Roadmap Towards Sustainable and Energy-Efficient Space Cooling in ASEAN

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Abstract

Space cooling is the fastest-growing use of energy in buildings globally and in the Association of Southeast Asian Nations (ASEAN). Electricity use for cooling in buildings across the region has increased dramatically over the past decades. Yet today, only 15% of households in Southeast Asia have an air conditioner; fans represent around another 9% of residential energy use. With continued economic development and population growth across the region, the International Energy Agency (IEA) projects that air conditioner ownership across the ASEAN Member States (AMS) will continue to grow. This growth could see electricity demand from space cooling in the region grow to 300 TWh in 2040 – approximately equivalent to the total electricity consumption of Indonesia and Singapore combined.

The *Roadmap towards Sustainable and Energy-Efficient Space Cooling in ASEAN* focuses on the policy tools available for AMS to drive energy efficiency improvements for space cooling. It sets ambitious milestones for space cooling technologies, including air conditioners and fans, that can help guide the ambitions outlined in this roadmap and subsequent action across ASEAN.

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Executive summary

Electricity use for space cooling in buildings in ASEAN has grown rapidly over recent decades to around 80 TWh in 2020 – seven times the level in 1990 and close to the total annual electricity consumption of the Philippines. Recent data shows that air conditioners accounted for around 15% of residential energy use across ASEAN and fans represented around another 9%.

With continued economic development and population growth across the region, the IEA projects that air conditioner ownership across the ASEAN Member States (AMS) will continue to grow too. Air conditioner stock across ASEAN is projected to grow from nearly 50 million units in 2020 up to 300 million units in 2040. This could see electricity demand from space cooling in the region grow to 300 TWh in 2040 – approximately equivalent to the total electricity consumption of Indonesia and Singapore combined.

However, there is a possible future in which access to space cooling services can increase across the AMS but with lower impacts on energy use and greenhouse gas (GHG) emissions. Policy makers have a number of tools at their disposal to drive improvements in sustainable and energy-efficient space cooling for air conditioners and fans to help meet the growing cooling demand in the region while limiting the growth in energy demand and GHG emissions.

Policy action supporting the deployment of more efficient air conditioners, along with other energy efficiency measures such as the use of efficient fans and building envelope efficiency improvements could help the AMS save 110 TWh of electricity in 2040, cutting the projected space cooling energy use by over one-third. This represents more than the current electricity consumption of Brunei Darussalam, Cambodia, Lao People's Democratic Republic (Lao PDR) and Viet Nam combined. These same actions would also reduce GHG emissions by over 55 million tonnes of CO_2 in 2040, which, alongside decarbonisation of the electricity supply, could see CO_2 emissions in 2040 from space cooling in ASEAN drop to lower than 2018 levels.

The *Roadmap towards Sustainable and Energy-Efficient Space Cooling in ASEAN* focuses on the policy tools available for AMS to drive energy efficiency improvements for space cooling. It sets ambitious milestones for space cooling technologies, including air conditioners and fans, that can help guide the ambitions outlined in this roadmap and subsequent action across ASEAN.

Policy can support an efficient future

This roadmap focuses on the policy tools available to the AMS to drive energy efficiency improvements for space cooling, with a focus on room air conditioners and fans. These policy tools can support an increase in space cooling access across the region decoupled from a linear increase in cooling energy demand and associated GHG emissions. This roadmap examines a wide range of sustainable and energy-efficient space cooling policies available to support these milestones under the three broad categories of regulation, information and incentives, and 12 types of policy measures across these categories.

We explore the current status of space cooling policies in the AMS and at the regional level, and provide actions and milestones for policy progress under each measure to achieve a range of energy and climate goals.

There is a wide range of policy measures available to the AMS, but the roadmap does not intend to recommend that any country implement a specific set of policies and programmes. Rather, it presents a wide range of policy options that governments can choose from to make an appropriate space cooling policy package tailored to their specific needs.

In order to achieve sustainable and efficient cooling, policies should aim to transform the market to make the sale of inefficient air conditioners and fans impossible across the ASEAN region. A policy package approach, drawing on a combination of regulations, information programmes and incentives can support the achievement of these milestones. Minimum energy performance standards (MEPS), labelling programmes and incentives form the foundation for progress on efficient, sustainable and affordable cooling options across the region. MEPS can help to remove the worst performing products from the market. Labelling programmes can help drive consumers towards more efficient products by providing them with better information about the efficiency of a cooling appliance they are considering buying and the potential reductions in their energy bills. Incentives can help pull more efficient products into the market, increasing their market share and driving down prices. While MEPS and labelling programmes can help to drive the improvement of new products sold, incentive programmes can also drive the early retirement of old and inefficient cooling appliances and their replacement with efficient and sustainable solutions.

This roadmap presents an approach based on the adoption of an ambitious regional product efficiency “ladder” for both air conditioners and fans. A product ladder can be used as an effective tool to bundle together the foundational policy measures in a cooling policy package, such as MEPS, labelling and other policy measures, such as High Energy Performance Standards (HEPS), to help meet short and long-term policy goals. This approach, as advocated by the Super-efficient Equipment and Appliance Deployment (SEAD) Initiative and the COP26 Product Efficiency Call to Action, provides governments, manufacturers, retailers and the entire supply chain

with a clear timeline for energy efficiency improvements relating to appliances. Providing long-term policy certainty supports businesses in making investment decisions which meet or exceed regulatory requirements to support efficient and sustainable space cooling goals for the region.

These policy measures can be supported by ongoing efforts pertaining to the harmonisation of testing methods, mutual recognition agreements and monitoring, verification and enforcement (MV&E). These efforts help to ensure that the standards set in regulations are met in practice and deliver the modelled energy and multiple benefits cost-effectively, streamlining administrative processes across the region while opening up new export opportunities.

This roadmap also explores a range of other policies that governments can draw on to support progress towards efficient and sustainable space cooling, including: information education and training programmes; air conditioner audit programmes; a selection of rebates, grants and tax incentives, loan programmes, on-bill finance and other financial instruments; manufacturing and innovation grants; and equity programmes (to support low-income households) to ensure access to affordable cooling for households which are most in need.

A Roadmap for Energy-Efficient Buildings and Construction in ASEAN has been developed in parallel to this roadmap. Viewing these two roadmaps side-by-side will help to ensure that space cooling is considered holistically along with the impacts of energy-efficient building fabric, passive design and urban planning on sustainable cooling.

A roadmap approach for sustainable cooling

This roadmap explores potential actions across three policy categories – regulation, information and incentives – and 12 types of policy measures.

An extensive list of potential policy instruments available to the AMS to support progress on sustainable and energy-efficient space cooling through room air conditioners and fans is considered in this roadmap.

However, a smaller set of measures form the foundation of a good policy package for space cooling, consisting of MEPS, harmonised test standards and labelling programmes. These programmes are also most effective when supported by a strong MV&E regime. A regional product efficiency “ladder” approach can help to unite these foundational policies.

As the AMS have different circumstances and priorities, each should choose to implement an appropriate mix of complementary policies beyond these foundational measures in order to build a successful policy package tailored to their local needs.

Roadmap towards Sustainable and Energy-Efficient Space Cooling in ASEAN Summary of Policy Measures

Regulation

Policy measure	Current status	By 2025	By 2030	Towards net zero-carbon
Minimum Energy Performance Standards (MEPS)	MEPS in place for room air conditioners in most AMS and MEPS for fans in some AMS.	Harmonised MEPS in place for all room air conditioners and harmonised regional product ladder adopted aiming for U4E model regulations Harmonised MEPS and product ladder fans under development	Increased stringency of MEPS including requirement for demand response capability AMS have adopted harmonised MEPS for fans as appropriate, and a product ladder aiming to double efficiency by 2030	MEPS approach today's BAT Air conditioner MEPS include phaseout of all high GWP refrigerants
Harmonisation of test standards	Air conditioners: ISO 5151 and ISO 16358 adopted by most AMS. Fans: Some AMS have adopted test standards.	More AMS have harmonised test and evaluation standards, agreeing to use IEC 60879: 2019 for fans Capacity building for testing facilities and round robin testing	Testing facility capability expanded and round robin testing completed regularly MRAs and harmonised standards updated	Test standards updated and harmonised in line with technological development over time
Monitoring, verification, and enforcement (MV&E)	Almost all AMS have MV&E strategies for air conditioners.	All AMS sign an MRA for air conditioners and rollout a regional MV&E strategy All AMS have product registries for air conditioners and fans and a regional registry under development	Rollout of a regional product registry. Regular market surveillance. Rollout of regional MV&E strategy for fans	MV&E strategies evolve over time expanding to cover additions such as demand response capabilities and refrigerant requirements

Information

Policy measure	Current status	By 2025	By 2030	Towards net zero-carbon
Labelling	Almost all AMS have energy labelling programmes for air conditioners, but only some for fans	Mandatory air conditioner labelling adopted. Labels start to include more information and QR codes	Mandatory labels for fans adopted, as appropriate All AMS labels have explored including QR codes Regional guidelines developed to include refrigerant information on labels	All air conditioner and fan labels include QR codes Air conditioner labels include information on the GWP of refrigerants
Endorsement labels and high energy performance standards (HEPS)	Present in some AMS	A regional basis for endorsement label and HEPS energy efficiency levels is explored based on a regional product ladder for air conditioners	All AMS have adopted harmonised endorsement labels and HEPS lists with increasing stringency to qualify. An adoption of fans labels follows in the future, as appropriate	A regional low-GWP refrigerant endorsement label could be considered for air conditioners to support a consumer led shift towards net-zero carbon goals
Information, education and training, and air conditioner audit programmes	Programmes are present in some AMS.	More AMS explore, develop and implement information, education and training as well as air conditioner audit programmes.	Widespread adoption of programmes, and audit and air conditioner tuneup programmes increase to address replacement and maintenance.	Programmes across AMS focus increasingly on retrofit and maintenance of older air conditioner systems with efficient and no/low GWP refrigerants.

