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Study on the Introduction of Heat Pumps and Once-Through Boilers to Support GX in Asia Phase 2

By
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Introduction of Introduction of Heat Pumps and Once-Through Boilers to Support GX in Asia Phase 2

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Preface

The widespread adoption of high-efficiency equipment – such as industrial heat pumps, commercial heat pump water heaters, advanced refrigeration and freezing systems, and once-through boilers – represents a fundamental and transformative step toward achieving sustainable energy use and long-term carbon neutrality across the Asian region. These technologies are not only energy-efficient but also offer a significant opportunity to reduce greenhouse gas emissions in industrial and commercial sectors where heating and cooling processes are major contributors to overall energy consumption.

Asia's rapid economic expansion, especially in emerging economies, has led to a substantial and persistent increase in energy demand. This trend has, in turn, intensified carbon emissions and placed enormous pressure on energy infrastructure, natural resources, and environmental systems. Against this backdrop, the urgent need to implement pragmatic and scalable decarbonisation solutions has never been more apparent. Addressing this challenge is essential not only for climate mitigation but also for ensuring long-term economic resilience and energy security throughout the region.

In the current phase of our work, we conducted a detailed assessment to determine which countries in the ASEAN region are most well-positioned to adopt energy-saving technologies. We investigated the feasibility and benefits of deploying such technologies in countries where energy-saving potential is high and industrial demand is growing. To gain deeper insights into the barriers hindering adoption, we engage in dialogue with government agencies and industry associations. These engagements have proven instrumental in identifying specific demands gaps amongst government agencies, local companies that consume energy and manufacturers providing high-efficiency equipment. These discussions are helping to shape concrete strategies for accelerating the deployment of energy-efficient systems and supporting long-term decarbonisation.

By demonstrating the value of these technologies and clarifying the pathways for their implementation, we aim not only to advance energy efficiency in Asia but also to offer a replicable framework for sustainable development in other regions. Through collaboration and innovation, we believe a low-carbon future is not only possible, but within reach.

Hiroshige Muraoka

President of Nomura Research Institute Singapore Pte. Ltd.

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Constructive discussions with other relevant stakeholders offered valuable input for shaping future strategies and policy frameworks aimed at advancing decarbonisation and improving energy efficiency. In particular, these dialogues contributed significantly to clarifying the direction of policies focused on accelerating the deployment of energy-efficient technologies – such as heat pumps and once-through boilers – across the Asian region. By integrating technical, economic, and regulatory perspectives, the discussions helped identify practical measures to encourage adoption, including incentives for early movers, the harmonisation of standards, and the development of supportive infrastructure.

The authors wish to express their sincere gratitude for the generous support extended to this study. Without such cooperation, the completion of this report would not have been possible. Any remaining errors or omissions are the sole responsibility of the authors.

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List of Abbreviations and Acronyms

AEEE	Alliance for Energy Efficient Economy
AHPNW	Asian Heat Pump Thermal Storage Technologies Network
ASEAN	Association of Southeast Asian Nations
ASME	American Society of Mechanical Engineers
AZEC	Asia Zero Emission Community
BAU	Business-as-usual
BEE	Bureau of Energy Efficiency
BIS	Bureau of Indian Standards
BMS	Building Management Systems
CAGR	Compound Annual Growth Rate
CAPEX	Capital Expenditure
CCUS	Carbon Capture, Utilisation and Storage
CDM	Clean Development Mechanism
CF	Carbon Fiber Composite
CFC	Chlorofluorocarbons
COP	Coefficient of Performance
COPt	Coefficient of Performance for tapping sanitary hot water
CO_2	Carbon Dioxide
CNG	Compressed Natural Gas
DEDE	Department of Alternative Energy Development and Efficiency
DEP	Domestic Energy Production
DIW	Department of Industrial Works
ECBC	Energy conservation building code
EEFP	Energy Efficiency Financing Platform
EERS	Energy Efficiency Resource Standards
EGAT	Electricity Generating Authority of Thailand
EIT	Engineering Institute of Thailand
EN	European Standards
ERIA	Economic Research Institute for ASEAN and East Asia
ESCO	Energy service companies
EV	Electric Vehicle
FEEED	Framework for Energy Efficient Economic Development
GDP	Gross Domestic Product
GGDC	Groningen Growth Developing Centre
GHG	Greenhouse Gas
GWP	Global Warming Potential
HCFC	Hydrochlorofluorocarbon
HFC	Hydrofluorocarbon
HSPF	Heating Seasonal Performance Factor

HUST	Hanoi University of Science and Technology
HVAC	Heating, Ventilation, and Air conditioning
ICC	India Cooling Coalition
IEA	International Energy Agency
IET	Institute of Energy Technology
IPPU	Industrial Processes and Product Use
ISHRAE	Indian Society of Heating, Refrigerating and Air Conditioning Engineers
ISO	International Organization for Standardization
JRAIA	Japan Refrigeration and Air Conditioning Industry Association
JIS	Japanese Industrial Standards
kWh	Kilowatt-hour
KMUTT	King Mongkut's University of Technology Thonburi
LED	Light Emitting Diode
MEPS	Minimum Energy Performance Standard
METI	Japan Ministry of Economy, Trade and Industry
MIND	Ministry of Industry
MNC	Multinational Corporation
MoEFCC	Ministry of Environment, Forest and Climate Change
MOIT	Ministry of Industry and Trade
MOU	Memorandum of understanding
MSME	Micro, Small, and Medium Enterprises
Mt	Metric Ton
MTEE	Market Transformation for Energy Efficiency
MU	Mahidol University
MW	Megawatts
NDC	Nationally Determined Contributions
NETR	National Energy Transition Roadmap
NIMP	New Industrial Master Plan
NMEEE	National Mission for Enhanced Energy Efficiency
NRI	Nomura Research Institute
ODS	Ozone Depleting Substances
PAT	Perform, Achieve and Trade
PLI	Production Linked Incentive
RAMA	Refrigeration and Air-conditioning Manufacturer Association
REC	Renewable Energy Certificates
ROI	Return on Investment
SEER	Seasonal Energy Efficiency Ratio
SME	Small and medium-sized enterprises
TBA	Thai Boiler Association
TES	Total Energy Supply
TIS	Thailand Industrial Standards
TISI	Thailand Industrial Standards Institute

TJ	Terajoule
ToD	Time of Day (Tariff)
ToU	Time of Use (Tariff)
TPES	Total primary energy supply
UNFCCC	United Nations Framework Convention on Climate Change
US$	United States Dollar
VTST	Viet Nam Thermal Science and Technology Institute
VCS	Verified Carbon Standard
VECEA	Viet Nam Energy Conservation and Energy Efficiency Association
VISRAE	Viet Nam Society of Refrigeration and Air-Conditioning Engineers
VNEEP	Viet Nam National Energy Efficiency Program
VOC	Volatile Organic Compound
VSQI	Viet Nam Standards and Quality Institute

Executive Summary

Rapid economic growth in Asia has led to a significant increase in energy demand and associated carbon emissions, particularly in countries such as Viet Nam, Thailand, and India. As these countries continue to experience rapid industrial growth, the need for sustainable energy solutions becomes increasingly critical to reducing greenhouse gas emissions and achieving carbon neutrality. To address this challenge, the introduction of high energy efficiency equipment, such as heat pumps and once-through boilers, presents a pivotal opportunity to achieve several objectives: continued economic growth and enhanced efficiencies through the scalability of the new technologies, as well as improved sustainable energy use and reduced carbon footprint across the region.

This report, commissioned by the Economic Research Institute for ASEAN and East Asia (ERIA), explores the feasibility and benefits of adopting heat pumps and once-through boilers in these countries. The study highlights the significant potential of these technologies to reduce energy consumption and carbon emissions in both industrial and commercial sectors. Heat pumps, which are three to five times more energy-efficient than traditional boilers, offer a sustainable solution for heating and cooling by extracting heat from the surrounding environment. Similarly, once-through boilers, which are more compact than traditional fire tube boilers, offer scalability and higher efficiency, significantly reducing fuel consumption in industrial processes.

We conducted both quantitative and qualitative research on ten Southeast Asian countries and India from economic and energy perspectives to evaluate the potential for introducing heat pumps and once-through boilers. Our findings indicate that while all countries are pursuing decarbonization and recognise the need for energy-efficient equipment, the need to reduce energy consumption is particularly pronounced in Thailand, Viet Nam, and India.

We believe that heat pumps and once-through boilers have the potential to significantly reduce energy consumption in these countries. However, despite the considerable benefits of these technologies, their adoption remains limited due to several barriers:

- High upfront costs: Both heat pumps and once-through boilers, though efficient, require significant initial investment. This may discourage adoption, especially amongst small and medium-sized enterprises (SMEs).
- Limited awareness of the potential benefits: In Viet Nam, Thailand, and India, there is still a general lack of awareness about the long-term benefits of these energy-efficient technologies, both in terms of cost savings and their positive environmental impact.

- Technical barriers: The complexity of integrating heat pumps into existing industrial systems, coupled with limited technical expertise, may render it difficult for businesses to adopt these technologies.
- Inadequate policy support: A lack of regulations, and guidelines further exacerbates the slow uptake of these energy-efficient equipment, as companies interviewed revealed a high inertia which can only be overcome with more policy support.

Faced with these challenges, we recommended the following five strategic directions to develop a roadmap for the improvement of adoption of such energy-efficient technologies and equipment in the previous phase:

- Financial schemes: It is necessary to reduce the initial financial burden on businesses, particularly SMEs, to incentivise the switch from conventional less energy-efficient technologies to their newer and improved counterparts. We propose the introduction of leasing options to alleviate this initial financial barrier. Furthermore, the leasing options can be combined with the use of carbon credits, where leasing companies collect carbon credit allowances generated by using energy-efficient equipment and trade them on the carbon credit trading market. This will hopefully lower the barriers to entry for companies interested in decarbonisation by removing the need for them to directly manage and trade carbon credits.
- Awareness campaigns: Governments and related partners can conduct targeted outreach programmes such as workshops and seminars especially for industry stakeholders and equipment user companies to raise the overall awareness about the long-term benefits (both financial and environmental) of these technologies and equipment.
- Technical training: It will also be essential to invest in local capacity building initiatives, as it would be insufficient to only implement the new equipment without training local staff, such as engineers and technicians, to operate and maintain it. Skilled technicians not only optimise the energy efficiency of heat pumps and once-through boilers while reducing safety risks and environmental impacts but also play a key role in promoting these technologies. By informing end-users about their advantages and proper operation, they help drive adoption and support long-term sustainability.
- Policy and regulatory support: Alongside the recent push to adopt greener technologies, governments and related ministries or agencies could establish standards and guidelines for these new energy-efficient equipment if they have not yet been created. For example, to make the benefits of the new energy-efficient equipment clearer, it would be beneficial to establish standards for the indices, evaluation methods, and guidelines to compare equipment performance. At the

same time, considering the safety aspect of heat pumps, it would also be necessary to create guidelines for the handling of refrigerants.

- Collaboration between different stakeholders: Although there are research initiatives that are led by the public sector, manufacturers, and academia, these tend to exist separately. The situation can be improved by leveraging the expertise of energy service companies (ESCO), who are experts in energy efficiency as they provide comprehensive solutions, from energy audits to installation and maintenance. Local ESCOs can be particularly effective in demonstrating the energy-saving potential and cost-effectiveness of the new energy-efficient equipment, because they tend to have strong ties with the local government as well as possess a wide local user base.

As a pathway forward, we have begun engaging with a wide range of stakeholders to explore how energy-efficient technologies, such as heat pumps and once-through boilers, can be effectively integrated into national, regional, and corporate-level energy strategies. As an initial step, our focus has been on identifying appropriate activities from the perspectives of technical training and policy and regulatory frameworks. This approach is intended to lay the foundation for a broader, long-term shift toward greater energy efficiency across Asia.

We have formulated several proposals that reflect our understanding of the policy and market environments. To test the feasibility and effectiveness of these proposals, we have conducted extensive dialogue with key local stakeholders, including government agencies, manufacturers and industrial associations, in each target country. The feedback obtained from the local stakeholders are then incorporated and the revised proposals are as follows:

- To accelerate the adoption of heat pumps, it is recommended that standardised measurement methods and performance indicators be developed to quantitatively and, where possible, visually demonstrate the key benefits of heat pumps, namely high energy efficiency and contribution to load levelling. These indicators would form the basis for the eventual integration of heat pumps into existing policy instruments such as energy efficiency labelling schemes and Minimum Energy Performance Standards (MEPS). Such policies can play a crucial role in helping users better understand the advantages of heat pumps when making decisions about heating system investments. However, implementing these schemes requires a minimum level of market maturity and awareness, which are currently limited. To address this, complementary measures should be undertaken in parallel, including sustained outreach and education efforts targeting government officials, industry associations, and potential end users. Engagement can be facilitated through stakeholder dialogues, technical workshops, and public seminars. In addition, a comprehensive market study will be necessary to assess

current conditions, identify barriers, and uncover opportunities for broader heat pump adoption.

- Developing training programmes focused on refrigerant characteristics and safe handling, alongside establishing a licensing system linked to these training efforts to ensure technical proficiency and safety compliance. This is done to close existing regulatory gaps and enhance refrigerant management practices. Technicians involved in the installation, servicing, and disposal of refrigerant-based equipment should be required to obtain formal qualifications, supported by mandatory training and awareness programmes. Next, for fluorocarbon refrigerants, countries should introduce mandatory protocols covering proper maintenance, regular leak checks, and the systematic documentation of refrigerant usage and emissions. Given the varying levels of regulatory development across countries and refrigerant types, a consultative process with stakeholders is essential to determine regulatory priorities. Some countries have initiated guidelines for refrigerant handling, but gaps remain, particularly for recovery, disposal, and the use of alternative refrigerants such as natural refrigerants. This calls for a flexible, context-specific approach that accounts for each market conditions and technical capabilities.
- Relaxing overly stringent regulations on once-through boilers, thereby facilitating their wider use by emphasising their inherent safety advantages. Stakeholder discussions revealed that the market for once-through boilers is more mature in Thailand, where prior policy attention and less stringent permitting have supported adoption, particularly amongst foreign-affiliated firms. In contrast, Viet Nam and India show limited uptake and low awareness amongst authorities. To support broader adoption across all three countries, it is recommended to establish a dedicated regulatory framework tailored to the unique characteristics of once-through boilers and to promote their safety, efficiency, and operational benefits through targeted outreach. These efforts can help create an enabling environment and pave the way for future labelling and performance-based regulations.

We believe that by taking a collaborative and context-sensitive approach to these initiatives, grounded in the realities of each local market, countries such as Viet Nam, Thailand, and India can make significant progress toward their carbon neutrality goals. Moreover, such efforts would meaningfully contribute to the broader global agenda of combating climate change and accelerating the transition to a low-carbon economy.

Chapter 1

Project Introduction

1. Project Introduction

1.1. Background and Objectives

As the largest contributor to global emissions, Asia plays a critical role in advancing global decarbonisation efforts. Policy approaches in the region must balance the urgent need to reduce emissions with the equally pressing goals of sustaining economic development and ensuring energy security, particularly for developing countries in the region. Given the continued growth in energy demand, improving energy efficiency and accelerating the deployment of renewable energy should be prioritised as central pillars of Asia's net-zero transition. In this regard, ERIA Asia Zero Emission Center conducted a study on the introduction of heat pumps and once-through boilers to support GX in Asia, published in January 2025, seeking to advance sustainable development and adoption of climate smart technologies in the region.

In the previous phase of the project, in-depth research was done relating to heat pumps and once-through boiler technology, which has been increasingly recognised worldwide as an energy-efficient and sustainable solution for both heating and cooling. For heat pumps, it was found that in much of Southeast Asia, the adoption of heat pumps remains limited. While some regions in these countries experience colder winters, the predominantly warm climate reduces the demand for heating, making it difficult to replicate market growth seen in colder regions such as Europe or Japan, where heating and hot water applications dominate. In Viet Nam, heat pump adoption is still in its early stages. According to the Japan Electro-heat Center, the country is in a transitional phase, with research institutions developing industrial heat pump applications. A limited number of units, mainly introduced by European and Japanese manufacturers, have entered the market but uptake remains constrained by low public awareness and high upfront investment costs. For Thailand, it has witnessed a handful of recent heat pump installations, particularly by local air-conditioning manufacturers. Yet, similar barriers such as limited awareness and high capital costs, continue to impede broader market penetration. In India, despite a few confirmed instances of heat pump usage, adoption in the industrial sector remains extremely limited. This is largely due to the sector's overwhelming dependence on fossil fuels (coal, oil, and natural gas) which account for approximately 83% of industrial energy consumption. As a result, fossil fuel-powered boilers remain dominant, presenting a significant barrier to heat pump deployment. For once-through boilers, it was found that in countries like Thailand and Viet Nam, multiple companies have installed and sold these boilers, suggesting that the market is expected to grow further in these regions. In parallel, similar efforts in India have been observed

as the country aims to reduce its substantial CO_2 emissions through the integration of cleaner energy sources and advanced technologies. Moreover, such decarbonisation technologies are expected to be increasingly adopted in the three countries given the continued promotion and incentives from the Asia Zero Emission Community (AZEC) of which the ASEAN countries are a part of (except for Myanmar). While India is not formally part of AZEC, its significant carbon emissions make it a crucial player in Asia's decarbonisation efforts. By addressing the unique challenges in these countries, can the broader goal of sustainable development be achieved which is also an outcome intended by this project.

1.2. Objectives

The overarching goal of this project is to support decarbonisation in Asia by promoting the introduction of energy-efficient technologies, specifically heat pumps and once-through boilers, and thereby contribute to sustainable development and enhance the region's resilience to climate change.

To achieve this, the project sets out two main objectives:

- Identify high-potential countries for the introduction of these technologies and analyse the key market barriers hindering their deployment.
- Develop policy recommendations and programme proposals tailored to the needs of each country, with the aim of accelerating market uptake. In addition, the project seeks to identify areas where advanced economies can provide targeted support to facilitate the implementation of these programmes and policies.

By addressing the specific challenges faced by ASEAN countries and India, and proposing actionable solutions, the project contributes to the broader regional effort to achieve carbon neutrality and a sustainable energy transition.

1.3. Scope of Technologies and Focus Countries

This report will focus on two technologies – heat pumps and once-through boilers. In this report, 'heat pumps' includes refrigerators, chillers and air conditioners with compressor-based compression and expansion mechanisms. The project emphasis is on industrial usage. 'Industrial' in this context encompasses all types of corporate use, not only limited to manufacturing and processing in factories but also includes commercial applications in hotels and similar establishments. For the purposes of this project, distinctions based on the heat source, or the state of the output (liquid or gas) are not explicitly made. Additionally, the report focuses on once-through boilers including small once-through boilers, which in Japan, can be handled by individuals who have received special training without the need for a boiler technician qualification.

The countries in-scope will be India and the ASEAN countries – Singapore, Malaysia, Thailand Viet Nam, Indonesia, Philippines, Brunei, Cambodia, Lao PDR, and Myanmar.

1.4. Methodology

The research on demand and potential for climate-smart technologies in ASEAN countries and India are conducted by analysing the energy landscape, assessing the urgency of carbon neutrality, and identifying the challenges and requirements related to the adoption of heat pumps and once-through boilers. Through the analysis, the countries with the highest potential will be focused on. Thereafter, targeted measures such as training programmes, standards development, and certification frameworks will be proposed to address market entry barriers and facilitate the introduction of these high-efficiency technologies into each country. These measures are being developed and refined through discussions with various stakeholders, including relevant countries, potential user companies in Japan's manufacturing sector, energy service companies, equipment manufacturers, and related industry organisations.

1.5. Chapter Overviews

Chapter 1 – Project Introduction

This Chapter provides an overview of the entire study on heat pumps and once through boilers, explaining the background, process, details and findings of this report. The introduction section includes project background, objectives, methodology, scope of technologies and focus countries. Chapter 1 aims to highlight the purpose of this report and its significance to increasing awareness and adoption of heat pumps and once through boilers in the Southeast Asian region.

Chapter 2 – Potential Demands of Heat pumps and Once-through Boilers

This Chapter details the findings and shortlisting process derived from the quantitative assessment, followed by the findings from the qualitative assessment of potential demand factors. Chapter 2 aims to evaluate the potential demand for heat pumps and once-through boilers in the target countries, shortlisting Thailand, Viet Nam and India based on country-level energy and environmental trends, which indirectly influence the adoption of heat pumps and once-through boilers.

Chapter 3 – Regulations and Standards in the target countries

This Chapter covers the relevant standards and regulations such as energy efficiency, equipment quality, material safety and operational performance related to heat pumps and once-through boilers in Viet Nam, Thailand, and India. This section includes an overview of existing regulations and standards, current issues and potential solutions. Chapter 3 aims to highlight the importance of comprehensive legislation and the areas which can be improved to aid the adoption of heat pumps and once through boilers.

Chapter 4 – Needs and Issues Regarding Heat pumps and Once-through boilers

This Chapter explores the needs and issues regarding heat pumps and once-through boilers including to identify barriers, propose and implement solutions, incorporate stakeholder insights, and refine key proposals. This section includes an issue map as well as solutions to address these issues. Chapter 4 aims to identify adoption barriers, clarify the types of support and interventions required and recommend concrete policy and programmatic actions.

Chapter 5 – Proposal of solutions to promote Heat pumps and Once-through boilers

This Chapter formulates a set of programmatic actions which would serve as a foundation for future collaboration with government bodies, industry players, and technical institutions. This section includes key takeaways from manufacturer interviews, details of three key proposals, incorporation of stakeholder feedback to refine proposals and recommendations for future programmes. P5 aims to ensure that any future programmatic interventions would be both relevant and effective in accelerating the deployment of energy-efficient technologies in Thailand, Viet Nam, and India.

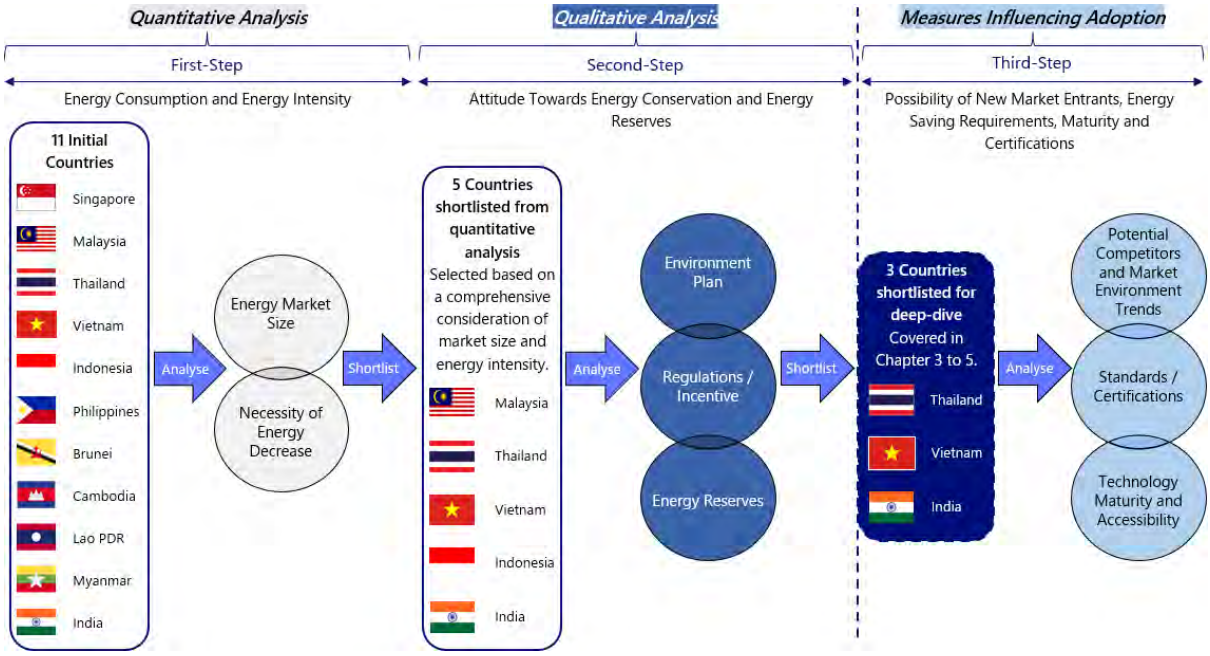
Chapter 2

Potential Demands of Heat Pumps and Once-through Boilers

1. Quantitative and Qualitative Assessment for Assessing Potential

This chapter details the findings and shortlisting process derived from the quantitative assessment, followed by the findings from the qualitative assessment, to evaluate the potential demand for heat pumps and once-through boilers in the target countries.

Figure 2.1: Overall Methodology



Source: Author.

The overall methodology follows a three-step approach (one quantitative step and two qualitative steps) to shortlist target countries. The analysis in Chapter 2 adopts a broader macro perspective, focusing on country-level energy and environmental trends, which indirectly influence the adoption of heat pumps and once-through boilers. Thereafter, Chapters 3 to 5 cover details on factors (e.g. standards and certifications) directly influencing their adoption.

1.6. Potential Demands in the Southeast Asian Countries (Quantitative factors)

1.6.1. Overview of the Study

The selection process began with the consideration of 10 Southeast Asian countries, and India. In this study, we assessed these 11 countries based on their potential demand for the adoption of heat pumps and once-through boilers. These evaluations serve as a foundation for identifying and prioritising the countries where concrete initiatives can be implemented in the next phase of our efforts.

To evaluate the feasibility of introducing new heat pumps and once-through boilers in each of these countries, several factors were analysed. The table below shows the summary of the figures for each country based on quantitative (energy and economic based) factors.

- Quantitative factors
    - Energy market size
        - GDP (nominal)
        - GDP by industry (manufacturing and services)
        - Population
        - Total energy consumption
    - Necessity of energy decrease
        - Energy intensity
        - Rate of renewable energy
        - Trade value of electricity imports

The quantitative analysis was carried out through two categories – 1) Energy market size and 2) Necessity of energy decrease, where attractive areas are highlighted in light blue, while areas which are deemed less attractive are highlighted in grey. Each country's unique circumstances were also considered in deriving the shortlist.

Table 2.1: Selection of Target Countries – Quantitative Factors

Category	Quantitative Factor*	Countries										
		SG	MY	TH	VN	ID	PH	BN	LA	CM	MM	IN
Energy Market size	Nominal GDP (bn US$)	498.5	418.9	515.0	429.7	1,371.2	462.3	15.1	16.5	42.3	67.4	3,567.6
	% GDP by Industry (Manufacturing)	19.7%	23.3%	27.1%	23.9%	18.7%	17.2%	11.6%	8.8%	26.3%	25.6%	13.0%
	% GDP by Industry (Services)	71.6%	50.9%	56.1%	42.4%	42.9%	61.2%	32.5%	40.3%	41.9%	39.4%	49.6%
	Population (million)	5.9	35.6	71.6	101.3	281.2	115.8	0.46	7.8	17.4	54.5	1,438.1
	Total energy consumption (TJ)	0.8 mil TJ	2.5 mil TJ	4.1 mil TJ	3.0 mil TJ	6.8 mil TJ	1.5 mil TJ	0.06 mil TJ	0.1 mil TJ	0.3 mil TJ	0.8 mil TJ	28.1 mil TJ
Necessity of Energy Decrease	Energy intensity** (kWh/$)	1.91	1.52	1.23	1.49	0.8	0.56	N/A	2.66	1.08	0.58	0.96
	Rate of renewable energy	4%	19%	10%	22%	13%	22%	0.1%	76%	24%	44%	18%
	Trade Value of Electricity Import (Mn US$)	24.00	1.05	2,007.81	171.7	56.2	0	0	0	332.6	23.57	9.5

*Note: Base year of nominal GDP, % GDP by Industry, total energy consumption, energy intensity and electricity import is 2022. Base year of population is 2024.
**Note: Energy intensity refers to the amount of energy used to produce a given level of output or activity (GDP). Using more energy to produce a product or provide a service results in higher energy intensity.
Source: Author.

1.6.1.1. Summary of Key Findings and Selection of Target Countries

Firstly, countries with low total energy consumption were expected to have a small market size and were therefore, excluded from the subsequent survey (Singapore, Philippines, Brunei Darussalam, Lao PDR, Cambodia, Myanmar). On the other hand, Malaysia, Thailand, Viet Nam, and Indonesia have a smaller energy consumption than India, but the GDP of their manufacturing and services industries, where the introduction of heat pumps and once-through boilers is expected, is relatively high, so it was judged that the market size for these solutions is potentially large and warrants a further consideration.

Table 2.2: Selection of Target Countries – Energy Market Size

Category	Quantitative Factor*	Countries										
		SG	MY	TH	VN	ID	PH	BN	LA	CM	MM	IN
Energy Market size	Nominal GDP (bn US$)	498.5	418.9	515.0	429.7	1,371.2	462.3	15.1	16.5	42.3	67.4	3,567.6
	% GDP by Industry (Manufacturing)	19.7 %	23.3 %	27.1 %	23.9 %	18.7 %	17.2 %	11.6 %	8.8 %	26.3 %	25.6 %	13.0 %
	% GDP by Industry (Services)	71.6 %	50.9 %	56.1 %	42.4 %	42.9 %	61.2 %	32.5 %	40.3 %	41.9 %	39.4 %	49.6 %
	Population (million)	5.9	35.6	71.6	101.3	281.2	115.8	0.46	7.8	17.4	54.5	1,438.1
	Total energy consumption (TJ)	0.8 mil TJ	2.5 mil TJ	4.1 mil TJ	3.0 mil TJ	6.8 mil TJ	1.5 mil TJ	0.06 mil TJ	0.1 mil TJ	0.3 mil TJ	0.8 mil TJ	28.1 mil TJ

Source: Author.

Next, energy intensity was analysed where a high energy intensity indicates that a country is paying a higher price for the energy it needs for its economy, and the higher the energy intensity, the greater the demand for energy-saving equipment such as heat pumps and once-through boilers. Singapore, Malaysia, Thailand, Viet Nam, and Lao PDR were selected from this perspective.

Singapore and Lao PDR are excluded from the subsequent survey due to Singapore's relatively higher energy price and small economy, and Lao PDR's high energy intensity, which was because its GDP is smaller than that of other countries.

Table 2.3: Selection of Target Countries – Necessity of Energy Decrease

Category	Quantitative Factor*	Countries										
		SG	MY	TH	VN	ID	PH	BN	LA	CM	MM	IN
Necessity of Energy Decrease	Energy intensity** (kWh/$)	1.91	1.52	1.23	1.49	0.8	0.56	N/A	2.66	1.08	0.58	0.96
	Rate of renewable energy	4%	19%	10%	22%	13%	22%	0.1 %	76%	24%	44%	18%
	Trade Value of Electricity Import (Mn US$)	24.0	1.1	2,007.8	171.7	56.2	0	0	0	332.6	23.6	9.5

Source: Author.

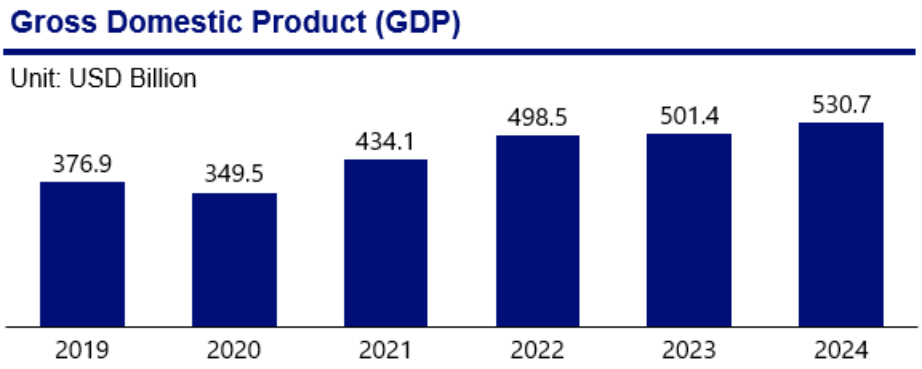
Therefore, the final selection of countries for the next step of qualitative assessment will be Malaysia, Thailand, Viet Nam, Indonesia, and India.

1.6.1.2. Detailed Findings by Country

I. Singapore

Singapore is a highly developed, free-market economy known for its strong and stable macroeconomic environment, and strategic location as a global trade hub.

Figure 2.2: Gross Domestic Product (GDP) of Singapore, 2019–2024



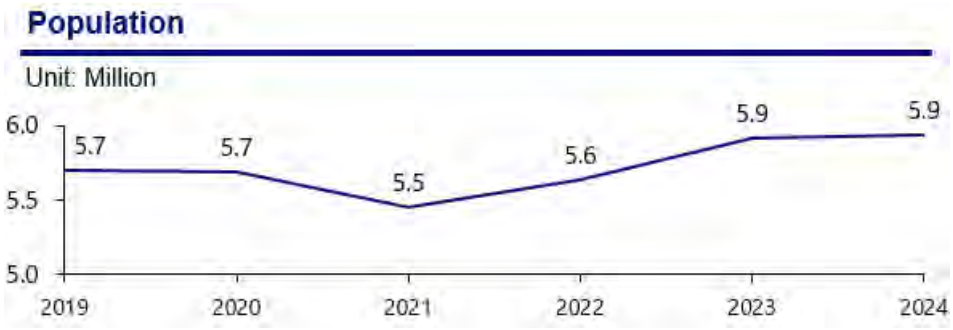
Source: World Bank (Verified in 2025).

Consequentially, Singapore has historically achieved robust GDP growth (7.1% CAGR over the last 5 years), driven by a pro-business environment and strong financial sector performance. GDP is expected to continue its growth momentum, supported by the easing of global financial conditions and the government's continual investment into the economy.

When we consider the % GDP by industry, Singapore's economy in 2022 was heavily driven by services (71.6%) and manufacturing (19.7%). The economic constituents were largely similar from 2018 to 2022[1].

[1] World Bank Open Data, https://databank.worldbank.org/reports.aspx?source=2&series=NY.GDP.MKTP.CD,NV.AGR.TOTL.ZS,NV.IND.TOTL.ZS,NV.IND.MANF.ZS,NV.SRV.TETC.ZS,NV.SRV.TOTL.ZS#

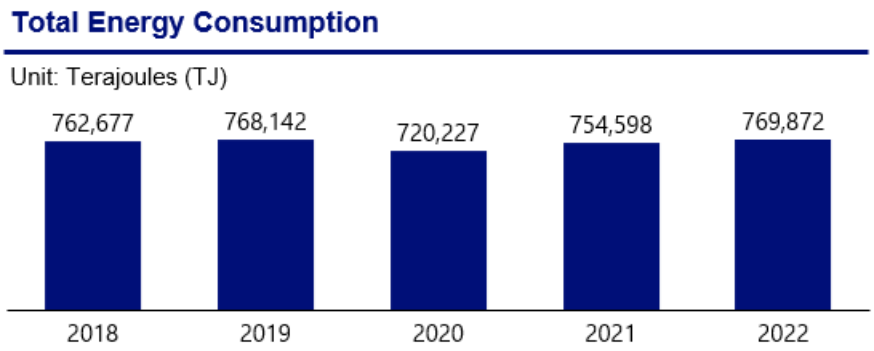
Figure 2.3: Population of Singapore, 2019–2024



Source: World Bank (Verified in 2025).

