooperation 2016-2025 has set a target of 23% of RE in the total energy mix, of which solar energy will account for 15% of the total RE (IRENA & ACE, 2016).

Compared to its ASEAN counterparts, 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's solar PV is only 4.5 Wp.[22] The prospects for solar PV development in Vietnam are based on the Power Development Plan (PDP), which includes a strategy for developing and creating rural power by 2020. As illustrated in Exhibit 5.1, the Vietnamese Government has also put incentive schemes in place to boost RE development, which includes solar PV. A FIT regulation has been issued for wind power and biomass-based power but is not yet available for solar power.

In the framework of the present analysis, a case study on Vietnam was undertaken. This case study aimed to look at non-tariff barriers to trade and at the rapid adoption of solar PV technology in Vietnam.

Exhibit 5.1: Existing incentive schemes to boost renewable energy development in Vietnam (Sources: Compiled from REDS and MOIT, 2015)[23]

Incentive type	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 the type 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 four years; 50% reduction of corporate income tax for the following nine years
Loan	Commercial loan at market interest rate	Loan of up to 80% of capital investment, with preferential interest rate for five years
Environmental protection fee	Depending on type of waste and quantity of pollutants in affluent	Exempted from environmental protection fee
Depreciation	Depending on type of fixed assets	Investors are allowed to apply 1.5 times higher depreciation rates for RE equipment compared with standard equipment. This results in lower taxes in the initial years of projects
Land lease	Depending on location of project	Exempted from land use fee and land lease fee

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

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

[23] 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

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) and 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 buyer could negotiate to extend the contract or sign a new contract as regulated by the law.
- The investor in a solar PV project would benefit from investment, import tax and corporate income tax credits, as prescribed by existing laws and regulations.
- The investor in a solar PV project would qualify for a reduction in land use and land hire fees. In addition, the Provincial Peoples' Committees would be responsible for arranging the land use plan for developing such solar PV projects.
- The purchase 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 purchase price of the excess power would be 15 US cents/kWh (VAT excluded). The price would be adjustable in accordance with the USD/VND exchange rate. The deficit power would be sold by the ladder-type power price scheme, in accordance with laws and regulations.
- Off-grid solar PV projects would benefit from incentives such as investment credits, tax credits, and reductions in land use and land hire fees.

In August 2016, the Vietnamese Government agreed to the draft mechanism proposed by MOIT and to support the development of 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 those located in areas potentially favourable for promoting solar PV, would be eligible for 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).

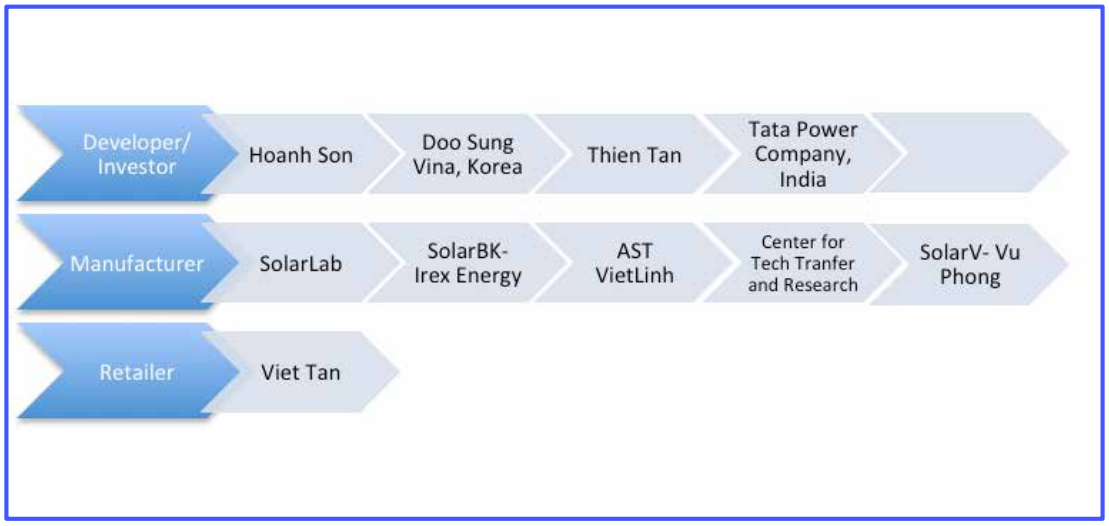
The draft incentives were revised so that future solar PV development will align with the country's power development master plan. This will also assist solar PV project developers in targeting optimal project locations in their business plans.