Incentives

Policy measure	Current status	By 2025	By 2030	Towards net zero-carbon
Rebates, grants and tax incentives	Programmes are not widespread in AMS	Programmes are explored by AMS and a number of programmes delivered to support energy efficient space cooling	Programmes implemented at scale across AMS to drive energy efficient cooling	Programmes drive super efficient new purchases, maintenance and retrofits. Also support safe degassing and low-GWP refrigerant space cooling technologies
Loan programmes, on-bill finance and other finance	Some finance offerings across ASEAN for sustainable and efficient cooling	AMS scopes ways to attract and deploy international development, public and private finance for sustainable cooling business models	Loan and finance programmes and business models are common across AMS to support sustainable and affordable cooling	Finance and loan programmes have supported achieving net-zero cooling appliances
Bulk and public procurement programmes	Bulk procurement and energy efficient public procurement programmes not widespread in AMS	AMS explore including energy performance criteria in government procurement policies Bulk procurement programmes considered and piloted in some AMS	Government procurement guidelines in place and improve with ladder and expand to sub-national government. Bulk procurement programmes widespread to support appliance efficiency	Government procurement includes building requirements and ESCO contracts. Both public and bulk procurement driving retrofits of cooling to low-GWP options
Manufacturing and innovation grants	A few programmes have been delivered in the region	Manufacturing and innovation grants explored to support achieving product ladder targets cost-effectively	Manufacturing grants have supported manufacturers across AMS to produce super efficient air conditioners and fans. Innovation grants increasing	Manufacturing and innovation grants supported all cooling appliances sold across ASEAN to be energy efficient and using low-GWP refrigerants
Market-based mechanisms and energy efficiency obligation programmes	Programmes not widespread in AMS	AMS have explored options and some AMS have implemented programmes	Several AMS have implemented a form of these programmes, and those that have not opted for other large-scale incentive programme	Market-based mechanisms and energy efficiency obligations support retrofit, replacement and safe degassing of old space cooling equipment
Equity programmes	Programmes not widespread in AMS.	Equity and affordable cooling programmes explored in some AMS.	Programmes are piloted and implemented across some AMS.	Programmes expanded over time to reach more households and support renewable energy-powered cooling and low-GWP solutions.

Chapter 1. Introduction

About this project

In late 2020, the Association of Southeast Asian Nations (ASEAN) commissioned the International Energy Agency (IEA) to deliver the *Roadmaps Towards Sustainable and Energy-Efficient Buildings and Cooling in ASEAN* project. The project was funded by the ASEAN-Australia Development Cooperation Program Phase II (AADCP II) and supported by the ASEAN Secretariat (ASEC), Energy Efficiency and Conservation Sub-Sector Network (EE&C-SSN) and the ASEAN Centre for Energy (ACE).

This project forms part of the ASEAN Plan of Action for Energy Cooperation (APAEC) Phase II 2021-2025. It will deliver Action Plan 3.1 to develop and disseminate the Sustainable and Energy-Efficient Buildings and Cooling Roadmaps for ASEAN under Outcome-based Strategies for Energy Efficiency and Conservation 2021-2025, while supporting the overall objective of the APAEC to reduce energy intensity by 32% in 2025 compared to 2005 levels.

The project aims to help address the increasing energy demand and emissions in ASEAN and improve collaboration among stakeholders in the region, by developing and delivering:

- the Roadmap for Energy-Efficient Buildings and Construction in ASEAN
- the Roadmap towards Sustainable and Energy-Efficient Space Cooling in ASEAN
- a capacity-building webinar series on cooling and buildings
- a series of stakeholder consultation workshops.

The outputs of this project are intended to support policy makers in developing, adopting and enforcing energy efficiency policies and programmes. This project also provides milestones over the short-term (2025), mid-term (2030) and long-term (net zero-carbon). These milestones and timelines are not intended to represent the views of the ASEAN Member States (AMS), but to provide future milestones in sustainable and efficient space cooling to support policy makers in the region.

There are a number of design and technological options available to keep buildings cool including: building design, orientation, choice of building fabric, shading, and natural ventilation. Trees and green spaces in urban environments can also provide shade to buildings and urban environments, helping to reduce the effects of buildings and roads absorbing and retaining heat, which can cause

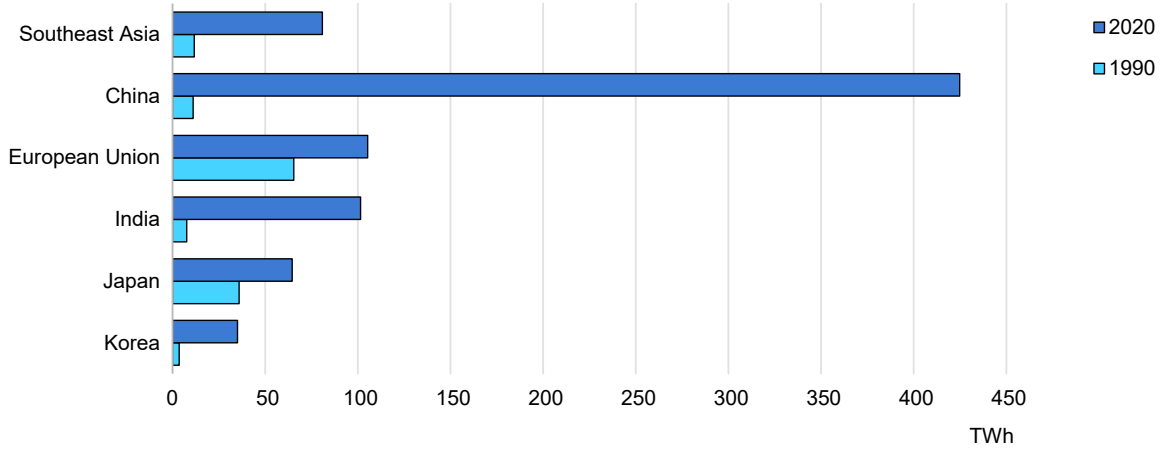
significant increases in urban temperatures. While these features are important components of sustainable space cooling, this roadmap primarily focuses on equipment within buildings, namely air conditioning (and mainly room air conditioners, rather than larger commercial systems) and fans. However, the Roadmap for Energy-Efficient Buildings and Construction in ASEAN, developed alongside this report, addresses a wider range of considerations that influence sustainable cooling.

An overview of space cooling in ASEAN

Historical levels of cooling and access to air conditioners

Electricity use for space cooling in buildings in the region has grown rapidly over recent decades to around 80 TWh in 2020 – seven times the level in 1990 and close to the annual electricity consumption of the Philippines.

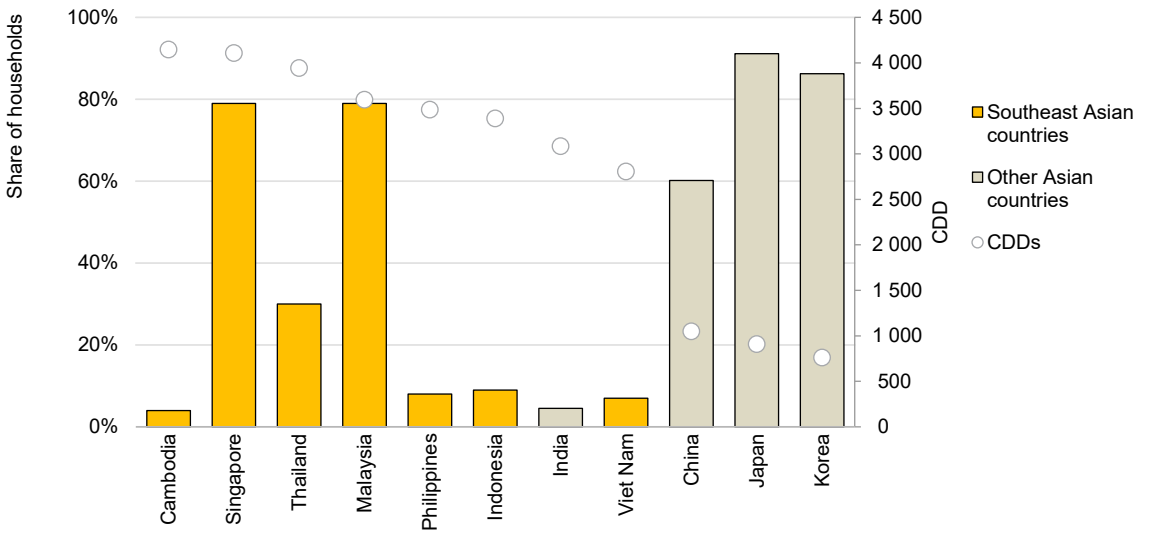
Electricity consumption from space cooling by country or region, 1990 and 2020



Note: China = the People's Republic of China. TWh = terawatt hours.