As of 2024, Singapore has a stable population of approximately 5.9 million and is expected to experience slow growth, likely to cross 6M by 2025. There was an anomalous decrease in pandemic-stricken 2021–2022 due to substantial proportion of non-residents (~30% of total population) leaving the country.

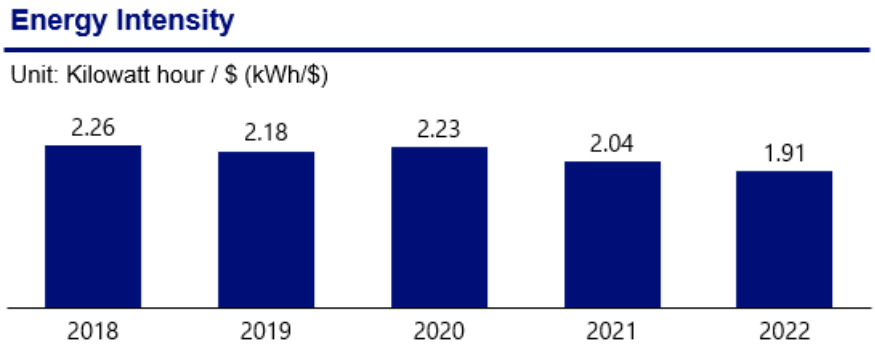
Figure 2.4: Total Energy Consumption in Singapore, 2018–2022



Source: IEA (n.d.)i, (Verified in 2025).

Singapore's total energy consumption has remained relatively stable since 2018, ranging around 720,227 TJ – 769,872 TJ annually. This highlights the need for Singapore to focus its efforts to balance economic growth with energy efficiency and sustainability initiatives.

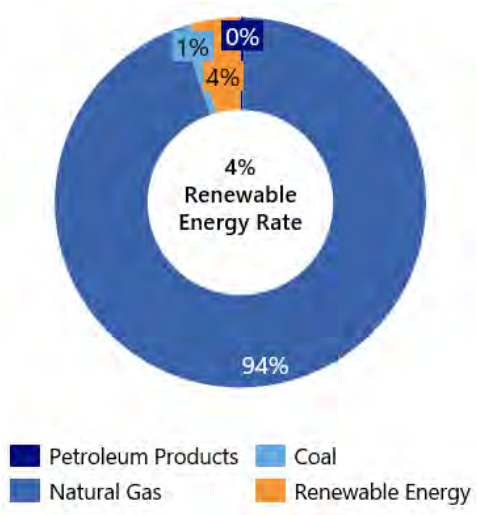
Figure 2.5: Energy Intensity of Singapore, 2018–2022



Source: Our World in Data (2023).

Singapore's energy intensity ranged from 2.26 kWh/US$ in 2018 to 1.91 kWh/US$in 2023, showing improved energy efficiency over time. This improvement reflects the country's ongoing efforts to enhance energy efficiency and transition towards a more sustainable energy system.

Figure 2.6: Singapore's Electricity Generation Sources, 2023



Source: Energy Market Authority (Verified in 2025).

In 2023, Singapore's energy mix is still predominantly generated by natural gas accounting for 94.5%, renewable energy accounted for 4.3%, while coal (0.9%) and petroleum products (0.4%) accounted for the rest. Singapore overwhelmingly relies on solar energy in its renewable energy generation.

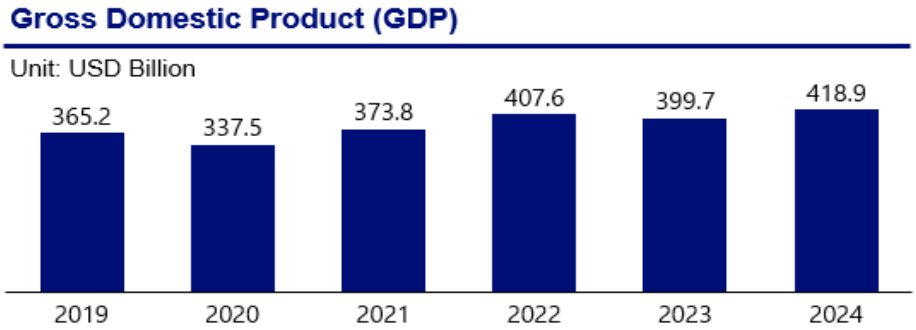
Singapore's electricity imports have been relatively small. The trade value from 2019 to 2021 was negligible while it spiked to US$24 million in 2022. Hence, electricity imports

are carried out on a supplementary needs basis and are not primarily dependent on by Singapore[2].

II. Malaysia

Malaysia is an emerging, upper-middle-class economy, and one of the world's top exporters of semiconductor devices and palm oil.

Figure 2.7: GDP of Malaysia, 2019–2024



Source: World Bank (Verified in 2025).

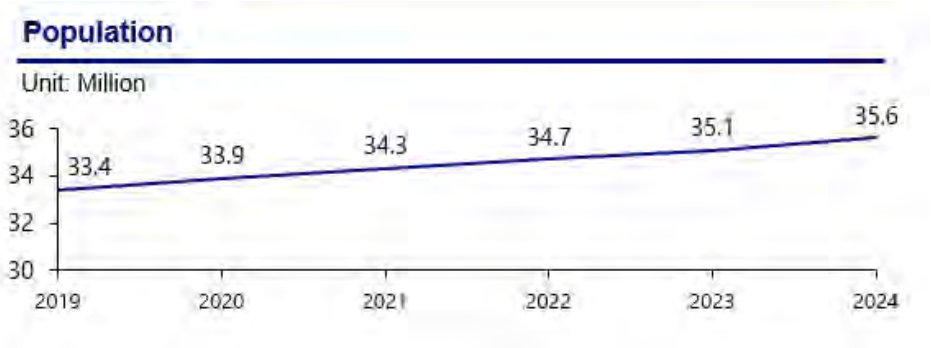
In recent times, Malaysia has experienced strong GDP growth (5.6% CAGR over the last 5 years), driven by a stabilising political environment, productive government infrastructure spending, and robust labour market conditions. Malaysia's cost advantages in land, electricity, and water, as well as its low exposure to natural disasters, make the country an increasingly attractive hub for data centre relocation. Coupled with its strong foothold in semiconductor manufacturing, Malaysia is primed to significantly benefit from the global tech upcycle and sustain its robust GDP growth trajectory.

Malaysia's economy in 2022 was primarily driven by services (51%), followed by manufacturing (23%). This composition has remained relatively consistent since 2018.[3]

[2] World Integrated Trade Solution, https://wits.worldbank.org/trade/comtrade/en/country/ALL/year/2023/tradeflow/Imports/partner/WLD/product/271600

[3] World Bank Open Data, https://databank.worldbank.org/reports.aspx?source=2&series=NY.GDP.MKTP.CD,NV.AGR.TOTL.ZS,NV.IND.TOTL.ZS,NV.IND.MANF.ZS,NV.SRV.TETC.ZS,NV.SRV.TOTL.ZS#

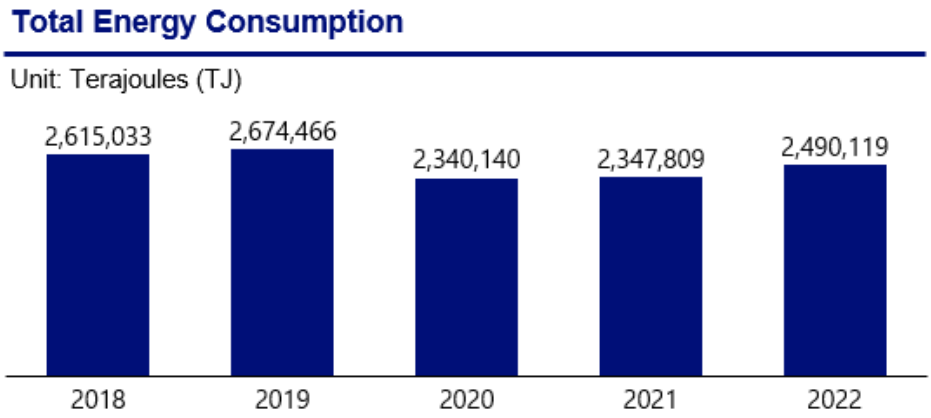
Figure 2.8: Population of Malaysia, 2019–2024



Source: World Bank (Verified in 2025).

Malaysia's population has increased steadily from 33.4 million in 2019 to 35.6 million in 2024 (1.2% CAGR over the last 5 years), driven by strong fertility rates.

Figure 2.9: Total Energy Consumption in Malaysia, 2018–2022



Source: IEA (n.d.)f, (Verified in 2025).

Malaysia's total energy consumption has remained relatively stable, trending between 2.3 and 2.7 million TJ annually. This is primarily driven by efforts to promote energy efficiency and conservation as key principles alongside economic growth.

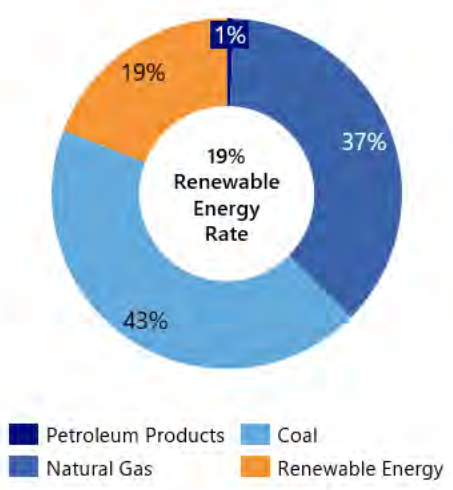
Figure 2.10: Energy Intensity of Malaysia, 2018–2022



Source: Our World in Data (2023c).

Despite strong GDP growth, Malaysia has managed to decrease its energy intensity from 0.42 kWh/$ in 2019 to 0.37 kWh/$ in 2023, successfully decoupling economic growth from energy consumption. This was driven by nation-wide efforts to improve energy efficiency, such as the National Energy Efficiency Action Plan enacted in 2019.

Figure 2.11: Malaysia's Electricity Generation Sources, 2023



Source: IEA (n.d.)f, (Verified in 2025).

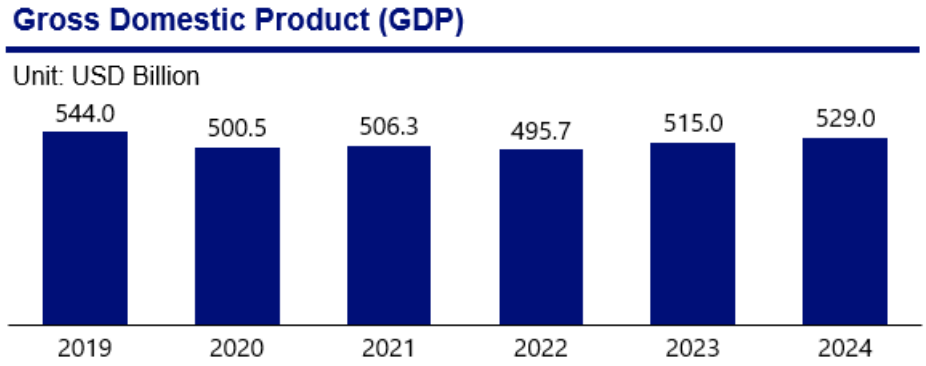
Malaysia's energy mix is predominantly composed of coal (43.4%) and natural gas (36.9%), which together account for majority of the country's electricity generation. Renewable energy sources contribute 19.1%, with hydropower being the dominant renewable source.

Since 2018, Malaysia's electricity imports have been nominal, valued between only US$1 million to US$2.5 million annually. This suggests that Malaysia is primarily self-sufficient for domestic electricity needs and only imports electricity as a diversification measure.[4]

III. Thailand

Thailand is a country with diverse economy driven by tourism, manufacturing, agriculture, and services.

Figure 2.12: Gross Domestic Product (GDP) of Thailand, 2019–2024



Source: World Bank (Verified in 2025).

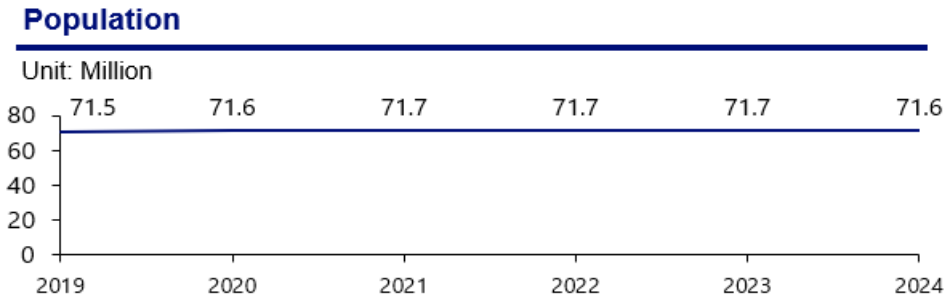
However, it's GDP has shrunk slightly (–0.6% CAGR over the last 5 years), due to slowdown in key industries such as tourism and services, which are major contributors to Thailand's economy because of the COVID-19 pandemic.

The primary driver of Thailand's economy in 2022 was services (56%), followed by manufacturing (27%). The economic constituents have largely remained consistent from 2018 to 2022.[5]

[4] World Integrated Trade Solution, https://wits.worldbank.org/trade/comtrade/en/country/ALL/year/2023/tradeflow/Imports/partner/WLD/product/271600

[5] World Bank Open Data, https://databank.worldbank.org/reports.aspx?source=2&series=NY.GDP.MKTP.CD,NV.AGR.TOTL.ZS,NV.IND.TOTL.ZS,NV.IND.MANF.ZS,NV.SRV.TETC.ZS,NV.SRV.TOTL.ZS#

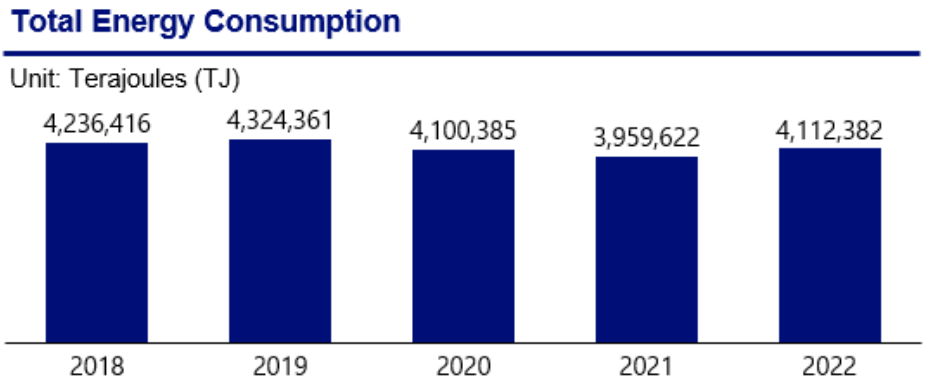
Figure 2.13: Population of Thailand, 2019–2024



Source: World Bank (Verified in 2025).

Thailand has maintained a stable population over the recent 5 years hovering around 71.6 – 71.7 million. However, it is expected to decline given the ageing population and decreasing fertility rates as the country continues to modernise.

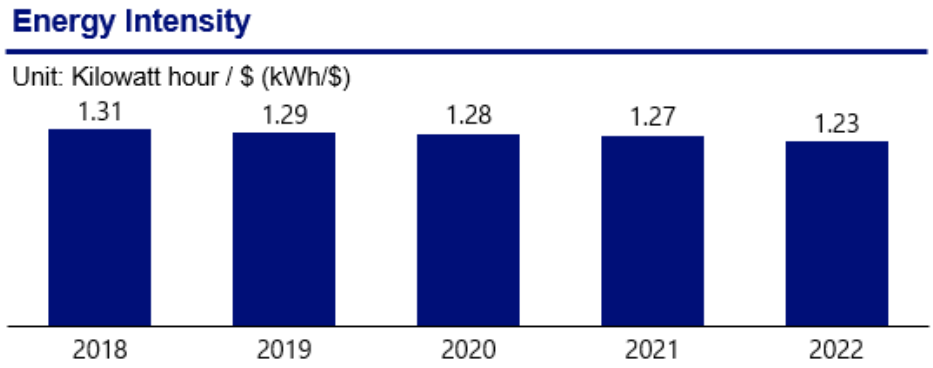
Figure 2.14: Total Energy Consumption in Thailand, 2018–2022



Source: IEA (n.d.)j, (Verified in 2025).

Thailand's total energy consumption has historically averaged around 4 to 4.3 million TJ annually. In 2022, Thailand's total energy consumption increased from 3.96 million TJ the previous year to 4.11 million TJ, primarily driven by a rebound in industrial and transport consumption following the COVID-19 pandemic.

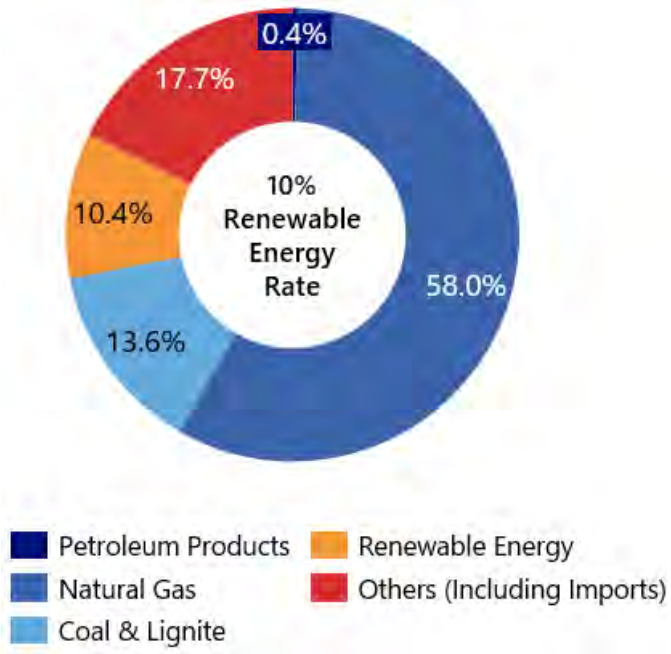
Figure 2.15: Energy Intensity of Thailand, 2018–2022



Source: Our World in Data (2023).

Thailand's energy intensity has improved steadily from 1.31 kWh/$ in 2018 to just 1.23 kWh/$ in 2022, signalling the success of energy efficiency initiatives, including the Ministry of Energy's 20-Year Energy Efficiency Development Plan.

Figure 2.16: Thailand's Electricity Generation Sources, 2023



Source: Energy Policy and Planning Office (Verified in 2025).

In 2023, Thailand's energy mix is still predominantly generated by natural gas accounting for 58.0%, while renewable energy only accounted for 10.4%. Energy from Biomass is expected to dominate Thailand's renewable energy sector, followed by Solar.

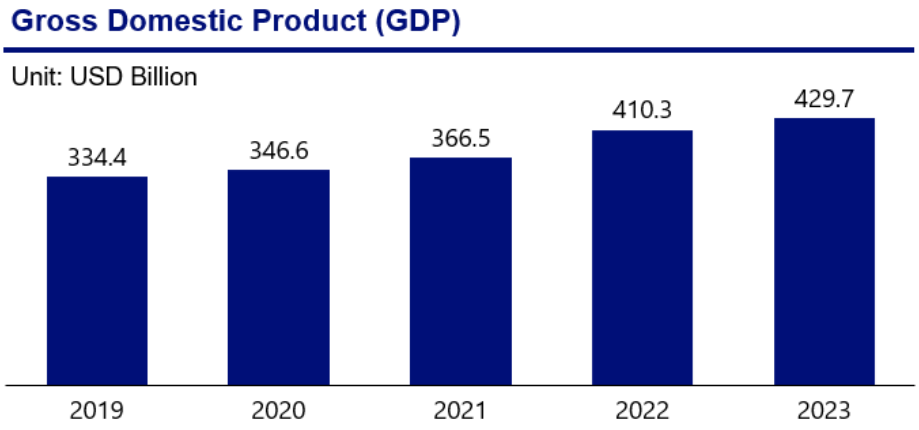
Historically, Thailand has been increasing their electricity imports, rising from US$1 Billion in 2016 to US$2 Billion by 2022. This growth is largely sustained by the Thai government's push to accelerate the clean energy transition, primarily through long-term hydroelectricity purchase agreements with neighbouring Lao PDR and Myanmar, both of which are leading hydroelectricity producers in the region.[6]

IV.Viet Nam

Viet Nam's economy has experienced significant growth of average 6–7% annually. The economy is diversified across various sectors, with manufacturing contributing 23.9% and services accounting for 42.4% in 2023.

Over the past few decades, Viet Nam has effectively leveraged its key advantages to become a major player in global supply chains, with its role gaining even more prominence amid the 'China Plus One' production relocation strategy. Viet Nam's manufacturing sector is a key driver of its economy, contributing significantly to GDP and exports, with a focus on both low-cost labour-intensive industries like textiles and electronics, and a growing trend towards high-tech, value-added manufacturing.

Figure 2.17: Gross Domestic Product (GDP) of Viet Nam, 2019–2023

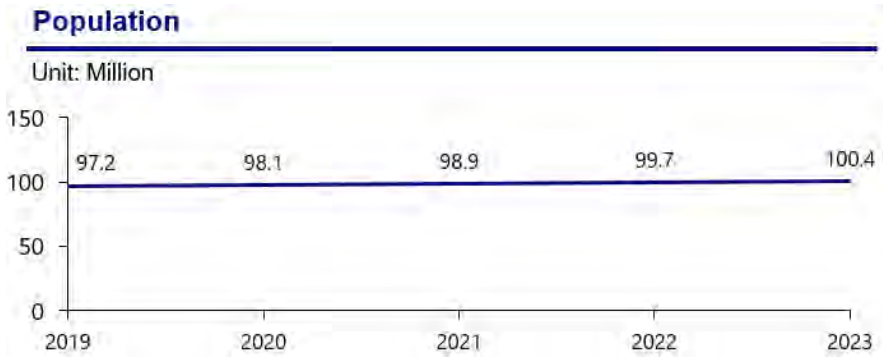


Source: World Bank (Verified in 2025).

Viet Nam's population growth has been steady over the years, although it is showing signs of slowing down due to a combination of declining birth rates and an ageing population. Compound annual growth rate of population from 2019–2023 was 0.8%, which is slower than the growth rates seen in previous decades.

[6] World Integrated Trade Solution, https://wits.worldbank.org/trade/comtrade/en/country/ALL/year/2023/tradeflow/Imports/partner/WLD/product/271600

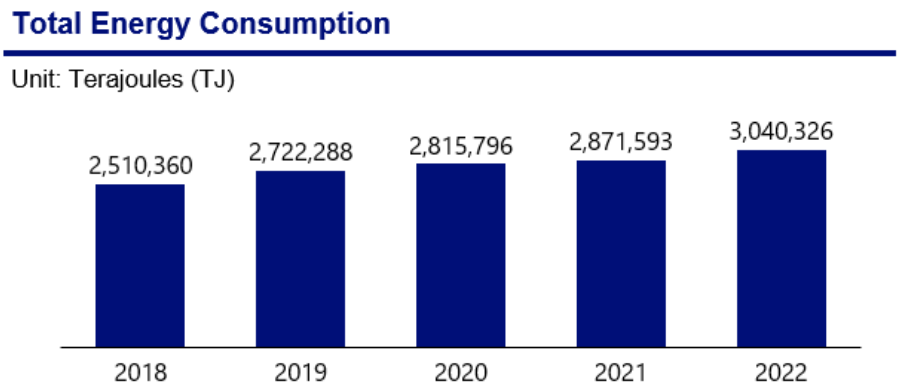
Figure 2.18: Population of Viet Nam, 2019–2023



Source: World Bank (Verified in 2025).

Viet Nam's energy consumption has experienced significant growth over the past decades, driven by rapid industrialisation and economic development. Compound annual growth rate for energy was 4.9% from 2018–2022, and this trend is expected to continue going forward.

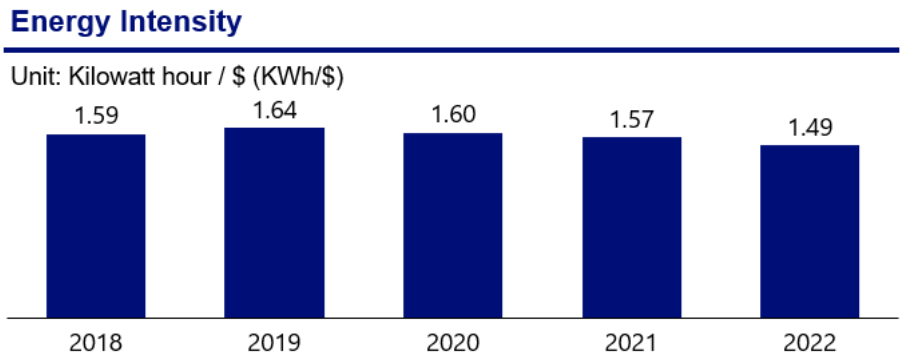
Figure 2.19: Total Energy Consumption in Viet Nam, 2018–2022



Source: IEA (n.d)k, (Verified in 2025).

Viet Nam's energy intensity, defined as energy consumption per unit of economic output, has been notably higher than global averages, reflecting its rapid industrialisation and energy consumption patterns. Addressing the high energy intensity is crucial for Viet Nam to enhance energy efficiency and align with global sustainability goals.

Figure 2.20: Energy Intensity of Viet Nam, 2018–2022

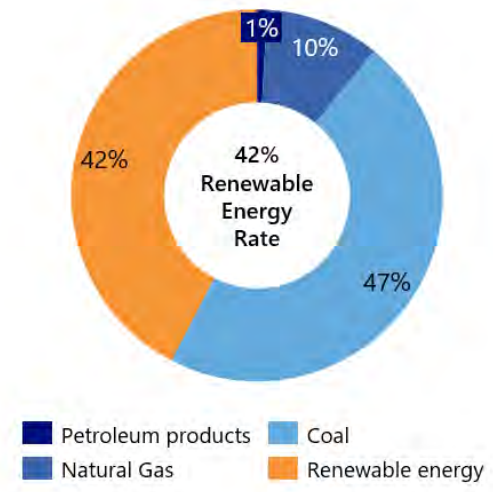


Source: Our World in Data (2023).

Viet Nam's electricity generation has experienced significant growth and diversification in recent years. While coal remains a dominant energy source, there were notable strides made in renewable energy, especially solar power and wind energy. The government's strategic plans aim to modernise the energy infrastructure, reduce reliance on fossil fuels, and meet the growing power demands of its manufacturing sector.

Viet Nam's electricity demand is projected to grow by 12–14% annually, driven by its ambitious economic growth targets. While Viet Nam is developing its own power sources, including renewable energy, some projects are facing delays, and existing hydropower sources are being fully utilised. Hydropower is a main contributor to power generation, however, the increasing frequency of droughts and prolonged dry seasons due to climate change have led to declining hydropower output in recent years, especially in the North.

Figure 2.21: Viet Nam's Electricity Generation Sources, 2023



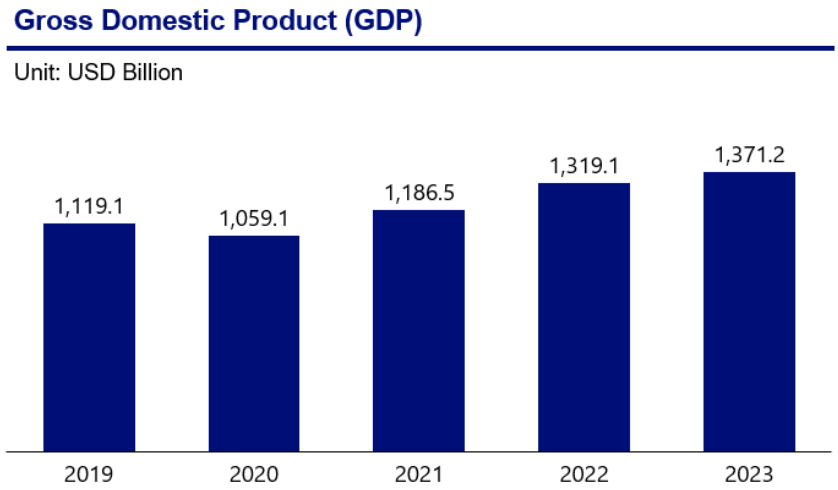
Source: LowCarbonPower (Verified in 2025).

In the long term, Viet Nam is facing challenge meeting the high-power demand, leading to potential shortage. Annual electricity imports from China and Lao PDR are expected to increase to 3,000 megawatts (MW) by 2025 and 5,000 MW by 2030 from the current about 1,000 MW.

V. Indonesia

Over the past decade, Indonesia's economic growth has generally been strong, averaging around 5% annually. Indonesia's economy is characterised by a mix of sectors, with services, manufacturing, and other industrial activities (including mining) being major contributors.

Figure 2.22: Gross Domestic Product (GDP) of Indonesia, 2019–2023

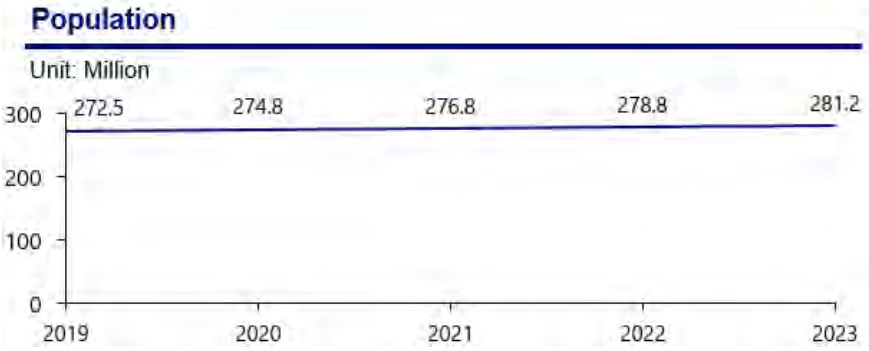


Source: World Bank (Verified in 2025).

Indonesia's manufacturing sector is a significant economic driver, contributing 18.7% to the country's GDP and employing a large workforce, with major industries including food & beverages, textiles, electronics, and automotive. The government aims to further strengthen this sector to achieve its 'Golden Indonesia 2045' vision, targeting a 28% GDP contribution.

As of 2023, Indonesia's population is estimated to be approximately 281 million people, making it the fourth most populous country in the world, after China, India, and the United States. Population growth rate averages 0.8% in the past 5 years.

Figure 2.23: Population of Indonesia, 2019–2023

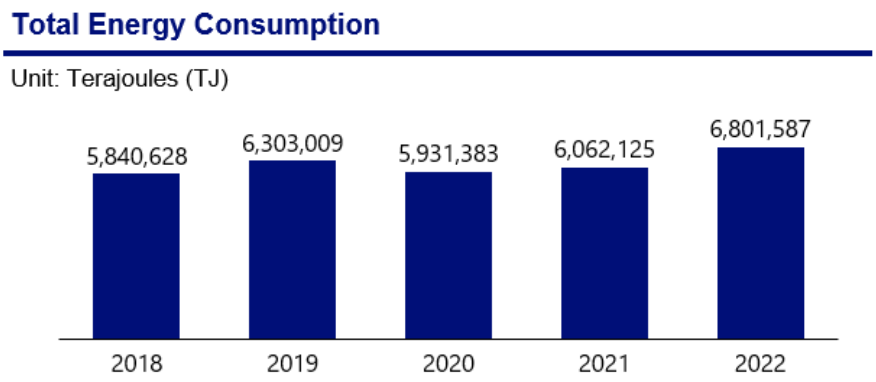


Source: World Bank (Verified in 2025).

Indonesia's energy consumption has experienced substantial growth over the past decades, reflecting its economic development and increasing energy demands.

Industry sector is the most significant user of energy, which accounted for 42% of total energy consumption in 2022.

Figure 2.24: Total Energy Consumption in Indonesia, 2018–2022

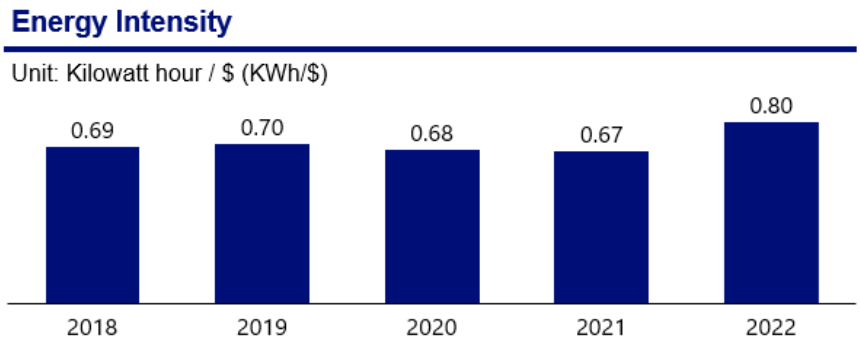


Source: IEA (n.d.)d, (Verified in 2025).

Indonesia's energy intensity (at current price) has fallen 22%[7] from 2020–2022. It is attributed to both improvements in energy efficiency within industries and a shift towards less energy-intensive industries.

[7] https://www.iea.org/countries/indonesia

Figure 2.25: Energy Intensity of Indonesia, 2018–2022

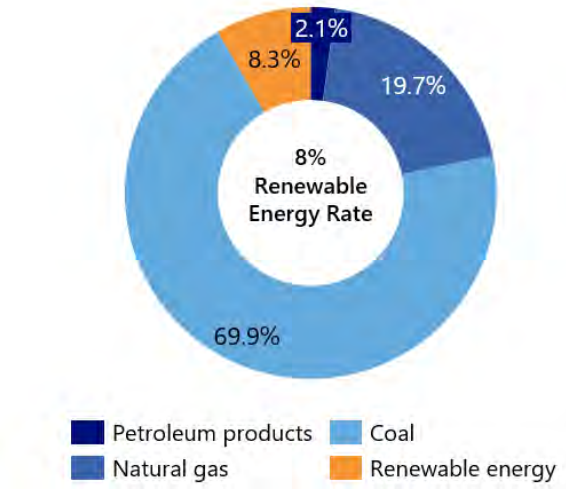


Source: Our World in Data (2023).

The country heavily relies on fossil fuels, particularly coal, for electricity generation. Indonesia's electricity generation is predominantly reliant on fossil fuels, with coal being the most significant contributor. In 2023, coal accounted for approximately 70% of the country's electricity production.

The government has recognised the need to transition towards renewable energy sources and has set ambitious targets to diversify its energy mix.

Figure 2.26: Indonesia's Electricity Generation Sources, 2023



Source: Our World in Data (n.d.)b, (Verified in 2025).

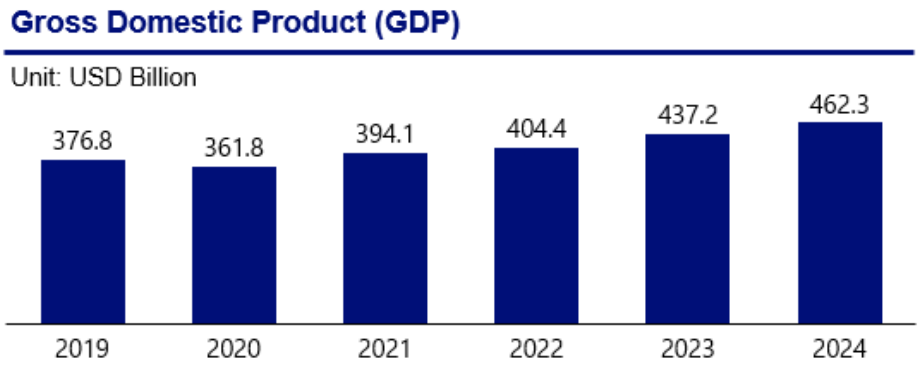
Indonesia does not face power shortage. Indonesia's electricity supply has been outpacing demand, especially in Sumatra and Java.[8]

[8] Institute for Essential Services Reform, https://iesr.or.id/en/indonesias-electricity-challenges-how-to-overcome-excess-electricity-supply/

VI.Philippines

Philippines is a developing, middle-income economy largely focused on its services sector, driven by its global leadership in Business Process Outsourcing and Information & Technology.