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

5.3 VALUE CHAIN OF VIETNAM'S SOLAR PV

The solar PV market in Vietnam has already attracted more than 30 investors, both international and domestic. Most domestic investors are private, and either limited or joint stock companies. These investors normally utilize foreign technology because of 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 illustrated in Exhibit 5.2.

Exhibit 5.2: Key players in the solar PV value chain in Vietnam



Most solar PV panels and batteries are imported. A portion of the inverters, controllers and other components are locally manufactured. However, several domestic manufacturers of solar PV components, as well as local research institutions, now conduct research and development (R&D) activities to assist in 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 is considered the biggest solar PV manufacturer in Vietnam. The company has exported its solar PV components both within the ASEAN region and to other countries, including Singapore, the United States, Costa Rica, the Netherlands, the United Kingdom and Tunisia, and its solar cells are exported to Indonesia, Malaysia, the United States, 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, such as Lao PDR and Cambodia, Chinese suppliers that have the advantage of lower prices currently dominate these nearby 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 Smart Integrated Photovoltaics – Madicub. • Installed around 70 solar PV villages, 30 solar charger stations, thousands of solar waterway 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	• Produces solar PV panels, with present capacity of 75 MW. • Distributes domestically and exports to Cambodia, Germany and New Zealand.
	SolarBK-Irex Energy, established in 2012	• Produces drivers, smart auxiliary controllers, solar cells, and mono-crystalline and 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 and UL 1703. • Also imports from ASEAN and out of ASEAN countries. • Exports to the United States, Korea, India and some ASEAN countries.
Designer and manufacturer	AST VietLinh, established in 1986	• Produces related components: back-up generators, inverter solar chargers, DC-AC inverters, AC-DC inverters, DC-DC inverters and solar regulators. • Produces solar PV products and grid tie solar inverters. • Provides and installs 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	• Produces chargeable solar lamps, solar generators, inverters, battery chargers and solar panels. • Imports solar panels from Singapore. • Capacity: 100,000 products/components per year. • By 2015, installed and provided 2,340 kW for solar power projects all over the country. • Manufactures for the domestic market.
Supplier and installer	Viet Tan, established in 1997	• Supplies and installs 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 (see Exhibit 5.4). Because Japanese, Korean and European products/components are becoming available on the market, retailers and manufacturers now tend to import products/components from these countries. The prices of the products and components imported from these new suppliers is not as low as for the Chinese ones. However, they have the advantage of being more reliable while still being reasonably priced. This especially concerns products and components originating from Korea (IES, 2015).

Exhibit 5.4: Sources of imported Solar PV components

No	Type of solar PV component	Exporting country
1.	Back sheet	Singapore, Korea
2.	EVA, ribbon	Malaysia, Korea
3.	Wafer	Japan, Korea, China, Taiwan
4.	J-B, frame, glass and some auxiliary components	Japan, Korea, China, Taiwan
5.	Micro processor	The United States, the European Union

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

In Vietnam, the rate of development of solar PV projects remains slow as a result of several barriers, including technological barriers, policies and institutional barriers, issues with economic and financial resources, and a lack of adequate data and information.

5.4.1 Technology barriers

- Historically, the solar PV technology available in Vietnam has been mostly imported, with large numbers of existing solar PV panels and components coming from China. However, local companies and research institutions are starting to play a more active role in the solar PV industry. In parallel, an increasing share of components is now being imported from Korea and some European countries, where quality is higher, and costs remain reasonable.
- The infrastructure of the power sector does not yet meet the requirement for solar PV integration. As an example, the infrastructure for rooftop net metering is not available.