However, air conditioner ownership is still relatively low in the region. Only 18% of households in the AMS had an air conditioner in 2019, compared with more than 90% of households in some advanced economies with similar climates (ACE and GIZ, 2020; IEA, 2019a). There are also large differences in ownership across the region, with more than four-fifths of households in Brunei Darussalam, Malaysia and Singapore owning an air conditioner in 2017, compared to fewer than 10% in Cambodia, Indonesia, Lao PDR, Myanmar, the Philippines, and Viet Nam (ACE and GIZ, 2020) (IEA, 2019a).

Cooling degree days and share of households using air-conditioning systems by country in 2017



Note: CDDs = For the purpose of this report, cooling degree days (CDD) are measured in degrees Celsius (°C), standardised to 18 °C in all countries. CDD measure how much the mean temperature exceeds the standard temperature each day over a given period.

Source: IEA (2019b), Southeast Asia Energy Outlook.

This suggests there is significant potential for air conditioner market growth in several countries in the region. As incomes rise and livelihoods improve, the demand for home cooling equipment will increase along with the demand for many other appliances.

Urbanisation across the region is also likely to be a factor in the increasing demand for cooling. Incomes tend to be higher in urban areas, and ambient air temperatures are also higher due to urban heat island effects.

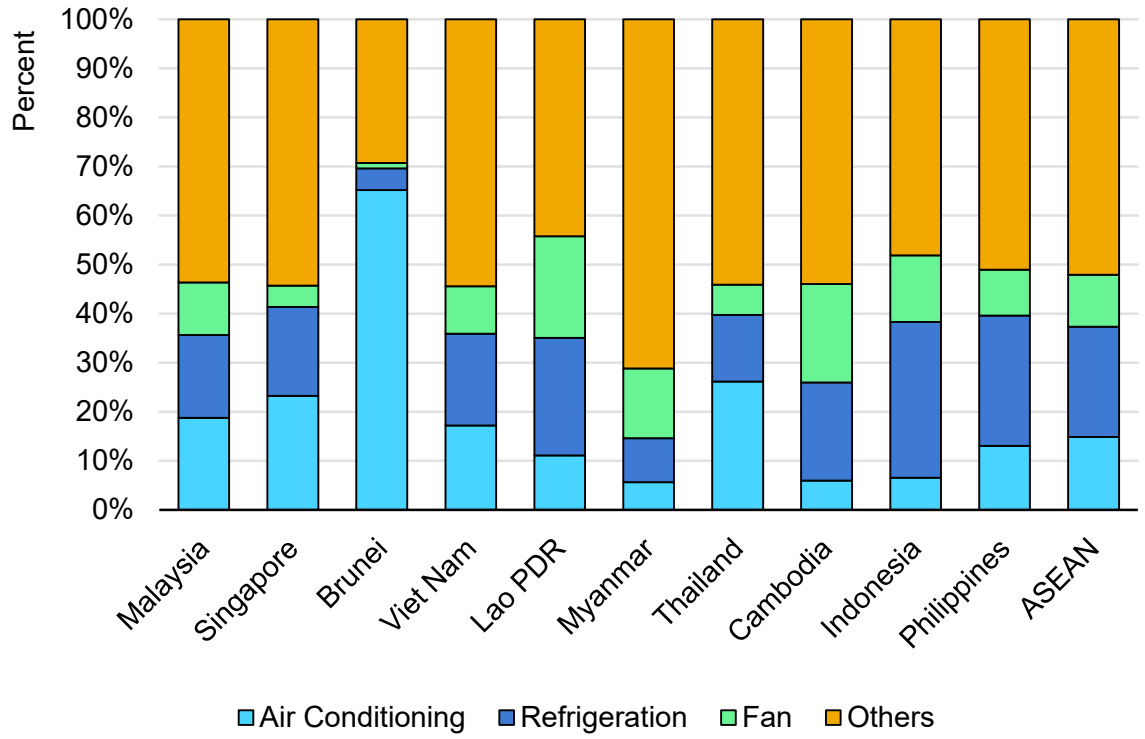
Electric fans offer an affordable low-energy cooling solution

Electric fans are a common form of cooling around the world. In 2016, 55% of global households were estimated to own at least one fan. An estimated 2.3 billion residential electric fans were in use. There were around twice as many electric fans in use in households as there were air conditioners (IEA, 2018). In 2017, air conditioners accounted for approximately 15% of total residential energy consumption across ASEAN while fans accounted for another 9%. Only 18% of households owned an air conditioner (ACE and GIZ, 2020).

Household fans offer an affordable and low-energy cooling alternative to air conditioners. In the AMS, household fan ownership is expected to grow rapidly alongside the growth in electricity access. Depending on the particular climate and

building design, fans can continue to meet a significant share of residential space-cooling needs into the future. As fans do not reduce the air temperature in a room, they cannot provide the same level of thermal comfort as air conditioners. However, they can nonetheless deliver considerable comfort without the use of air conditioners in buildings which are well designed and which have energy-efficient envelopes.

Cooling and appliances share of residential electricity demand in ASEAN in 2017



Source: ACE & GIZ (2020), The 6th ASEAN Energy Outlook (AEO6) model analysis, based on ACE compilation of historical data.

Projections for space cooling demand and electricity demand

Business as usual trends in residential and commercial buildings

Based on current and planned policies in the IEA's Stated Policies Scenario,[1] the AMS would need to add an additional 200 GW of capacity by 2040, roughly equivalent to Germany's total current electricity capacity, to meet the growing

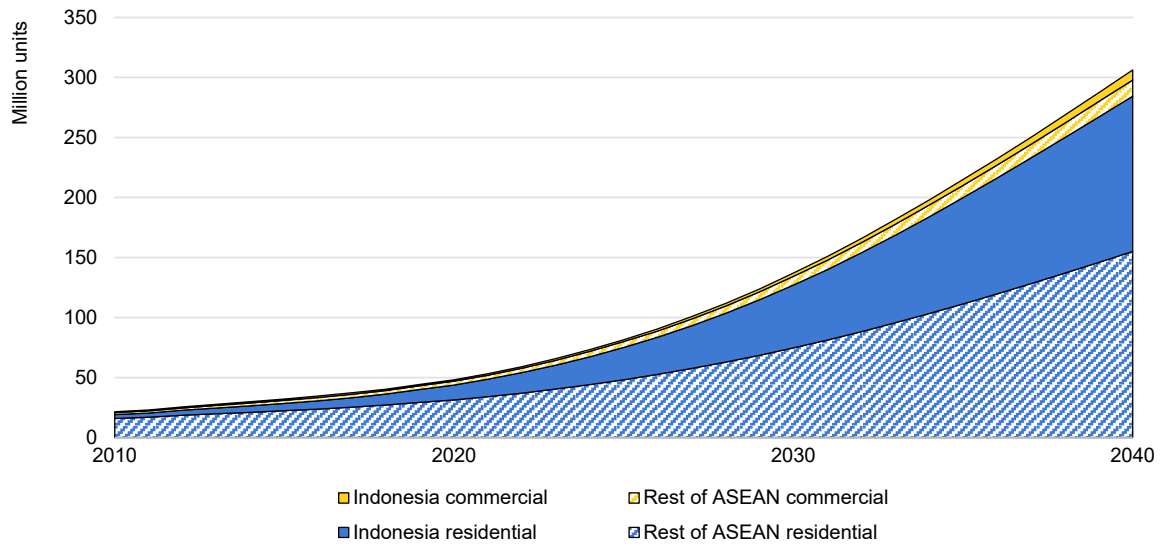
[1] The Stated Policies Scenario and Sustainable Development Scenario (SDS) Analysis referred to in this report are based on The Future of Cooling in Southeast Asia 2019.

energy demand to power air conditioners (IEA, 2019a). This potential growth, to meet cooling demand alone, would represent almost a doubling of installed electricity generation capacity in ASEAN compared with 2017 levels (ACE and GIZ, 2020).

The amount of energy needed to meet space cooling demand in the Stated Policies Scenario grows to 300 TWh in 2040, greater than India's current annual household electricity consumption. Cooling will also account for an increasing share of household energy use in the Stated Policies Scenario: By 2040, the share of cooling in total electricity consumption in the AMS will more than double to almost 19%, up from 8% in 2017.

This is driven by the projected growth in the stock of air conditioners in the AMS, projected to reach 300 million units in 2040, compared with around 50 million units in 2020. Indonesia, alone, will account for half of this growth.