Figure 2.27: GDP of Philippines, 2019–2024



Source: World Bank (Verified in 2025).

Philippines is amongst the fastest-growing economies in Asia (5.2% CAGR over the last 5 years), driven by government investments in public infrastructure and exceptional growth in digital financial services. Strong growth momentum is expected to continue as the Philippine central bank loosens monetary policy to spur domestic consumption and investments.

Additionally, Philippines' economy is primarily driven by the services sector (61%), followed by manufacturing (17%). This has remained largely consistent since 2018.[9]

[9] World Bank Open Data (n.d.), https://databank.worldbank.org/reports.aspx?source=2&series=NY.GDP.MKTP.CD,NV.AGR.TOTL.ZS,NV.IND.TOTL.ZS,NV.IND.MANF.ZS,NV.SRV.TETC.ZS,NV.SRV.TOTL.ZS#

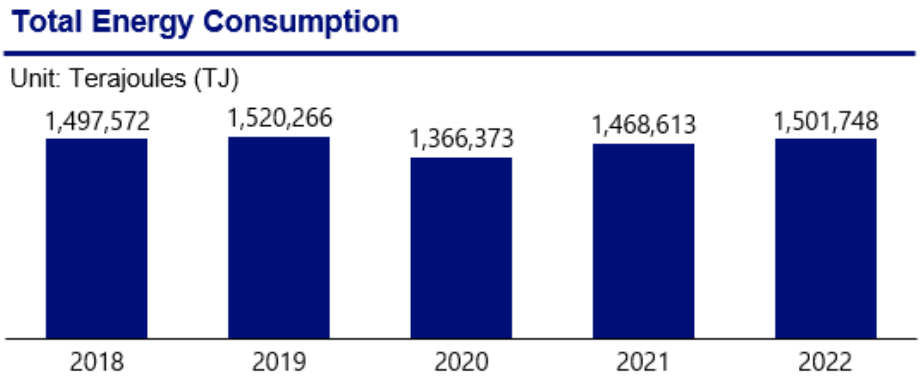
Figure 2.28: Population of Philippines, 2019–2024



Source: World Bank (Verified in 2025).

Despite being the 2nd most populous country in ASEAN and ranking 14th globally, the Philippines is experiencing a slowing population growth rate (0.8% CAGR over the last 5 years). This decline is largely attributed to socioeconomic progress, leading to improved access to family planning and greater female participation in the workforce.

Figure 2.29: Total Energy Consumption in Philippines, 2018–2022



Source: IEA (n.d.)h, (Verified in 2025).

The Philippines' total energy consumption has largely trended around the 1.5 million TJ level, although there was a significant dip to 1.37 million TJ in 2020, largely driven by a sharp decline in transport energy consumption due to pandemic lockdowns.

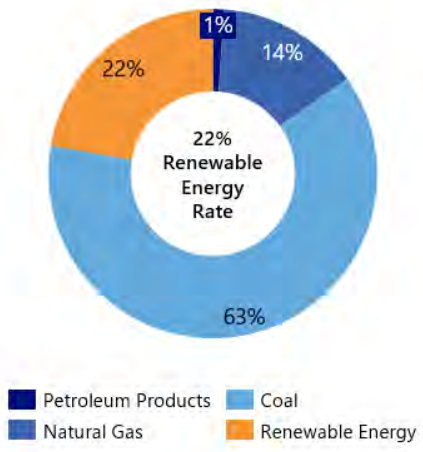
Figure 2.30: Energy Intensity of Philippines, 2018–2022



Source: Our World in Data (2023d).

Philippines has maintained a consistent energy intensity of approximately 0.56 to 0.59 kWh/$ over recent years, underscoring the effectiveness of the government's strategies in promoting economic growth by managing energy consumption.

Figure 2.31: Philippines' Electricity Generation Sources, 2023



Source: Department of Energy (2024).

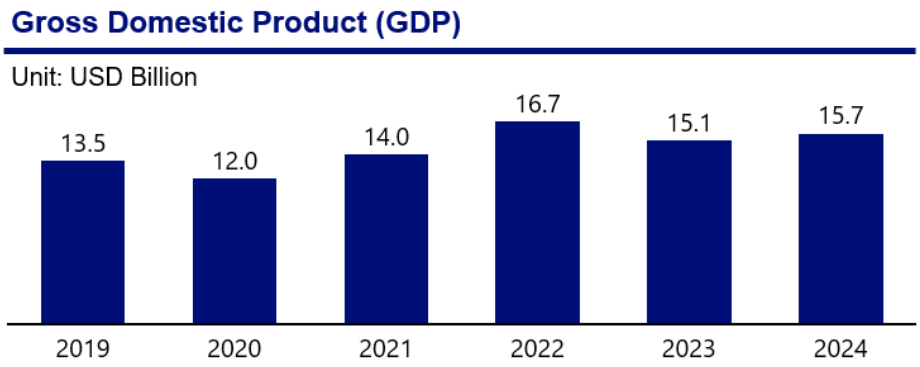
Coal remains the dominant source of energy (62.5%) for the Philippines, although there is also strong contribution from renewable sources (22.3%) and natural gas (14.1%). The bulk of Philippines' renewable energy is generated from geothermal (40.8%) and hydropower (39.1%).

The Philippines does not import any electricity, highlighting the country's self-sufficiency in meeting their own domestic electricity demand.[10]

VII. Brunei Darussalam

Brunei Darussalam is a developed, high-income country. A substantial proportion of the Bruneian economy is fuelled by the country's vast natural resources of crude oil and natural gas.

Figure 2.32: GDP of Brunei Darussalam, 2019–2024



Source: World Bank (Verified in 2025).

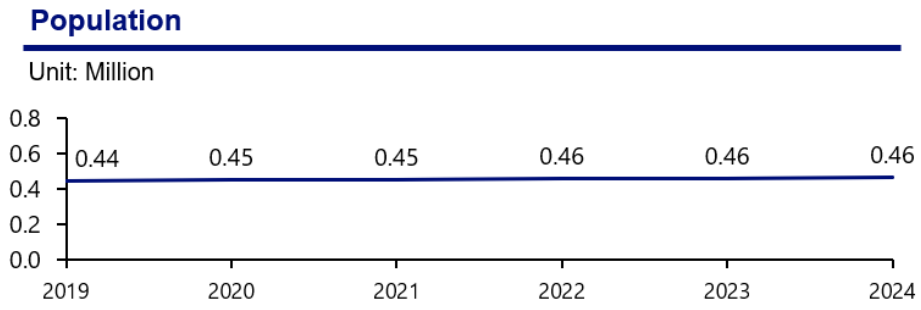
The country's GDP has historically fluctuated between US$12.0 and 16.7 billion, reflecting its dependence on crude oil and natural gas exports. This reliance on hydrocarbons makes the economy highly volatile, as it remains susceptible to external market price changes.

The country's GDP drivers reflect the country's reliance on its natural resources. The Bruneian economy is primarily led by industry (68%), followed by services (33%) and agriculture (1%). Since 2018, there has been a noticeable shift away from services (37% to 33%) into industry (63% to 68%), as the government commences efforts to expand into manufacturing as an attempt to diversify its oil–dependent economy.[11]

[10] World Integrated Trade Solution (n.d.), https://wits.worldbank.org/trade/comtrade/en/country/ALL/year/2023/tradeflow/Imports/partner/WLD/product/271600

[11] World Bank Open Data (n.d.), https://databank.worldbank.org/reports.aspx?source=2&series=NY.GDP.MKTP.CD,NV.AGR.TOTL.ZS,NV.IND.TOTL.ZS,NV.IND.MANF.ZS,NV.SRV.TETC.ZS,NV.SRV.TOTL.ZS#

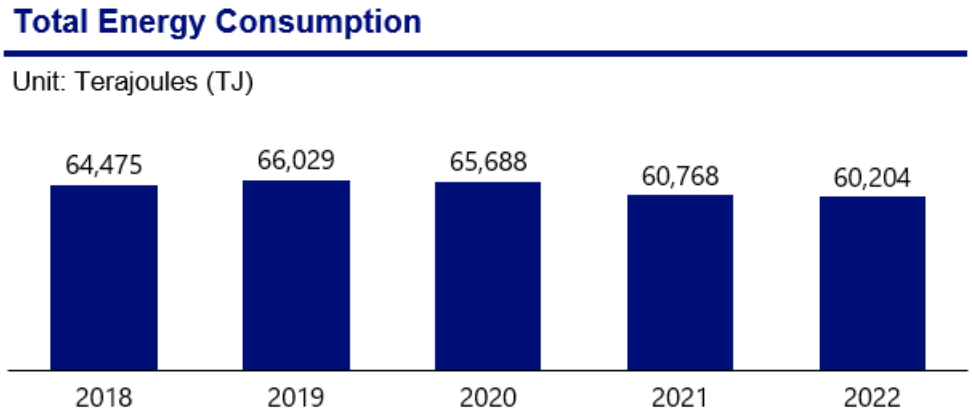
Figure 2.33: Population of Brunei Darussalam, 2019–2024



Source: World Bank (Verified in 2025).

As of 2024, Brunei Darussalam has a relatively small population of approximately 460,000 residents. Its slow population growth (0.8% CAGR over the last 5 years) highlights the country's high level of development, characterised by greater access to education and family planning.

Figure 2.34: Total Energy Consumption in Brunei Darussalam, 2018–2022



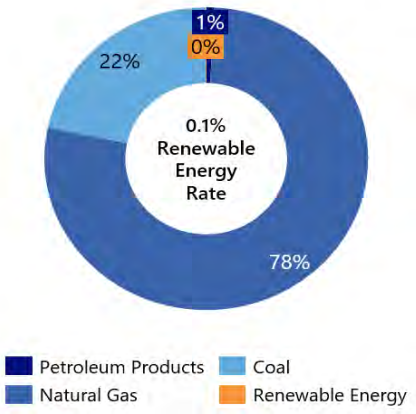
Source: IEA (n.d.)a, (Verified in 2025).

The country's total energy consumption has shown a decrease in recent years, falling from 64,475 TJ in 2018 to just 60,204 TJ, underscoring the country's efforts to improve fuel economy standards.

Energy intensity information is not available. However, the government has been taking the concerted efforts to improve the power efficiency of the country's power stations, including phasing out single-cycle power stations and diesel-powered plants in favour of combined-cycle turbine and co-generation power plants[12].

[12] Ministry of Energy, Brunei Darussalam (2023), Brunei Darussalam Country Report. https://www.eria.org/uploads/media/Books/2023-Energy-Outlook/9_Ch.3-Brunei.pdf

Figure 2.35: Brunei Darussalam's Electricity Generation Sources, 2022



Source: IEA (n.d.)a, (Verified in 2025).

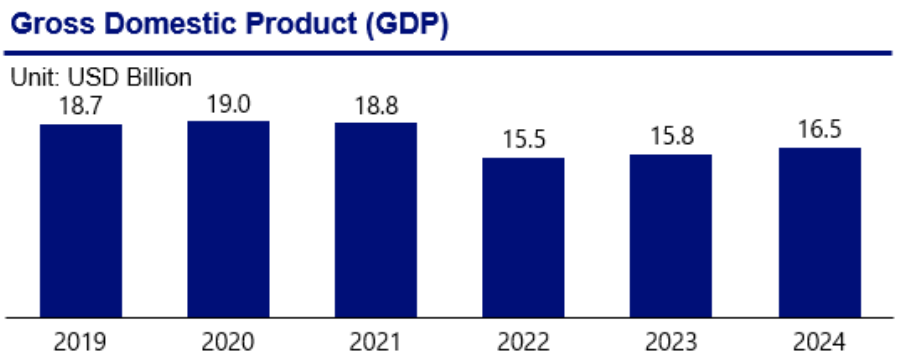
The country's energy mix largely comprises natural gas (77.5%) and coal (21.6%). Brunei Darussalam remains laggard in its transition to clean energy (<0.1%), largely reflecting the country's overall dependence on natural hydrocarbons.

Brunei Darussalam's vast abundance of crude oil and natural gas also means that it can meet its own domestic electricity demands, without needing to import any electricity.[13]

VIII. Lao PDR

Lao PDR is an emerging, lower-middle-income economy predominantly focused on mining of metal resources like copper and tin.

Figure 2.36: GDP of Lao PDR, 2019–2024



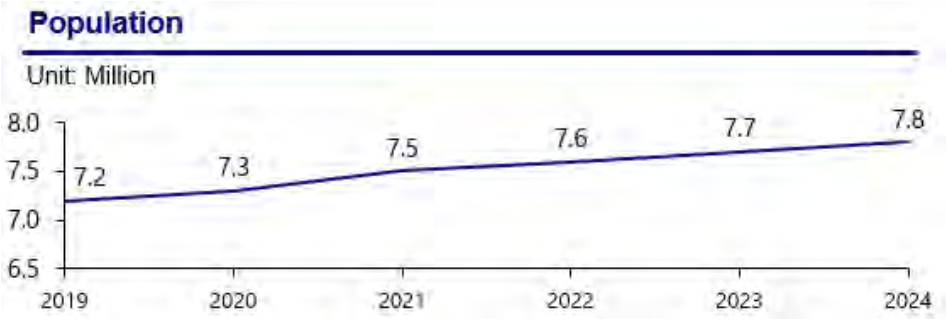
Source: World Bank (Verified in 2025).

[13] World Integrated Trade Solution (n.d.), https://wits.worldbank.org/trade/comtrade/en/country/ALL/year/2023/tradeflow/Imports/partner/WLD/product/271600

Since 2020, Lao PDR has been experiencing a shrinking economy (–3.5% CAGR over the last 5 years), driven by constricted household consumption amid high inflation, inadequate infrastructure, and a rough business environment. In recent years, Lao PDR' economy has shown signs of moderate recovery, with GDP rebounding from a low of US$15.5B in 2022 to US$16.5B in 2024. This turnaround is driven by growth in key sectors such as tourism, logistics, and power.

Lao PDR's economy is still primarily driven by services (40%), although there is strong contribution from other sectors, reflecting the country's developing economic stage. The economic constituents have largely remained consistent from 2018 to 2022.[14]

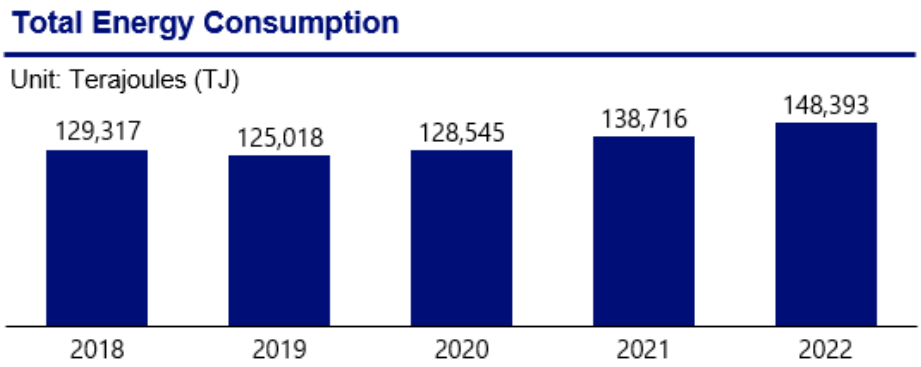
Figure 2.37: Population of Lao PDR, 2019–2024



Source: World Bank (Verified in 2025).

The population of Lao PDR has increased steadily from 7.3 million in 2020 to 7.8 million in 2024, at a 5–year CAGR of 1.6%. This is driven by relatively high fertility rates of a younger population structure, and declining mortality rates due to improvements in the country's public healthcare infrastructure.

Figure 2.38: Total Energy Consumption in Lao PDR, 2018–2022

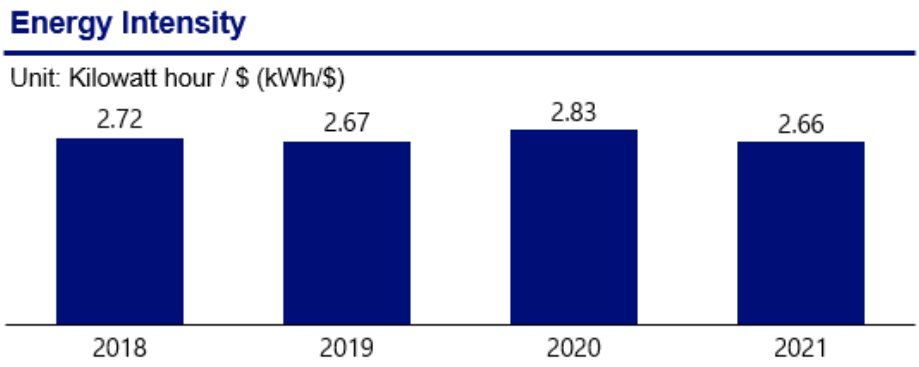


Source: IEA (n.d.)e, (Verified in 2025).

[14] World Bank Open Data (n.d.), https://databank.worldbank.org/reports.aspx?source=2&series=NY.GDP.MKTP.CD,NV.AGR.TOTL.ZS,NV.IND.TOTL.ZS,NV.IND.MANF.ZS,NV.SRV.TETC.ZS,NV.SRV.TOTL.ZS#

Lao PDR' total energy consumption has increased steadily from 129,317 TJ in 2018 to 148,393 TJ by 2022 (3.5% CAGR over the last 5 years). This robust increase is largely attributable to a surge in electricity demand from the country's rapidly expanding yet highly energy-intensive cryptocurrency mining sector.

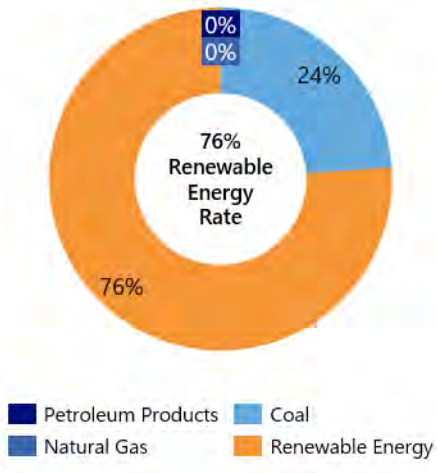
Figure 2.39: Energy Intensity of Lao PDR, 2018–2021



Source: Our World in Data (2023a).

Lao PDR has maintained a stable energy intensity, averaging around 2.66 to 2.83 kWh/$. However, the country's energy intensity remains elevated compared to its ASEAN peers, primarily driven by low GDP levels.

Figure 2.40: Lao PDR' Electricity Generation Sources, 2022



Source: IEA (n.d.)e, (Verified in 2025).

Although Lao PDR is a land-locked country, its favourable position along the Mekong River makes it an attractive location for hydroelectricity generation in Southeast Asia. 75.9% of

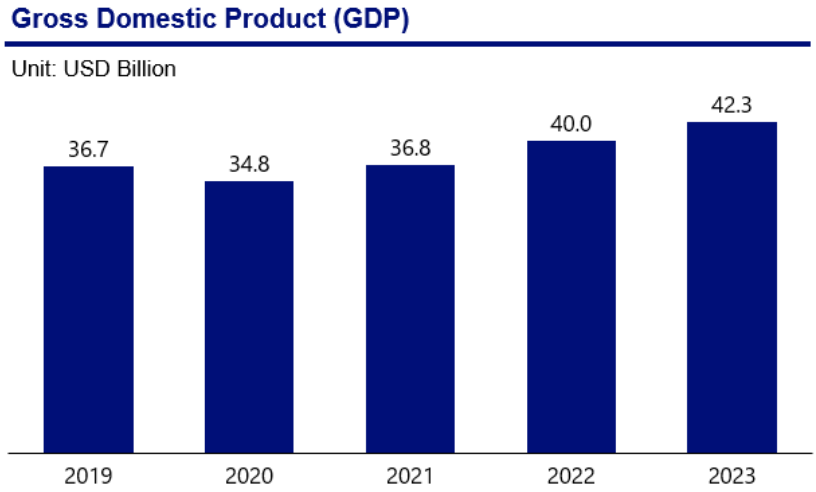
Lao PDR' energy mix comes from hydropower, with coal (23.9%) accounting for the rest. There is no material contribution from oil or natural gas in Lao PDR' energy mix.

IX.Cambodia

Cambodia's economy has shown significant growth over the past decades, although per capita income remains relatively low compared to neighbouring countries. Compound annual growth rate during 2019–2023 was 3.6%.

There has been a shift from agriculture-based economy to a more diversified one, with substantial contributions from industry and services. The industrial sector's prominence is largely due to the growth of manufacturing, particularly textiles and garments, while the services sector encompasses areas like tourism, finance, and real estate. Manufacturing accounted for 26.3% of total GDP in 2023.

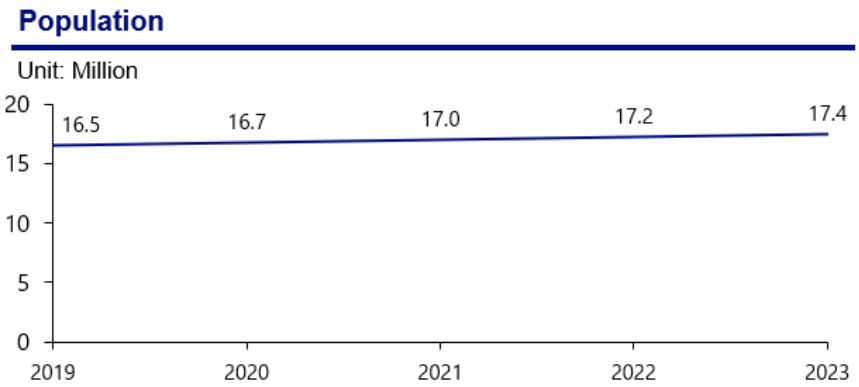
Figure 2.41: Gross Domestic Product (GDP) of Cambodia, 2019-2023



Source: World Bank (Verified in 2025).

Population growth averages 1.4% in the past 5 years. Cambodia's population growth rate has been steadily decreasing in recent years but remains relatively high compared to many other countries.

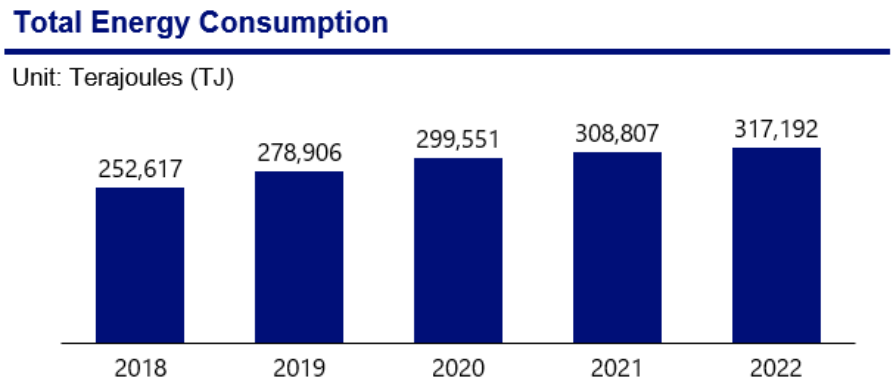
Figure 2.42: Population of Cambodia, 2019–2023



Source: World Bank (Verified in 2025).

Cambodia's energy consumption has experienced significant growth over the past decades, driven by economic development and increased demand for electricity. This growth is primarily attributed to increased industrial activity, urbanisation, and improved access to electricity. However, challenges persist, including high electricity tariffs and limited access in rural areas. To address these issues, Cambodia is investing in renewable energy sources and infrastructure development to meet the rising demand and promote sustainable growth.

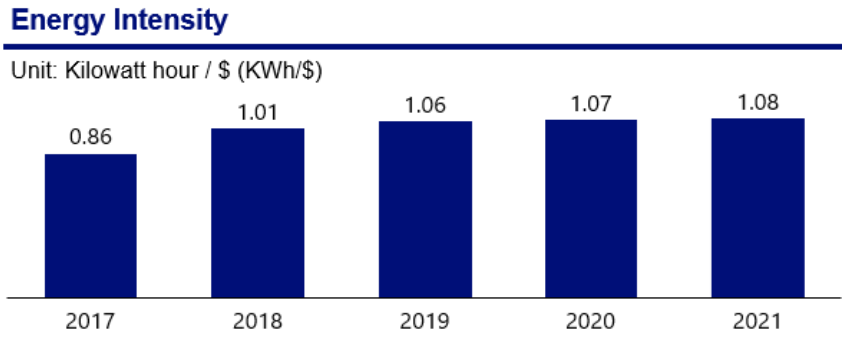
Figure 2.43: Total Energy Consumption in Cambodia, 2018–2022



Source: IEA (n.d)b, (Verified in 2025).

Energy intensity in Cambodia was 1.08 kWh/$ as of 2021, lower than global average of 1.32 kWh/$. However, energy intensity has been increasing, in line with the country's economic growth.

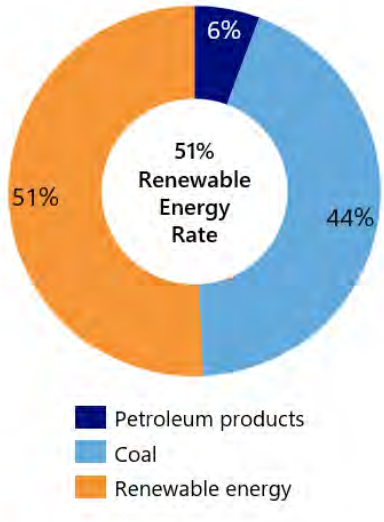
Figure 2.44: Energy Intensity of Cambodia, 2017–2021



Source: Our World in Data (2023).

Cambodia's electricity generation mix has undergone significant changes in recent years, transitioning from a reliance on biomass and oil to a more diversified portfolio that includes coal, hydroelectric power, and solar energy. Hydropower and solar energy are the main sources of renewable energy in the country.

Figure 2.45: Cambodia's Electricity Generation Sources, 2022



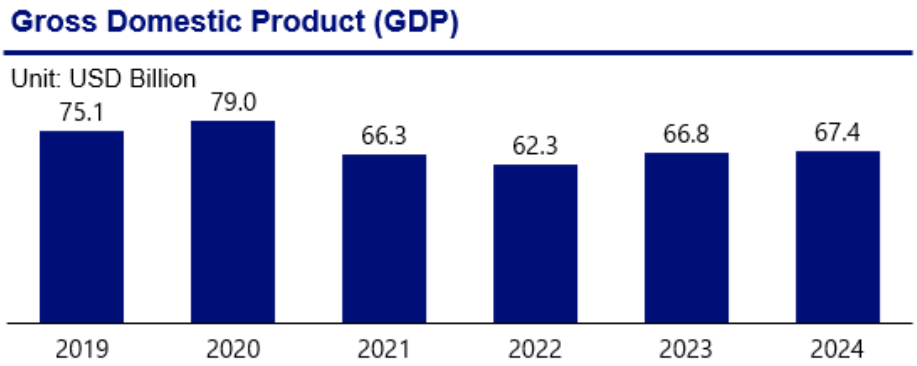
Source: IEA (n.d)b, (Verified in 2025).

Cambodia imports electricity from Lao PDR, Viet Nam, and Thailand, currently at 1,030 MW, and aims to significantly increase imports, particularly of renewable energy, to address growing demand and energy security.

X. Myanmar

Myanmar is an emerging, lower-middle-income economy, primarily focusing on agricultural activities such as crops production of rice, bean, and corn.

Figure 2.46: GDP of Myanmar, 2019–2024

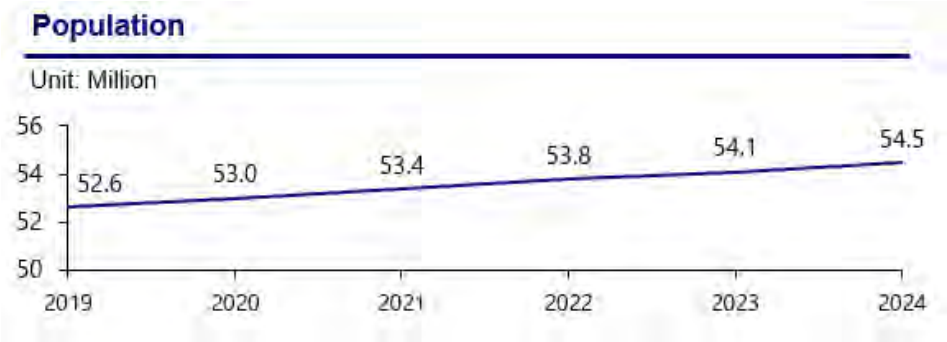


Source: World Bank (Verified in 2025).

Myanmar's economy has constricted since 2020, falling at a CAGR of 3.9% over the last 5 years. This was largely attributable to political turmoil caused by a civil war beginning in 2021. Since then, Myanmar macroeconomic performance has remained subdued by high inflation and unemployment.

Myanmar's GDP breakdown by sector also reflects the economy's developing status. The country is largely driven by services (39%) although there is strong contribution from manufacturing (26%) and agriculture (22%). This composition has also largely remained the same since 2018.[15]

Figure 2.47: Population of Myanmar, 2019–2024



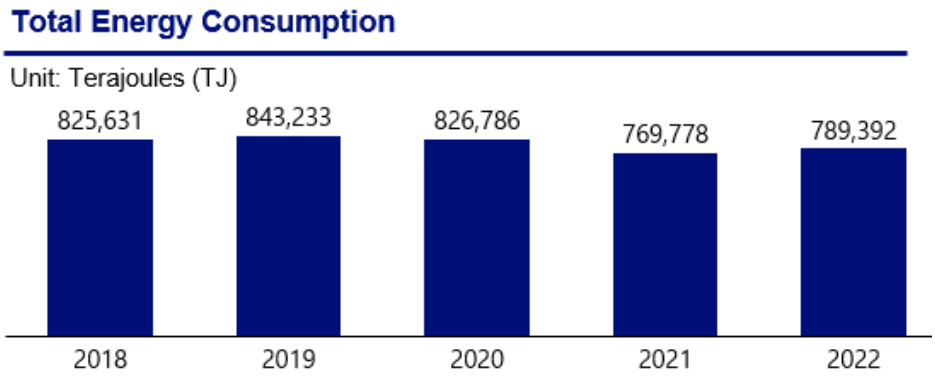
Source: World Bank (Verified in 2025).

Myanmar's population has grown marginally from 52.6 million in 2019 to 54.5 million in 2024 (0.7% CAGR over the last 5 years). This is slower than expected for a developing

[15] World Bank Open Data (n.d.), https://databank.worldbank.org/reports.aspx?source=2&series=NY.GDP.MKTP.CD,NV.AGR.TOTL.ZS,NV.IND.TOTL.ZS,NV.IND.MANF.ZS,NV.SRV.TETC.ZS,NV.SRV.TOTL.ZS#

economy, with population growth depressed by heavy outmigration and a slowdown in fertility rates amid economic instability.

Figure 2.48: Total Energy Consumption in Myanmar, 2018–2022



Source: IEA (n.d)g, (Verified in 2025).

Myanmar has maintained consistent total energy consumption in recent years, ranging between 770,000 TJ and 850,000 TJ. In 2021, Myanmar's energy consumption fell 6.9% from 826,786 TJ the previous year to 769,778 TJ, likely driven by damaged critical transmission networks amidst political conflict.

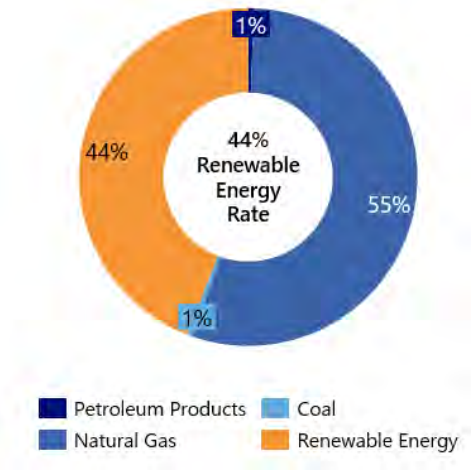
Figure 2.49: Energy Intensity of Myanmar, 2018–2021



Source: Our World in Data (2023b).

Before 2021, Myanmar had shown strong improvement in energy intensity, decreasing from 0.55 kWh/$ in 2018 to 0.49 kWh/$ in 2020. Following the onset of political conflict, it has risen to 0.58 kWh/$, likely driven by softer GDP performance.

Figure 2.50: Myanmar's Electricity Generation Sources, 2022



Source: IEA (n.d.)g, (Verified in 2025).

Natural gas is the dominant source of energy for Myanmar (54.8%), although the country also heavily relies on renewable energy sources (43.4%). Myanmar's main source of renewable energy is hydroelectric power, due to an abundance of high-hydropower potential rivers in the country.

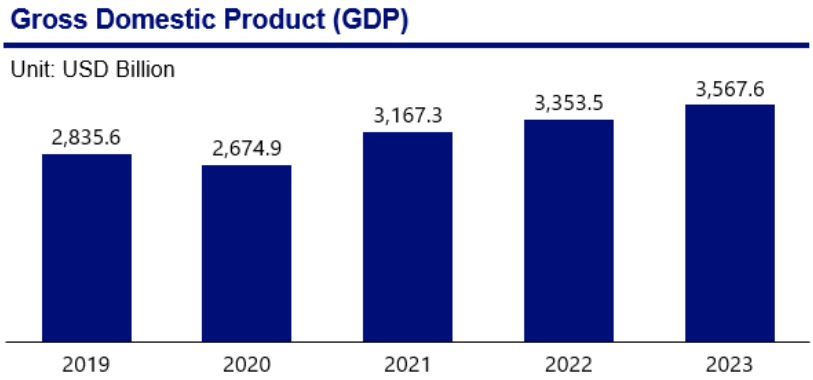
Myanmar imported US$23.6 million of electricity in 2022 and has consistently imported more than US$17 million of electricity annually since 2018. This indicates the country's ongoing challenges in meeting its own domestic electricity demand.[16]

XI. India

India's economy continues to demonstrate significant growth of 5.9% CAGR from 2019–2023, positioning the nation as one of the world's largest and fastest-growing economies. Service sector is the largest contributor to GDP, followed by Industry and Agriculture. India's industrial sector is a pivotal component of its economy, encompassing various industries such as mining, manufacturing, construction, and utilities. Manufacturing accounted for 13% of total GDP in 2023.