5.4.2 Policy and institutional barriers

- The existing policy framework provides limited support for solar PV development. The only policies that can be applied are the Renewable Energy Development Strategy (REDS) and version VII of the revised Power Development Plan (PDP). No action plan has been developed for two policies, which causes frustration for solar PV developers and manufacturers. Because of the lack of a specific action plan or clear instructions on the construction, installation and development of rooftop solar power systems and ground-mounted solar power plants, solar PV investors question the feasibility of their projects and are reluctant to invest.
- Since the promulgation of the REDS and the revised PDP, there has been no progress on the adoption of solar PV supportive mechanisms, especially in terms of financial incentives. Although a draft incentive policy was partly approved 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 starting from 2016. The rooftop solar power tariff requires revision in line with the decreasing market price of solar devices/equipment.
- The underdevelopment of the policy framework, as well as uncertain support mechanisms, cast doubt on the government's commitment to support solar PV development. The supportive mechanisms are limited, and financial incentives for power purchase prices will be available only for projects implemented before the end of 2018. The existing mechanism and even the draft mechanism are not attractive enough to compensate investors for the high investment cost of solar PV projects.

5.4.3 Economic and Financial Resource Issues

- The Vietnamese market for solar PV is not mature. Financial support for solar PV development principally depends on the state budget, which does not favour the development of a competitive solar power market. Meanwhile, financial support is limited, which includes tax exemptions, clear land hire mechanisms and transparent land fees. The most tangible incentive for the power tariff scheme is applicable only for planned on-grid solar power projects up and running by 2019. In parallel, the proposed power tariff will require the government to commit to an extensive budget, while the sources of that budget are still being questioned.
- In addition, investors still have difficulty mobilizing finance and making loan arrangements with banks, especially when projected cash flows must be presented. These are new skill sets for many companies. Only one of three surveyed companies, the Centre for Technology Transfer and Research, which is a government facility, said that it has no difficulty in gaining access to capital investment.

5.4.4 Lack of Adequate Data and Information

- To date, neither a map of Vietnam's solar resources, nor a master plan for Vietnam's solar PV development have been published. With insufficient policy support for solar PV projects and no master plan for solar PV development, project developers and investors have a limited understanding of investment procedures. Such a scenario results in guessing their way through many procedural steps in an attempt to obtain permissions such as investment certificates, construction permissions and electricity operation licenses.
- The lack of experience in solar PV technology, as well as the lack of knowledge in 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. This makes investment in solar PV projects a high-risk venture.

Significant barriers therefore still hinder the fast deployment of solar PV in Vietnam. As illustrated by Exhibit 5.5 below, the support of the government will play an essential role in removing many of these barriers.

Exhibit 5.5: Comments from representatives from leading Vietnamese solar companies regarding current government incentives[24]

Solar PV Manufacturers and Retailers on Supportive Mechanisms and Incentives

"One of the barriers for promoting 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 farms. The favourable solar power purchasing price will create a huge change, and even the promotion of net metering mechanisms 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 of 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)

[24] Direct interviews were conducted with Vietnamese stakeholders, including Government authorities and manufacturers, during the period of 2-12 August 2016.

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

Value chain cooperation between Vietnam and other ASEAN countries has been established despite the underdevelopment of the Vietnamese policy frameworks and incentives. Currently, Vietnam imports some solar PV components from regional partners, particularly solar panels from Malaysia and Singapore. Solar PV products from Vietnam are also exported to some ASEAN countries.
Although foreign markets are not the first priority of Vietnamese solar PV manufacturers, it is expected that efforts in solar PV R&D will cause the price of Vietnamese solar PV products to decrease. Vietnamese solar PV products will thereby become more competitive relative to their current Chinese counterparts in the ASEAN market.

Once the policies on Renewable Portfolio Standards (RPS) and net metering are endorsed, the solar market in Vietnam will bloom. At that point, on-grid solar power projects will attract keen investors, and owners of residential buildings, industries and even households will be able to participate in the solar market by investing in rooftop solar power systems and ground-mounted solar farms.

ASEAN investors interested in the Vietnamese market should be aware of Chinese competition. A Chinese-invested solar PV factory is already under construction in the centre of Vietnam. Chinese products offer the usual advantage of being cheaper. Meanwhile, according to a survey conducted by the Institute of Energy Science on the EE and RE market in Vietnam, Vietnamese customers favour cheap products and a quick rate of return. Notwithstanding, the same customers do not normally like Chinese products (IES, 2015). The prices of ASEAN solar PV products, especially solar panels, are lower than for American and European products, but still higher than the prices of Chinese products.