Number of air conditioning units in residential and commercial buildings under the Stated Policies Scenario



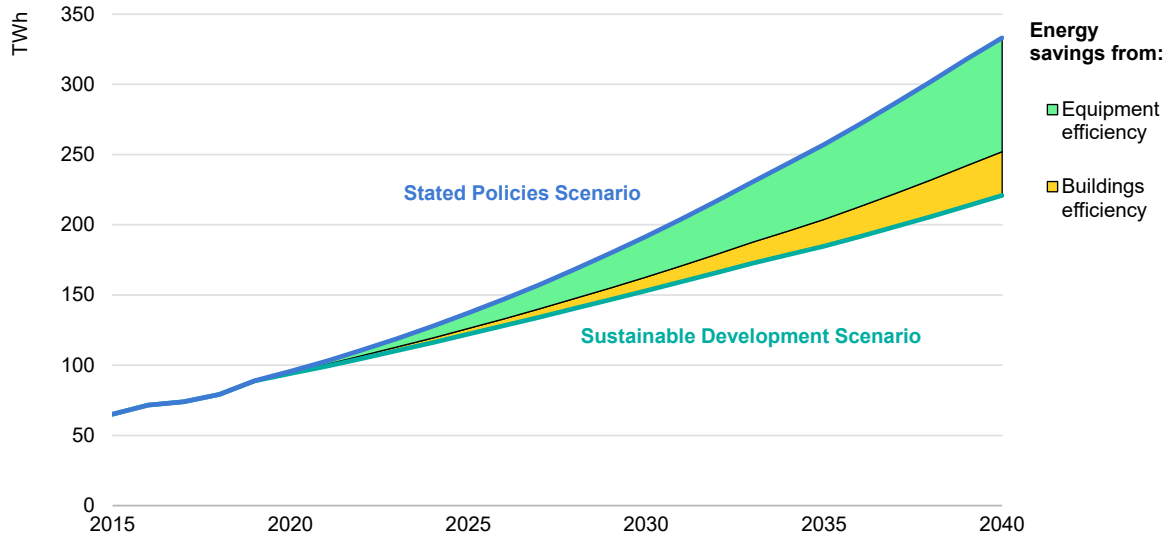
Source: IEA (2019b), Southeast Asia Energy Outlook.

This increase in air conditioners is strongly linked to economic growth, rising temperatures and rising incomes. The share of households owning one and the number owned per household both rise as incomes rise. By 2040, 60% of households in the AMS are estimated to have access to space cooling, and each of these households is expected to have an average of just under two air conditioners.

A sustainable and energy-efficient cooling future

However, this ratcheting up of electricity demand growth due to increased air conditioner ownership rates can be decelerated. In the Sustainable Development Scenario, deploying more efficient air conditioners, along with other efficiency measures such as introducing more fans and improving building envelope efficiency, would help the AMS save 110 TWh of electricity by 2040, nearly equivalent to the current total electricity production of Malaysia, the Philippines and Viet Nam combined.

Reduction in space cooling demand in the Sustainable Development Scenario compared to the Stated Policies Scenario



Note: TWh = Terawatt hours. Building efficiency measures include thermally efficient features such as insulation, roofs, walls and windows.

Source: IEA (2019b), Southeast Asia Energy Outlook.

Government policy can shape the future of space cooling

Governments can use policy levers to maintain space cooling growth on a sustainable and energy-efficient path, delivering multiple benefits to society.

Standards and Labelling

Many governments have scope to raise Minimum energy performance standards (MEPS) and labelling stringency for air conditioners and fans in line with the Sustainable Development Scenario, with minimal impacts on local industries and marginal costs to consumers.

A gradual implementation of MEPS, resulting in an increase in air conditioner efficiency standards over time, has been successful in many countries. The IEA

recommends a medium-term (2030) target for all of the AMS to at least double the efficiency of air conditioners at the regional level.

International best practice in procurement, efforts to harmonise efficiency standards for motors and product registration systems offer valuable precedents for the AMS in their efforts to increase air conditioner and fan efficiency.

Refrigerant gases

In addition to increasing air conditioner and fan efficiency, cooling needs should be considered holistically to include low global warming potential (GWP) refrigerants, building design, consumer engagement and private sector innovation.

National cooling action plans

The AMS could consider developing national cooling action plans (NCAPs), which take an integrated approach to cooling policy, and also cover refrigeration, cold chain and process cooling.

An NCAP can assist a country in identifying pathways to integrate comprehensive action on cooling and create a framework to enable the stakeholder collaboration required for effective implementation. A number of countries around the world are already in the process of developing NCAPs to co-ordinate action on energy efficiency and the transition to low-GWP refrigerants. The development of an NCAP also helps to identify pathways to proactively address the rapidly increasing cooling needs, while reducing the climate impacts of cooling practices, improving access to cooling and supporting several Sustainable Development Goals.

An NCAP development process can also help governments identify opportunities for incorporating efficient cooling into enhanced Nationally Determined Contributions (NDCs) and associated implementation plans (United Nations Environment Programme and International Energy Agency, 2020).

A coalition of international organisations and experts has published an online NCAP methodology to support countries seeking to develop an NCAP.

Cambodia and Indonesia: National Cooling Action Plans (NCAPs)

A comprehensive NCAP methodology is being piloted by the Kingdom of Cambodia and Government of Indonesia with support from the United Nations Environment Programme (UNEP)-led Cool Coalition, the United Nations Economic and Social Commission for Asia and the Pacific (UN ESCAP) (Cool Coalition, 2021). The core objectives in developing NCAPs in both countries are to provide access to sustainable cooling across all the cooling sectors and to contribute to the international commitments.

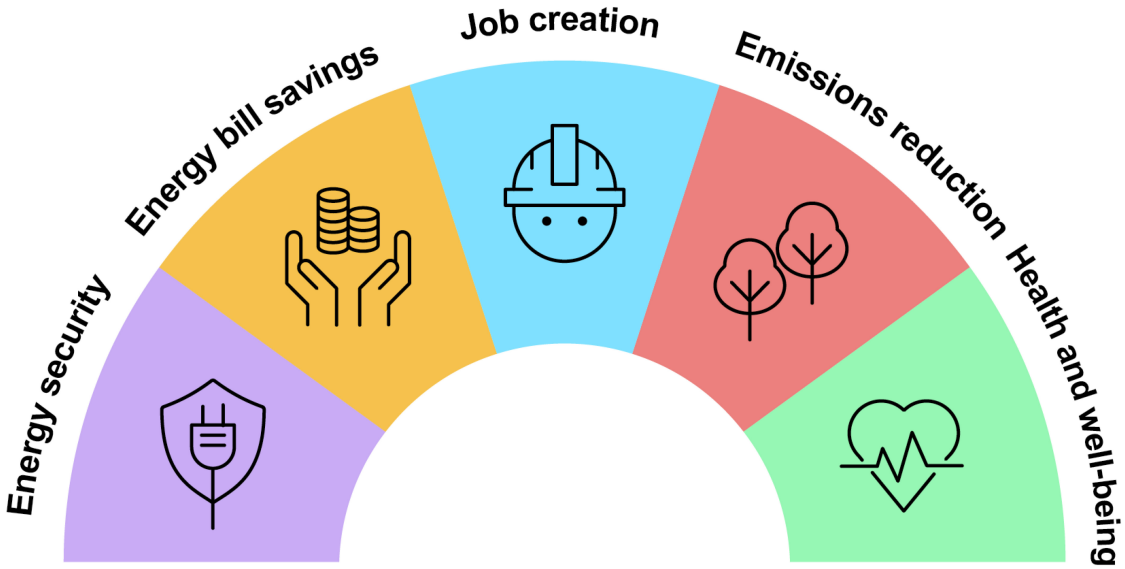
Through the NCAP development process, Indonesia and Cambodia have identified pathways to integrate comprehensive actions aimed at reducing the energy and refrigerant-related emissions resulting from cooling. The NCAP process also supports tracking and progress of cooling-related Sustainable Development Goals.

In Cambodia, the Department of Climate Change under the General Secretariat of the National Council for Sustainable Development and the General Directorate of Environmental Protection of the Ministry of Environment have led engagement and co-ordination across the relevant government ministries and stakeholders to support cooling data collection and verification. Total emissions from the cooling sector in Cambodia are conservatively estimated to reach around 13 million tonnes of CO_2 by 2030, of which around 11 million tonnes of CO_2 are energy-related emissions. A mitigation scenario estimates the potential to reduce cooling emissions by around 2.5 million tonnes of CO_2 by 2030 (Green Cooling Initiative by GIZ).

In Indonesia, the Ministry of Energy and Mineral Resources (MEMR) has led the NCAP development process. A multi-stakeholder working group was established, headed by MEMR to support the data collection, which involves gathering inputs (through consultations) and cooling demand assessments, and shaping an NCAP implementation plan. By 2030, Indonesia's total emissions from the cooling sectors are conservatively estimated to reach almost 180 million tonnes of CO_2. Of this total, energy-related emissions are estimated to account for 142 million tonnes of CO_2, with refrigerant-related emissions making up the remainder. A mitigation scenario estimates the potential to reduce cooling related emissions by around 35 million tonnes of CO_2 by 2030 (Green Cooling Initiative by GIZ).

Both Cambodia's and Indonesia's NCAPs are expected to be finalised in 2022.