[16] World Integrated Trade Solution (n.d.), https://wits.worldbank.org/trade/comtrade/en/country/ALL/year/2023/tradeflow/Imports/partner/WLD/product/271600

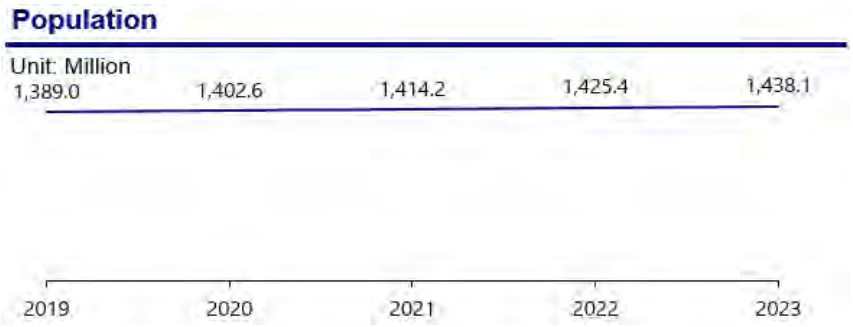
Figure 2.51: Gross Domestic Product (GDP) of India, 2019–2023



Source: World Bank (Verified in 2025).

As of 2023, India's estimated population is approximately 1.44 billion people, making it the world's most populous country. Population CAGR was 0.9% from 2019–2023. With declining birth rate, India's population growth rate has been slowing down.

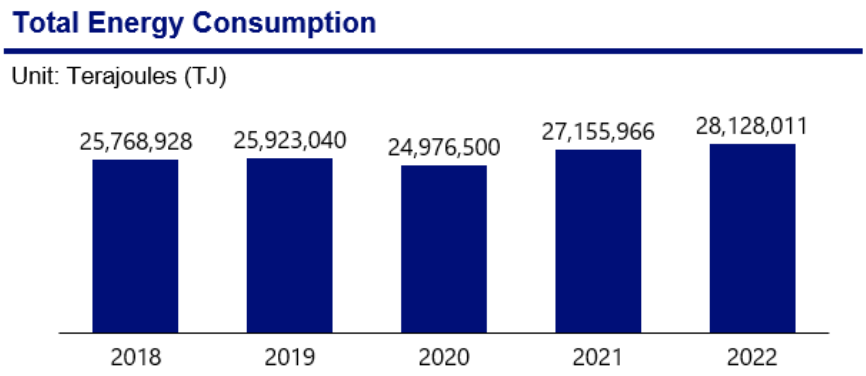
Figure 2.52: Population of India, 2019–2023



Source: World Bank (Verified in 2025).

India's energy consumption has been on the rise, reflecting its growing economy and population. Energy consumption CAGR was 2.2% from 2018–2022. Manufacturing is the largest energy consumer, with industries such as cement, iron, and steel production being particularly energy intensive. The manufacturing sector's rapid expansion has significantly driven up energy demand.

Figure 2.53: Total Energy Consumption in India, 2018–2022



Source: IEA (n.d)c, (Verified in 2025).

India has been active in implementing energy efficiency policies, and the government's financial incentives for energy–efficient projects and clean technologies help make energy efficiency more viable for companies.

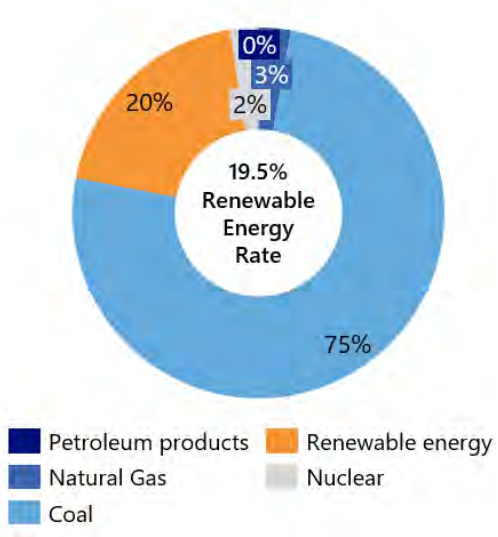
Figure 2.54: Energy Intensity of India, 2018–2022



Source: Our World in Data (n.d.)a

The electricity mix in India is evolving rapidly, with a growing emphasis on renewable energy sources in addition to traditional fossil fuels. However, coal still contributes a significant portion to India's total energy consumption and power generation.

Figure 2.55: India's Electricity Generation Sources, 2023



Source: Our World in Data (n.d.)a, (Verified in 2025).

India imports electricity, primarily from Bhutan and Nepal, especially during the monsoon season when hydropower generation in those countries' peaks, and it also exports electricity to neighbouring countries like Bangladesh and Nepal. India is expected to face increasing evening power cuts by 2027, according to recent research from the India Energy and Climate Centre at the University of California, Berkeley. Despite the projected expansion in coal and gas power, researchers predict a shortfall of 15–20 GW during evening hours.

1.7. Potential Demands in the Southeast Asian Countries (Qualitative factors)

1.7.1. Overview of the Study

Based on quantitative indicators, we have selected Viet Nam, Indonesia, Malaysia, Thailand, and India as the countries within the 10 ASEAN nations plus India that are expected to see an increase in energy consumption and have a high demand for energy reduction. By comparing these countries in terms of the development of relevant policies and standards, as well as the level of environmental awareness, we identified those with the highest potential for the future deployment of heat pumps and once-through boilers.

- Qualitative factors
    - Environmental protection posture
    - Attitude towards energy conservation
    - Requirements for industry standards
    - Possibility of new market entrants providing value to each of the markets

1.7.2. Summary of Key Findings and Selection of Target Countries

Asian countries highlighted in the table are actively pursuing ambitious energy efficiency improvements and carbon neutrality targets between 2050 and 2070. While some nations like Malaysia and Indonesia benefit from energy surpluses, others such as Viet Nam, Thailand, and India face significant energy import challenges, driving a stronger emphasis on efficiency and clean energy adoption. Governments are implementing a variety of regulations, financial incentives, and support programmes to encourage the replacement of inefficient equipment and promote sustainable energy use, reflecting a regional commitment to balancing economic growth with environmental sustainability

Table 2.4: Selection of Target Countries – Qualitative Factors

Country	Environment Plan	Regulations & Incentives	Energy Reserves
Viet Nam	Viet Nam has pledged to achieve net-zero emissions by 2050. Policies to promote energy efficiency have been launched since the early 2000s. The government has set a target of 8–10% (vs 2025) energy reduction by 2030.	The government has set a roadmap for the elimination of low efficiency equipment, and it may require companies to replace old equipment. Funding from international bodies such as the World Bank's $11.3 million for Viet Nam Scaled up Energy Efficiency Project may result in incentives for the adoption of heat pumps and once-through boilers.	Although Viet Nam was an exporter of energy once, it now imports 39% of total energy supply (as of 2022), which has increased the need to improve energy efficiency.
Malaysia	The government has set a target to achieve carbon neutrality by 2050. The transition includes improving energy efficiency and targets a 22% energy saving compared to BAU by 2040.	The Green Technology Financing Scheme, Green Investment Tax Allowance and environmental regulations like the Energy Efficiency and Conservation Act aim to improve overall energy efficiency and promote energy efficient equipment.	Malaysia is a net exporter of energy and has little pressure to decrease energy consumption.
Indonesia	The government set a target to achieve net-zero emissions before 2060.	Energy Efficiency Regulation 33/2023 fiscal and non fiscal incentives. The government may also fund mandatory energy audits for eligible companies.	Although energy demand is expected to increase rapidly along with economic growth, Indonesia has an energy surplus due to the expansion of coal-fired power plants.
Thailand	The government has set a target to achieve carbon neutrality by 2065. Thailand has formulated a draft National Energy Plan 2024 which is a 2.9 trillion-baht (~US$85.9 billion) clean energy plan. This plan aims to	Regulations such as the mandatory energy audit and minimum energy efficiency standards may help to promote heat pumps and once-through boilers. Subsidies for the purchase or tax exemption of energy efficient equipment may be a	Thailand's net energy shortfall has steadily increased from 24.5% to 37.7% and the country relies heavily on energy imports, highlighting the need for energy efficiency improvements.

	improve energy efficiency 30% by 2030.	good incentive to introduce heat pumps and once-through boilers.	
India	India has pledged to achieve net zero carbon emissions by 2070. The National Mission for Enhanced Energy Efficiency is particularly focused on strengthening the market for energy efficiency by creating a conducive regulatory and policy regime.	The government prepared several incentives to improve energy efficiency such as interest subsidies. The Labelling programme and Energy Conservation Building Code run by BEE also promote energy efficient equipment.	India imports large amounts of energy and is targeting 'energy independence' by 2047.

Source: Author.

Detailed Findings by Country

I. Viet Nam

Along with its economic growth, GHG emissions in Viet Nam have risen rapidly, recording a 544% increase from 2000 to 2021. CO_2 emissions of 285Mt CO_2 in 2021 were the second highest in ASEAN.

Under the National Climate Change Strategy, Viet Nam has pledged to achieve net-zero emissions by 2050, along with the transition into a climate resilient economy. Viet Nam has set a goal to reduce national GHG emissions by 43.5% from the Business-As-Usual (BAU) level by 2030 while GHG emissions are expected to peak by 2035 before reaching net zero in 2050. Renewable energy will constitute at least 33% of total electricity generation by 2030, and 55% by 2050. New coal-fired power plants will not be built after 2030, and total capacity will be reduced after 2035.

The government aims to strengthen energy efficiency measures in all sectors, increase the usage of energy efficient technologies and equipment, and enhance the energy efficiency level in boilers, engines, heating and cooling systems. Viet Nam's carbon neutral strategy outlines a plan to peak carbon emissions in 2035. The strategy also includes sector-specific targets, focusing on energy, agriculture, forestry, waste, and industry.

Figure 2.56: Key milestones to achieve carbon neutrality

Goals	2030	2050
% of RE in power generation	33% →	67.5 – 71.5%
Energy consumption reduction vs 2025	8-10%	-
GHG emission reduction	-43% vs BAU →	Net zero

Source: Author (Based on UNFCCC, 2022b).

Policies to promote energy efficiency have been launched since the early 2000s such as the National Climate Change Strategy, the National Green Growth Strategy 2021–2030 and the National Electricity Development Plan until 2030. For example, the Viet Nam National Energy Efficiency Program (VNEEP) was launched in 2006 and had achieved an energy consumption reduction of 3% from 2006–2010, and 6% 2011–2015. Moving forward, VNEEP aims to achieve energy saving of 5%–7% from 2019–2025 and 8%–10% from 2025–2030.

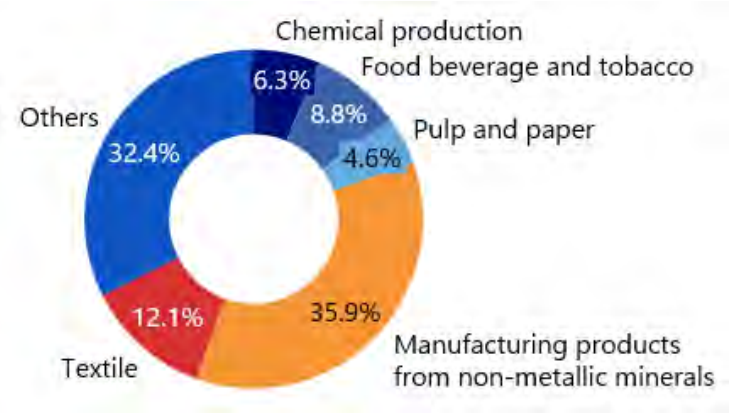
Figure 2.57: VNEEP objectives, 2019–2030

2019–2025	2025–2030
Reduce average energy consumption in industries compared to 2015–2018 by: Steel: 3–10% Chemicals: >7% Plastics: 18–22.46% Cement: >7.5% Textile: >5% Beer, alcohol and beverage: 3–6.9% Paper: 8–15.8%	Reduce average energy consumption in industries compared to 2015–2018 by: Steel: 5–16.5% Chemicals: >10% Plastics: 21.55–24.81% Cement: >10.89% Textile garment: >6.8% Beer, alcohol and beverage: 4.6 – 8.44% Paper: 9.9–18.48%

Source: Ministry of Industry and Trade (2021) VNEEP (Verified in 2025).

The focus of VNEEP is on the industrial sector which accounts for 54% of total energy consumption. The manufacturing products from non-metallic minerals accounted for 35.9% of energy consumption while the textile subsector accounted for 12.1%. The smallest subsector was pulp and paper with only 4.6% of energy consumption but chemical production is similar with 6.3%.

Figure 2.58: Energy consumption by industry subsectors, 2020



Source: Ministry of Industry and Trade, 2024 (Verified in 2025).

Overall, approximately 3,000 companies with major energy consumption are required to produce an annual energy management report and implement activities to achieve energy efficiency. In addition, food processing, chemical and paper industry have strong presence in Viet Nam, which presents significant opportunities for the introduction of heat pumps and once-through boilers.

Viet Nam has also rolled out several regulations to phase out low efficiency equipment and it is evident that financial support is provided mainly by international donors.

Figure 2.59: Summary of key regulations and incentives

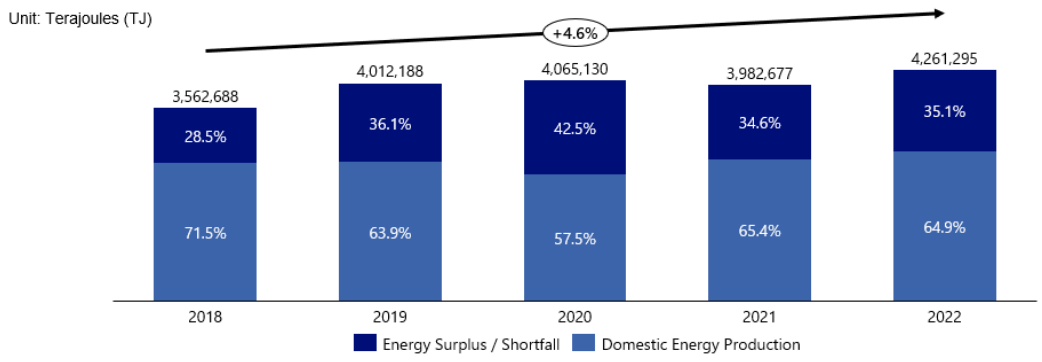
Viet Nam	Regulations and Incentives
Policy	1. National Climate Change Strategy • Emission reduction in Industry by 38.3% from Business-as-usual level by 2030 • Increase the usage of energy efficient technologies and equipment, and enhance the energy efficiency level in boilers, engines, heating and cooling systems. 2. Viet Nam National Energy Efficiency Program (VNEEP) • Objective is to improve energy efficiency in the industrial sector. VNEEP aims to achieve energy saving of 8%–10% from 2025–2030.
Economic Measures	1. VNEEP Funding • Energy efficiency projects can receive funding support from VNEEP 2. Tax incentives • Businesses investing in energy efficiency and renewable energy projects can benefit from preferential corporate income tax rates, including a 10% rate for 15 years, with potential extensions and other incentives • Import tax rebates – equipment, spare parts and material for the development of energy saving technologies that cannot be produced domestically and are on the list prescribed by the Government are exempted from or have reduced import tax 3. Viet Nam Scaling Up Energy Efficiency Project 2019–2025

	• $11.3 million funding from the World Bank, credit guarantee and technical assistance for private enterprises to execute 4. Preferential loans from Viet Nam Development Bank • Lower interest rate from Viet Nam Development Bank for energy efficiency projects
Regulatory Approach	1. Law on Energy Efficiency and Conservation 2010 • Regulates the economical and efficient use of energy; policies and measures to promote the economical and efficient use of energy 2. Decision 14/2023/QD-TTg on roadmap for elimination of low efficiency equipment • Decision 14/2023/QD-TTg provides the list and roadmap for elimination of low-efficiency equipment. The list includes commercial refrigerators and industrial boilers 3. Decision 04/2017/QD-TTg on list of equipment and vehicles required to have energy levels and minimum energy efficiency levels • The list includes commercial refrigerators and air conditioning systems

Source: Author (Based on ASEAN Centre for Energy, 2025).

Lastly, Viet Nam's electricity demand is growing rapidly, outpacing economic growth and creating a strain on the power grid. The development of both traditional and renewable energy projects has been slow, failing to keep pace with increasing demand. Extreme weather events, such as heatwaves and droughts can further strain the power grid and reduce hydropower generation. As demand surpasses supply, Viet Nam has become a net energy importer with its energy imports expanding while exports shrink. For example, they are actively increasing electricity imports, particularly from Lao PDR, to meet growing demand. Therefore, addressing this requires a multifaceted approach, including energy efficiency measures, grid upgrades, and diversifying energy sources.

Figure 2.60: Viet Nam's total energy supply, 2018–2022



Note: Energy Reserves is calculated as Total Energy Supply required in the country (TES) – Domestic Energy Production (DEP) where TES is lower than DEP. If TES is higher than DEP, there is an energy shortfall. If TES is lower than DEP, there is an energy surplus and can be exported.
Source: IEA (n.d.)k, (Verified in 2025).

II. Malaysia

In Malaysia's environment plan, the government has set a target to achieve carbon neutrality by 2050. The government outlined this goal in the National Energy Transition Roadmap (NETR) [17] which covers six energy transition levers: energy efficiency, renewable energy, hydrogen, bioenergy, green mobility, and carbon capture, utilisation and storage (CCUS). Malaysia's NETR Responsible Transition pathways aim to increase the use of renewable energy in the power generation mix, phase out coal from the power generation mix, pursue energy efficiency initiatives and expedite the shift to electrification and biofuels in the transport sector. By 2050, NETR initiatives are expected to deliver a 32% reduction in GHG emissions for the energy sector compared to the 2019 baseline.

Figure 2.61: Key milestones to achieve carbon neutrality

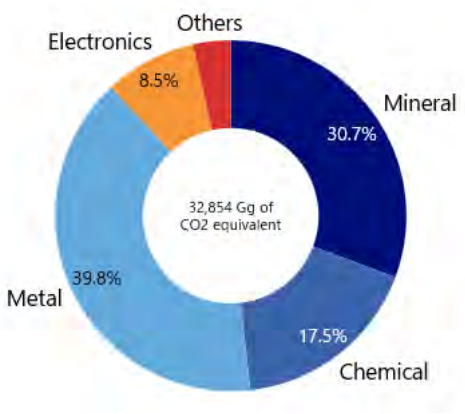
Goals	2030	2050
% of RE in power generation*	30%	70%
GHG emission intensity (vs GDP) reduction	-45% (vs 2005)	Net zero
EV penetration	20%	80%

Source: Author (Based on Ministry of Economy, 2023).

In 2019, the Industrial Processes and Product Use (IPPU) sector contributed 9.94% of Malaysia's total GHG emissions. The metal industry was the leading emitter in this sector, responsible for 39.8% of emissions while the mineral and chemical industries made up 30.7% and 17.5% of emissions, respectively. Emissions from Electronics made up 8.5% while emissions from other sources such as mobile air conditioning, use of electrical equipment and medical application contributed to 3.5% of total emissions.

[17] Ministry of Economy (2023), National Energy Transition Roadmap. https://ekonomi.gov.my/sites/default/files/2023-08/National%20Energy%20Transition%20Roadmap.pdf

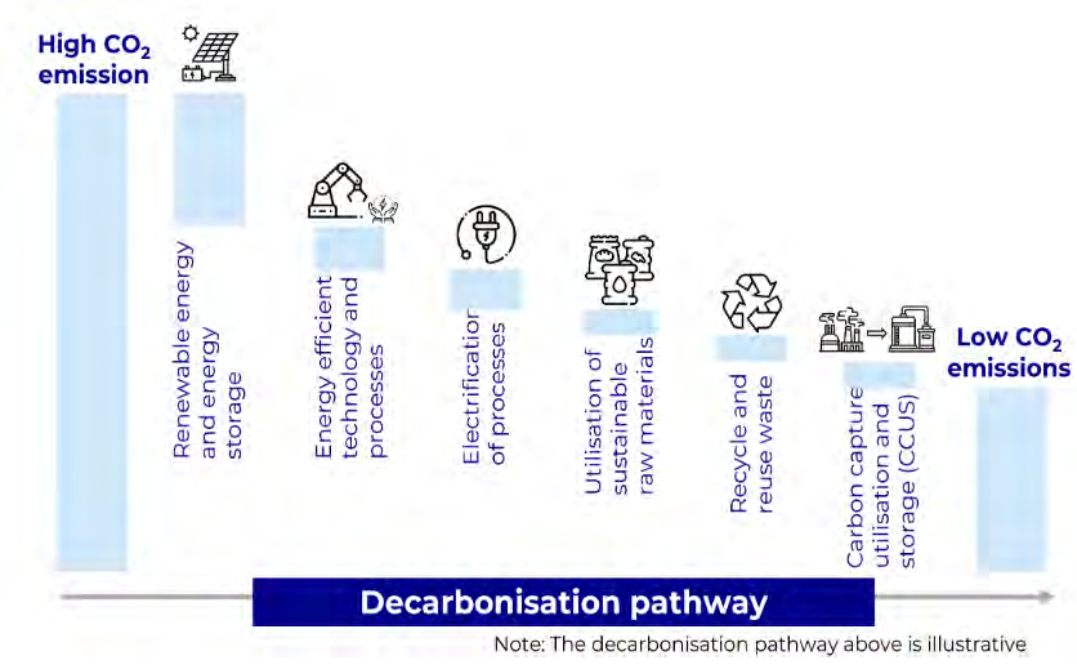
Figure 2.62: GHG emission from the IPPU sector, 2019



Source: Ministry of Natural Resources, Environment and Climate Change (Verified in 2025).

Overall, Malaysia aims to improve energy efficiency in the industrial sector as a means of lowering energy intensity and reducing emissions. NETR is targeting to achieve a 22% energy saving compared to the Business-as-Usual (BAU) scenario by 2040, a significant increase from the previously set goal of achieving 11% energy savings by 2040. In line with NETR, the New Industrial Master Plan 2030 (NIMP) also outlines a mission to decarbonise the manufacturing sector. As such, the push to improve energy efficiency in the industrial sector will open more opportunities for energy efficiency solutions such as heat pumps and once-through boilers.

Figure 2.63: NIMP mission 3: Push for net zero



Source: Ministry of Investment, Trade and Industry (2023).

Also, Malaysia has several schemes in place to provide technical assistance and financing support for businesses to implement energy efficiency solutions.

Figure 2.64: Summary of key regulations and incentives

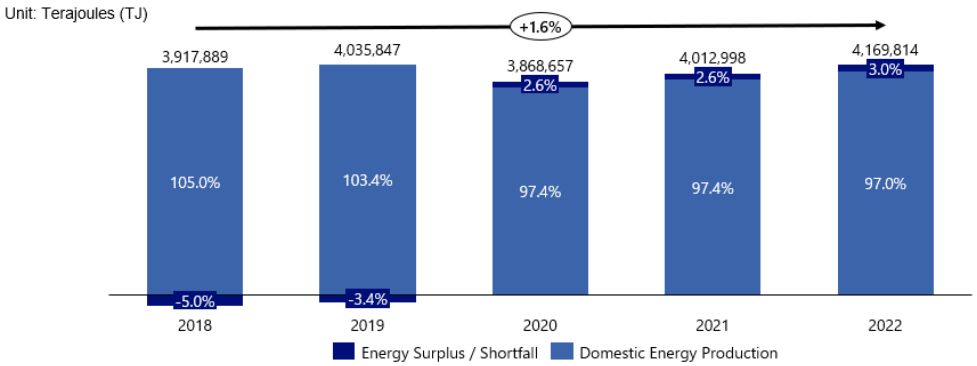
Malaysia	Regulations and Incentives
Policy	1. National Energy Transition Roadmap (NETR) • Target for Malaysia to achieve carbon neutrality by 2050 • Encourages energy efficiency, renewable energy, hydrogen, bioenergy, green mobility, and carbon capture, utilisation and storage (CCUS) 2. New Industrial Master Plan (NIMP) 2030 • 'Push for Net Zero' is a key mission outlined in NIMP. To that end, NIMP plans to create decarbonisation pathway role models for sectors that require showcase references to adopt decarbonisation technologies methodologies including energy efficiency measures, as well as leveraging key enablers such as technical assistance and financing to promote adoption 3. National Energy Efficiency Action Plan 2016–2025 • Targets energy efficiency improvement by promoting energy efficient appliances, introducing Minimum Energy Performance Standards (MEPS), implementing energy audits and management, promoting co-generations, and incorporating energy efficient building design • A second phase of the National Energy Efficiency Action Plan for 2026–2035 is expected to be announced in 2025
Economic Measures	1. Green Technology Financing Scheme • Interest Subsidy guarantee of the loan amount by Danajamin Nasional Berhad for financing for companies and service providers involved in energy efficiency, renewable energy, water, waste management, etc 2. Green Investment Tax Allowance • Tax relief to businesses investing in green technology assets or services that promote energy efficiency and environmental sustainability
Regulatory Approach	1. Energy Efficiency and Conservation Act • Entities consuming a large amount of energy in the manufacturing and commercial sectors are required to conduct regular energy audits through registered auditors as well as Submit an annual energy efficiency report detailing energy consumption and proposed improvements 2. Green building codes for energy-intensive buildings • Mandatory national standard that outlines energy efficiency parameters for both new residential and commercial buildings as well as retrofit for existing building to meet a minimum Building Energy Intensity level

Source: Author (Based on ASEAN Centre for Energy, 2025).

Lastly, Malaysia is a net exporter of energy and has maintained a positive energy reserve over the past 5 years as it possesses significant reserves of oil and natural gas in offshore fields in Sabah and Sarawak. While there is no shortfall in energy, Malaysia plans to reduce its Total Primary Energy Supply (TPES) to deliver a 32% reduction in GHG

emissions for the energy sector by 2050 compared to the 2019 baseline under the National Energy Transition Roadmap (NETR).

Figure 2.65: Malaysia's total energy supply, 2018–2022



Note: Energy Reserves is calculated as Total Energy Supply required in the country (TES) – Domestic Energy Production (DEP) where TES is lower than DEP. If TES is higher than DEP, there is an energy shortfall. If TES is lower than DEP, there is an energy surplus and can be exported.
Source: IEA (n.d)f, (Verified in 2025).

III. Indonesia

Indonesia has made progress in integrating its 2060 net zero goal into the energy sector, targeting energy efficiency and renewable energy as the key strategy. In November 2024, the newly inaugurated President Prabowo made ambitious announcements about the country's energy transition, pledging to retire all fossil fuel and coal-powered plants within 15 years and achieve net-zero emissions before 2050, a decade earlier than previously indicated. The official target is still net zero emissions by 2060, but recent statements from Indonesian leaders indicate the country is exploring the possibility of achieving this goal earlier, potentially by 2055 or even before 2050, contingent on international support and investment.

Indonesia's National Master Plan for Energy Conservation (RIKEN) sets a goal of decreasing energy intensity by 1% annually from 2015 to 2025. Indonesia aims to achieve GHG emission reduction of 358–446 mil tCO_2 by 2030 through the development of renewable energy, energy efficiency and conservation programmes as well as clean technology.

Figure 2.66: Key milestones to achieve carbon neutrality

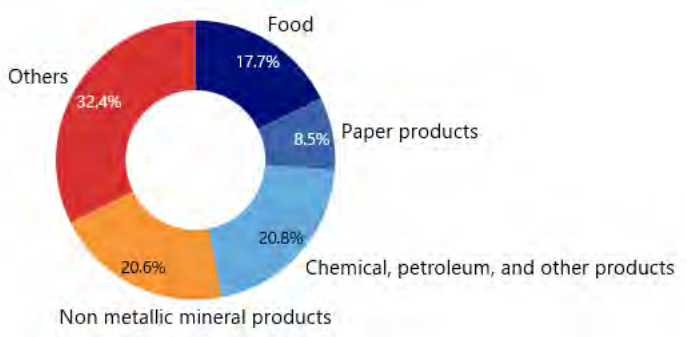
Goals	2030	2050
GHG emission reduction	32% vs Business-As-Usual (or 43% with international support)	Net zero
% of RE in power generation	23% (2025)	31%
EV penetration	20%	100%

Source: Author, based on Ministry of Energy and Mineral Resources, 2024.

Indonesia's manufacturing sector plays a leading role in the economy as it constitutes 18% of GDP. The need to become more sustainable comes from two urgent priorities: decarbonising production and more efficient energy use. The manufacturing sector accounts for approximately 28% of Indonesia's emissions, with the top emitting subsectors including chemical, cement, pulp and paper, food and beverage, iron steel, plastic, soap and detergent and textile.

This presents a significant opportunity: sectors, where energy consumption is high (e.g. chemicals, textile and food and beverage), stand to benefit most from adopting mature technologies such as heat pumps and once-through boilers.

Figure 2.67: Energy consumption by industry subsector, 2015

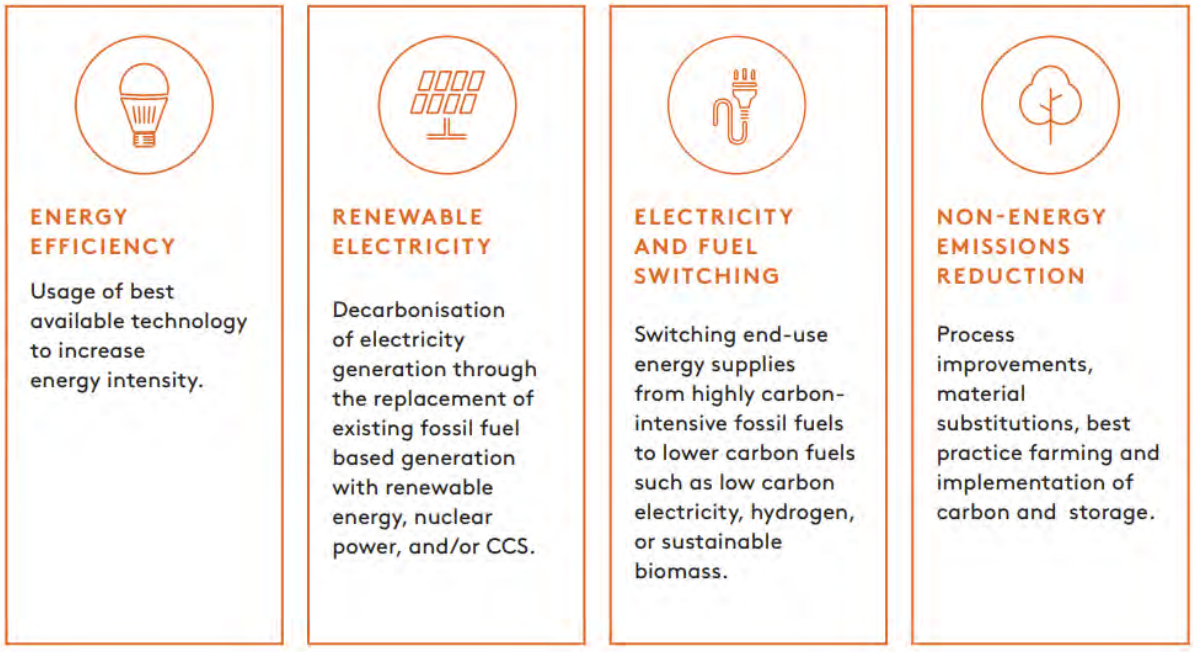


Source: Author, based on Setyawan, 2020. (Verified in 2025).

Indonesia's green industry development strategies, according to the National Industry Development Master Plan (RIPIN) 2015–2035, aims to transform existing industries into green industries and develop new green principles. The initiative facilitates decarbonisation by encouraging assistance from 'green' industry service companies and through certification, such as the Green Industry Certification. Apart from assistance and certification efforts, industry players are left to implement decarbonisation measures

independently. Fully decarbonising entails measures to address the four pillars of decarbonisation as well as material efficiency.

Figure 2.68: Four pillars of decarbonisation



Source: ClimateWorks Centre (2025).

Also, policy frameworks to promote energy efficiency are in place but financing supports comes mainly from international donors and the private sector.

Figure 2.69: Summary of key regulations and incentives

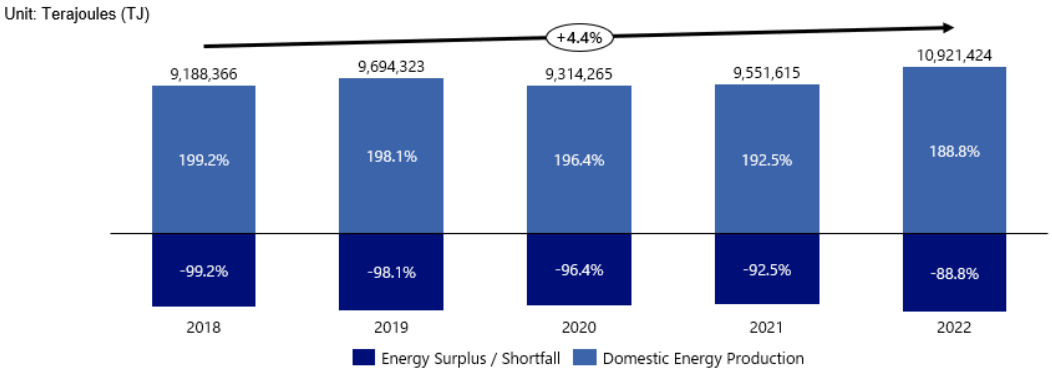
Indonesia	Regulations and Incentives
Policy	1. National Master Plan for Energy Conservation • The programme focuses on the following directions: (i) Standards and labelling (ii) Energy efficient technology implementation (iii) Energy management (iv) Investment on energy efficiency and conservation service business (v) Public awareness enhancement 2. Ministry of Industry's Green Industry initiative • The programme aims to transform existing industries into green industries and develop new green principles 3. National Cooling Action Plan • In 2020, the National Cooling Action Plan was developed. It represents a comprehensive roadmap to achieving sustainable cooling that reduces energy demand and GHG emissions, through the triple strategy of passive cooling, energy efficiency and phase down of climate warming refrigerants • Its implementation could reduce electricity consumption by 57% and mitigate greenhouse gas emissions by 55% in 2040, as compared to business-as-usual.

Economic Measures	1. Asian Development Bank loan • In 2022, the Asian Development Bank approved a $500 million loan to support Indonesia's energy sector reforms to boost fiscal sustainability and governance, expand private sector investments in clean and renewable energy 2. Commercial bank green financing • Various commercial banks have offered green financing and sustainability-linked loans, such as U-Energy from PT Bank UOB which is an integrated financing platform for energy efficiency projects for buildings. 3. Energy Efficiency Regulation 70/2009 • The regulation includes developing and implementing a series of incentives for improved energy management such as tax exemption and fiscal incentives on imports of energy saving equipment and appliances, and low interest rates on investments in energy conservation.
Regulatory Approach	1. Energy Efficiency Regulation 33/2023 • The regulations mandate energy conservation and efficiency improvements, including mandatory energy audits, energy management systems as well as introducing energy conservation standards and energy efficiency labels for products. • Explicit sector-specific thresholds for mandatory energy management: 1. Energy suppliers > 6000 toe per year 2. Transportation Sector > 4000 toe per year 3. Industrial Sector > 4000 toe per year 4. Building Sector: > 500 toe per year • It also recognises Energy Service Companies (ESCOs) as formal partners for financing, installation, operation, and verification of efficiency projects • Around 18% of Indonesia's total energy use in 2018 was subject to mandatory energy efficiency policies. 2. National Energy Policy 2014: • This regulation aims for energy independence and security through energy management based on fairness, sustainability, and environmental soundness.

Source: Author (Based on ASEAN Centre for Energy, 2025).