06

CONCLUSION AND RECOMMENDATIONS

6.1 CONCLUSIONS

As the preferential tariffs in ASEAN are zero or very low for most products, including the selected EE and RE technologies, the interest of ASEAN countries, such as Thailand, Malaysia and Vietnam, in participating in the EGA negotiations can be better understood from a global perspective than from a regional one.

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 ASEAN Big Six countries, namely Indonesia, Malaysia, the Philippines, Singapore, Thailand and Vietnam. In that regard, a lack of harmonization is notably observed particularly for energy performance testing methods, MEPS and labelling. Most notably, the analysis concludes:

- MEPS and labelling requirements for the technologies identified in this study greatly vary across the region.
- There is a lack of enforcement, specifically relating to electric motors, lighting, refrigerators and distribution transformers, even for countries that have developed and implemented MEPS.
- Across the technologies studied, labelling is still in its initial stages, even for the ASEAN Big Six countries

Given the current scenario, there is a limited potential for mutual recognition of energy performance when technologies are traded between countries. This lack of mutual recognition directly impacts the potential for increasing intra-ASEAN trade in EE and RE technologies.

The study shows than ASEAN countries have demonstrated substantial progress and interest in developing and adopting national and international testing standards; in adopting MEPS regulations; and in adopting labelling for RACs, refrigerators and lighting. Meanwhile, these countries have been slower to make such progress on distribution transformers and electric motors. The likely reason is that setting up standards for products manufactured at scale is simply easier. Thus, from the perspective of harmonization, RACs, refrigerators and lighting represent “low-hanging fruit” that could be prioritized for immediate action. A summary of existing energy performance testing standards, MEPS and labelling is given in Exhibits 6.1, 6.2 and 6.3.

Exhibit 6.1 Summary of applied performance testing standards for selected technologies in ASEAN

Country	National Energy Performance Testing Standard			
	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 with 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 (aligned with IEC 60034-2)
Malaysia	Aligned with ISO 5151 (old version)	MS IEC 62552-3:2016 (Aligned with IEC 62552-3:2015)	Apply IEC 60076-1 (Electric utilities)	Aligned with IEC 60034-2
Myanmar	N/A	N/A	N/A	N/A
Philippines	(1) Aligned with ISO 5151-PNS ISO 5151:2014 (2) 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 with ISO 5151	Aligned with 62552-3:2007	Apply IEC 60076-1 (Electric utilities)	N/A
Thailand	Aligned with ISO 5151 (old version)	TIS 455-2537 and TIS 2186-2547	Apply IEC 60076-1 (Electric utilities), and TIS 384-2453	TIS 867-2550-2007 (Aligned with IEC 60034-2)
Vietnam	Aligned with ISO 5151 (old version)	TCVN 7829:2016 (ongoing) aligned with IEC 62552 (1/2/3)	TCVN 6301-1:2015 aligned with IEC 60076-1:2011	TCVN 6627-2-1:2010 aligned 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 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 - voluntary - 1-4 stars	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	Mandatory label	Mandatory 1-5 star rating, pending implementation	None	None
Singapore	Mandatory - comparative label, 1-5 rating	Mandatory 1-4 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

Supporting value chain integration and cooperation may further facilitate the wider diffusion of EE and RE technologies in ASEAN; in this respect, the situation varies among countries and technologies.

- For RACs, refrigerators, lighting and distribution transformers, local manufacturing capacities are found in most “big” countries. Intra-regional trade flows already exist and concern all countries.
- For solar PV, solar modules and panels are assembled locally. ASEAN manufacturers of solar cells are found in Malaysia, the Philippines, Singapore, Thailand and, to a lesser extent, Vietnam. Most of the other components of the solar PV value chain (such as BoS) are imported.
- Most electric motors are sourced from imports (i.e., there is no real manufacturing capacity in ASEAN countries).
- In general, Singapore positions itself as a trading hub by applying very low to zero tariffs for imports. Vietnam, which has cheaper labour costs than Thailand and Indonesia, has an opportunity to position itself differently, to attract foreign investment for the establishment of new manufacturing facilities.