Multiple benefits of sustainable space cooling



It is becoming widely recognised that energy efficiency can contribute to multiple energy, environmental, social and economic objectives. Energy efficiency helps households and businesses to lower their energy bills. It also creates jobs, reduces peak demand, improves grid reliability and delivers a range of other benefits, including reducing greenhouse gas (GHG) emissions. Approximately 80% of the energy efficiency improvements to 2030 considered under the IEA's Net Zero Emissions by 2050 Scenario would result in consumer cost savings (IEA, 2021).

Access to affordable space cooling is key to the economic and social development objectives of the AMS. Space cooling supports multiple benefits through comfortable indoor environments that promote health and well-being, enhanced productivity, and improved education and learning outcomes. Policies are needed to ensure improvements in the energy efficiency and sustainability of cooling appliances for energy systems and the environment.

Energy-efficient and sustainable cooling can also help to achieve the energy efficiency and conservation goal outlined in the ASEAN Plan of Action for Energy Cooperation APAEC Phase II, namely, to reduce energy intensity by 32% in 2025 based on 2005 levels.

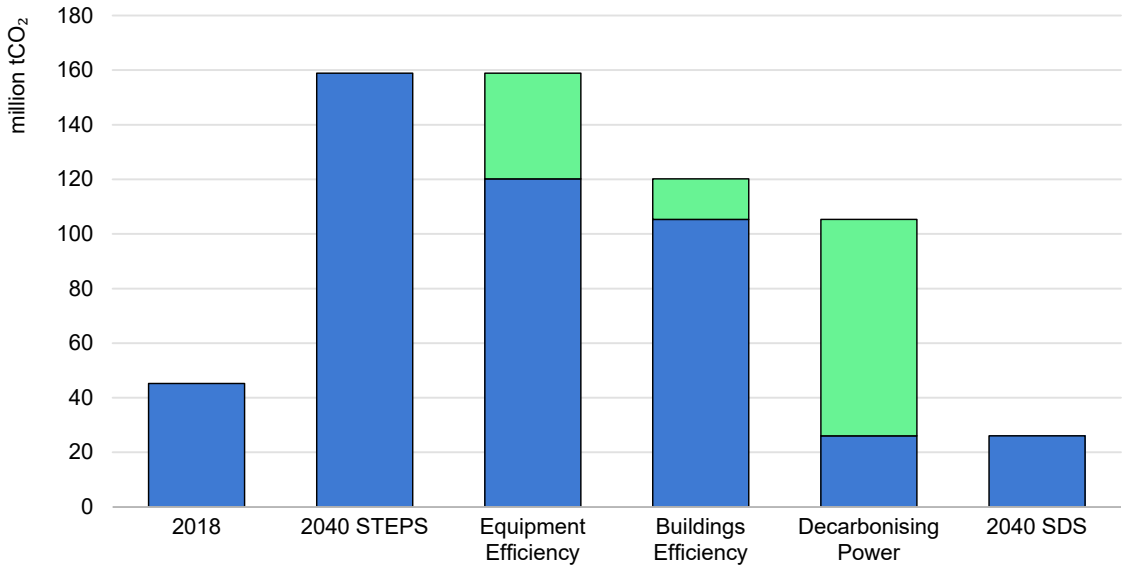
Greenhouse gas emissions

Energy-efficient and sustainable cooling delivers a number of environmental benefits.

Energy efficiency has a central role in tackling climate change and meeting net zero 2050 milestones, as suggested in the IEA's Net Zero by 2050 Roadmap. Energy efficiency enables the delivery of energy service demand with lower energy use, which is a crucial component in meeting the decarbonisation goals to 2030.

Energy efficiency also has a significant role to play in the decarbonisation of cooling in ASEAN. While the decarbonisation of electricity supply will deliver the largest share of emissions reductions under the Sustainable Development Scenario, cooling equipment efficiency improvements and building energy efficiency are expected to deliver over 55 million tonnes of CO_2 abatement by 2040 compared to the Stated Policies Scenario.

Cooling decarbonisation pathways in Southeast Asia in 2040



Source: IEA (2019a) The Future of Cooling in Southeast Asia.

While this report is primarily focussed on energy-efficient space cooling, it should also be noted that sustainable and efficient cooling and air conditioning also have an important role to play in reducing the climate impacts of high-GWP refrigerant gases through the use of air conditioners running on lower GWP refrigerants, natural refrigerants or equipment requiring no refrigerants at all.

Co-ordinated international action on energy-efficient, climate-friendly cooling, especially for space cooling and refrigeration services could avoid as much as 460 billion tonnes of GHG emissions – roughly equal to eight years of global emissions at 2018 levels – over the next four decades (United Nations Environment Programme and International Energy Agency, 2020).

Air conditioners typically use refrigerants that impact climate change in two ways: through their influence on operational energy-related emissions (and their impact on system efficiency) and through refrigerant leakage, including at the end of a product's life (IEA, 2018). Since many refrigerants used in air conditioners have a GWP over a thousand times more potent than carbon dioxide, deployment of the available technologies which enable shifting away from high-GWP refrigerants is critical to climate action and reducing GHG emissions (U4E, 2019). The Kigali Amendment to the Montreal Protocol is a critical policy measure to tackle the phasing out of higher GWP refrigerants. Adoption across all of the AMS could play an important part in tackling GHG emissions across the whole GHG emissions lifecycle.

An integrated approach to the transition towards energy-efficient and climate-friendly cooling would enable identification of synergies for more impactful solutions which effectively achieve national goals and accelerate progress on international commitments, including the Paris Climate Agreement, SDGs and the Kigali Amendment.

Collaboration across government entities, academia, the private sector and other relevant stakeholders is key to building in-depth understanding of the national context and delivering comprehensive actions encompassing optimisation of cooling demand, integration of energy efficiency and refrigerant transition efforts and improving access to cooling services in a more equitable manner, among many others.

Health and well-being

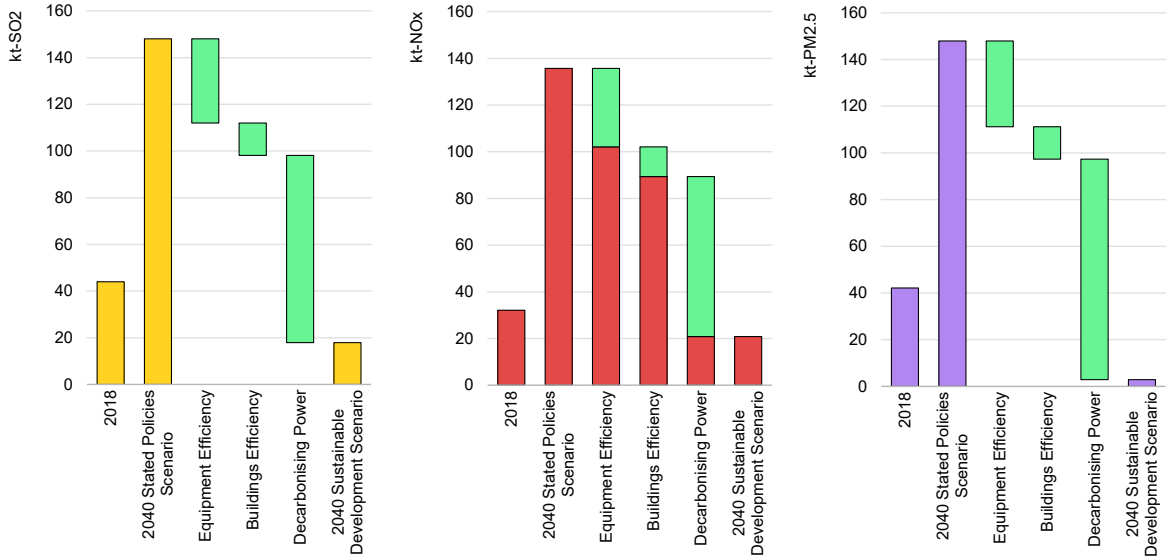
Improving energy efficiency and switching to cleaner fuels and technologies can have considerable benefits to health and well-being, reducing deaths and disease.

While direct combustion of fuels, such as coal, biomass and gas inside homes, or transport fuels can have some of the largest impacts on health and well-being, energy-efficient cooling can also deliver a range of benefits. Studies show that when buildings are too hot, in either temperate or warm climates, people are at higher risk of stroke and heart attacks (Fouillet et al. 2006) (Vandentorren et al. 2006).

The IEA estimates that over 90% of the global population breathes polluted air on a daily basis, resulting in over five million premature deaths a year. Air pollution contributes to many serious diseases, placing an extra burden on healthcare systems which are currently overwhelmed by the Covid-19 pandemic (IEA, 2021). The IEA's Sustainable Development Scenario modelled significant health benefits from the avoidance of air pollution: a 75% reduction in CO_2 and NOx emissions,

an 80% reduction in SO_2 emissions and up to a 95% reduction in PM2.5 emissions by 2040, compared with business as usual trends under the Stated Policies Scenario.

Reductions in air pollution through the use of efficient air conditioners and buildings, 2018 and 2040



Note: Decomposition of factors for reduction of SO_2, NOx and PM2.5 emissions between the Stated Policies Scenario (STEPS) and the Sustainable Development Scenario (SDS).
Source: IEA (2019a), The Future of Cooling in Southeast Asia.