Lastly, Indonesia has an energy surplus due to the rapid expansion of coal-fired power plants and the government's 35,000 MW electricity construction programme. Energy demand is expected to increase rapidly along with economic growth. At the same time, to enable its energy transition, Indonesia needs to reduce coal usage which will result in more emphasis being placed on energy efficiency. Hence, the government is exploring options like exporting electricity to Singapore and focusing on energy efficiency as well as renewable energy.

Figure 2.70: Indonesia's energy reserve, 2018–2022



Note: Energy Reserves is calculated as Total Energy Supply required in the country (TES) – Domestic Energy Production (DEP) where TES is lower than DEP. If TES is higher than DEP, there is an energy shortfall. If TES is lower than DEP, there is an energy surplus and can be exported.
Source: IEA (n.d)d, (Verified in 2025).

IV.Thailand

In Thailand, the government has an environmental plan which targets to achieve carbon neutrality by 2065. The government outlined this goal in the national policy 'Thailand 4.0' initiative, which emphasises sustainable economic growth and environmental responsibility with aiming to reduce carbon emissions and promote greener practices across industries.

Separately, Thailand has formulated a draft National Energy Plan 2024 under the Energy Policy and Planning Office as a policy framework. This is a 2.9 trillion-baht (~US$85.9 billion) clean energy plan, focusing on renewable energy expansion, grid improvements and private sector investments to guide related agencies towards transformational change to clean energy systems. It also focuses on balancing economic growth with environmental sustainability. There are expected to be initiatives for alternative energy development, energy efficiency, oil, and natural gas. Drafts of these plans have recently been discussed in public hearings and are expected to be implemented by the end of 2024.

Figure 2.71: Key milestones of NEP2024 to achieve carbon neutrality

Target Year	2030	2035	2037
%RE in Power Generation	30%	→	50%
Energy Efficiency	30%	→	36%
Share of EV car	50%	→ 100%*	

*Focus on new cars launched

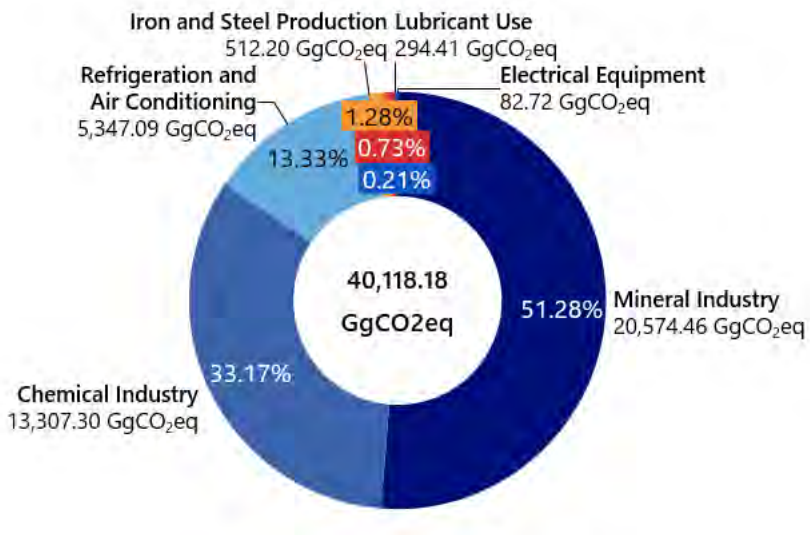
Source: Energy Policy and Planning Office.

To help achieve carbon neutrality, the government is intending to introduce a carbon tax, calculated based on the carbon content of products. Additionally, Thailand will extend its EV incentive programme to drive the adoption of EV cars significantly.

The new National Energy Plan will combine 5 major energy strategies: the Power Development Plan, Alternative Energy Development Plan, Energy Efficiency Plan, Gas Plan, and Oil Plan. These plans will integrate decarbonisation goals for the energy sector. The strategy includes a significant increase in the share of renewable energy in power generation, targeting rapid installation of renewable energy sources, with a goal of at least 50% of new power plants being renewable energy by 2050.

In 2000 and 2018, the Industrial Processes and Product Use (IPPU) sector contributed 8.65% and 10.77% of Thailand's total GHG emissions, respectively. The cement industry was the leading emitter in this sector, responsible for 51.28% of emissions. The chemical industry and the use of products like substitutes for ozone-depleting substances made up 33.17% and 13.33% of emissions, respectively. Emissions from metal production, non-energy products derived from fuels, and other product manufacturing and uses accounted for 2% of the sector's total GHG emissions.

Figure 2.72: GHG emission from the IPPU sector, 2018

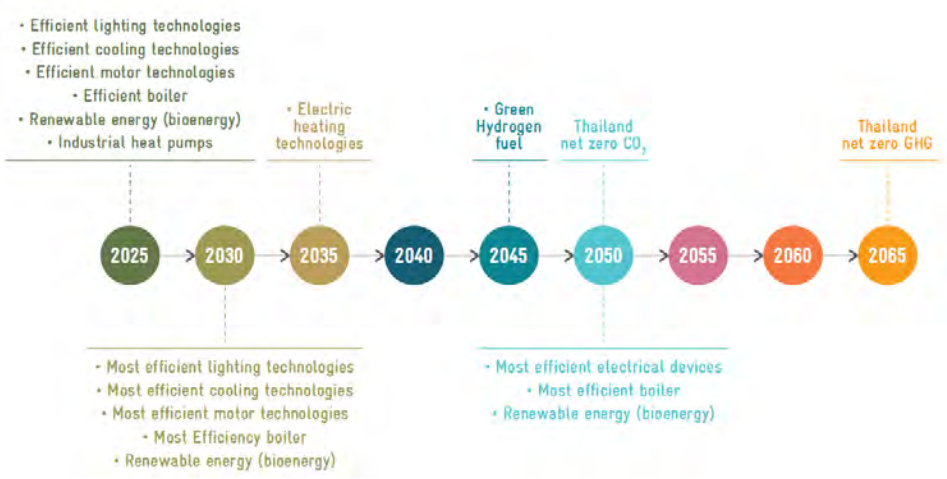


Source: United National Development Programme, 2024 (Verified in 2025).

The figure below outlines the timeline for implementing key GHG reduction measures in manufacturing to achieve net-zero emissions. Thailand's private sector acknowledges that the shift to a low-carbon economy presents numerous opportunities for value creation, improved efficiency, and cost savings. These include enhancing efficiency as industries move toward value-added S-curve sectors under the growth-share matrix, which is developed by Boston Consulting Group, reducing costs through waste recovery,

boosting energy efficiency and green logistics, and accessing new markets for sustainable, climate-friendly products.

Figure 2.73: Net zero GHG emission timeline for manufacturing industries



Source: Ministry of Natural Resources and Environment (2022).

Overall, there are opportunities for climate friendly solutions such as heat pumps and once-through boilers as the industrial sector seeks to reduce costs through waste recovery and boosting energy efficiency. The Thai government plans to collaborate closely with the private sector to develop clear policies and incentives, helping transform financial and investment challenges into opportunities for low-carbon growth.

Thailand has also introduced a range of support programmes and regulations pushing for energy efficient green technologies such as heat pumps.

Figure 2.74: Summary of key regulations and incentives

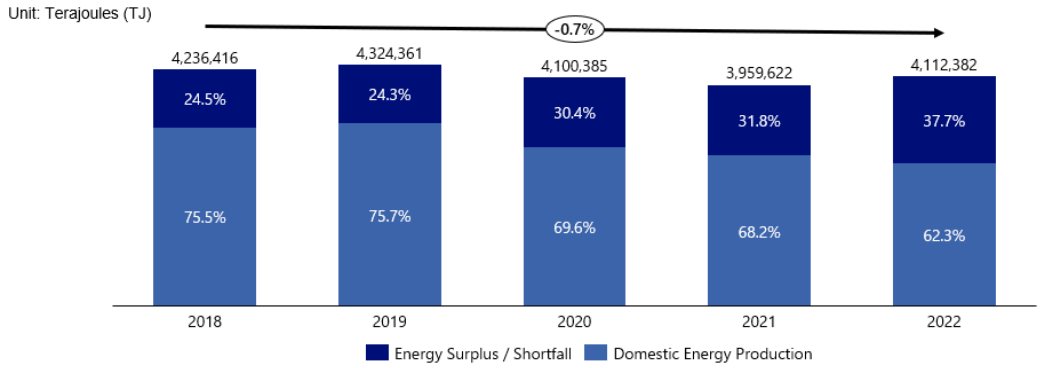
Thailand	Regulations and Incentives
Policy	1. Energy Efficiency Development Plan Promote the adoption of more energy-efficient heat pumps with the goal of achieving an annual energy savings of 14,515 $ktCO_2e$ (kilotons of carbon equivalent) to achieve a 30% reduction in energy intensity by 2036. 2. Alternative Energy Development Plan Goal of 30–35% renewable energy by 2036.
Economic Measures	1. Energy Service Company (ESCO) Fund • Equity investment and low-interest loans of up to THB 25 million for energy conservation projects, potentially including heat pumps. 2. Preferences for energy conservation, alternative energy, and equipment • Subsidies from THB 50,000 to THB 3,000,000 for the purchase of high energy efficiency equipment with a payback period of 7 years or less (heat pumps are also eligible). • 25% of the cost of investment in energy-efficient equipment can be added to the actual cost of the equipment and recorded as a cost.

	• Exemption from machinery import tax if energy consumption is reduced to the specified ratio through investment of at least 1 million baht (500,000 baht for SMEs). Also, exemption from corporate income tax for 3 years (up to 50% of the investment amount, 200% for SMEs). 3. ESCO Project • Promote investment by providing SMEs with incentives to finance energy conservation and renewable energy projects
Regulatory Approach	1. Law Concerning the Promotion of Energy Saving • Instruct factories and buildings to conduct energy audits and promote energy conservation and efficiency 2. Energy Efficiency Resource Standards (EERS) • Top-down regulation of major energy providers to implement energy conservation measures that encourage customers to use energy more efficiently 3. Energy Conservation Act • Mandatory minimum renewable energy use for industrial, transportation, and commercial buildings. • Set minimum standards for energy efficiency.

Source: Author (Based on ASEAN Centre for Energy, 2025).

Lastly, from 2018–2022, Thailand experienced a persistent energy shortfall due to domestic energy production (DEP) being lower than total energy consumption (TES). This shortfall was met through energy imports, which have grown significantly over the years as the gap widened from 24.5% in 2018 to 37.7% in 2022. This trend highlights the country's increasing reliance on external energy sources, posing energy security concerns. Efforts to enhance domestic energy production or energy efficiency improvement to reduce consumption will be critical in addressing this widening shortfall.

Figure 2.75: Thailand's total energy supply, 2018–2022



Note: Energy Reserves is calculated as Total Energy Supply required in the country (TES) – Domestic Energy Production (DEP) where TES is lower than DEP. If TES is higher than DEP, there is an energy shortfall. If TES is lower than DEP, there is an energy surplus and can be exported.
Source: IEA (n.d)j, (Verified in 2025).

V. India

India has pledged to achieve net zero carbon emissions by 2070 at COP26 with improvement in energy intensity playing an important role in achieving its net zero target. This commitment is part of India's broader climate strategy, termed the 'Panchamrit' action plan which was also announced at COP26. It outlines five key commitments to address climate change, including increasing non-fossil energy capacity, achieving 50% renewable energy by 2030, reducing carbon emissions by 45% by 2030, and achieving net-zero emissions by 2070.

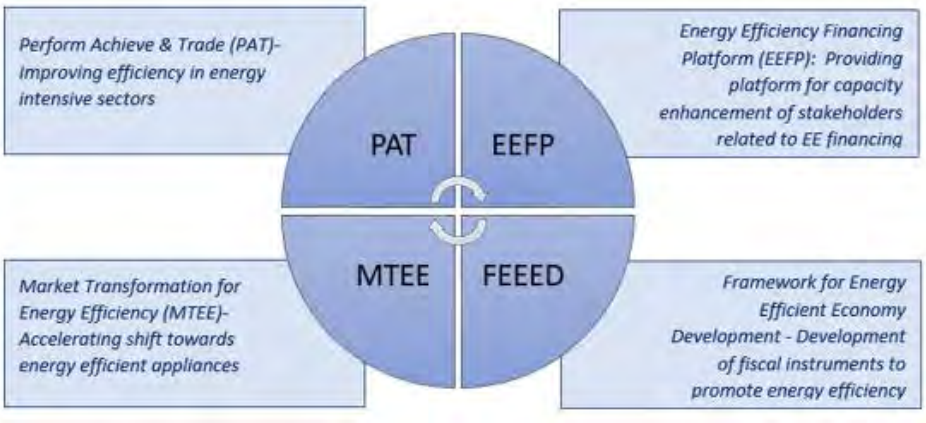
Figure 2.76: Key milestones to achieve carbon neutrality

Goals	2030	2070
% of RE in power generation	50%	Net Zero
GHG emission intensity (vs GDP) reduction	-45% (vs 2005)	-
EV penetration rate	30%	-

Source: Author (Based on UNFCCC, 2022a).

The country launched its National Action Plan on Climate Change in 2008 with eight different national missions spread across different sectors to focus on sustainable development. The second mission – the National Mission for Enhanced Energy Efficiency (NMEEE) is particularly focused on strengthening the market for energy efficiency by creating a conducive regulatory and policy regime, in which innovative and sustainable business models for the energy efficiency sector are envisaged.

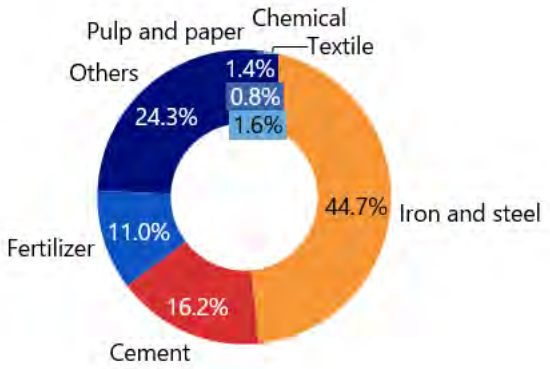
Figure 2.77: Initiatives taken under the NMEEE



Source: Bureau of Energy Efficiency (n.d.) (Verified in 2025).

In the industrial sector, which accounts for more than half of India's domestic energy consumption, coal and petroleum still dominate as energy sources, even as electrification efforts are gradually progressing. The sector's GHG emissions increased at an average annual growth rate of 10.42% between 2005 and 2018. In contrast, the overall average growth rate of all other sectors combined was 7.8%. The iron and steel industry were the leading emitter at 44.7% while the cement and fertiliser sectors accounted for 16.2% and 11%, respectively. Both the textile and pulp and paper sectors accounted for similar industry energy consumption at 1.6% and 1.4%, respectively, while the lowest was the chemical sector at 0.8% only.

Figure 2.78: Industry energy consumption by sector, 2023–2024



Source: Ministry of Power, India, 2024. (Verified in 2025).

The Bureau of Energy Efficiency (BEE), under the Ministry of Power, was formed in March 2002 to develop energy-efficient policy and strategies, with a thrust on self-regulation and market principles. BEE flagship programme includes the Perform, Achieve and Trade (PAT) scheme – which is a market-based mechanism that incentivises energy efficiency improvements in designated energy-intensive industries by allowing them to trade energy savings certificates. Another flagship programme is the Star Rating programme which assigns energy efficiency ratings to appliances like refrigerators, air conditioners, and LED lamps to guide consumers toward efficient choices. Others include energy conservation building codes, energy efficiency in Small & Medium Enterprises (SME) and energy efficiency through demand side management. Overall, given this market-led approach, Indian companies are likely to adopt energy efficient equipment like heat pumps in the long run.

Also, financial support for energy efficiency activities is provided for SMEs either through specific funds or tax and interest rebates.

Figure 2.79: Summary of key regulations and incentives

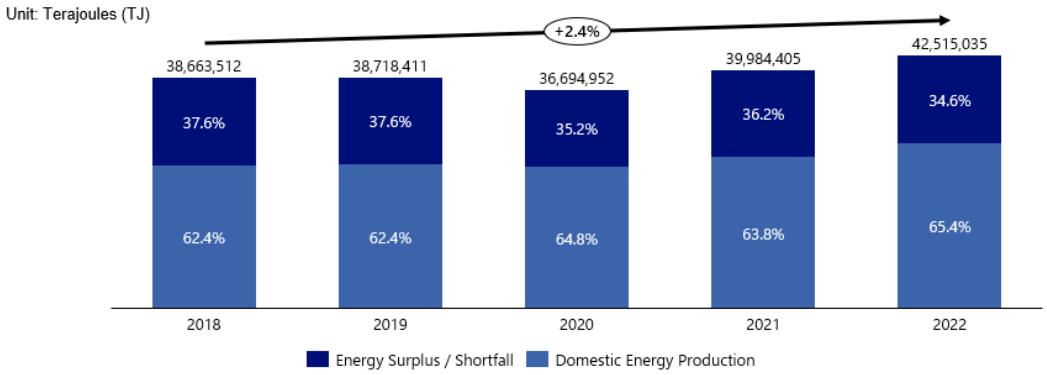
India	Regulations and Incentives
Policy	1. National Mission for Enhanced Energy Efficiency (NMEEE) • NMEEE focuses on strengthening the market for energy efficiency by creating a conducive regulatory and policy regime, in which innovative and sustainable business models for the energy efficiency sector are envisaged 2. Perform, Achieve and Trade (PAT) scheme • A market-based mechanism that incentivises energy efficiency improvements in designated energy-intensive industries by allowing them to trade energy savings certificates.
Economic Measures	(A) Government Subsidy Schemes • Offer several subsidy schemes to address the need for technology upgrades and investments in energy-saving devices for MSMEs. (B) Framework for Energy Efficient Economic Development (FEEED) • Under this initiative, the Bureau of Energy Efficiency has created financial instruments to help financial institutions in active engagement with industries and provide funds for energy efficiency projects. This includes the Partial Risk Guarantee Fund for Energy Efficiency and the Venture Capital Fund for Energy Efficiency. (C) Interest and tax rebates • 100% grant for pre-implementation activities such as energy audit • Special concessions for entrepreneurs establishing EE projects in specific location (D) Assistance in Deploying Energy Efficient Technologies in Industries & Establishment • This 100-billion-rupee scheme provides interest subsidies (from 3–5% depends on a company size) for SMEs adopting energy-efficient technologies.
Regulatory Approach	1. Energy Conservation Act • Established the Bureau of Energy Efficiency (BEE) to implement policies and strategies. • Provides minimum requirements for renewable energy usage and energy efficiency standards across industrial, transportation, and commercial buildings 2. Energy Conservation Building Code • establishing effort-based metrics for energy efficiency in building design and construction 3. Electricity (Amendment) Bill, 2018 • This bill defines renewable energy, requires coal-based power stations to generate power from renewable sources, and provides for a National Renewable Energy Policy.

Source: Author (Based on Bureau of Energy Efficiency).

Lastly, India's energy demand is rapidly growing, fuelled by economic development, urbanisation, and a burgeoning population with projections indicating a significant increase in electricity demand in the coming years, including a 34% rise in peak power demand. India's energy imports are substantial, particularly for crude oil and natural gas,

with a high dependence on imported fossil fuels. India is the second-largest importer of crude oil and the third-largest consumer globally. Energy efficiency increases have enabled the avoidance of an additional 15% energy demand and 300 $MtCO_2$ emissions over the period 2000–2018 and will continue to be a key factor in reducing the country's import bills.

Figure 2.80: India's energy reserves, 2018–2022



Note: Energy Reserves is calculated as Total Energy Supply required in the country (TES) – Domestic Energy Production (DEP) where TES is lower than DEP. If TES is higher than DEP, there is an energy shortfall. If TES is lower than DEP, there is an energy surplus and can be exported.
Source: IEA (n.d.)c, (Verified in 2025).

1.8. Summary

Our research into the demand and potential for climate-smart technologies has reaffirmed the urgent need for energy saving solutions in the evolving energy landscapes of Viet Nam, Thailand, and India. This conclusion is supported by our quantitative and qualitative analysis. From our quantitative analysis, we shortlisted Malaysia, Thailand, Viet Nam, Indonesia and India as the most suitable markets based on their high energy consumption and energy intensity, factors that signal stronger demand for technologies like heat pumps and once-through boilers. Our subsequent qualitative analysis found that, although all the 5 countries have environmental plans and regulatory frameworks aimed at promoting climate-smart technologies, Viet Nam, Thailand, and India emerged as having the most critical need as these 3 countries are experiencing steadily increasing net energy shortfalls, heavily supplemented by energy imports, which underscores the urgency for improving energy efficiency. As a result, Viet Nam, Thailand and India are expected to face increasing pressure to optimise energy consumption, making the demand for energy saving technologies such as heat pumps and once-through boilers to be higher.

Building on these findings, the following chapters will delve into Viet Nam, Thailand, and India in detail, analysing the issues and solutions relating to market dynamics, regulatory standards and licensing requirements. Thereafter, recommendations for the introduction of heat pumps and once-through boilers in these countries will be proposed.

Chapter 3

Regulations and Standards in Target Countries

1. Standards and Regulations in Target Countries

The following section covers the relevant standards and regulations related to heat pumps and once-through boilers in Viet Nam, Thailand, and India. Information was obtained from interviews with local associations, ESCOs, as well as desktop research. Standards mostly refer to any existing technical standards and performance evaluation criteria for heat pumps and once-through boilers while regulations largely refer to laws on the collection, transportation, storage, recycling, reuse and treatment of hazardous substances or chemicals. These standards and regulations cover aspects such as energy efficiency, equipment quality, material safety and operational performance.

The objective is to comprehend the present regulatory environment and its obstacles, and to leverage this knowledge to develop programmes.

Thailand

I. Overview of Existing Standards and Regulations

Thai industry standards for heat pumps and once-through boilers are essential for promoting energy efficiency, environmental sustainability and consumer safety since energy efficiency is a primary focus of Thailand's heating, ventilation, and air conditioning (HVAC) industry.

Table 0.1: Thailand regulations for heat pumps and once-through boilers

Official Number	Content of Industry Standard	Type of Industry Standard		
		Technical	Safety	Energy Efficiency
TGL-57-11	Green Label Requirements for Heat Pump Products			✓
TGL-07-R4-20	Green Label Requirements for Room Air Conditioners Products			✓
EN 255-3	Air conditioners, liquid chilling packages and heat pumps with electrically driven compressors. Heating mode. Testing and requirements for marking for sanitary hot water units (Used as reference for Energy Label by DEDE for heat pumps)	✓		✓

TIS 385-2524	Room air conditioners	✓		
TIS 1155-2557	Air-cooled split type room air conditioners	✓		
TIS 1529-2561	Air-Conditioner safety requirement (Compulsory)		✓	
TIS 2134-2565	Room air conditioners: energy efficiency (Compulsory)			✓
TIS 2564-2555	Room air conditioners: installation	✓		
TIS 2710-2558	Non-ducted air conditioners and heat pumps - Testing and rating for performance	✓	✓	✓
TIS 2711-2558	Ducted Air-Conditioners and Air-to-Air Heat pumps - Testing and Rating for Performance	✓	✓	✓
TIS 2712-2558	Multiple Split-System Air-Conditioners and Air-to-Air Heat pumps - Testing and Rating for Performance	✓	✓	✓
TIS 2714-2558	Air-cooled air conditioners and air-to-air heat pumps - Testing and calculating methods for seasonal performance factors	✓	✓	✓
TIS 3201-2564	Non-ducted portable air-cooled air conditioners and air-to-air heat pumps having a single exhaust duct - Testing and rating for performance	✓	✓	✓
TIS 3623-2566	Air to Water Heat Pump: Energy Efficiency Requirement			✓
TIS 855-2532	Boilers: general construction	✓		
TIS 2609-2557	Non-destructive testing - Magnetic particle testing for boiler and pressure vessel			✓

Source: Author.

Table 0.2:Thailand regulations for heat pumps and once-through boilers

Purpose	Regulations	Authority	Overview
Handling refrigerants (particularly CFCs)	Hazardous Substance Act B.E. 2535	Department of Industrial Works	• A comprehensive framework for the import, manufacture, storage, use and disposal of hazardous materials. • Hazardous substances are categorised based on their production, use, import, and export. Type 3 hazardous substances require official permits for production, possession, import, or export. Procedures for applying, renewing, and revoking such permits are detailed. Type 2 and 3 substances not already listed must be registered with authorities and handled according to ministerial regulations, developed with input from the Committee. The law prohibits the handling of fake, deteriorated, or unregistered substances across all types (1, 2, or 3). It also outlines the duties and civil liabilities of those involved in the hazardous substance supply chain and includes criminal penalties for violations. • CFCs and HCFCs are classified as a type 3 hazardous substances under the act due to their environmental risks. • The Ministerial Notification on Hazardous Waste Manifest System under the act mandates for waste collectors, processors and transporters handling hazardous waste to comply with the manifest system under the authorisation of Department of Industrial Works.
	Factory Act B.E. 2535	Department of Industrial Works	• A framework regulating the establishment, operation, and management of factories to ensure public safety, environmental protection, and the well-being of workers. • The Ministerial Notification on Industrial Waste Disposal under the act mandates the maximum on-site storage period of hazardous waste (including CFCs, HCFCs, and HFCs) which requires waste generators to have qualified pollution control supervisors and emergency response plans.
Handling hazardous substances (particularly Ammonia, CO_2)	Hazardous Substance Act B.E. 2535	Department of Industrial Works	• Refer to the overview for the same act in the above section on handling refrigerants. • Ammonia is classified as a type 3 hazardous substance under the act due to its toxicity, flammability, and potential risks in industrial application.
	Factory Act B.E. 2535	Department of Industrial Works	• Refer to the overview for the same act in the above section on handling refrigerants.
	Ordinance Regulating Safety Measures for Cooling	Department of Industrial Works	• Regulates the design, installation, operation, and maintenance of ammonia-based cooling systems. • Operators must have emergency response plans, conduct regular inspections, and ensure

	Systems Using Ammonia B.E. 2554		personnel are properly trained. A 2024 notification requires operators to submit reports to the Department of Industrial Works (DIW) for any installation, modification, repair, or system abandonment.
Handling high pressure gas	Hazardous Substance Act B.E. 2535	Department of Industrial Works	• Refer to the overview for the same act in the above section on handling refrigerants
	Factory Act B.E. 2535	Department of Industrial Works	• Refer to the overview for the same act in the above section on handling refrigerants
	Safety measure for gas business operation B.E. 2548	Department of Industrial Works	• Sets the safety standards for gas business facilities in Thailand and mandates that all gas containers and filling systems meet Thai or recognised international standards, undergo regular inspection and certification.
Installing equipment (Particularly heat pumps, HVAC)	National Skill Standard	Department of Skill Development	• A skill certification system for air conditioning technicians (for home and small-scale commercial use). • According to a 2015 Ministry of Labor notification (B.E. 2558), air conditioning technicians are a profession that is related to public safety, and from October 26, 2016, it has become compulsory to obtain a skill certification.

Source: Department of Industrial Works (1992), Department of Skill Development (2002) and Ministry of Industry and Trade (2005) (Verified in 2025).

Ministry of Industry (MIND) already has a department that handles refrigerant-related matters (storage, import quotas) in accordance with the Montreal Protocol. However, Thailand lacks clear regulations mandating the destruction or proper disposal of refrigerants. As of 2023, there are no laws requiring refrigerant destruction. The DIW and the METI are collaborating on ammonia and CO_2 refrigeration systems and are providing training and sharing knowledge on this topic. New legislation on ammonia handling is scheduled to take effect in February of next year.

II. Issues

Thailand's standards and certification for heat pumps was established approximately more than 10 years ago and only includes the capacity of heat pumps used during that time which were mostly lower in temperature. Given that Thailand industries need high-temperature (90–120°C) for heating purposes, there is a lack of scope for appropriate standards that cover higher temperatures of heat pumps and once-through boilers. Additionally, most existing standards for heat pumps relate to practices and instruction, not the product itself. TIS3623-2566 is the only standard for heat pump products. However, it is a voluntary standard, and manufacturers do not see any marketing or sales benefits in obtaining it. Consequently, this standard is rarely applied. TISI, the government

agency responsible for the standard, is also believed to be a factor in the lack of active development or promotion of heat pump standards because it lacks a thorough understanding of the benefits of heat pumps and once-through boilers.

1.9. Viet Nam

I. Overview of Existing Standards and Regulations

The Vietnamese Energy Efficiency standards are based on international standards, while the Energy Efficiency performance levels are prescribed by the Ministry of Industry and Trade (MOIT). Testing at laboratories designated by the MOIT is mandatory. To bear the Energy Efficiency label, the products must meet the minimum energy performance standard (MEPS) prescribed by the MOIT in corresponding Energy Efficiency standards.

Table 0.3: Viet Nam standards for heat pumps and once-through boilers

Official Number	Content of Industry Standard	Type of Industry Standard		
		Technical	Safety	Energy Efficiency
TCVN 6104	Refrigeration and heat pump systems - Safety and environmental requirements		✓	✓
TCVN 10273	Air-cooled air conditioners and air-to-air heat pumps - Test methods and calculations of seasonal efficiency coefficients	✓		✓
TCVN 11276	Refrigeration systems and heat pumps - Details of hoses, anti-vibration dampers, expansion joints and non-metallic pipes - Requirements and classification	✓		
TCVN 11277	Refrigeration and heat pump systems – Assessment of tightness of components and connections	✓		
TCVN 13139	Ductless, portable, single-exhaust ductless air-cooled air conditioners and air-to-air heat pumps – Testing and performance specification	✓	✓	
TCVN 13854	Heat pump for water heating - Testing and determining feature specifications.	✓	✓	
TCVN 13855	Water heating heat pump – Testing and determining performance parameters under low load conditions and calculate performance according to heating season	✓	✓	
TCVN 13856	Refrigeration system and heat pump - Valve, Requirements, testing and labelling	✓	✓	

TCVN 6576	Ductless air conditioners and heat pumps - Test and define feature specifications	✓		✓
TCVN 6577	Air conditioners and ducted air-to-air heat pumps - Test and define feature specifications	✓		✓
TCVN 7327	Determine the sound power level of air conditioners and air source heat pumps.	✓		
TCVN 7328	Water source heat pump - Testing and evaluation of the feature	✓		
TCVN 9981	Multi-cluster system air conditioners and air-to-air heat pumps – Testing and evaluation of feature specifications	✓		✓
TCVN 12728:2019	Boilers - technical requirements for design, manufacture, installation, use and repair	✓		
QCVN: 01 - 2008/BLĐTBXH	National technical regulation on safe work of steam boiler and pressure vessel	✓	✓	
Decision 67/2008/QD-BLDTBXH	Issuing the Procedure for technical safety inspection of boilers, pressure vessels, refrigeration systems, gas filling systems, gas cylinders and steam and hot water pipelines	✓	✓	
Decision 235-QD/LB	Issuing technical safety regulations for boilers	✓	✓	
TCVN 12728:2019	Technical requirements for boiler design and manufacture	✓	✓	
TCVN 8630:2019	Boilers – energy efficiency and determination methods			✓

Source: Author.

Table 0.4: Viet Nam regulations for heat pumps and once-through boilers

Purpose	Regulations	Authority	Overview
Handling refrigerants (particularly CFCs)	Law No. 06/2007/QH12 - Law on Chemicals	Viet Nam Chemicals Agency	• Primary legal framework for chemical management, governing the production, trade, use, storage, and disposal of chemicals, that serves as the basis for subsequent decrees and regulations. • **Decree No. 113/2017/ND-CP on Hazardous Chemicals** sets safety requirements, and mandates chemical declarations, incident response plans, and licensing procedures. • **National Technical Regulation QCVN 05A:2020/BCT** sets standards for safety in the production, commerce, use, storage, and transportation of hazardous chemicals in the industrial sector.
	TCVN 6739:2015 – Refrigerants: Designation and Safety Classification	Viet Nam Chemicals Agency	• National standard to naming refrigerants and classifying their safety based on toxicity and flammability characteristics. It serves as the foundational reference for identifying and categorising refrigerants used in various applications.
	Law No. 72/2020/QH14 - Law on Environmental Protection	Ministry of Natural Resources and Environment	• Foundational legislation for environmental protection in the country, requiring environmental impact assessments, permits, and strict controls on waste and emissions, also serving as the basis for subsequent requirements and decrees. • **Decree No. 06/2022/ND-CP** on mitigation of GHG emissions and protection of ozone layer introduces a quota and licensing system for refrigerants (like HCFCs and HFCs), mandates the reporting of imports and production. • **QCVN 76:2023/BTNMT** establishes technical and safety requirements for the collection, transportation, storage, recycling, reuse, and handling ODS refrigerants.
Handling hazardous Substance (particularly Ammonia, CO_2)	Law No. 06/2007/QH12 - Law on Chemicals	Viet Nam Chemicals Agency	• Refer to the overview for the same law in the above section on handling refrigerants.
	Law on Environmental Protection (2020)	Ministry of Natural Resources and Environment	• Refer to the overview for the same law in the above section on handling refrigerants. • Ammonia is regulated as a hazardous substance, while CO_2 is regulated as a greenhouse gas, with emissions subject to monitoring, reporting, and compliance.
	QCVN 03:2019/BYT	Ministry of Health	• Sets technical standards on the permissible exposure limits of 50 chemicals including Ammonia and CO_2, and mandates workers with exposure to

			provided appropriate protective equipment and undergo annual assessment for such chemicals.
Handling high pressure gas	Law No. 06/2007/QH12 - Law on Chemicals	Viet Nam Chemicals Agency	• Refer to the overview for the same law in the above section on handling refrigerants.
	Law No. 72/2020/QH14 - Law on Environmental Protection	Ministry of Natural Resources and Environment	• Refer to the overview for the same law in the above section on handling refrigerants.
	Decree No. 87/2018/ND-CP on Gas Business	Ministry of Industry and Trade (MOIT)	• Outlines the legal requirements for entities involved in the gas business, encompassing activities such as production, import, export, storage, and distribution of gases.
Installing equipment (Particularly heat pumps, HVAC)	QCVN 09:2017/BXD – National Technical Regulation on Energy Efficiency Buildings	Ministry of Construction	• Mandates air-conditioning and heat pump equipment to be certified prior to installation in buildings with a gross floor area of 2,500 m^2 or larger. Equipment must meet minimum Coefficient of Performance values and other efficiency criteria to be certified.

Source: Vietnam Chemical Agency (2007), Ministry of Natural Resources and Environment (2020), Ministry of Construction (2017) (Verified in 2025).

Currently, Viet Nam has introduced national technical regulations like QCVN 76:2023/BTNMT that covers the collection, transportation, storage, recycling, reuse and treatment of refrigerants. Although regulations exist, there appear to be challenges in enforcement and compliance which suggests that refrigerants may not always be handled appropriately. Viet Nam lacks facilities for recycling or properly disposing of refrigerants. Even when refrigerants are recovered, they are often not handled appropriately throughout their entire life cycle.

II. Issues

Meanwhile, Viet Nam faces the issue of modernisation of their standards. Take for example the standards for boilers were last revised in 2019. This is happening due to the lack of established evidence from case studies and scientific research both locally and internationally that allows MOIT, which is the key agency that can authorise the development or revision of the standards, to make further improvements in Viet Nam.

1.10. India

I. Overview of Existing Standards and Regulations

India has mandatory standards and regulations which are primarily focused on boilers, governed by the Indian Boiler Regulations, 1950, which provide detailed technical guidelines for the design, materials, construction, testing, and inspection of boilers and related components. For appliances such as refrigerators, air conditioners, and chillers, Indian standards exist but are not as stringent.