The perceptions of end users represent another significant barrier to accelerate the deployment of EE and RE technologies.

- In most countries, market behaviour is characterized by impulse buying of cheaper products, without consideration for operational and energy consumption costs. It is therefore necessary to educate end users on the lifecycle costs of EE and RE equipment.
- In addition, the deployment of EE and RE technologies may also be hindered by the lack of local expertise to install, operate, maintain and dispose of the technology properly; this situation has been observed especially with rooftop solar PV in most ASEAN countries, and with inverter RACs in Indonesia. A lack of adequate services can affect the actual performance of the EE and RE equipment, making it difficult to convince end users to adopt this equipment

6.2 RECOMMENDATIONS

Energy Efficiency Technologies

Two general strategies have high potential to support trade and to facilitate the deployment of EE technologies in the region. These are (i) the harmonization of energy performance testing methods for EE technologies; and (ii) the adoption and harmonization of MEPS.

The first recommended strategy is to **harmonize energy performance testing methods for EE technologies:** This is an important, tangible way for ASEAN governments to facilitate intra-ASEAN integration in EE technologies. Not all ASEAN countries are referencing their national standards to the relevant international standards. Alignment of national standards to an international standard has been achieved for RACs, where the reference used is ISO 5151:2010. This is not the situation for the other household appliances in this study (refrigerators and linear fluorescent and non-directional LED lighting), nor for other EE equipment used in industry (electric motors and transformers).

The second general strategy is to **adopt and harmonize MEPS:** This strategy is important for phasing out inefficient equipment from the market. The rationale is that technologies with lower efficiency usually have a lower initial price, which consequently limits market opportunities for more efficient equipment.

Specifically for air conditioners, it is advisable to continue the implementation of the ASEAN SHINE national roadmaps developed during Phase 1 of the ASEAN SHINE program.

Renewable Energy Technologies

Due to the lack of information on the solar thermal market, it is difficult to propose a general strategy for the selected RE technologies. However, for solar PV technology, supporting the harmonization of installation standards, notably for connection to the grid, arises as a key recommendation. Before further recommendations are made on RE technologies, it is necessary to gather more information on the market in other ASEAN countries.

07

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APPENDICES

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

A.1 – Air Conditioners

Country	National testing standard	Labelling	MEPS
Brunei Darussalam	Being developed	➢ Under consideration for development ➢ Voluntary ➢ Comparative	None (under development)
Cambodia	None	None	None
Indonesia	Aligned to ISO 5151 (old version)	➢ Under development ➢ 1-4 star rating ➢ Voluntary	➢ (EER (BTU/hr)/COP): o Inverter: 9.01/2.64 o Non-Inverter 8.53/2.50 ➢ Mandatory
Lao PDR	None	None	None (under dev.)
Malaysia	Aligned to ISO 5151 (old version)	➢ 1-5 star rating ➢ Voluntary ➢ Endorsement (ST)	➢ EER based (BTU/hr) ➢ Mandatory
Myanmar	Being developed	None	None (under dev)
Philippines	➢ Aligned to ISO 5151-PNS ISO 5151:2014 ➢ PNS ISO 16358-1:2014	➢ 1-5 star rating ➢ Mandatory ➢ Pending implementation	➢ EER based (BTU/hr and W/W) ➢ Mandatory
Singapore	Aligned to ISO 5151	➢ 1-5 tick rating ➢ Mandatory	➢ 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)	➢ 1-5 star rating ➢ Mandatory ➢ Comparative ➢ Voluntary endorsement	➢ EER based (BTU/hr and W/W) ➢ Mandatory