In ASEAN, as well as causing hundreds of thousands of premature deaths, poor air quality has long-term economic costs which are estimated to reduce GDPs by 1.0% to 1.5% (OECD, 2016).

Sustainable cooling can also lead to higher productivity in classrooms. Improving indoor work and educational environments through energy-efficient and climate-friendly cooling can also provide healthier and more productive work environments

Energy bills

One of the best known benefits of energy efficiency is lower energy bills for all consumers, thereby freeing up income to spend on additional goods and services. For low-income households, this often means more money for food, health and education. For businesses, it means improved energy productivity, and for governments it means freeing up taxpayer funds to spend on better public services, such as hospitals, schools and public transport.

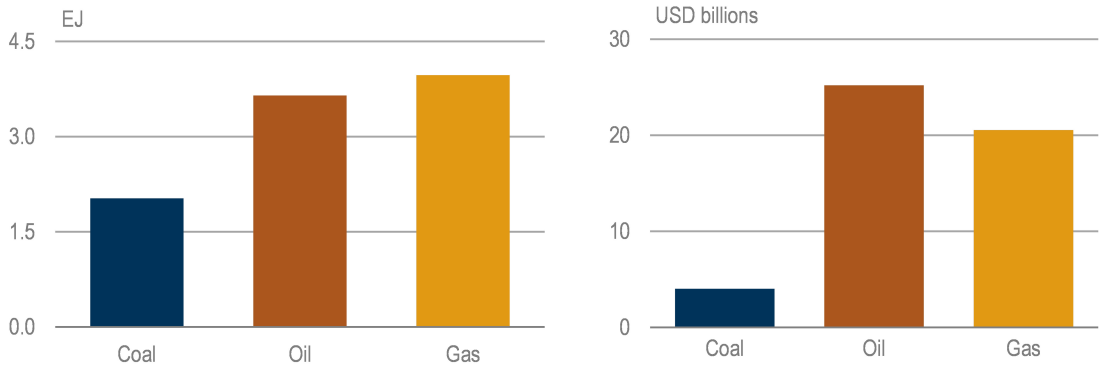
IEA modelling suggests that the deployment of more efficient and sustainable air conditioners along with building efficiency improvements could lead to 110 TWh

of electricity savings in the AMS by 2040 compared to business as usual. This is more than the current electricity consumption of Brunei Darussalam, Cambodia, Lao PDR, the Philippines and Viet Nam combined (IEA, 2019a).

Energy security

Energy efficiency, including efficient and sustainable cooling, can also boost regional and national energy security. By reducing overall energy demand, efficiency can reduce reliance on fuel imports such as oil, gas and coal, as well as reducing the amount of new renewable energy generation capacity required to meet future energy demand.

Reduction in fossil fuel energy imports in IEA countries and major emerging economies due to energy efficiency improvements since 2000



Note: The countries covered here include all IEA countries as well as the People's Republic of China, India, Brazil, Indonesia, the Russian Federation, South Africa and Argentina.

Source: IEA (2019c), Multiple Benefits of Energy Efficiency: From "hidden fuel" to "first fuel".

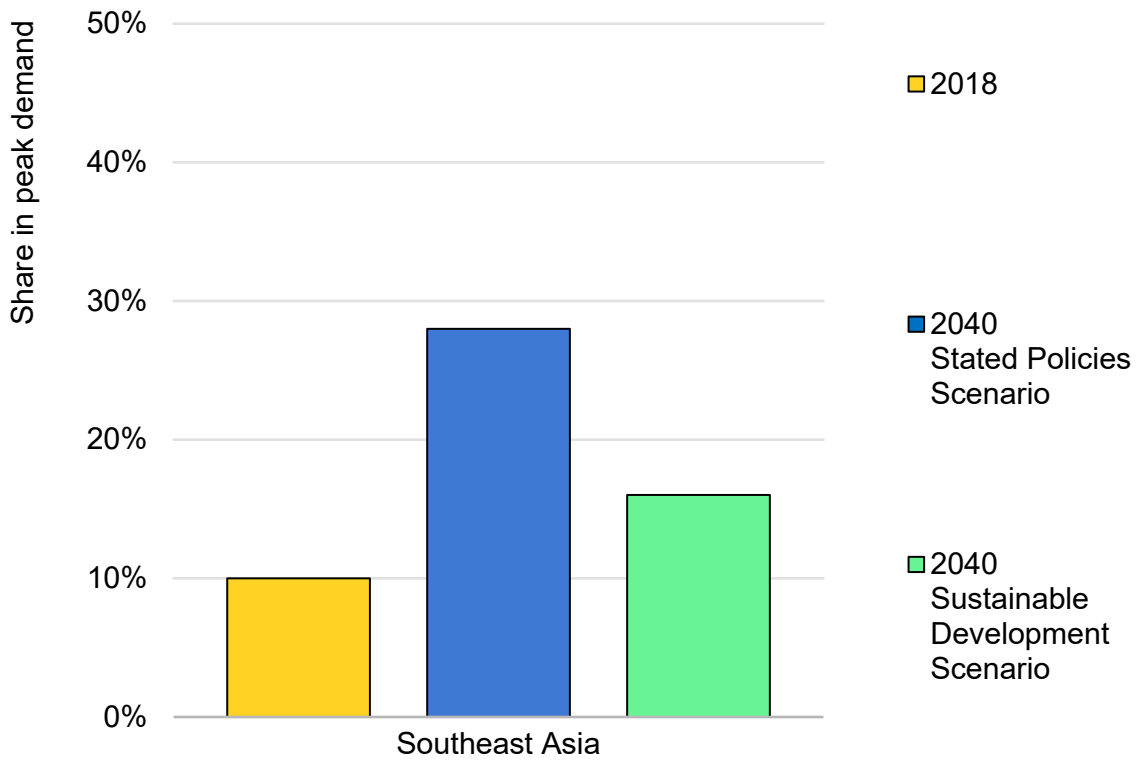
Energy efficiency also improves overall energy system security and reliability and reduces the likelihood of supply interruptions. Energy-efficient technologies can enable a range of other demand management measures, including demand response and load-shifting, which can help to improve grid stability and offer flexible energy services that support a higher amount of variable renewables in the energy system.

Sustainable and energy-efficient cooling can also deliver benefits that reduce overall energy system costs. As sustainable cooling technologies often also save energy at times of generation peaks and network peaks, efficient cooling technologies can also help to place downward pressure on overall system costs, in that they reduce the need to build costly generation and network capacity to meet peaks that serve the system for a small part of the year.

Efficient cooling under the Sustainable Development Scenario is expected to reduce the contribution of cooling to peak demand by over 10% compared to

business as usual trends by 2040. This means enhanced system security, reliability and lower energy prices. These benefits could be enhanced further through the adoption of smart and digital devices to support demand management in a network of efficient air conditioners.

Reduction in cooling's contribution to peak demand in 2040



Source: IEA (2019a), The Future of Cooling in Southeast Asia.

Employment

Energy-efficient and sustainable space cooling can also lead to economic and social benefits through job creation. The employment opportunities that flow from efficient and sustainable appliances can be categorised as direct jobs, from manufacturing, wholesale, retail and maintenance, and indirect jobs flowing from the associated supply chains.

Investment in energy efficiency can lead to skilled job creation through the actions of retrofitting existing buildings, more efficient new constructions, and increasing access to clean fuels. Measures to improve the efficiency of buildings and appliances have been shown to generate 10 to 15 job-years per million dollars invested (IEA, 2020).

For example, a ten-year appliance replacement programme for low-income households in Mexico created more than 1 600 new permanent jobs and 10 500 temporary jobs, while replacing nearly 2 million refrigerators and air conditioners, avoiding over 3.4 million tonnes of CO_2 a year from the energy savings, and a further half a million tonnes of CO_2 a year from the safe capture and destruction of refrigerant gases.

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Chapter 2. A sustainable and energy-efficient space cooling roadmap for ASEAN

Introduction

This chapter explores a wide range of potential actions across three policy category headings – regulation, information and incentives – and 12 types of policy measures. For each of these policy measures, as summarised in the tables at the beginning of each section, the roadmap examines the current status of the policy across ASEAN, as well as proposing indicative 2025, 2030 and net zero-carbon milestones designed to progress action on sustainable and energy efficiency space cooling through room air conditioners and fans. The roadmap also presents near-term actions to support co-ordination and policy progress for each measure, and provides case studies and examples.

Among the policy measures discussed below, the foundation of a good policy package for sustainable and efficient space cooling consists of Minimum energy performance standards (MEPS), harmonised test standards and labelling programmes, supported by a strong monitoring, verification and enforcement (MV&E) regime. A regional product efficiency "ladder" approach can help to unite these foundational policies.

Each ASEAN Member State (AMS) has different circumstances and priorities. Therefore, from the remaining measures, each AMS could choose to implement an appropriate mix of complementary policies beyond these foundational measures to build a successful policy package tailored to its local needs.