Table 0.5: India standards for heat pumps and once-through boilers

Official Number	Content of Industry Standard	Type of Industry Standard		
		Technical	Safety	Energy Efficiency
IS 16528	Boiler and Pressure Vessels performance requirements	✓	✓	
IS 8633	Technical requirements for location of boilers installations and boiler houses	✓		
IS 13980	Acceptance tests on industrial boilers – code of practice	✓		
IS 3503	Steel for marine boilers, pressure vessels and welded machinery structures	✓		
IS 8596	Recommended parameters of stationary steam boilers	✓		
IS 3412	Electric Water Boilers	✓	✓	
IS 16590	This standard specifies the requirements and test methods for	✓		✓

	determining the performance of vapor compression type chillers used for cooling applications			
IS 16678	Refrigerating Systems and Heat Pumps Safety and Environmental Requirements		✓	✓
IS 18154	Air-cooled air conditioners and air-to-air heat pumps Testing and calculating methods for seasonal performance factors	✓		✓
IS 1391	Room Air conditioners- Specifications	✓		
IS 1474	Specification for commercial refrigerators	✓		
IS 17550	Household Refrigerating Appliance- Characteristics and test methods	✓	✓	
IS 13261	Sound power rating of air - Conditioning and air - Source heat pump equipment	✓		
IS 302	Safety of household and similar electric appliances		✓	
TCVN 6104	Refrigeration and heat pump systems - Safety and environmental requirements		✓	✓

Source: Author.

Table 0.6: India regulations for heat pumps and once-through boilers

Purpose	Regulations	Authority	Overview
Handling refrigerants (particularly CFCs)	Environment (Protection) Act, 1986	Ministry of Environment, Forest and Climate Change (MoEFCC)	• Umbrella legislation providing a framework for the protection and improvement of the environment, that serves as the basis for subsequent regulations • The Ozone Depleting Substances (Regulation and Control) Rules, 2000 regulates the production, import, sale, and use of ODS refrigerants (like CFCs and HCFCs), and mandates the licensing, record-keeping, and reporting by entities. • The Second Amendment to the E-Waste (Management) Rules, 2023 requires manufacturers, refurbishers and recyclers to ensure secure, accountable, and sustainable management of refrigerant generated from the end-of-life refrigeration and air-conditioning equipment by adopting approved destruction technologies.
	The Factories Act, 1948	Ministry of Labour and Employment	• Framework to ensure the health and safety of workers employed in factories. • Mandates safe handling, storage, and use of dangerous substances used in manufacturing processes, and requires proper training, equipment, and protocols to be put in place when workers handle hazardous substances.
Handling hazardous Substance (particularly Ammonia, CO_2)	Environment (Protection) Act, 1986	MoEFCC	• Refer to the overview for the same law in the above section on handling refrigerants. • The law sets out standards for the emission and discharge of ammonia and CO_2.
	The Factories Act, 1948	Ministry of Labour and Employment	• Refer to the overview for the same law in the above section on handling refrigerants.
Handling high pressure gas	Environment (Protection) Act, 1986	MoEFCC	• Refer to the overview for the same law in the above section on handling refrigerants.
	The Factories Act, 1948	Ministry of Labour and Employment	• Refer to the overview for the same law in the above section on handling refrigerants.
	The Explosives Act, 1884	Petroleum and Explosives Safety Organization	• Mandates safety standards and inspections for anyone manufacturing, storing, or transporting explosives, including liquefied gases.
	The Inflammable Substances Act, 1952		• Sets guidelines for the storage and transportation of high-pressure inflammable gases.
Installing equipment (Particularly	Relevant NSDC Certifications (e.g.) HVAC Technician/	Ministry of Skill Development and	• Vocational training programmes in collaboration with the Electronics Sector Skill Council of India issues government-recognised skill certificates under the Skill

heat pumps, HVAC)	Field Technician – AC	Entrepreneurship	India Mission, a government initiative aimed at enhancing the employability of youths via the National Skill Development Corporation. • While not legally mandatory, certification may be required for public sector contracts.

Source: Ministry of Environment, Forest and Climate Change (1986), Ministry of Labour and Employment (1948), Ministry of Skill Development and Entrepreneurship (2008) (Verified in 2025).

Currently, regulations exist for the handling of refrigerants and hazardous substances commonly used in such equipment. However, India does not have a comprehensive regulatory framework covering the full refrigerant lifecycle including recovery, recycling, reuse and destruction.

II. Issues

For India, there is a strong need for a formal licensing framework, which is increasingly becoming a hot topic in industry forums and conferences. The absence of a formal scheme raises safety and standardisation concerns. Despite ongoing efforts by bodies like the Indian Society of Heating, Refrigerating and Air Conditioning Engineers through voluntary certification, these are still not equivalent to a formal government licensing scheme. Ultimately, there is a need for a standardised certification scheme for heat pumps to ensure quality and authenticity and to prevent the spread of substandard, locally assembled products.

1.11. Summary

A persistent challenge across all three countries is the lack of up-to-date and comprehensive standards for advanced or industrial-scale heat pumps and once-through boilers. As shown in the previous phases of this study, the development of robust regulatory frameworks is essential for promoting the adoption of high-quality equipment. Clear and modern standards not only ensure safety and reliability but also establish benchmarks for energy performance, guiding manufacturers in designing more efficient technologies. At the same time, such frameworks provide policymakers with effective tools to steer industrial practices toward national goals for energy efficiency and emissions reduction.

Next, Chapter 4 will explore the needs and issues regarding heat pumps and once-through boilers including to identify barriers, propose and implement solutions, incorporate stakeholder insights, and refine key proposals for advancing heat pump and once-through boiler adoption in Thailand, Viet Nam, and India.

Chapter 4

Needs and Issues regarding Heat Pumps and Once-through Boilers

1. Issues and Needs Identified

1.1. Background and Objectives

Despite the significant advantages of heat pumps and once-through boilers – such as their ability to substantially reduce energy use for heating and cooling compared to conventional boiler systems – their adoption in the target countries remains limited. This can be a missed opportunity, as these technologies have the potential to play a key role in improving industrial energy efficiency and reducing greenhouse gas emissions across the region.

The consideration in this chapter builds on the findings of a previous phase, which involved extensive discussions with a wide range of stakeholders, including equipment manufacturers, potential user companies, and relevant industry associations in Thailand, Viet Nam, India, and Japan. These discussions revealed a range of common challenges impeding the deployment of these energy-efficient systems. Barriers included limited awareness, high upfront investment costs, inadequate technical capacity, and the absence of enabling policy frameworks.

The objective of this phase is to systematically identify these adoption barriers, clarify the types of support and interventions required, and recommend concrete policy and programmatic actions. Ultimately, the goal is to support the wider introduction of these technologies in Asia and contribute to carbon neutrality and sustainable industrial development.

1.2. Methodology

This issue and solution map is a synthesis of data from stakeholder interviews and surveys conducted in a previous phase of this project. The research encompassed key markets, which are Thailand, Viet Nam, and India, and Japan as one of the major providers, focusing on the adoption of heat pumps and once-through boilers.

Our engagement strategy targeted a diverse group of stakeholders, including potential user companies from the manufacturing sector, energy service companies (ESCOs), equipment manufacturers, and relevant industry associations. User companies, such as those in the food and beverage and automotive industries, provided valuable insights through a comprehensive survey. In-depth interviews were conducted with ESCOs, manufacturers, and industry associations to gain a deeper understanding of market

dynamics, challenges, and opportunities. This multi-faceted approach allowed us to create a robust and comprehensive analysis, which forms the foundation of our current strategic recommendations.

To structure the analysis of barriers and solutions for the adoption of heat pumps and once-through boilers, this project employed three complementary analytical frameworks: the 4P marketing mix (Product, Price, Place, Promotion), the value chain approach, and a resource-based strategy (Human resources, Physical resources, Capital resources, Information).

4P marketing framework (Product, Price, Place, Promotion) was for identifying both demand-side and supply-side barriers by breaking down how a product is perceived, delivered, and promoted in the market. The 4P model allowed for a structured evaluation of the technical and market readiness of the products (Product), the economic considerations including initial cost and perceived value (Price), the distribution and servicing capacity (Place), and the awareness, incentives, and regulatory environment (Promotion). This approach was effective in highlighting the gap between the technical potential of these technologies and the actual market conditions that hinder their deployment.

The value chain framework was applied to understand the end-to-end challenges and opportunities involved in the introduction of heat pumps and once-through boilers – from manufacturing and procurement to sales, integration, and after-sales service. This approach was particularly useful because it allowed us to pinpoint where in the supply chain the most critical barriers exist, and how these barriers differ between manufacturers and user companies. Given that technologies of heat pumps and once-through boilers require cross-functional coordination – including technical design, compliance with international standards, integration with existing systems, and lifecycle maintenance – the value chain lens helped clarify:

- The technical and regulatory hurdles manufacturers face in producing and customising equipment
- The procurement, planning, and financing challenges encountered by user companies
- The skill and service gaps across installation, operation, and maintenance stages.

By mapping out the full ecosystem, the value chain analysis provided a comprehensive understanding of what systemic changes are needed to enable widespread adoption of these energy-efficient technologies in the target countries.

The resource-based analysis was adopted to evaluate the foundational enablers and constraints that affect the adoption of heat pumps and once-through boilers in the target countries. This framework focuses on four critical resource categories: human resources, physical resources, capital, and information. We chose this framework because the successful deployment of these technologies depends not only on product availability or

market demand, but also on the capacity to install, operate, and maintain the equipment effectively. The analysis revealed:

- Human resource gaps, including a shortage of trained personnel across all stages – from business planning and technical design to installation and after-sales maintenance.
- Physical infrastructure limitations, such as unstable electricity supply, lack of spare parts, and challenges in ensuring equipment compatibility.
- Capital constraints, particularly high upfront costs and expensive components, which inhibit investment.
- Information deficits, including low environmental awareness, limited technical support, and a lack of understanding of regulations and safety standards.

By identifying these resource-related barriers, the framework provided actionable insights into what capacities need to be strengthened – whether through training programmes, infrastructure investment, or regulatory reform – to enable large-scale adoption of these energy-efficient technologies.

1.3. Issue Map

1.3.1. Issues Related to Heat Pumps

Despite the proven energy efficiency and environmental benefits of heat pumps and once-through boilers, their adoption across the target countries remains limited. An integrated analysis using the 4P framework, value chain analysis, and resource-based strategy reveals that this is not due to a single factor, but rather a systemic set of barriers spanning the market, technology ecosystem, and institutional capacities.

The 4P analysis highlights a persistent lack of understanding of the technologies' value, both in terms of energy cost savings and environmental impact. Market actors are largely unaware that long-term operational savings may outweigh the high upfront costs, and non-monetary benefits such as ESG compliance or regulatory readiness are undervalued. The absence of clear government incentives, energy-efficiency standards, and promotional efforts further weakens the business case for adoption.

The value chain analysis reveals critical structural and technical barriers along every stage of the deployment process. Manufacturers facing difficulties adapting to varying national standards (e.g., refrigerants, certifications), User companies struggling to plan for integration into existing systems, Limited local customisation and servicing capability, A severe lack of skilled technicians for design, installation, and maintenance. In short, even if demand were stimulated, the supply-side infrastructure would struggle to respond effectively or at scale.

The resource-based analysis emphasises that human capital is the weakest link. There is a shortage of engineers and planners who understand both the technology and relevant international standards. Physical infrastructure gaps, such as unreliable power supply and lack of spare parts, pose further operational risks. Moreover, information gaps – regarding regulations, environmental risks, and technical handling of refrigerants – reflect weak institutional ecosystems and a lack of coordinated knowledge dissemination.

Table 0.1: Issue map of Heat Pumps

Marketing	Products	• Low awareness of product value in industrial areas and air conditioning applications, considering that there are not many areas with cold climates compared to developed heat pump countries (Europe, U.S., Japan). • Need to improvement to cover high-temperature output (boilers capable of steam output, which demands are higher in factories).
	Price	• Low awareness of a heat pump cost can be lower than ordinal boilers as operating costs can be reduced by improving energy efficiency in the long run, while the same amount of installation cost is required in addition to the equipment price, resulting in a high initial installation cost. Companies usually prefer short-term economic benefit and expect ROI is less than 3 years. • Low awareness of benefits other than money, such as social responsibility and sustainability. • Low awareness that operational costs can be reduced due to the possibility of lower energy use even that heat pumps use higher priced fuel costs than conventional boilers. – (4)
	Place/Distribution	• The limited number of operators and engineers who can introduce the equipment while integrating it with existing equipment. Heat pumps have the potential to be made more efficient by using waste heat and combining them with boilers, and integration with existing equipment may be the key.
	Promotion	• Need proper measurement of energy efficiency (currently judged only by how much cooler and cheaper the electricity bill is). • The lack of subsidies and other incentives, introduction/stricter environmental regulations. In addition to establishing regulations, ensure their effective implementation at the operational level. • Low environmental awareness to prioritise energy efficiency. - (1) • Low awareness of the efficiency of heat pumps and their long-term contribution to the environment and cost-reduction. • Low awareness of the environmental advantages that differentiate these products from alternatives such as biomass boilers and hydrogen boilers. • Low awareness of the benefits of device safety in addition to energy efficiency. • Need further enhancement of efficiency by utilising heat pumps in a manner that takes into account their strengths and limitations – for example, through integration with boilers, central air conditioning and hot water systems, utilisation of waste heat, and combined heating and cooling applications. – (7)

Value chain		Manufacturers by themselves	Towards User companies
	Business and Production Planning	• Need to shift from Chlorofluorocarbons (CFC) to natural refrigerants in target countries (allowed refrigerants differ amongst countries).	• Need to consider integration into business plans at an early stage, as large-scale investments are typically planned approximately one year in advance.
	Procurement	• Parts need to be procured in compliance with existing standards such as ISO and ASME. • Need further cost competitiveness to offset high tariff rates, particularly in the Indian market.	• Need various financing scheme such as leases. • Need integration and overall optimisation with existing facilities. • Dependent on imported heat pumps.
	Manufacture / Customised	• Need to design equipment to maximise energy efficiency and optimise overall energy utilisation while integrate existing facilities. • Need to compliance with standards such as ISO and ASME.	• Technically difficult for heat pumps to provide over 100 Celsius degrees (To use heat pumps with a boiler is a way to cover high temperature. Higher temperature heat pumps are under development). • It takes longer time for heat pumps to start providing hot water (To use with a boiler is a way to cover heat pumps' longer heating times.).
	Sales / implementation	• Few engineers who can propose usage integrating heat pumps with existing equipment. • Little care about handling of refrigerants.	• Need to expand area to use heat pumps such as the chiller sector (warehouse, data centre), to improve energy efficiency throughout the building.
	After-sales / maintenance	• Need proper recovery, reuse and disposal of refrigerants since refrigerants could lead global warming or hazards to humans.	• Need 24/7/365 maintenance provision to prevent machine breakdown. • Less maintenance could cause trouble due to the local water quality and other operating environment.

Value chain (Standardisation Strategy)	Business and Production Planning	• Lack of evaluation methods and indicators that can appropriately demonstrate energy efficiency. • Since it is not subject to the environmental labelling system, there is little incentive to adopt it.
	Procurement	• Lack of / low awareness of product standards.
	Manufacture / Customised	• Lack of / low awareness of product standards.
	Sales / implementation	• Lack of a guideline for equipment installation. – (8) • Lack of technical knowledge of optimising energy use optimisation and efficient usage. – (10)

	After-sales / maintenance	• Lack of a guideline for equipment maintenance and servicing. • Lack of a guideline for proper handling of refrigerants.

Resource strategy	Human Resources	Business and Production Planning	• Low awareness of energy conservation at both management and operational levels and improve understanding of technologies. – (2)
		Procurement	• Limited number of personnel who understand International / Japanese standards. And lower awareness of standardisation such as safety, quality. – (6)
		Manufacture / Customised	• Limited number of personnel capable of proposing effective ways to use heat pumps.
		Sales / implementation	• Limited capability of proper installation (heat pump installation is complicated and requires technical knowledge). – (9)
		After-sales / maintenance	• Limited number of personnel capable of maintenance (Be independent on agents). – (11)
	Physical Resources	Business and Production Planning	• Need to provide reliable equipment with low risk of failure to avoid long breakdown.
		Procurement	• Need to ensure a stable electricity supply, as interruptions in heat pump operation can have a significant impact on business activities. And minimise the impact of power outages.
		Manufacture / Customised	N/A
		Sales / implementation	• Need to ensure compatibility with existing equipment before instalment (heat pumps cannot directly replace boilers)
		After-sales / maintenance	• Need to ensure the availability of spare parts to prevent operational downtime.
	Capital Resources	Business and Production Planning	N/A
		Procurement	• High cost of raw materials and components.
		Manufacture / Customised	N/A
		Sales / implementation	N/A

		After-sales / maintenance	• Predictive maintenance is preferrable to prevent losses caused by equipment failures.
	Information	Business and Production Planning	• Low environmental awareness amongst local companies and government agencies, including those directly involved in on-the-ground operations. – (3) • Lack of strong Energy Regulations and Policy Introduction. – (5)
		Procurement	• Lack of understanding of regulations, including de facto standards in each country.
		Manufacture / Customised	• Low awareness of the capability to achieve high performance and efficiency.
		Sales / implementation	• Lack of technical support information. • Lack of information that can be maintained in-house.
		After-sales / maintenance	• Lack of educational initiatives on the correct handling and management of refrigerants. – (12)

Source: Author.

1.3.2. Issues Related to Once-through Boilers

From a marketing perspective, there is a significant lack of awareness amongst users regarding the long-term economic and environmental benefits of once-through boilers. Although they offer reduced fuel consumption and improved safety, this is often overshadowed by their high upfront costs. Many companies prioritise short-term ROI, typically expecting payback within three years, which creates a reluctance to invest in equipment with higher initial costs. Non-financial benefits, such as improved workplace safety and alignment with corporate sustainability goals, are also not fully appreciated or factored into purchasing decisions. Promotional challenges further compound these issues. These boilers are also often compared unfavourably to alternative technologies like biomass or hydrogen boilers, despite their potential for more stable and efficient performance.

Across the value chain, key barriers exist in procurement, manufacturing, and after-sales phases. Manufacturers struggle with international standards and cost competitiveness. On the user side, a lack of engineers capable of properly installing or maintaining these sensitive systems limits their effectiveness and reliability. There are no visual indicators that show users the advantages of water-tube boilers, such as energy efficiency and safety.

A resource analysis highlights a shortage of qualified personnel across the entire boiler lifecycle. The high cost of raw materials and lack of compatible components and

predictive maintenance tools also pose operational risks. From an information standpoint, there is a general lack of technical knowledge and clarity around applicable standards and regulations amongst both local firms and government agencies.

Table 0.2: Issue map of Once-through boilers

Marketing	Products	• Low awareness of the high safety of conventional boilers with fewer explosion accidents
	Price	• Low awareness that once-through boiler cost can be lower than ordinal boilers as operating costs can be reduced by improving energy efficiency in the long run, while the same amount of installation cost is required in addition to the equipment price, resulting in a high initial installation cost. Companies usually prefer short-term economic benefit and expect ROI is less than 3 years. • Low awareness of benefits other than money, such as social responsibility and sustainability. • Low awareness that operational costs can be reduced due to the possibility of lower energy use even that once-through boilers use higher priced fuel costs than conventional boilers. – (4)
	Place/Distribution	N/A
	Promotion	• Need proper measurement of energy efficiency (currently judged only by how much cooler and cheaper the electricity bill is). • The lack of subsidies and other incentives, introduction/stricter environmental regulations. In addition to establishing regulations, ensure their effective implementation at the operational level. • Low environmental awareness to prioritise energy efficiency. - (1) • Low awareness of the efficiency of heat pumps and their long-term contribution to the environment and cost-reduction. • Low awareness of the environmental advantages that differentiate these products from alternatives such as biomass boilers and hydrogen boilers. • Low awareness of the benefits of device safety in addition to energy efficiency. • Need further awareness of high efficiency by optimising energy consumption and efficiency by installing multiple small once-through boilers rather than a single large boiler. – (7)

Value chain	Manufacturers by themselves	Towards User companies
Business and Production Planning	N/A	N/A
Procurement	• Parts need to be procured in compliance with existing standards such as ISO and ASME.	• Need various financing scheme such as leases.

	• Need further cost competitiveness to offset high tariff rates, particularly in the Indian market.	• Need integration and overall optimisation with existing facilities.
Manufacture / Customised	• Need to design equipment to maximise energy efficiency and optimise overall energy utilisation while integrate existing facilities. • Need to compliance with standards such as ISO and ASME.	N/A
Sales / implementation	• Few engineers who can propose usage integrating once-through boilers with existing equipment.	N/A
After-sales / maintenance	N/A	• Need 24/7/365 maintenance provision to prevent machine breakdown. • Less maintenance could cause trouble due to the local water quality and other operating environment.

Value chain (Standardisation Strategy)	Business and Production Planning	• Lack of evaluation methods and indicators that can appropriately demonstrate energy efficiency. • Since it is not subject to the environmental labelling system, there is little incentive to adopt it.
	Procurement	• Lack of / low awareness of product standards.
	Manufacture / Customised	• Lack of / low awareness of product standards.
	Sales / implementation	• Lack of a guideline for equipment installation. – (8) • Lack of technical knowledge of optimising energy use optimisation and efficient usage. – (10)
	After-sales / maintenance	• Lack of a guideline for equipment maintenance and servicing.

Resource strategy	Human Resources	Business and Production Planning	• Low awareness of energy conservation at both management and operational levels and need to improve understanding of technologies. – (2)
		Procurement	• Limited number of personnel who understand International / Japanese standards. And lower awareness of standardisation such as safety, quality. – (6)
		Manufacture / Customised	• Limited number of personnel capable of proposing effective ways to use heat pumps.

		Sales / implementation	N/A
		After-sales / maintenance	• Limited number of personnel capable of maintenance (Be independent on agents). – (11)
	Physical Resources	Business and Production Planning	• Need to provide reliable equipment with low risk of failure.
		Procurement	N/A
		Manufacture / Customised	N/A
		Sales / implementation	• Once-through boilers are particularly sensitive to water quality. And equipment that is compatible with local water quality conditions is desirable.
		After-sales / maintenance	• Need to ensure the availability of spare parts to prevent operational downtime.
	Capital Resources	Business and Production Planning	N/A
		Procurement	• High cost of raw materials and components.
		Manufacture / Customised	N/A
		Sales / implementation	N/A
		After-sales / maintenance	• Predictive maintenance is preferrable to prevent losses caused by equipment failures.
	Information	Business and Production Planning	• Low environmental awareness amongst local companies and government agencies, including those directly involved in on-the-ground operations. – (3) • Lack of strong Energy Regulations and Policy Introduction. – (5)
		Procurement	• Lack of understanding of regulations, including de facto standards in each country.
		Manufacture / Customised	• Low awareness of the capability to achieve high performance and efficiency.
		Sales / implementation	• Lack of technical support information. • Lack of information that can be maintained in-house.
		After-sales / maintenance	N/A

Source: Author.

1.4. Solutions for the Issues Map

Our analysis, based on interviews and surveys with stakeholders, identified several key challenges impeding the adoption of advanced heating technologies. To address these findings, we have developed a set of twelve specific solutions based on the challenges detailed in our issue map (Table 4.3).

Table 0.3: Issues and Solutions that could be implemented

No.	Issues	Solutions
(1)	• Low environmental awareness to prioritise energy efficiency.	• Disseminate information through seminars and similar outreach activities.
(2)	• Low awareness of energy conservation at both management and operational levels and improve understanding of technologies.	• Conduct trial installations and pilot projects for the equipment.
(3)	• Low environmental awareness amongst local companies and government agencies, including those directly involved in on-the-ground operations.	• Organise sessions for local governments to increase their understanding of the high efficiency of the equipment, including the introduction of past case studies.
(4)	• Low awareness that operational costs can be reduced due to the possibility of lower energy use even that heat pumps and once-through boilers use higher priced fuel costs than conventional boilers.	• Hold sessions to raise awareness amongst local governments about the advantages of the equipment. • Conduct trial installations and pilot projects for the equipment. Introduce case studies to potential users.
(5)	• Lack of strong Energy Regulations and Policy Introduction.	• Engage in discussions with energy-conscious governments on the introduction of regulations and incentive schemes.
(6)	• Limited number of personnel who understand International / Japanese standards. And lower awareness of standardisation such as safety, quality.	• Propose the adoption of regulations such as Japan's Refrigeration Safety Code and improve awareness of the importance of following standards. • Introduce license scheme for refrigerants handling to motivate people to learn.
(7)	• Need further enhancement of efficiency by utilising heat pumps in a manner that takes into account their strengths and limitations – for example, through integration with boilers, central air conditioning and hot water systems,	• Develop and disseminate manuals and guidelines. • Conduct training programmes to develop human resources capable of making proposals from the perspective of energy optimisation.

	utilisation of waste heat, and combined heating and cooling applications. • Need further awareness of high efficiency by optimising energy consumption and efficiency by installing multiple small once-through boilers rather than a single large boiler.	
(8)	• Lack of a guideline for equipment installation.	• Develop and disseminate manuals and guidelines.
(9)	• Limited capability of proper installation (heat pump installation is complicated and requires technical knowledge).	• Provide training on equipment installation and distribute related training materials.
(10)	• Lack of technical knowledge of optimising energy use optimisation and efficient usage.	• Conduct training programmes to develop human resources capable of making proposals from the perspective of energy optimisation.
(11)	• Limited number of personnel capable (Be independent on agents).	• Prepare maintenance manuals and training programmes tailored to the specific conditions of each country.
(12)	• Lack of educational initiatives on the correct handling and management of refrigerants.	• Implement training sessions and distribute training materials accordingly.

Source: Author.

These issues can be broadly categorised into a lack of awareness, an underdeveloped policy and regulatory environment, and technical and human resource limitations.

Our analysis identified a significant lack of awareness regarding the long-term economic and environmental benefits of energy-efficient equipment. Both local companies and government agencies often fail to prioritise these benefits, with many focusing on short-term ROI. This is compounded by a limited understanding of how new technologies can reduce operational costs over time, even with higher initial fuel prices. To address this, we recommend disseminating information through seminars, conducting trial installations to demonstrate real-world benefits, organising sessions for local governments to showcase equipment efficiency with case studies, and introducing labelling scheme to highlight energy benefits.

The market also suffers from an underdeveloped policy and regulatory environment. Many regions lack strong energy regulations and incentives to encourage conservation, and there is a limited understanding of international and Japanese safety and quality standards. This absence of a supportive framework weakens the value proposition of high-efficiency equipment. We believe that engaging in discussions with energy-conscious governments to introduce regulations and incentive schemes and proposing the adoption of safety regulations or certification programme is important for driving

market change. It is also important to give companies peace of mind when using these devices.

Finally, we identified significant technical and human resource limitations as a major barrier. There is a limited number of personnel capable of proper installation and maintenance, especially for complex systems. Users also lack the technical knowledge to optimise energy use, such as integrating heat pumps with other systems or utilising multiple small boilers for maximum efficiency. This lack of a skilled workforce prevents companies from fully realising the potential benefits of new technologies. Our proposed solutions include developing and disseminating manuals and guidelines, implementing training programmes to build a skilled workforce, and creating maintenance manuals and training sessions specifically tailored to local conditions.

Chapter 5

Proposal of Solutions to Promote Heat Pumps and Once-through Boilers

1. Discussions Regarding Potential Solutions

1.1. Needs and Potential Solutions

There are multiple barriers that hinder the widespread adoption of heat pumps and once-through boilers in emerging markets. To identify which countermeasures should be prioritised, consultations were first held with Japanese manufacturers of these technologies. These companies, which possess extensive experience in both domestic and international markets, provided valuable feedback regarding the practical challenges, technological constraints, and regulatory gaps that affect market penetration in developing countries. Based on their input, a shortlist of potentially impactful and feasible policy and technical interventions was developed.

To ensure that these proposed measures are grounded in local realities and aligned with the needs of end users and market stakeholders, further interviews were conducted with key actors involved in promoting the adoption of heat pumps and once-through boilers in Thailand, Viet Nam, and India. These actors included representatives from government agencies, industry associations, equipment distributors, and service providers. Their perspectives provided important insights into country-specific conditions, such as differences in energy pricing, infrastructure availability, certification requirements, and consumer awareness levels.

The primary objective of these efforts was to ensure that any future programmatic interventions would be both relevant and effective in accelerating the deployment of energy-efficient technologies in these countries. Through these discussions, it became clear that close coordination with local stakeholders is essential to tailoring solutions that are technically appropriate, economically viable, and administratively implementable.

Finally, drawing on the collective feedback obtained from the interviews with Japanese manufacturers as well as local stakeholders in the three focus countries, a set of recommended programmatic actions has been formulated. These proposals are intended to serve as a foundation for future collaboration with government bodies, industry players, and technical institutions in Thailand, Viet Nam, and India, with the aim of supporting the successful and sustainable diffusion of heat pumps and once-through boilers in each market.

Figure 0.1: Planned steps to refine the proposal

: Meetings with stakeholders in the partner country are required

	(1) Interview with Japanese manufacturers	(2) First draft of programs	(3) Interview with local stakeholders	(4) Revised programs	(5) Finalize programs with stakeholders
Step	A first interview to understand manufacturers' needs	Make first drafts of our proposal of standards/guidelines and training program.	Collect feedbacks on our proposals and understand gaps (if any)	Make revised our proposal of standards, guidelines / training program.	Collect feedbacks on our proposals and understand gaps (if any)
Goal	• To understand gaps between Issues and Solutions from the last phase	• To make draft proposals get consensus from Japanese manufactures	• To understand need gaps between target countries and manufacturers. • Build relationships with local stakeholders	• Create a program proposal that can build consensus with local stakeholders	• Gather the opinions of stakeholders regarding the final proposal. • Create a final proposal to move forward with a gov-gov dialogue
Out-puts	• Needs of Japanese manufacturers to solutions • Interview memo	• Draft proposals (4 pattern)	• Feedbacks on draft proposals (4 pattern) • Find compromise proposals of standards/guidelines and training program.	• Final proposals (4 patters), which include detailed plan and training document	• Summary of Feedbacks on the final proposal • Documents for gov-gov dialogue (finalized proposals)

Source: Author.

1.2. Key Takeaways from Manufacturer Interviews

Through interviews with manufacturers, three key proposals were identified as particularly promising for implementation in Thailand, Viet Nam, and India:

First, in response to Issue No. 5, it was proposed that the thermal storage capability of heat pumps can contribute significantly to flattening the electricity load curve, thereby reducing inefficiencies in electricity generation. Specifically, heat pumps equipped with thermal storage tanks can produce hot water during off-peak hours – such as at night – when electricity demand is low and then store it for use during peak hours in the daytime. In many markets, electricity consumption tends to surge during weekday daytime hours due to heightened commercial and industrial activity. By shifting electricity usage to off-peak periods, this load levelling function not only optimises the utilisation of generation capacity but also helps reduce the environmental impact of peak-time power generation, which is often more carbon-intensive. If such benefits – alongside improvements in energy efficiency – are effectively communicated to end users through labelling schemes or product marketing materials, it may enhance consumer awareness of the broader advantages of adopting heat pump systems.

Second, in relation to Issue No. 8, stakeholders suggested that further institutionalisation of refrigerant handling practices is essential for ensuring the safe and environmentally responsible use of heat pumps. This includes the establishment of structured training programmes and licensing systems for technicians who install and maintain these systems. Proper handling of refrigerants, many of which are greenhouse gases or have

harmful effects to humans, is critical to minimising environmental harm and ensuring the long-term safety and reliability of equipment. The development of certification mechanisms for technicians would promote best practices in refrigerant recovery, leakage prevention, and compliance with emerging environmental standards.

Third, with regard to once-through boilers, and again in relation to Issue No. 5, it was proposed that regulatory requirements concerning installation and operation – such as licensing mandates and 24-hour on-site monitoring – be reconsidered, particularly in light of the relatively higher safety profile of once-through boilers compared to conventional boiler systems. These modern boilers are generally equipped with automated control and safety features that reduce the risk of accidents and make continuous human supervision less necessary. By easing such regulatory constraints where appropriate, broader and more rapid deployment of once-through boilers could be facilitated, especially in sectors or regions where access to licensed operators or constant supervision is currently a barrier to adoption.

1.3. Details of Three Key Proposals

Three initial proposals were formulated based on interviews with manufacturers and issue maps. The three proposals are linked to the issues identified in Chapter 5 as follows:

Proposal 1 addresses the core issues of low awareness and an underdeveloped policy environment by creating a system that clearly demonstrates the advantages of high-efficiency equipment. In this context, it was proposed that heat pumps, given their strong energy efficiency and their role in load levelling, should be explicitly included in the energy efficiency labelling scheme. At the same time, the establishment of measurement standards and indicators to quantitatively capture these benefits will be necessary.

The proposal is linked to these Challenges:

- Low environmental awareness to prioritise energy efficiency: By linking heat pumps and boilers to systems like Time of Use tariffs or labelling schemes, we can visualise their energy efficiency in terms of tangible cost savings and environmental contributions. This shifts the focus from vague environmental concerns to concrete, economic benefits. (Issue and solution (1))
- Lack of strong Energy Regulations and Policy Introduction: Implementing labelling or certification programmes sends a strong signal that the government prioritises energy efficiency. This can serve as a catalyst, increasing market-wide interest and laying the groundwork for future regulatory action. (Issue and solution (5))
- Low awareness that operational costs can be reduced due to the possibility of lower energy use even that heat pumps and once-through boilers use higher priced fuel costs than conventional boilers: By shifting electricity usage to off-peak periods, this load levelling function not only optimises the utilisation of generation capacity but also helps reduce the environmental impact of peak-time power

generation, which is often more carbon-intensive. If such benefits – alongside improvements in energy efficiency – are effectively communicated to end users through labelling schemes or product marketing materials, it may enhance consumer awareness of the broader advantages of adopting heat pump systems. (Issue and solution (4))

Proposal 2 directly tackles the problems of technical and human resource limitations by building a skilled workforce.

The proposal is linked to these Challenges:

- Limited capability of proper installation: Training in refrigerant handling is essential for developing the technical skills necessary for handling the complexities of installation. A certification system would enable technicians to demonstrate their reliability, reducing user concerns. (Issue and solution (9))
- Limited number of personnel capable: Training and certification systems raise awareness of safety. In particular, the introduction of a certification system incentivises individuals to acquire skills that differentiate them from others. (Issue and solution (11))
- Lack of educational initiatives on the correct handling and management of refrigerants: This programme directly addresses this issue by providing the knowledge necessary for the safe and efficient operation of equipment. (Issue and solution (12))

Proposal 3 focuses on using regulatory reform and a targeted awareness campaign to make once-through boilers more accessible.

The proposal is linked to these Challenges:

- Low awareness amongst local governments and companies: Clearly demonstrating the safety benefits of once-through boilers and streamlining regulations can deepen government understanding and encourage more positive policy decisions. Using past case studies to highlight these benefits is essential. (Issue and solution (3))
- Lack of clear installation guidelines: By coupling regulatory easing with the development of clear safety and installation guidelines, we can remove major barriers to adoption while ensuring safe implementation. (Issue and solution (8))

Lack of technical knowledge for optimisation: Even with easier access, users need to know how to maximise the benefits. This programme would provide guidance on achieving both safety and efficiency, ensuring that newly installed equipment performs to its full potential. (Issue and solution (10)).