A.2 – Refrigerators

Country	National testing standard	Labelling	MEPS
Brunei Darussalam	None	None	None
Cambodia	None	None	None
Indonesia	(Reference to IEC 62552-2: 2015 is currently available under SNI 62552-2-2016)	➢ Under development ➢ Voluntary ➢ 1-4 star rating	This is currently being drafted
Lao PDR	None	None	None
Malaysia	MS IEC 62552-3:2016 (aligned to IEC 62552-3:2015)	➢ 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	Aligned to 62552-3:2015: DPNS 62552-3:2016	➢ Mandatory ➢ 5-star rating ➢ Comparative label is pending implementation ➢ Endorsement label is mandatory	➢ EEF based ➢ Mandatory ➢ Minimum 1 star
Singapore	Aligned to IEC 62552:2007	➢ Mandatory ➢ 1-4 tick rating	➢ Mandatory ➢ Linear energy consumption based on adjusted capacity
Thailand	TIS 455-2537 and TIS2186-2547	➢ Voluntary ➢ Comparative ➢ 1-5 star rating ➢ EGAT accepts only level 3 and up ➢ Endorsement label (TGL/TEI)	➢ Mandatory ➢ Linear energy consumption based on adjusted capacity
Vietnam	TCVN 7829:2016 (ongoing) – aligned to IEC 62552 (1/2/3)	➢ Mandatory ➢ Comparative ➢ 1-5 star rating	➢ Mandatory ➢ Linear energy consumption based on adjusted capacity

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

Country	National testing standard	Labelling	MEPS
Brunei	None	None	None
Cambodia	None	None	None
Indonesia	SNI IEC 60034-2-1:2012 (aligned to IEC 60034-2-1)	➢ Under development ➢ Comparative ➢ 1-4 star rating ➢ Voluntary	➢ IE1 ➢ Mandatory
Lao PDR	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	PNS IEC 60034-2-2:2016
Singapore	None	None	None
Thailand	➢ TIS 867-2550 (2007), aligned to AS/NZS 1359.5 (2004) ➢ Ongoing development of new standard aligned to 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 ➢ IE2 ➢ Voluntary
Vietnam	TCVN 6627-2-1:2010 aligned to IEC 60034-2-1 (2007)	➢ Mandatory ➢ Endorsement (MOIT)	➢ Mandatory ➢ In line with IE1 ➢ Covering (3-phase, asynchronous squirrel cage electric motors with voltage not exceed 400V, and rated power from 0.55-150kW)

A.4 – Distribution Transformers

Country	National testing standard	Labelling	MEPS
Brunei Darussalam	None	None	None
Cambodia	None	None	None
Indonesia	SPLN 50:2007 (utilities)	None	None
Lao PDR	None	None	None
Malaysia	Apply IEC 60076-1 (for utilities)	None	None
Myanmar	None	None	None
Philippines	PNS IEC 60076-1:2002	None	None
Singapore	Apply IEC 60076-1 (for utilities)	None	None
Thailand	Apply IEC 60076-1 (for utilities)	None	None
Vietnam	TCVN 6301-1: 2015 aligned to IEC 60076-1: 2011	➢ Mandatory ➢ Endorsement (MOIT)	Mandatory: >Minimum power efficiency @ 50% load, for 3 phase liquid type

A.5 – Status of Energy Performance Testing Standards for Linear Fluorescent Lamps and Non-directional LED Lamps

Countries	Tubular linear fluorescent	Non-directional LED
Brunei Darussalam	None	None
Cambodia	None	None
Indonesia	None	None
Lao PDR	None	None
Malaysia	IEC 60969:2006	MS IEC 62612 (reference to IEC 62612/2013)
Philippines	PNS IEC 60081:2006 (reference to IEC 60081)	None
Singapore	None	IEC 62612/2013
Thailand	TIS 2309-2549, TIS 236-2548, IEC 60969, TIS 956-2548	None
Vietnam	TCVN 7451-2:2005	None

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		
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 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 to HS 850421, HS 850422, HS 850433, and HS 850490 (Distribution Transformers and Transformer Parts)

Country	MFN Tariff Six-digit HS Code: Distribution transformers and parts (%)					
	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 RACs in ASEAN (HS 8415.10, 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 and others)

Country	MFN Tariff for six-digit HS Code (%)		
	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 for six-digit HS Code (%)			
	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

Note:
- 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.

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 for six-digit HS Code (%)		
	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

Note:
- HS 940510: Chandelier and other electric ceiling or all lighting fittings, excluding those of a kind used for lighting public open space or thoroughfares;
- HS 940540: Electric lamps and lighting fittings.

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 for six-digit HS code (%)	
	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 and solar evacuated tube collector, including parts)

Country	MFN tariff for six-digit HS code (%)	
	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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