Regulation

Regulation

Policy measure	Current status	By 2025	By 2030	Towards net zero-carbon
Minimum Energy Performance Standards (MEPS)	MEPS in place for room air conditioners in most AMS and MEPS for fans in some AMS.	Harmonised MEPS in place for all room air conditioners and harmonised regional product ladder adopted aiming for U4E model regulations Harmonised MEPS and product ladder fans under development	Increased stringency of MEPS including requirement for demand response capability AMS have adopted harmonised MEPS for fans as appropriate, and a product ladder aiming to double efficiency by 2030	MEPS approach today's BAT Air conditioner MEPS include phaseout of all high GWP refrigerants
Harmonisation of test standards	Air conditioners: ISO 5151 and ISO 16358 adopted by most AMS. Fans: Some AMS have adopted test standards.	More AMS have harmonised test and evaluation standards, agreeing to use IEC 60879: 2019 for fans Capacity building for testing facilities and round robin testing	Testing facility capability expanded and round robin testing completed regularly MRAs and harmonised standards updated	Test standards updated and harmonised in line with technological development over time
Monitoring, verification, and enforcement (MV&E)	Almost all AMS have MV&E strategies for air conditioners.	All AMS sign an MRA for air conditioners and rollout a regional MV&E strategy All AMS have product registries for air conditioners and fans and a regional registry under development	Rollout of a regional product registry. Regular market surveillance. Rollout of regional MV&E strategy for fans	MV&E strategies evolve over time expanding to cover additions such as demand response capabilities and refrigerant requirements

Minimum energy performance standards (MEPS)

MEPS form a critical foundation for efficient and sustainable space cooling packages, and have the ability to drive economy-wide and cost-effective improvements in energy efficiency. MEPS help to remove the worst-performing products from the market, and improve the energy efficiency of new products sold. Adopting a long-term regional product ladder approach for air conditioners and fans can support cost-effective improvements in energy efficiency while providing governments and industry with policy certainty. It should be noted that while MEPS for air conditioners should be a regional priority to support energy-efficient and sustainable products deployed, fans may not be a priority appliance for product efficiency programmes in all of the AMS.

SEAD Product Efficiency Call to Action

The Super-efficient Equipment and Appliance Deployment (SEAD) Initiative was founded in 2009 under the Clean Energy Ministerial. With 22 members, it is co-led by the European Commission, India, Sweden, and the United Kingdom. It aims to support appliance energy efficiency policy development in its member countries and beyond. In the lead up to COP26, the United Kingdom (holding the COP26 presidency) and the IEA launched a call to action to support countries in achieving their “raised ambition more quickly, easily and at a lower cost” (IEA, 2021a).

“The objectives of the call to action are to: (1) Set countries on a trajectory to double the efficiency of key products sold globally by 2030 – industrial motors; residential lighting, air conditioners and refrigerators; (2) Support the delivery of crucial national climate change targets; (3) Provide consumers and businesses with more efficient products that are affordable and cost-effective to own and operate; (4) Stimulate innovation and provide businesses with export opportunities; and (5) Promote a dual course of action making products both energy-efficient and climate friendly by reducing the use of refrigerants in cooling appliances” (IEA, 2021a).

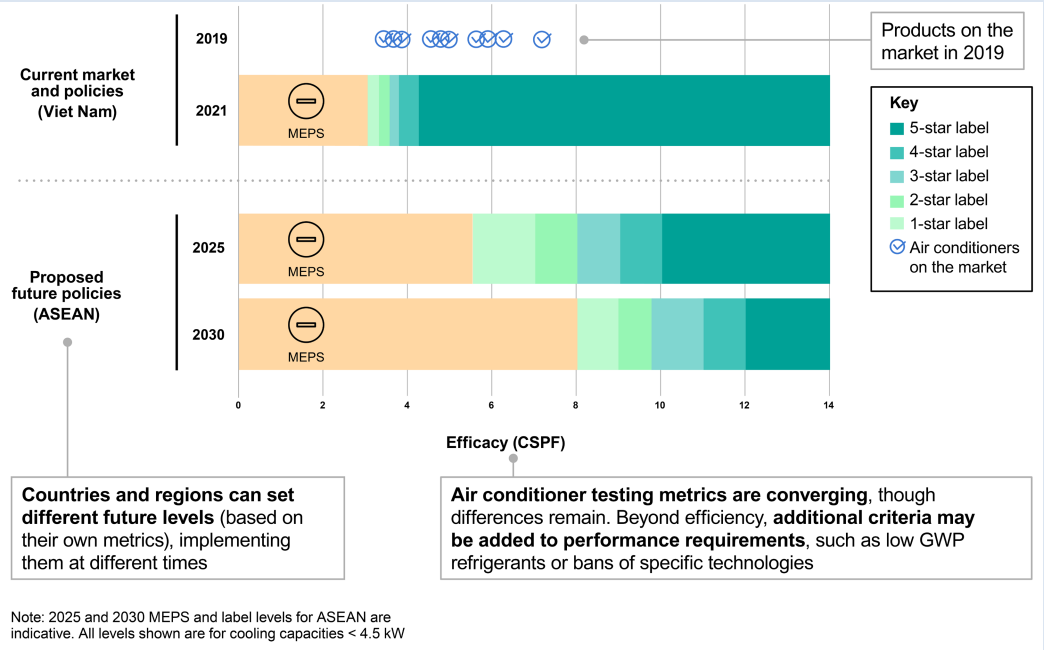
In developing policy, it can be more effective if different policies employ a shared set of energy efficiency performance levels or tiers. This makes it easier for industry to comply with regulations, and also for policy makers to specify appropriate performance levels, and to raise ambitions more quickly. These performance tiers may be considered as a performance ladder, where the aim is to set policy at higher and higher levels. In developing future policy, there are several key steps in developing a successful policy for increasing the energy efficiency of appliances and equipment:

- Decide on energy efficiency testing standards, and employ international standards where they exist, and develop as appropriate.
- Define energy efficiency thresholds as steps on the efficiency ladder, which could be used in different policies (from MEPS to energy labelling thresholds). Where appropriate these should be aligned with other national and international efforts.

The example of a ladder approach, shown below, provides a framework for a gradual increase for both MEPS and energy labelling, which allows continuous improvement in the energy efficiency of the air conditioners that are available in the market at any given time. A similar approach could be used for fans.

A well designed ladder approach helps to provide policy makers, manufacturers and the market with clear long-term certainty for improvements to MEPS and labelling programmes. This approach can help to support national and regional energy and climate goals while providing sufficient policy certainty about future changes to product manufacturers, suppliers and retailers.

A proposed ladder approach for air conditioner MEPS and labelling



Note: The proposed future efficiency levels that are shown above are indicative.

The Cooling Seasonal Performance Factor (CSPF) is the ratio of the total annual amount of heat that the equipment can remove from the indoor air when operated for cooling in active mode to the total annual amount of energy consumed by the equipment during the same period. Wh/Wh = Watt-hour of cooling output per watt-hour of electricity input. Based on data provided by CLASP and the Ecology and Environment Institute.

Current status

MEPS are currently in place for room air conditioners in most of the AMS, and under development in others. MEPS for fans exist in three countries across ASEAN, with regulations still under development in a number of nations.

For air conditioners, the Promotion of Higher Efficiency Air Conditioners in ASEAN: A Regional Policy Roadmap suggested a harmonised regional MEPS of 2.9 W/W Energy Efficiency Ratio (EER) or 3.08 Wh/Wh CSPF by 2020. Currently, most of the AMS have adopted or are in the process of adopting harmonised MEPS. As part of a parallel Japan-ASEAN Integration Fund project, the ASEAN Centre for Energy and the Department of Alternative Energy and Efficiency, Ministry of Energy, Thailand have recently completed a report: Recommendations for Updating the ASEAN Regional Policy Roadmap on Energy Efficient Air Conditioners and have proposed increasing MEPS levels to 3.7 CSPF by 2023 and 6.09 CSPF by 2025.

Current status of MEPS for air conditioners

Country	Cooling Capacity (CC)	MEPS	Year	Metrics
Brunei Darussalam	CC <7.1 Kw	2.9	2021	COP
Cambodia				
Indonesia	CC ≤ 7.9 kW	3.10	2021	CSPF
Lao PDR*	CC ≤ 3.52 kW 3.52 kW < CC ≤ 8 kW 8 kW < CC ≤ 12 kW	(Draft) 3.08 (FS), 3.4 (VS) 3.03 (FS), 3.3 (VS) 2.97 (FS), 3.2 (VS)		CSPF
Malaysia	CC < 4.5 kW 4.5 kW ≤ CC ≤ 7.1 Kw	3.10 2.9	2018	CSPF
Myanmar	CC ≤ 5.5 kW 5.5 kW ≤ CC ≤ 12 kW	3.08 2.89	Voluntary in 2022, Mandatory in 2023	CSPF
Philippines	CC < 3.33 kW 3.33 kW ≤ CC < 10 kW 10 kW ≤ CC < 14 kW	3.08 2.81 (none)	2019	CSPF
Singapore	CC ≤ 8.8 kW No limits No limits	2.90 (C&W) 3.78 (FS) 3.78 (VS)	2018	EER EER WEER

Country	Cooling Capacity (CC)	MEPS	Year	Metrics
Thailand	CC ≤ 8 kW 8 kW < CC ≤ 12 kW	(New drafts) 3.19 (W), 3.19 (FS), 3.90 (VS) 3.15 (W), 3.15 (FS), 3.46 (VS)	Draft 2021	CSPF
Viet Nam	CC < 4.5 kW 4.5 kW ≤ CC < 7 kW 7 kW ≤ CC < 12 kW	3.10 3.00 2.80	In force since 2017	CSPF

Notes: *Under development. (FS) = Fixed speed, (VS) = Variable speed, (C&W) = Casement and Windows, (W) = Window. (CSPF) = cooling season performance factor, (COP) = coefficient of performance, (EER) = Energy Efficiency Ratio, (WEER) = Weighted Energy Efficiency ratio. All enforced MEPS are mandatory.