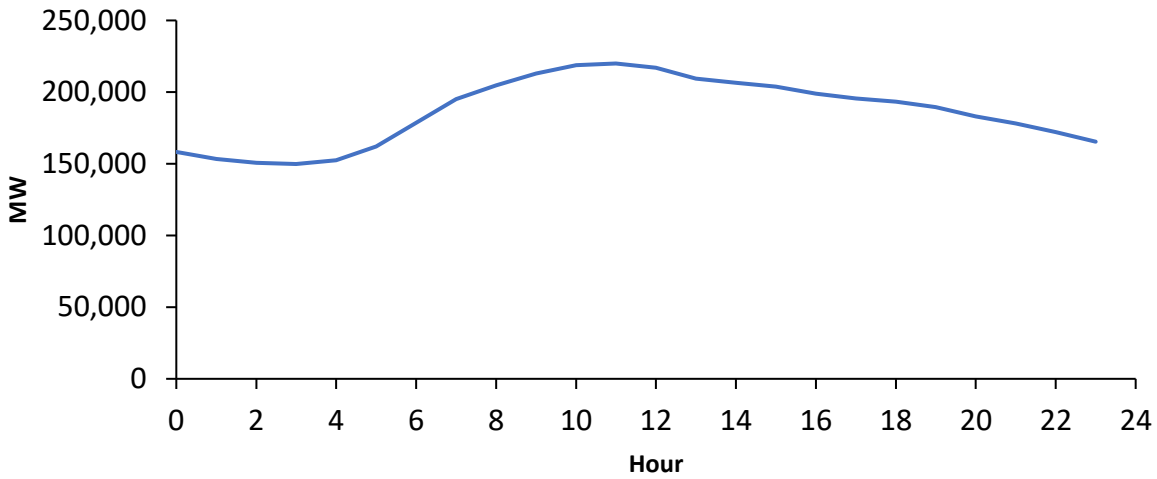
1.3.1. Proposal 1: Expanding the Energy Efficiency Labelling Scheme to Include Heat Pumps

It is proposed that heat pumps be explicitly incorporated into the energy efficiency labelling scheme, with their dual advantages of high energy efficiency and contribution to load levelling clearly recognised. To ensure these benefits are communicated in a credible and comparable way, the establishment of standardised measurement methods and performance indicators is also recommended.

In many countries, the amount of electricity generated does not significantly vary between day and night. This is because the major power generation methods – thermal, nuclear, and hydro – require substantial time and effort to shut down and restart, making it difficult to adjust output according to time of day. At the same time, weather-dependent renewables like solar and wind are on the rise. It is difficult to control the amount of electricity generated from natural energy, which varies depending on weather conditions and other factors. Since electricity cannot be stored easily, power generation must consistently match peak demand to ensure supply sufficiency, which sometimes leading to excess power that must be discarded.

Normally, electricity is consumed more during the day when activity levels are high. Therefore, at night when electricity consumption is relatively low, surplus electricity is wasted unless it is stored. For example, in India, electricity consumption peaks between 10 a.m. and 12 p.m. Conversely, demand is low in the early morning, with hourly electricity demand differences reaching 50 MW or more (Figure 5.2).

Figure 0.2: Hourly electricity demand in India (2024, Maximum)



Source: India Energy (Verified in 2025).

Battery storage systems are a well-known option for electricity storage, but their high cost continues to pose a barrier to large-scale deployment. Heat pumps provide an alternative form of storage by generating hot water during off-peak hours and retaining it in thermal tanks for use during periods of higher demand. This function can, to some extent, substitute for battery storage and also enables the absorption of surplus electricity from renewable energy sources as well as excess base-load power used to balance renewable fluctuations.

The ability of heat pumps to contribute simultaneously to load shifting, system stability, and energy efficiency represents a distinct advantage. Reflecting these benefits within awareness campaigns and product labelling systems may help broaden consumer decision-making beyond upfront costs to include environmental and social considerations. Such recognition can also support wider policy objectives in the areas of energy efficiency and energy security.

To make these benefits more visible and comparable, the introduction of standardised measurement methods, performance indicators, and labelling approaches will be important. These tools would enable policymakers, manufacturers, and consumers to evaluate efficiency improvements and system-level effects in a transparent and consistent manner.

Positioning heat pumps within the framework of energy efficiency labelling in this way could reinforce both the economic and environmental rationale for their adoption, while at the same time contributing to policy targets related to demand-side flexibility and long-term system stability.

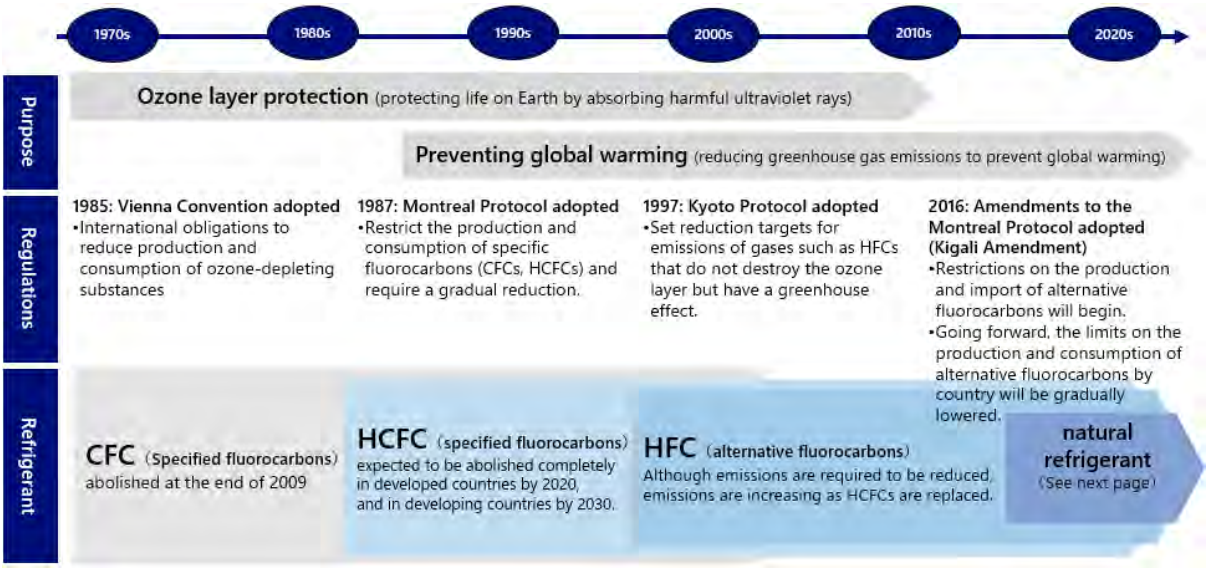
1.3.2. Proposal 2: Enhancing Refrigerant Safety through Licensing and Training

We proposed that a licensing and certification system for refrigerant handling be introduced, requiring technicians to undergo proper training before being permitted to install, maintain, or dispose of equipment that uses refrigerants as the second proposal. Such a system would ensure safe practices, reduce the risk of harmful emissions, and align with international efforts to mitigate the environmental and health risks associated with high-GWP refrigerants.

Refrigerators, air conditioners, and heat pumps use refrigerants by design. Historically, ammonia was commonly used as a refrigerant, but due to its toxicity and stimulating odour, it was replaced by chlorofluorocarbons (CFCs). However, CFCs have high global warming potential (GWP) and, when released into the atmosphere, destroy the ozone layer and contribute to climate change. Following the discovery in the 1970s that CFCs deplete the ozone layer, many countries recognised the environmental risk and adopted the Montreal Protocol, initiating a global phase-out of CFCs. Although hydrochlorofluorocarbons (HCFCs) were introduced as alternatives, they also have high GWPs and are now being phased out as designated ozone-depleting substances. Today,

hydrofluorocarbons (HFCs) are becoming the dominant refrigerants globally. While HFCs do not deplete the ozone layer, their high GWPs remain a concern, leading to growing momentum toward the use of natural refrigerants such as ammonia and carbon dioxide.

Figure 0.3: Changes in refrigerants use



Source: Author.

In Thailand, Viet Nam, and India, many systems still use ammonia rather than fluorinated gases, but there remains a significant number of systems using CFCs and HCFCs. These countries are also expected to transition to natural refrigerants to help curb global warming. However, natural refrigerants can pose health and safety risks due to their toxicity, stimulating odour, or mild flammability.

According to on-site interviews, there appears to be a lack of awareness in these countries regarding the dangers of refrigerants. Improper practices such as releasing gases into the atmosphere during disposal or poor management of gas cylinders have been reported, leading to potential leaks. Proper knowledge about refrigerants is essential for the safe installation, operation, and disposal of heat pumps.

During interviews with manufacturers, a proposal was made to establish a licensing system whereby only individuals who have completed training on the proper handling of refrigerants would be permitted to handle them. Such a system would not only promote safer use of heat pumps but also provide an incentive for technicians to undergo proper training.

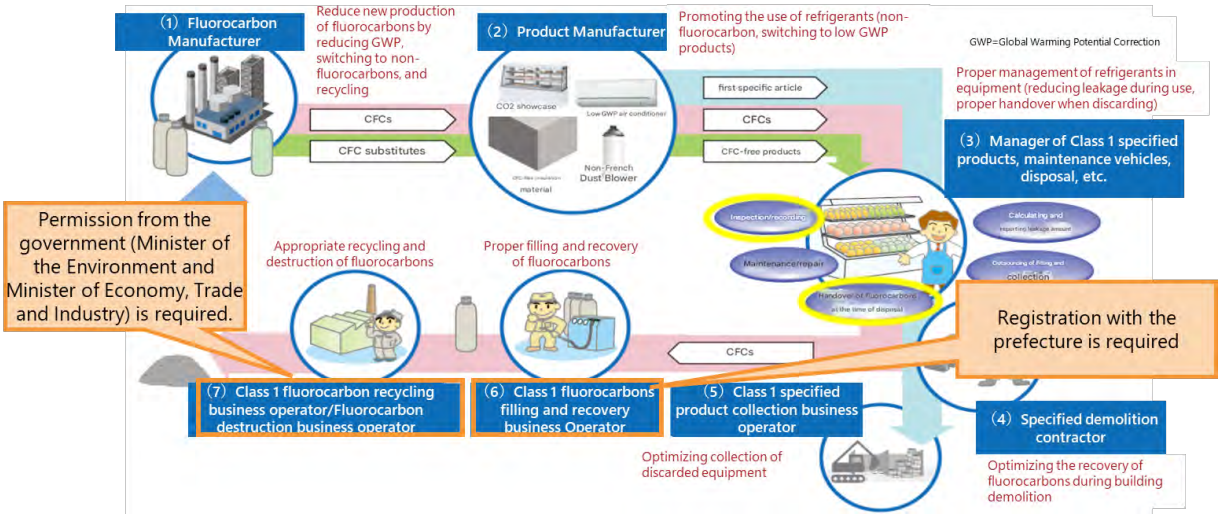
For example, in Japan, handling fluorocarbons (also known as CFCs or Freon) and other refrigerants is strictly regulated due to their environmental impact, particularly their role in ozone depletion and global warming. To ensure proper management and safe handling, specific qualifications are required for technicians who install, maintain, or dispose of

equipment that uses refrigerants. One of the main certifications is the 'Refrigerant Recovery Technician'. This certification is required for professionals who recover refrigerants from air conditioners, refrigerators, and other equipment during repairs or disposal. The goal is to prevent the release of harmful gases into the atmosphere. Additionally, there are categories of certified refrigeration engineers, which vary based on the type and scale of equipment handled. These certifications require both theoretical knowledge and practical training, covering topics like safe handling procedures, environmental regulations, and equipment maintenance.

The handling of fluorocarbons is also governed by the Fluorocarbon Emissions Control Law, which mandates proper maintenance, leakage checks, and record-keeping for commercial refrigeration and air-conditioning systems. Companies must ensure that only certified personnel handle these tasks.

By coupling the regulation of refrigerant handling with a certification system, it becomes possible to ensure that only qualified individuals with the necessary expertise manage these substances. Introducing similar certification and regulatory systems in other Asian countries could help prevent the release of fluorocarbons into the atmosphere, thereby contributing to the mitigation of global warming.

Figure 0.4: Fluorocarbon life cycle and licenses



Source: Ministry of Environment Japan (n.d.) (Verified in 2025).

1.3.3. Proposal 3: Regulatory Relaxation for Safer and More Efficient Boilers

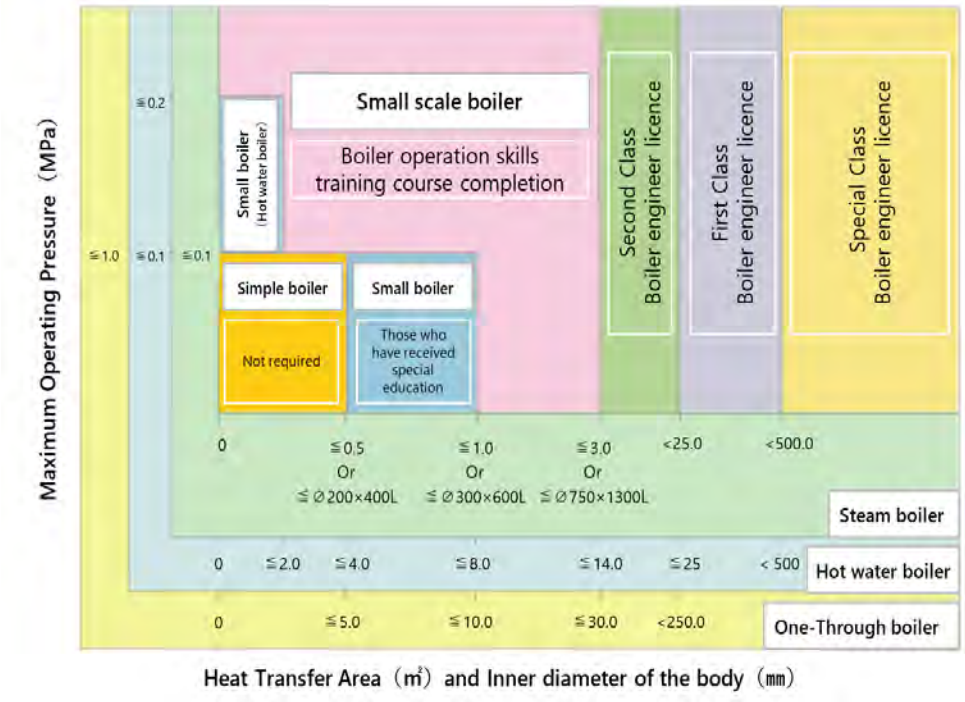
To balance safety assurance with reduced compliance costs, the adoption of regulatory easing for small once-through boilers is recommended. Drawing on the Japanese model, this approach would relax licensing obligations under specific conditions while reinforcing oversight through standardised safety measures, inspections, and monitoring systems.

Amongst various types of boilers, including fire-tube and water-tube boilers, small once-through boilers are considered relatively safe due to their low water content, which reduces the risk of issues such as tube rupture. In Japan, boilers are classified based on parameters such as heat transfer area and operating pressure. Small once-through boilers that fall into the 'small boiler' category are recognised for their high safety, and, if certain conditions are met, are exempt from licensing requirements such as holding a boiler operator license or completing specific training. In Japan, even simpler boilers (referred to as 'simplified boilers') do not require any qualification, while small boilers slightly larger than these may be operated upon completion of a special education programme.

If similar regulatory easing were to be introduced in other countries – alongside appropriate safety mechanisms such as standardised design criteria, periodic inspections, and remote monitoring – it could significantly reduce the compliance burden on businesses, especially small- and medium-sized enterprises, without compromising safety.

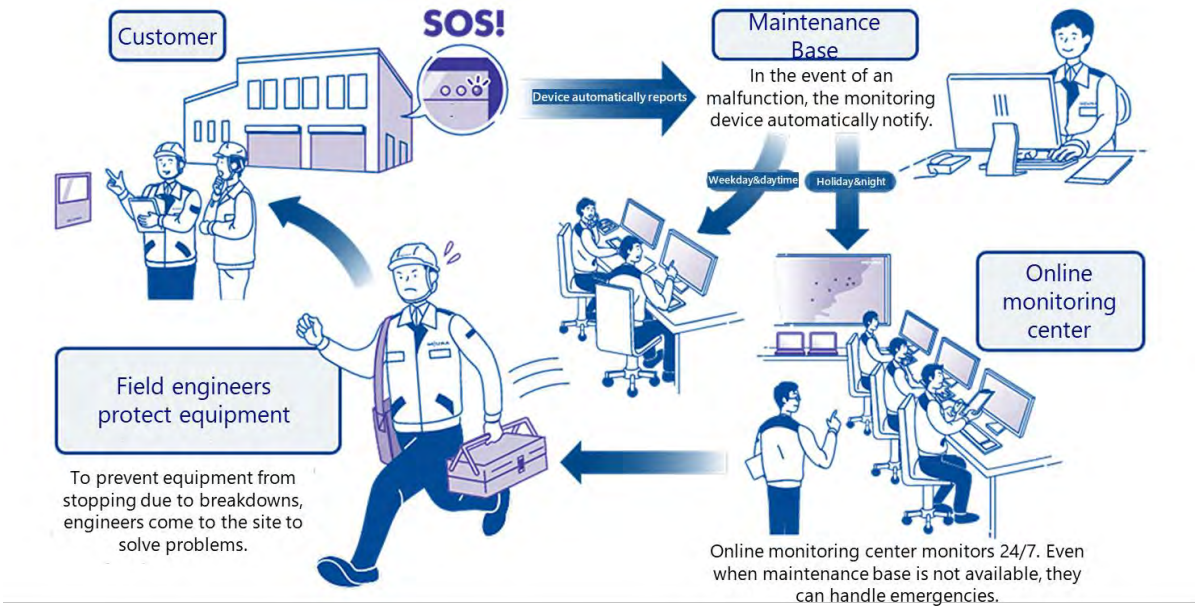
However, relaxing regulations may cause concern amongst users. To make users feel secure about using once-through boilers, a safety system must be established that includes remote monitoring and immediate support in the event of malfunctions (Figure 5.6). This will allow users to feel confident about using or continuing to use once-through boilers.

Figure 0.5: Once-through boiler classification and qualification requirements for operation



Source: Gas Bureau City of Sendai, Japan Boiler Association (Verified in 2025).

Figure 0.6: Safety measures to use boilers



Source: Miura.

1.4. Incorporating Stakeholder Feedback to Refine Proposals

The next step involves collecting feedback on the three proposed measures from relevant organisations and stakeholders in Thailand, Viet Nam, and India. These organisations may include government agencies responsible for energy and environmental policy or standards, industry associations, and other entities involved in the promotion or regulation of energy-efficient technologies. By engaging directly with these local stakeholders, the aim is to assess the relevance, feasibility, and potential effectiveness of each proposal in the context of the unique market conditions and regulatory frameworks of each country.

This consultation process will not only help identify any gaps between the challenges perceived by manufacturers and those recognised on the ground in the target countries but also reveal any overlooked barriers or local constraints that might impact implementation. In doing so, it will enable the refinement of the proposals to ensure that they are well-aligned with local needs, capacities, and priorities. For example, a measure that seems technically sound from a Japanese perspective might require adjustment to account for differences in institutional readiness, workforce training infrastructure, or public awareness levels in the target countries.

Ultimately, the goal is to use the insights gained from this feedback to bridge the perception gap regarding the introduction of heat pumps and once-through boilers, and to revise the proposed activities so that they truly reflect what is needed and achievable in Thailand, Viet Nam, and India. This iterative process of local engagement and proposal

refinement is expected to significantly enhance the practical impact and adoption potential of the initiatives.

1.4.1.Proposal 1

I. Thailand

Local Associations and ESCO's perspective

Thailand has already established energy efficiency labels for heat pumps by the Department of Alternative Energy Development and Efficiency (DEDE), but there are limitations in its coverage as it does not extend towards those used in industrial purposes. Only heat pumps less than 36kW capacity can obtain the energy efficiency certification/label by the government. The energy efficiency standards for heat pump, TIS 3623-2566 are also present, which reduces the need for its adoption.

- 'DEDE has established energy efficiency label for heat pumps under 36kW. Currently, there are no testing facilities or laboratories in Thailand for testing of heat pumps over 36 kW. Thailand industries need high-temperature heat pumps (90-120°C) but DEDE currently promotes only low-temperature units (60–65°C).' (TBA)
- 'DEDE plans to upgrade the energy efficiency standards in the future to include larger capacity heat pumps. However, this expansion is currently limited by the available testing facilities. The two main sectors using heat pumps in Thailand were hotels and hospitals, which generally require medium-temperature heat.' (AHPNW)
- 'As the standard, which requires time and financial resources for application, is not mandatory, manufacturers do not pay much attention to apply for the energy efficiency label.' (TN Group, Energica)

Furthermore, monetary reasons remain a key consideration towards wide scale adoption as users must be convinced of the energy saving potential rather than the technical specifications of energy efficiency labels.

- 'There is a demand to see heat pump efficiency (e.g. profitability/ROI/etc.) and investment value to differentiate from other heat exchangers.' (TBA)
- 'Higher investment costs remain a significant barrier, especially for residential and
  hotel sectors.' (AHPNW)
- 'Factory owners only read spec sheets and energy saving factor for decision-making without much interest in whether the heat pump has the energy efficiency label.' (TN Group, Energica).

Government's perspective

The views from the local association and ESCOs were largely supported by the views from the government agencies in Thailand. Further information was shared by DEDE of upcoming plans to expand the energy efficiency label (label No.5) to cover both heat pumps smaller than 4kW and larger than 36kW, and to make the label application simpler and valid for longer period to improve adoption. It was shared that another problem persists, which was the overlap in coverage by the current heat pump energy efficiency TIS 3623-2566 standard created by the TISI with the energy efficiency label no.5 created by the DEDE. This created a disconnect in manufacturers' perception of the need for energy efficiency labels for their heat pumps.

- 'TIS 3623-2566 is the only voluntary TIS for heat pump products, developed collaboratively with DEDE. However, manufacturers have not applied for the voluntary TIS 3623-2566 possibly because they do not see sufficient marketing or sales advantages that would justify the time and cost required for the certification.' (TISI)
- 'The energy efficiency label No.5 is purely voluntary, mainly for marketing tools for manufacturers and is also probably why no users apply for TIS 3623-2566 as energy label no.5 already covers similar roles.' (DEDE)

The expansion and modernisation of the energy efficiency label is slow due to limitations in resources which has made it difficult for the energy efficiency label to remain relevant for adoption. The government agencies are aware of the issues and believes that it will be possible to overcome them with some external support.

- 'There are limitations of testing capacity. The current testing labs at King Mongkut's University of Technology Thonburi (KMUTT) and Mahidol University (MU) are only able to test less than 36kW and cannot test higher temperature heat pumps and heat pumps other than air-to-water type cannot be tested.' (DEDE)
- 'Thailand requires support in helping Thai universities build testing and certification capabilities and on-site testing support. Furthermore, training for Thai engineers about heat pump design and case studies on heat pump safety management will be helpful.' (MIND, DIW)

Time-based Tariff Structures

As a mechanism to promote load levelling, Time-of-Use (ToU) and Time-of-Day (ToD) tariff schemes have been introduced in several countries. In Thailand, ToU and ToD tariffs have been introduced in Thailand primarily aimed at medium and large business, industrial, and institutional consumers. These tariffs vary according to the time of day and are structured to encourage energy use during off-peak hours when electricity is more readily

available and less costly to generate. Eligibility is typically based on demand or consumption thresholds and are split into various categories with the two most relevant ones being Schedule 3 and 4.

Medium General Service (Schedule 3): Average integrated energy demand in 15 minutes over any period is 30 kW to less than 1,000 kW and an average monthly consumption over the last 3 months which is not over 250,000 kWh.

Large General Service (Schedule 4): Average integrated energy demand in 15 minutes over any period is 1,000 kW or more and an average monthly consumption over the last 3 months which is over 250,000 kWh.

Table 0.1 :Thailand Time of Use (ToU) & Time of Day (ToD) Rates

Schedule 3 & 4	Demand (Peak)	Energy (Peak)	Energy (Off-Peak)	Service Charge
TOU: <22 kV	210.00	4.3297	2.6369	312.24
TOU: 22kV – 33kV	132.93	4.1839	2.6037	312.24
TOU: >69kV	74.14	4.1025	2.5849	312.24

Schedule 4 Only	Demand (Peak)	Energy Charge	Service Charge
TOU: <22 kV	210.00	4.3297	2.6369
TOU: 22kV – 33kV	132.93	4.1839	2.6037
TOU: >69kV	74.14	4.1025	2.5849

Source: Provincial Electricity Authority, 2023.

II. Viet Nam

a) Local Associations and Research Institute's perspective

Viet Nam is preparing to introduce the energy labelling scheme for heat pumps and a roadmap for action from 2025–2030 is being drafted. A revised Law on Energy Efficiency and Conservation has been passed in June to reduce the administrative procedures and audits by 50% to encourage energy labelling. Once introduced, it could nudge companies towards the adoption of heat pumps but will be difficult to introduce as heat pumps are not the only system that can store energy. Activities to raise awareness should be conducted to generate sufficient demand before launching such labelling scheme.

- 'The introduction of a Demand Peak Suppression label can be considered, to nudge companies towards the adoption of heat pumps. As the main result is to reduce cost, but not direct GHG emission reduction, it would be difficult to persuade regulators to make it mandatory. Therefore, it should be a voluntary scheme.' (GreenDC)
- 'Viet Nam is preparing to introduce the energy labelling scheme for heat pumps. A roadmap for action from 2025–2030 is being drafted. It is difficult to introduce Demand peak suppression label for heat pumps because heat pump is not the only system that can store energy. Currently many businesses have started to invest in other energy storage systems for usage during peak hours.' (IET)
- 'In June, a revised Law on Energy Efficiency and Conservation (No. 77/2025/QH15) was passed. The amended Law reduced 50% of the administrative procedures related to issuing energy labelling certificates and energy audit certifications.' (VTST)

To facilitate the introduction of the energy labelling scheme, local stakeholders are actively cooperating with the Ministry of Industry and Trade (MOIT). Research is being conducted locally while taking reference to international standards such as those from Japan and US. The eventual introduction of the energy labelling scheme could be pegged towards a Minimum Energy Performance Standards (MEPS) criterion.

- 'IET has conducted research on the current situation for heat pump market and currently advising the Ministry of Industry and Trade on this scheme. References from Japan, US, and ISO standards are taken into consideration.' (IET)
- 'There are ongoing discussions that heat pumps should be certified by MOIT, by establishing the Minimum Energy Performance Standards (MEPS), for larger scale adoption.' (VTST)

Government's perspective

Viet Nam is open to introducing the energy labelling scheme. National standards, technical specifications and performance thresholds for energy efficiency levels of heat pumps must be established prior to the introduction of the energy efficiency label. The introduction of demand peak suppression label is seen as difficult, and the government agencies would need to see successful case studies in other countries before it can be considered.

- 'Currently energy label scheme is generic. It would be difficult to introduce the Demand peak suppression label in Viet Nam, if it has not been introduced

elsewhere. Viet Nam wants to see the successful case studies of the scheme before it can consider having one.' (VSQI)

Time-based Tariff Structures

In Viet Nam, TOU and TOD electricity pricing schemes are applied to large consumers, such as those in the manufacturing and commercial sectors, with the aim of distributing electricity demand more evenly and alleviating peak loads on the grid.

Viet Nam's electricity pricing system underwent major reform with the issuance of Decision No. 14/2025/QD-TTg on May 29, 2025[18], and the framework introduces a detailed ToU or ToD tariff structure, aiming to make electricity pricing more transparent, cost-reflective, and supportive of efficient energy use. Also, industrial users will need to manage both their peak demand and total consumption to control costs under a two-part tariff for large users. Firstly, the capacity charge is based on the maximum electricity demand a customer requires at any given time, regardless of how much electricity used during that period. Secondly, the energy charge is based on actual kWh consumed, varying by ToU time band.

Table 0.2: Viet Nam Time of Use (ToU) Rates

Period	Time Range	Rate Impact
Standard Hours	4am – 09:30am 11:30am – 5pm 8pm – 10pm	1kV–35kV: **86%** 35kV–220kV: **85%** >220kV: **84%**
Peak Hours	09:30am – 11:30am 5pm – 8pm	1kV–35kV: **157%** 35kV–220kV: **151%** >220kV: **146%**
Off–Peak Hours	10pm – 4am (All days)	1kV–35kV: **56%** 35kV–220kV: **54%** >220kV: **53%**

Source: Viet Nam Electricity (2024).

III. India

a) Local Associations and Manufacturer's perspective

India has a TOD electricity pricing tariff that could be complemented by the adoption of heat pumps as it provides heating and cooling energy consistently. Since the TOD is variable across the Indian states, it complicates a uniform national strategy for heat pump

[18] Vietnam Electricity (2025), WHOLESALE ELECTRICITY TARIFF (Decision No. 1279/QD-BCT dated 9 May 2025 of Ministry of Industry and Trade) https://en.evn.com.vn/d/en-US/news/WHOLESALE-ELECTRICITY-TARIFF-Decision-No-2699QD-BCT-dated-11-October-2024-60-28-260

adoption. A good starting point will be to target colder states or sectors with consistent hot water demand.

- 'Variability in TOD electricity pricing thresholds across Indian states complicate a uniform national strategy for heat pump adoption. Industries face added labour and overtime costs if shifting production to benefit from TOD schemes, with marginal price differences reducing incentive. The static pricing structure limits flexibility.' (AEEE)
- 'Thermal storage may be viable for the hotel sector in regions with consistent hot
  water demand, but local climate conditions are an important factor.' (Aspiration Energy)

Indian industrial sector could be deterred from heat pumps as they are concerned about CAPEX and ROI while other renewable energy solution, such as Solar, is preferred due to cost and operational efficiency.

- 'High capital expenses and integration costs make conventional boilers more economical in trials.' (AEEE)
- 'In the Indian industrial sector, businesses focus on total Capital Expenditure (CAPEX) and Return on Investment (ROI) when considering heat pumps. Many Indian industries increasingly adopt renewable energy solutions, especially solar energy via captive power plants. Industries generally prefer solar energy systems for hot water due to cost and operational efficiency; thus, TOD tariffs are not seen as attractive incentives.' (Aspiration Energy)

Government's perspective

Energy efficiency targets are set by Bureau of Energy Efficiency (BEE), and any product meeting these targets becomes eligible for the labelling programme. However, BEE does not certify individual appliances or components. Instead, it assesses the overall performance of the unit. Nonetheless, heat pumps are currently a small-volume product in India and thus, do not meet the market maturity required for energy efficiency labelling.

- 'BEE's labelling program focuses on energy efficiency rather than how the product is used. The usage of products, such as combining heat pumps with thermal storage tanks to benefit from TOD tariffs, cannot be labelled. This is because the product's performance must be evaluated on a standalone basis, not based on combinations or specific usage scenarios. As heat pumps mature and their market scale grows, BEE can assist with labelling if the product meets the required energy efficiency standards.' (BEE)

Time-based Tariff Structures

In India, a dynamic pricing mechanism designed to encourage consumers to shift their electricity usage to periods when demand is lower or when renewable energy, especially solar, is abundant. ToD tariff would be applicable for commercial and industrial consumers having maximum demand of 10 KW and above, from April 2024 and for all other consumers except agricultural consumers, latest from April 2025. The widespread adoption of smart meters is a critical issue for implementation of this pricing system nationwide. Since solar power is cheaper, the tariff during the solar hours will be less but during non-solar hours thermal and hydro power as well as gas-based capacity is used – their costs are higher than that of solar power – this will be reflected in Time-of-Day Tariff.

Table 0.3: India Solar Hour Time of Day (ToD) Rates

Period	Time Range	Rate Impact
Solar Hours	8 hours in daytime	10–20% lower
Peak Hours	6pm – 10pm	10–20% higher
Normal Hours	6am – 6pm	Standard rate
Off-Peak Hours	10pm – 6am	Lower rate

Source: Press Information Bureau, 2023.

IV.Need for Energy Efficiency Labelling beyond Time-Based Tariff Structures

In Proposal 1, we emphasised the benefits of using heat pumps to level out electricity demand. The three target countries – Thailand, Viet Nam, and India – have all implemented TOU electricity tariffs that reflect fluctuations in demand between peak and off-peak hours. These tiered tariff systems are designed to promote energy consumption patterns that align with the availability of renewable energy sources, thereby reducing the strain on the power grid during peak demand. This aligns perfectly with the load-levelling advantages of heat pumps.

Both TOU and labelling schemes can serve as policy tools that highlight the advantages of heat pumps, namely their high energy efficiency and potential to support load shifting. A common issue in Thailand, Viet Nam, and India is that existing labelling programmes – originally designed to promote the spread of energy-efficient air conditioners – either exclude heat pumps and once-through boilers entirely or cover only a very limited range of products. Moreover, there is virtually no awareness of the potential role that heat pumps, and similar technologies could play in load management.

Against this backdrop, introducing a labelling system that makes the superior energy efficiency and thermal storage capacity of industrial heat pumps visible could help raise awareness of their value. Such a system would not only demonstrate the direct financial benefits of heat pumps but also align them with broader government objectives on energy management and sustainability.

However, discussions with local stakeholders revealed that energy labels are still seen purely as tools for energy efficiency, and integrating the concept of load shifting into these schemes would face significant resistance. More urgently, there is a clear need to first expand the scope of labelling programmes to include a wider range of heat pumps, including industrial-scale models. Accordingly, the proposed approach is to focus on incorporating heat pumps into existing energy policy tools, such as labelling programmes, while prioritising the development of appropriate measurement methods, testing conditions, and performance benchmarks needed to define their energy efficiency.

Proposal 2

The level of regulation for each refrigerant varies from country to country. Based on our research and interviews, the current regulatory status of each refrigerant is showed in Table 5.4.

Table 0.4: Regulatory status

Country	Refrigerants	Handling	Storage/Transport	Recycling/Disposal
Thailand	CFCs	Regulated primarily under environmental and industrial laws aligned with international agreements such as the Montreal Protocol	Regulated primarily under environmental and industrial laws aligned with international agreements such as the Montreal Protocol	The Ministerial Notification on Hazardous Waste Manifest System B.E. 2547 Management of Waste or Unused Materials B.E. 2566 The Ministerial Notification on Industrial Waste Disposal
	Alternative CFCs	Hazardous Substance Act B.E. 2535 Factory Act B.E. 2535	Safety measure for gas business operation B.E. 2548 Factory Act B.E. 2535	The Ministerial Notification on Hazardous Waste Manifest System B.E. 2547 Management of Waste or Unused Materials B.E. 2566 The Ministerial Notification on Industrial Waste Disposal

	Ammonia	Hazardous Substance Act B.E. 2535 Ordinance Regulating Safety Measures for Cooling Systems Using Ammonia B.E. 2554 Factory Act B.E. 2535	Safety measure for gas business operation B.E. 2548 Factory Act B.E. 2535	The Ministerial Notification on Hazardous Waste Manifest System B.E. 2547 Management of Waste or Unused Materials B.E. 2566 The Ministerial Notification on Industrial Waste Disposal
	CO_2	NA	NA	NA
Viet Nam	CFCs	Law No. 72/2020/QH14 - Law on Environmental Protection QCVN 76:2023/BTNMT: Technical and safety requirements for ODS refrigerants Decree No. 06/2022/ND-CP: Mitigation of GHG emissions and protection of ozone layer Law No. 06/2007/QH12 - Law on Chemicals TCVN 6739:2015 – Refrigerants: Designation and Safety Classification	Law No. 72/2020/QH14 - Law on Environmental Protection QCVN 76:2023/BTNMT: technical and safety requirements for ODS refrigerants Law No. 06/2007/QH12 - Law on Chemicals National Technical Regulation QCVN 05A:2020/BCT	Law No. 72/2020/QH14 - Law on Environmental Protection QCVN 76:2023/BTNMT: technical and safety requirements for ODS refrigerants Law No. 06/2007/QH12 - Law on Chemicals
	Alternative CFCs	Law No. 72/2020/QH14 – Law on	Law No. 72/2020/QH14 - Law	Law No. 72/2020/QH14 - Law

		Environmental Protection QCVN 76:2023/BTNMT: Technical and safety requirements for ODS refrigerants Decree No. 06/2022/ND-CP: Mitigation of GHG emissions and protection of ozone layer Law No. 06/2007/QH12 - Law on Chemicals TCVN 6739:2015 – Refrigerants: Designation and Safety Classification	on Environmental Protection QCVN 76:2023/BTNMT: Technical and safety requirements for ODS refrigerants Law No. 06/2007/QH12 - Law on Chemicals National Technical Regulation QCVN 05A:2020/BCT	on Environmental Protection QCVN 76:2023/BTNMT: Technical and safety requirements for ODS refrigerants Law No. 06/2007/QH12 - Law on Chemicals
	Ammonia	Law No. 72/2020/QH14 – Law on Environmental Protection Law No. 06/2007/QH12 - Law on Chemicals TCVN 6739:2015 – Refrigerants: Designation and Safety Classification QCVN 03:2019/BYT: Viet Nam's national technical regulation on the permissible exposure limit values (OELs)	Law No. 72/2020/QH14 - Law on Environmental Protection Law No. 06/2007/QH12 - Law on Chemicals National Technical Regulation QCVN 05A:2020/BCT	Law No. 72/2020/QH14 - Law on Environmental Protection Law No. 06/2007/QH12 - Law on Chemicals

	CO_2	Law No. 72/2020/QH14 – Law on Environmental Protection Law No. 06/2007/QH12 - Law on Chemicals TCVN 6739:2015 – Refrigerants: Designation and Safety Classification QCVN 03:2019/BYT: Viet Nam's national technical regulation on the permissible exposure limit values (OELs)	Law No. 72/2020/QH14 - Law on Environmental Protection Law No. 06/2007/QH12 - Law on Chemicals National Technical Regulation QCVN 05A:2020/BCT	Law No. 72/2020/QH14 - Law on Environmental Protection Law No. 06/2007/QH12 - Law on Chemicals
India	CFCs	Environment (Protection) Act, 1986 Ozone Depleting Substances (Regulation and Control) Rules, 2000	Environment (Protection) Act, 1986	Environment (Protection) Act, 1986 Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016 Second Amendment to the E-Waste (Management) Rules, 2023
	Alternative CFCs	Environment (Protection) Act, 1986 The Factories Act, 1948	Environment (Protection) Act, 1986 The Factories Act, 1948	Environment (Protection) Act, 1986 Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016 Second Amendment to the E-Waste (Management) Rules, 2023

	Ammonia	Environment (Protection) Act, 1986 The Factories Act, 1948	Environment (Protection) Act, 1986 The Factories Act, 1948 Gas Cylinders Rules, 2016	Environment (Protection) Act, 1986 Hazardous and Other Wastes (Management and Transboundary Movement) Rules, 2016
	CO_2	Environment (Protection) Act, 1986 The Factories Act, 1948	Environment (Protection) Act, 1986 The Factories Act, 1948 Gas Cylinders Rules, 2016	Environment (Protection) Act, 1986

Source: Author.

I. Thailand

Local Associations and ESCO's perspective

There are regulations covering the usage of refrigerants in Thailand, but the training and licensing schemes are limited to none. Since there are no mandatory licensing requirements for technicians working with refrigerants, technicians are less inclined to participate or to improve their knowledge. Involvement from both manufacturers and the governmental agencies are required to introduce training and licensing schemes for refrigerants before increased activity in its usage can be observed.

- 'The Department of Industrial Works (DIW) creates regulations, sets safety standards, and monitor compliance to minimise risks associated with refrigerant use. It is recommended to contact DIW for further discussion.' (AHPNW)
- 'Currently there are no mandatory permit requirements for technicians working with refrigerants. However, machine (including heat pumps) manufacturers are the ones who choose which refrigerants to use then they prepare instruction and safety manuals. Technicians may not be interested in permits if they're not compulsory. However, mandatory permits could initially slow down heat pump market growth.' (TN Group, Energica)

Government's perspective

Cross governmental efforts are necessary in handling refrigerants from import to its usage and disposal, as market control is more complex in Thailand due to the numerous refrigerant importers from various countries (e.g. China, Europe, Japan and India). This has created a need for a more institutionalised training and licensing scheme to address the different usage requirements of refrigerants. In view of this, our proposal for training and licensing scheme was well-received across the government agencies.

- 'MIND already has a department which handles matters about refrigerants (storage and import quota) referring to Montreal Agreement. New laws regulating ammonia usage have been introduced to be enforced starting February next year. Restrictions on ammonia use are imposed by the Department of Public Works and Town & Country Planning.' (MIND, DIW)
- 'Import quotas for refrigerants are controlled by the Department of Industrial Works.' (TISI)
- 'We are supportive of the training initiative and there should be no issue if the training is overlapping with existing programs. More training is always better for safety purposes.' (DEDE)

To facilitate the governmental agencies in establishing the training and licensing scheme of refrigerants, knowledge sharing support will be essential. This goes beyond guidelines from developed countries and can include market surveys detailing the market share of refrigerants currently used in Thailand.

- 'Knowledge sharing regarding ammonia used as fuel, especially how it is stored and managed differently from refrigeration systems as ammonia is now also used as a fuel for combustion will be helpful.' (MIND, DIW)
- 'It will be helpful to include guidelines for refrigerants in the proposal. The guidelines can be based on the Japanese ones. Market survey to include the list and market share of refrigerants circulating in the market, including their Global Warming Potential (GWP), and a flammability summary to make this proposal more interesting.' (DEDE)

II. Viet Nam

a) Local Associations and Research Institute's perspective

No licensing requirements have been introduced although natural refrigerants such as CO2 are already in use especially by seafood processing and F&B companies for high-capacity refrigeration systems, and there will be an increasing demand for training and guidelines by the industry. Studies have been conducted on using CO2 refrigerants, but there is still lack of development of training programmes and guidelines. Collaboration

with local universities / institutes will be important to customise it towards the local requirements, while active involvement from The Ministry of Agriculture and Environment, who is the agency in charge of training programmes on refrigerant handling for technicians, will be crucial for its approval and introduction.

- 'To initiate such training and licensing scheme for natural refrigerant, it is necessary to have a thorough assessment of different procedures during the product life cycle. The assessment should identify who is the party in charge and therefore key stakeholder for licensing/training, whether it is the refrigerant producer, or air-conditioning manufacturers, or operators. Such training program should be customised for local requirements. Currently quite a few seafood processing companies have started using CO_2 as a natural refrigerant so there could be increasing demand for training and guidelines on this aspect. To conduct training, it is better to collaborate with universities / institutes (e.g. Hanoi University for Science & Technology, or vocational training institutes) who have experience designing and running the program.' (GreenDC)
- 'The Ministry of Agriculture and Environment is the agency in charge of training programs on refrigerant handling for technicians. They also provided support for companies for the transition towards more environmental-friendly refrigerant. There is no licensing requirement now, and it is up to the government to decide.' (IET)
- 'Training program is necessary. NRI can collaborate with MOIT to organise and VTST can conduct the training. Some studies were conducted on using CO_2 as refrigerant, in combination with CCUS to extract CO_2.' (VTST)

Government's perspective

No licensing requirements have been introduced for refrigerants but there are currently many regulations and standards on refrigerant handling. To introduce the training scheme, the support and involvement of The Ministry of Agriculture and Environment (in dealing with dangerous chemical) and Ministry of Internal Affairs (in terms of occupational safety) will be important.

- 'There are currently many regulations and standards on refrigerant handling. Licensing is, however, not yet introduced. Training scheme for refrigerant handling is under the authority of The Ministry of Agriculture and Environment (in dealing with dangerous chemicals) & Ministry of Internal affairs (in terms of occupational safety).' (VSQI)

III. India

a) Local Associations and Manufacturer's perspective

India currently lacks a formal licensing programme and while boiler operators must be licensed, no similar requirement exists for heat pump or refrigerant handlers. Existing certification programmes are not nationally standardised and there is a pressing need to establish a licensing scheme to ensure safety and standardisation across India.

- 'No official government-backed licensing program exists yet; existing certification programs are not nationally standardised. There is a potential to develop a formal licensing framework in collaboration with skill councils and international bodies (METI, ERIA). We can consider leveraging the India Cooling Coalition (ICC) for knowledge transfer and best practices.' (AEEE)
- 'A formal licensing program would enhance safety and compliance with best practices in the industry which India currently lacks. Associations like The Indian Society of Heating, Refrigerating and Air Conditioning Engineers (ISHRAE) offer training and certification but lack official government licensing authority.' (Aspiration Energy)

Proposal 3

I. Thailand

Local Associations and ESCO's perspective

Before deregulation of licenses for safer boilers (such as once-through boilers) can occur, there must be increase in awareness of the differences between once-through boilers and traditional boilers from the perspective of users. A common misconception currently held is that once-through boilers require the same frequency of inspection and maintenance just like traditional boilers. Beyond the users, the country itself also faces a huge challenge in the quality of its feedwater necessary for boilers, as it contains high levels of contaminants. This accelerates equipment degradation and increases maintenance costs of boilers which reduces its adoption.

- 'Traditional boilers are inspected annually by third-party engineers who check their safety. These engineers must sign a guarantee certifying that the boilers are safe to operate. If there is sufficient evidence to guarantee that accidents from small or simple boilers are extremely small, the further minimisation of the auditing process might be possible to apply for once-through boilers.' (AHPNW)
- 'Many users still consider once-through boilers as regular boilers requiring engineer inspection and maintenance. From the user's point of view, it's still necessary to acquire the permit for once-through boilers like every boiler to

ensure the safety of pressure vessels. Another factor to consider is that Thailand's water quality is not as good as Japan's and routine inspection for any boilers are still required as the water might cause corrosion.' (TNG Group, Energica).

Government's perspective

The views from the local association and ESCOs were largely supported by the views from the government agencies in Thailand. Although there is a growing trend of once-through boiler adoption in Thailand, driven by their efficiency and safety benefits, the regulatory landscape today still needs to reflect greater differentiation between once-through boilers and traditional boilers. On this regard, DEDE has shown strong interest in this proposal noting that it differs from other ongoing initiatives and has not been previously undertaken by other government agencies. The creation of new Thai-specific standards for boilers are not being carried out as it is viewed as a niche industrial product whereby the limited resources of the government are being prioritised in developing standards that protect the general consumer. As a result, regulatory advancements for boilers may need to rely more on aligning with international standards rather than developing new national ones which are already closely followed by manufacturers in Thailand.

- 'DIW conducted a study on once-through boilers around 20 years ago. Many users in Thailand are also adopting once-through boilers due to their safety and efficiency advantages. Regulations are not as strict with once-through boilers compared to conventional boilers. To put it simply, Thailand already has similar system in getting certificates like Japan. The main problem in Thailand is poor water quality; high levels of contaminants in feed water cause boilers to break down quickly.' (MIND, DIW)
- 'TISI does not prioritise creating new Thai standards for boilers as they are considered a niche product, and TISI's main priority is consumer protection. Manufacturers of boilers in Thailand typically already obtained widely used international standards (e.g. JIS, ASME, EN).' (TISI)
- 'This could be the main proposal to work with DEDE because it is quite different from other proposals and has never been done by any other departments. DEDE would like more information such as the product information details, the specification and application range.' (DEDE).

II. Viet Nam

a) Local Associations and Research Institute's perspective

Viet Nam's boiler market is large and highly regulated, with a strong push toward environmentally friendly technologies such as biomass and centralised boiler systems, particularly in industrial zones where third-party operators manage large-capacity units. This shift is driven by the cost-effectiveness and availability of biomass like wood pellets, as well as the need to reduce emissions. While these trends may limit the use of once-through boilers, there is still potential in distributed systems. Realising this potential will require evaluating market demand, assessing technical feasibility, and conducting pilot testing under local conditions, with technology transfer from Japan potentially supporting adoption.

- 'For boilers – it is better to consult the VTST. Boiler market is big and there are a lot of regulations on boilers and programs to promote environmentally friendly boilers.' (GreenDC)
- 'Usage of once-through boilers in Viet Nam could be limited, due to 2 reasons: (1) Companies are switching to biomass for industrial boilers. Biomass (e.g. wood pellets) are cheaper, readily available and more environmentally friendly compared to LNG or oil. (2) Boiler operation is being outsourced to third party operators to minimise cost. In industrial zone, centralised boiler system with large capacity is being used to provide steam to multiple users. Once through boilers with small capacity is not relevant in such cases.' (IET)
- 'There's a shift towards biomass boilers and centralised boilers in industrial zones, driven by increasing focus on decarbonisation. But for distributed system, small boilers are still applicable. So, there is potential for more usage of once through boilers. Technology transfer from Japan would be helpful. In order to formalise the deregulations for once-through boilers, there should be sufficient interest and demand for the product. The 1st step is to evaluate the market potential. 2nd step is to analyse the opportunity and challenge of the technology. 3rd step will be to have a prototype testing in an authorised facility, in local operating conditions.' (VTST)

Government's perspective

Boiler standards in Viet Nam were last updated in 2019 and are subject to revision every 3 years. To remove or adjust requirements for once-through boilers, solid evidence from international case studies and scientific research is needed. The VSQI under the Ministry of Science and Technology, plays a central role in this process and is particularly interested in understanding relevant Japanese boiler regulations for reference. Manufacturers can collaborate with the government to propose changes through

technical committees led by VSQI, which include representatives from various agencies and the private sector.

- 'Standards for boilers were last revised in 2019. Standards can be changed every 3 years. In order to remove the requirements for once through boilers, there should be established evidence from international case study and scientific research. VSQI wants to know the corresponding law for boilers in Japan for reference. Manufacturers can work with the government to propose such changes. VSQI, under the Ministry of Science and Technology, leads a technical committee with representatives from different agencies and private sector companies. Proposals can be submitted via such committees.' (VSQI)

III. India

a) Local Associations and Manufacturer's perspective

Local stakeholders are supportive of deregulation of licenses for safer boilers as stringent boiler regulations hinder adoption of safer, efficient technologies. Technology transfer from Japan to India via partnerships with ESCOs, BEE, and demonstration projects will be helpful to facilitate adoption of once-through boilers in India.

- 'There is potential to explore classification of small once-through boilers under non-IBR category to ease initial licensing, with plans to work with government bodies for further regulatory relaxation. National Productivity Council and competent regulatory authorities should be engaged. Partnerships and collaboration with ESCOs and BEE will be crucial to facilitate adoption' (AEEE)

1.5. Recommendations For Future Programmes Based on Stakeholder Feedback

In response to stakeholder input, we revised our proposals to ensure they are more relevant to the circumstances of the target countries.

Proposal 1: Development of Quantitative Metrics and Testing Scheme as Standards

In response to stakeholder feedback, we propose that Thailand, Viet Nam, and India **prioritise the development of metrics, criteria for quantitatively measuring and developing uniform testing conditions**. This foundational step is crucial for promoting the adoption of high-efficiency heat pump technologies in emerging markets.

Establishing a standardised framework for visualising the benefits of heat pumps is essential for their broader acceptance. This involves setting performance standards and testing standards that can be effectively evaluated. Once this institutional framework for these standards is in place, it will serve as the basis for adding heat pumps to existing

energy efficiency labelling systems, Minimum Energy Performance Standards (MEPS) and others.

However, this recommendation is accompanied by two critical observations: first, that the successful implementation of a standard requires a certain degree of market maturity; and second, that awareness of heat pump technology remains limited amongst key stakeholders, including policymakers, industry actors, and end-users, which lead low priority to make a standard or other political instrument to make heat pumps' advantages for consumers.

To address these challenges, a comprehensive package of actions is suggested. These include efforts to enhance public understanding of the energy-saving and grid-balancing potential of heat pumps, as well as initiatives to build the necessary technical and institutional capacity to support a new measurement and labelling framework. Outreach activities – such as stakeholder dialogues, technical workshops, and public seminars – should play a central role in promoting recognition of heat pumps as a viable solution for clean and efficient heating and cooling.

At the same time, practical measures must be taken to support the introduction of this framework. These include:

- Conducting local market assessments to identify demand trends, user needs, and adoption barriers.
- Launching public information campaigns to raise awareness of heat pump benefits.
- Establishing or upgrading testing facilities capable of verifying performance based on internationally accepted standards.
- Developing and standardising testing protocols and quantitative metrics to measure key benefits like thermal storage capacity and grid-levelling potential.

To facilitate these steps, partner countries would benefit from targeted support by developed countries and international partners. Recommended forms of assistance include:

- Facilitating technical exchanges through site visits to testing laboratories in developed countries and providing support for the development or enhancement of local testing infrastructure.
- Sharing established methodologies for measuring and standardising metrics, offering technical guidance for initial performance testing, with necessary adaptations for local conditions.
- Assisting in the formulation of national performance standards and efficiency criteria based on tested data and international best practices.

- Supporting in-depth market research and data collection to ensure evidence-based policy and programme design.

By combining these technical, institutional, and awareness-raising efforts, partner countries can create the foundation for a credible and effective labelling system. This will not only strengthen consumer trust and policy alignment but also catalyse broader market uptake of heat pump technologies.

Proposal 2: Improving Refrigerant Safety Through Licensing and Training

The second proposal, **'Improving refrigerant safety through licensing and training'** has emerged as a critical priority across several partner countries, including Thailand, Viet Nam, and India. Feedback from local stakeholders reveals that regulatory systems for the handling, recovery, reclamation, and disposal of refrigerants remain underdeveloped. Without structured licensing and training mechanisms, there is a substantial risk of improper refrigerant use and uncontrolled emissions of high-global warming potential (GWP) substances.

To close this regulatory gap and enhance the safe management of refrigerants, the following measures are proposed as central pillars of national policy development:

- Technicians involved in installing, maintaining, and decommissioning refrigerant-using equipment should be required to obtain formal qualifications. Certification should be contingent upon participation in recognised training programmes, and efforts must be made to raise awareness and attract technicians to these programmes.
- For fluorocarbon refrigerants in particular, mandatory procedures should be adopted for preventive maintenance, leak inspections, and the systematic tracking of refrigerant usage and emissions.

However, the level of regulatory maturity differs across countries and refrigerant types. While some governments are drafting handling guidelines for certain refrigerants, others lack any protocols for recovery, disposal, or the use of alternative refrigerants, including natural options. As a result, a flexible and consultative approach is needed – one that accounts for local market dynamics, technical capacity, and safety considerations. A process of dialogue amongst stakeholders will be essential to define which refrigerants should be prioritised for regulation and training.

Given the limited institutional experience in some countries, external support will be crucial to accelerate progress. Developed countries can provide the following forms of assistance:

- Share reference models of refrigerant-related regulation, licensing, and technician training systems already in place in advanced economies. These can offer practical templates for local adaptation.

- Support local surveys to identify refrigerants currently used in the market, accompanied by technical information on their GWP, flammability, and toxicity. These data will inform risk-based policy design.
- Assist in drafting the initial versions of regulations and protocols that are both aligned with international best practices and grounded in local feasibility.
- Deliver training programmes, awareness campaigns, and capacity-building initiatives to enhance national readiness and promote safe refrigerant management practices.

These actions are designed to foster the development of enforceable, science-based refrigerant management systems. By investing in technician certification and institutional capability, partner countries will be better positioned to minimise emissions, safeguard public health, and support long-term transitions to climate-friendly cooling technologies.

Japan has a strong track record of supporting such initiatives in Southeast Asia through the Joint Crediting Mechanism (JCM) and other activities. For instance, Japan has provided assistance by conducting surveys on the current status of fluorocarbon gases and offering training on refrigerant recovery and destruction. These past efforts and accumulated expertise enable Japan to provide effective and appropriate support for the establishment of a robust institutional framework.

Proposal 3: Regulatory Relaxation for Once-through Boiler

Another key proposal identified through stakeholder engagement is **'the regulatory relaxation for once-through boilers'**. To accelerate the adoption of high-efficiency once-through boilers, this policy proposal advocates for regulatory reform centred on their inherent safety. Specifically, it recommends defining once-through boilers in a way that distinguishes them from other type of boilers and then relaxing regulations concerning licensing and monitoring based on their low-risk profile.

The market maturity and regulatory readiness for once-through boilers vary across Thailand, Viet Nam, and India. Current regulatory frameworks in many countries have not yet been fully adapted to reflect the unique characteristics of this technology.

In Thailand, preliminary steps have already been taken. The DIW and other relevant authorities have explored the potential of once-through boilers, and licensing and permitting procedures are already somewhat differentiated from those for conventional boilers. As a result, government officials are generally more familiar with the technology. Although some local companies remain cautious, adoption has progressed, particularly amongst foreign-invested enterprises that prioritise energy efficiency and operational reliability.

By contrast, in Viet Nam and India, once-through boilers are still relatively unknown. Adoption is limited to a small number of companies, and awareness amongst regulators

and industrial associations remains low. In these markets, there is a clear need not only to improve market awareness but also to actively engage with government agencies. Specifically, it is important to emphasise the safety, efficiency, and operational advantages of once-through boilers to policymakers and regulatory officials, helping to build the foundational understanding required for supportive policy reform.

To facilitate the wider adoption of once-through boilers, it is proposed that partner countries revise their regulatory frameworks. This should include:

- Establishing clear definitions and technical standards for once-through boilers, along with regulatory provisions that reflect their lower risk profile. These may include simplified licensing processes and performance-based compliance standards that differ from those applied to conventional boilers.
- Carrying out awareness-raising activities aimed at both potential users and government stakeholders to highlight the high energy efficiency and safety advantages of once-through boilers. Such initiatives can help ensure that regulatory easing is recognised not as a simple relaxation, but as a measure grounded in proven safety features, thereby fostering broader acceptance and policy support.

To support these efforts, developed countries and technology providers can:

- Offer technical documentation, benchmarking data, and comparative analyses that clearly demonstrate the advantages of once-through boilers. These materials can guide regulatory reform and help reduce unnecessary administrative burdens.
- Organise capacity-building workshops and seminars for both industry stakeholders and regulatory bodies – especially in Viet Nam and India – where awareness remains low. A dual-track approach that builds market demand while also fostering regulatory understanding will be critical to unlocking adoption in these markets.

By implementing these activities, we can strategically relax regulations for once-through boilers in a manner that prioritises safety. This approach, grounded in clear definitions and broad awareness, will remove administrative barriers and enable the widespread adoption of this highly efficient technology. We are confident this is the path to sustainable industrial growth.

1.6. Summary of the Proposed Actions

These three proposals – development of quantitative metrics and testing scheme for Heat Pumps, introducing regulatory frameworks and training systems for refrigerant handling, and facilitating the adoption of once-through boilers – represent significant undertakings that may be challenging for any single country to implement independently. Although Japan and other advanced economies have already been involved in promoting energy-

efficient technologies such as heat pumps and once-through boilers in Thailand, Viet Nam, and India, there is a growing expectation for further collaboration and expanded activities.

In light of global decarbonisation goals and the need to improve industrial energy efficiency, it is strongly recommended that developed countries deepen their cooperation with stakeholders in these three countries. Such partnerships can play a vital role in realising the proposals outlined above and accelerating the deployment of high-efficiency technologies, thereby contributing to both national and international climate objectives.

Conclusion

This project's research into the demand and potential for climate-smart technologies has reaffirmed the urgent need for energy saving solutions in the evolving energy landscapes of Viet Nam, Thailand, and India. This conclusion is supported by our quantitative and qualitative analysis. The quantitative analysis shortlisted Malaysia, Thailand, Viet Nam, Indonesia and India as the most suitable markets based on their high energy consumption and energy intensity, factors that signal stronger demand for technologies like heat pumps and once-through boilers. Our subsequent qualitative analysis found that, although all the 5 countries have environmental plans and regulatory frameworks aimed at promoting climate-smart technologies, Viet Nam, Thailand, and India emerged as having the most critical need as these 3 countries are experiencing steadily increasing net energy shortfalls, heavily supplemented by energy imports, which underscores the urgency for improving energy efficiency. As a result, Viet Nam, Thailand and India are expected to face increasing pressure to optimise energy consumption, making the demand for energy saving technologies more critical than ever.

Our issues and solutions mapping for heat pumps and once-through boilers revealed several barriers towards adoption. From a marketing perspective, low awareness of product value, a shortage of operational expertise, and weak distribution networks limit market penetration. On the value chain side, both manufacturers and end users must optimise their processes, from production planning and procurement to installation and after-sales maintenance, to integrate these technologies effectively into their existing business. The absence of standardisation, evaluation methods and performance indicators further undermine confidence, leaving installers and buyers without clear guidelines for equipment selection, installation, and upkeep. Finally, high capital expenditures and significant infrastructure and human-resource costs continue to deter investment. Together, these challenges are impeding broader adoption of heat pumps and once-through boilers.

Given our findings, the project team have consulted Japanese manufacturers of heat pumps and once-through boilers. Based on the feedback received, and together with our current understanding of the policy and market environments, we have narrowed down a set of potential proposals for further action. To test the feasibility and effectiveness of these proposals, we have conducted extensive dialogue with key local stakeholders, including government agencies, manufacturers and industrial associations, in each target country. The feedback obtained from the local stakeholders are then incorporated and the revised proposals are as follows:

- To accelerate the adoption of heat pumps, it is recommended that Thailand, Viet Nam, and India prioritise the development of quantitative metrics and standardised testing schemes that can reliably measure and demonstrate the

benefits of heat pump technologies. Establishing such criteria is a critical first step toward enabling the integration of heat pumps into existing policy instruments, including energy efficiency labelling systems and Minimum Energy Performance Standards (MEPS). By providing transparent and comparable data on indicators such as thermal storage capacity, grid load management potential, and overall energy efficiency, these standards will form the foundation for informed policymaking and broader market uptake. Practical measures are needed to support this framework. These include building or upgrading testing facilities, developing standardised protocols consistent with international best practices, and conducting market studies to identify adoption barriers and opportunities. Outreach efforts – such as stakeholder dialogues, technical workshops, and public seminars – will also be important to increase recognition of heat pumps' role in energy efficiency and grid stability. Support from international partners will further strengthen this process. Assistance may include technical exchanges with established laboratories, sharing measurement methodologies, and providing guidance on adapting standards to local conditions. In combination, these actions will lay the groundwork for a credible measurement and labelling system that highlights the tangible benefits of heat pumps, thereby fostering greater consumer trust, policy alignment, and market adoption.

- Developing training programmes focused on refrigerant characteristics and safe handling, alongside establishing a licensing system linked to these training efforts to ensure technical proficiency and safety compliance. This is done to close existing regulatory gaps and enhance refrigerant management practices. Technicians involved in the installation, servicing, and disposal of refrigerant-based equipment should be required to obtain formal qualifications, supported by mandatory training and awareness programmes. Next, for fluorocarbon refrigerants, countries should introduce mandatory protocols covering proper maintenance, regular leak checks, and the systematic documentation of refrigerant usage and emissions. Given the varying levels of regulatory development across countries and refrigerant types, a consultative process with stakeholders is essential to determine regulatory priorities. Some countries have initiated guidelines for refrigerant handling, but gaps remain, particularly for recovery, disposal, and the use of alternative refrigerants such as natural refrigerants. This calls for a flexible, context-specific approach that accounts for regional market conditions and technical capabilities.
- Relaxing overly stringent regulations on once-through boilers, thereby facilitating their wider use by emphasising their inherent safety advantages. Stakeholder discussions revealed that the market for once-through boilers is more mature in Thailand, where prior policy attention and less stringent permitting have supported adoption, particularly amongst foreign-affiliated firms. In contrast, Viet Nam and India show limited uptake and low awareness amongst authorities. To

support broader adoption across all three countries, it is recommended to establish a dedicated regulatory framework tailored to the unique characteristics of once-through boilers and to promote their safety, efficiency, and operational benefits through targeted outreach. These efforts can help create an enabling environment and pave the way for future labelling and performance-based regulations.

Through these multifaceted measures, we hope to significantly enhance the adoption rate of energy-saving equipment, such as heat pumps and once-through boilers, in Viet Nam, Thailand, and India. By doing so, we aim to contribute meaningfully to the reduction of energy consumption in these regions, thereby playing our part in the global fight against climate change. We firmly believe that the widespread deployment of energy-efficient technologies will help accelerate progress toward a more sustainable and environmentally responsible future.

Annex

The following are the organisations and companies we have interviewed during this phase or key stakeholders highlighted regarding heat pumps or once-through boilers in the interviews conducted.

Thailand

- Asian Heat Pump Thermal Storage Technologies Network (AHPNW)

Organisation Type: Association

A collaborative regional network dedicated to promoting the use and development of heat pump and thermal storage technologies across Asia. The network aims to facilitate information sharing, policy recommendations, and technical exchange amongst member countries, which include China, Japan, Korea, Viet Nam, Thailand, and India.

- Department of Alternative Energy Development and Efficiency (DEDE)

Organisation Type: Government body

A government agency under Thailand's Ministry of Energy that leads national efforts in alternative energy development and energy efficiency. DEDE was originally created in 1953 (as the National Energy Authority) and has since evolved into Thailand's primary institution for driving energy transition policies, promoting renewables, and implementing energy-saving initiatives.

- Department of Industrial Work (DIW)

Organisation Type: Government body

An agency under Thailand's Ministry of Industry, responsible for the regulation, supervision, and promotion of the industrial sector, particularly the management and control of factories, hazardous substances, industrial waste, and environmental protection in industrial settings.

- Energica

Organisation Type: ESCO

A Thai company established in 2005, specialising in energy conservation, renewable energy, environmental management, and indoor air quality. It is registered as an ESCO with Thailand's Institute of Energy and is a member of the Thai Energy Service Company Association, providing energy consulting services registered with the Thai Ministry of Finance.

- Ministry of Industry (MIND)

Organisation Type: Government body

A key cabinet ministry in the Government of Thailand responsible for the promotion, regulation, and development of the industrial sector. Its main roles include advancing Thai industry, supporting small and medium-sized enterprises (SMEs), fostering new and innovation-driven industries, and promoting digital transformation within the industrial ecosystem.

- TN Group

Organisation Type: ESCO

A leading Thai company specialising in manufacturing and importing industrial products, with over 50 years of experience since its founding in 1969. Their offerings include industrial blowers, pulleys, industrial fans for factory ventilation, power supplies, flame throwers, and industrial water pumps. Headquartered in Krathumban, Samut Sakhon province, TN Group employs over 500 people.

- Thai Industrial Standards Institute (TISI)

Organisation Type: Government body

A key national standards organisation under Thailand's Ministry of Industry, established in 1969 and formalised under the Industrial Product Standards Act. TISI also serves as Thailand's member organisation in international bodies like ISO, IEC, and participates in regional standardisation efforts within ASEAN and Asia-Pacific.

- Thai Boiler Association (TBA)

Organisation Type: Association

An organisation in Thailand established around 2008 which serves as a platform for experts and professionals working with boilers, thermal oil heaters, and pressure vessels. The association focuses on advancing the boiler and pressure vessel industry in Thailand through knowledge sharing, technical development, and supporting industrial competitiveness.

Viet Nam

- GreenDC

Organisation Type: ESCO

Green Development Centre is one of the top consultancy, judgment and social expertise on green development and sustainability in Viet Nam. Staff and experts from the GreenDC are professional and experienced in such fields including, energy, environment, infrastructure development, science and technology transfer, ESCO, sociology and coping with climate change.

- Hanoi University for Science and Technology (HUST)

Organisation Type: Association

Viet Nam's first and largest multidisciplinary technical university, established in 1956. It is recognised as the country's leading institution for engineering and technology education, playing a central role in training high-quality human resources and a major centre for research, technological innovation, and knowledge transfer.

- Institute for Energy Technology (IET)

Organisation Type: Association

Established in January 2024 through the merger of the Institute of Energy Science (IES) and the Institute of Environmental Technology (IET), the Institute of Science and Technology for Energy and Environment (ISTEE) operates under the Viet Nam Academy of Science and Technology conducting research and development for energy and environment.

- Viet Nam Standards and Quality Institute (VSQI)

Organisation Type: Government body

A key institution under Viet Nam's Ministry of Science and Technology responsible for the development, promulgation, and enforcement of national standards across multiple sectors, including food safety, product quality, and industrial standards. It operates as a subsidiary of the Directorate for Standards, Metrology, and Quality (STAMEQ).

- Viet Nam Thermal Science and Technology Institute (VTST)

Organisation Type: Association

The largest and most prominent multidisciplinary research body in Viet Nam, encompassing various specialised institutes and research centres in physical sciences,

energy, environment, and technology. It was founded in 1975 and has multiple research divisions across scientific fields, including energy and thermal technologies.

India

- Alliance for Energy Efficient Economy (AEEE)

Organisation Type: Association

A leading not-for-profit organisation in India focused on promoting energy efficiency as a key resource for sustainable growth, acting as both a policy advocacy group and a market enabler. AEEE is recognised for its contributions to market transformation, such as developing the India Cooling Action Plan and the State Energy Efficiency Index.

- Aspiration Energy

Organisation Type: ESCO

A Chennai-based company specialising in innovative and sustainable industrial heating solutions, with a core mission to replace fossil fuels in process heating using advanced technologies. Established in 2010, it delivers decentralised solar thermal systems and high-efficiency industrial heat pumps designed for sectors requiring temperatures in the 40–120°C range.

- Bureau of Energy efficiency (BEE)

Organisation Type: Government body

A statutory body under the Ministry of Power, established in March 2002, under the provisions of the Energy Conservation Act, 2001, to promote energy efficiency and conservation nationwide. Its core mission is to promote energy efficiency and conservation, with the primary objective of reducing the energy intensity of the Indian economy while ensuring sustainable growth.

- India Cooling Coalition (ICC)

Organisation Type: Association

A multi-stakeholder group in India composed of non-profits, academic and research institutions, and industry associations, committed to promoting sustainable cooling research and applications. It acts as a platform for dialogue amongst stakeholders and provides policy recommendations to support government programmes and ensure access to affordable and sustainable cooling solutions.

- Indian Society of Heating, Refrigerating and Air Conditioning Engineers (ISHRAE)

Organisation Type: Association

A premier professional society in India dedicated to advancing the arts and sciences of heating, ventilation, air conditioning, and refrigeration. It has over 28,780 professionals and student members spread across 41 chapters nationwide with its headquarters in India. ISHRAE focuses on energy efficiency, sustainable building development, and improving indoor air quality.

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