Source: Park et al. (2021), Harmonizing Energy-Efficiency Standards for Room Air Conditioners in Southeast Asia, Lawrence Berkeley National Laboratory & United Nations Environment Programme

For fans, there are currently no harmonised regional MEPS.

Current status of MEPS for fans

Country	Blade Diameter (mm)	Service Value (m^3/min/W)	Status	Year
Brunei Darussalam				
Cambodia				
Indonesia	150 – 600 (DF)	0.6 – 1.0	Mandatory	2021
Lao PDR				
Malaysia	254 – 406 (DF) No limits (CF)	1.01 – 1.07 2.58 – 2.65	Mandatory	2013
Myanmar				
Philippines				
Singapore				
Thailand	400 (DF)	1.3	Voluntary	
Viet Nam	230 – 599 (DF) BD < 1200 (CF) BD > 1400 (CF)	0.64 – 1.13 2.4 2.5	Mandatory	2015

Source: CLASP and IIEC 2020 (unpublished), Technical Note: Electric Comfort Fans in the Philippines – A report on Residential Electric Fans Technologies and Market Informing Policy Development for Electric Comfort Fans; Indonesia, Ministry of Energy and Mineral Resources (2021), Minimum Energy Performance Standards and Energy Efficiency Labels for Fans, Decision of the Minister of Energy and Mineral Resources No.114.K/EK.07/DJE/2021

Notes: DF = Desk fans, CF = Ceiling fans.

Timelines

Regulation

Harmonising and ratcheting up fans MEPS

Current status	By 2025	By 2030	Toward net zero-carbon
3 AMS currently have mandatory MEPS, one voluntary, and these minimum standards are not harmonised	Harmonised MEPS for fans are under development Development of product ladder for fans is underway	AMS have adopted harmonised MEPS for fans and a product ladder, as appropriate	Most appliances and cooling systems sold globally are at today's best available technology (BAT) by 2035 Ratcheting up of MEPS over time

Near-term actions to support co-ordination and policy development for air conditioner MEPS

- **Adopt an ambitious regional ladder approach to provide long-term policy certainty for improvements to MEPS:** When MEPS are paired with transparent and long-term planning schedules for improvements, the market (manufacturers, suppliers and retailers of space cooling products) are provided with long-term price signals to adjust their product lines and stock over time. In many markets, this approach has supported supply chains by improving the efficiency of products with no, or limited increases in consumer prices, as manufacturers have found economies of scale or developed innovative ways to reduce the cost of energy efficiency improvements or cooling products.

- A regional MEPS ladder should aim to meet or exceed the levels outlined in the U4E Model Regulation Guidelines for Energy Efficient and Climate Friendly Air conditioners. Where higher energy efficiency standards exist, ASEAN could also consider matching the CSPFs of major economies and trading partners, opening up new opportunities for trade and delivering potential cost reductions through economies of scale.

- **Continued and proactive communication with appliance manufacturers and suppliers:** Ongoing communications and capacity- building efforts with the manufacturing industry and suppliers are important to facilitate understanding of upcoming changes to MEPS and strong compliance. They also help open up channels of communication for feedback and opportunities for industry to request support required to meet new standards. As more stringent MEPS for efficient and sustainable air conditioners are introduced, it is in the interests of all involved to be made aware of complementary policies and programmes. For example, where local manufacturers currently produce less energy-efficient fixed-speed air conditioners, continued and proactive communication can help to establish complementary programmes and incentives to upgrade production facilities and supply chains.
- **Support MEPS with monitoring, verification and enforcement (MV&E) programmes:** MEPS will only deliver the modelled benefits with MV&E programmes to support and ensure good compliance with standards. This is discussed further in a dedicated section below.
- **Include smart control and demand response-enabled device requirements in air conditioner MEPS:** Expanding MEPS to require all new units to include smart controls for demand response will help encourage flexibility services to reduce peak demand and energy system costs, improve grid reliability and support a higher proportion of variable renewable energy in the system. As highlighted in the IEA's Net Zero by 2050 report, this could lower costs for both grid operators and consumers alike, and would be an important action to support net zero emissions milestones.
- **Support decarbonisation and energy efficiency milestones through the use of low-GWP refrigerants:** support regional stakeholders in following the U4E Model Regulation Guidelines for Energy Efficient and Climate Friendly Air conditioners on the maximum GWP and ozone depletion potential (ODP) for refrigerants. These guidelines were based on inputs from over sixty experts. By following the guidelines, all units should comply with either International Organisation for Standardization ISO 5149:2014 or IEC 60335-2-40:2018 standards. With air conditioner sales in the region projected to increase from around 50 million units in 2020 to over 300 million in 2040, an earlier transition (such as by 2030) to a low GWP refrigerant standards for air conditioners would deliver significant GHG emission reduction benefits across the region.
- **Explore a regional approach to default set-point temperatures for air conditioners across the region as part of MEPS:** This type of policy approach allows consumer flexibility to change the temperature settings. However, it places a default appropriate to the climate while driving sustainable energy use. This approach has been employed in India by the Bureau of Energy Efficiency which will face growth in air conditioner use and peak demand over the coming decades. Through behavioural and technological research and industry consultation, a default set-point temperature of 24 degrees Celsius was established, with the potential to save 20 000 GWh in a single year (Users TCP and IEA, 2020).

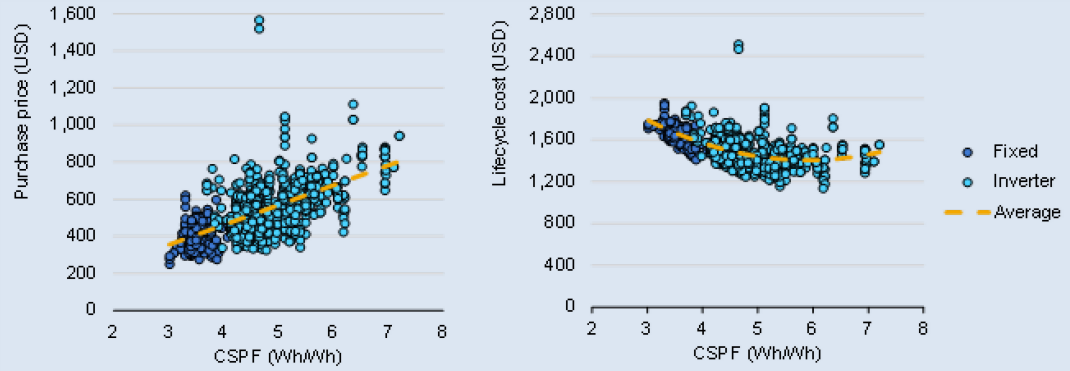
Case study: Energy-efficient air conditioners are not more expensive: Evidence from Southeast Asia

While energy-efficient appliances often tend to be cheaper across their lifetime (as they have lower running costs), consumers can sometimes struggle to calculate the lifecycle costs of an appliance, which can imply that purchasing decisions are often made based on the purchase price alone, a well-known barrier to increasing energy efficiency.

However, even if consumers have neither access to information nor a desire to calculate lifecycle costs, evidence from Southeast Asia shows that some energy-efficient appliances can be cheaper in terms of upfront purchase price alone. For example, in Viet Nam there are several models of air conditioner available with a seasonal performance factor of five or over, that are well below the average purchase price of USD 530 (purchase prices normalised to 12 000 BTU/h).

This suggests that improvements in the stringency of MEPS may result in a decrease in the lifetime costs of air conditioners for consumers, and may also result in no, or negligible, increase in the upfront purchase price for consumers.

Purchase price (left) and lifecycle cost (right) versus efficiency of air conditioners by technology in Viet Nam, 2019



Source: IEA (2020a), Energy Efficiency 2020.

Requirements for refrigerants (upper limits)

	GWP	ODP
Self-contained systems	150	0
Ductless split systems	750	0

Source: U4E (2019), Model Regulation Guidelines Energy-Efficient and Climate-Friendly Air Conditioners.

Timelines

Regulation

Ratcheting up air conditioner MEPS

Current status	By 2025	By 2030	Towards net zero-carbon
Almost all AMS have adopted the regional air conditioner MEPS of 3.08 W/W CSPF or an equivalent standard. For more information on historical MEPS see Figure 4.5	MEPS are fully harmonised and AMS adopted the target ladder. Aim for the thresholds in the U4E model regulations as the next MEPS steps	AMS have adopted harmonised MEPS for fans and a product ladder, as appropriate	Most appliances and cooling systems sold globally are at today's best available technology (BAT) by 2035 Phase out of high global warming potential (GWP) refrigerants

Near-term actions to support co-ordination and policy for fans

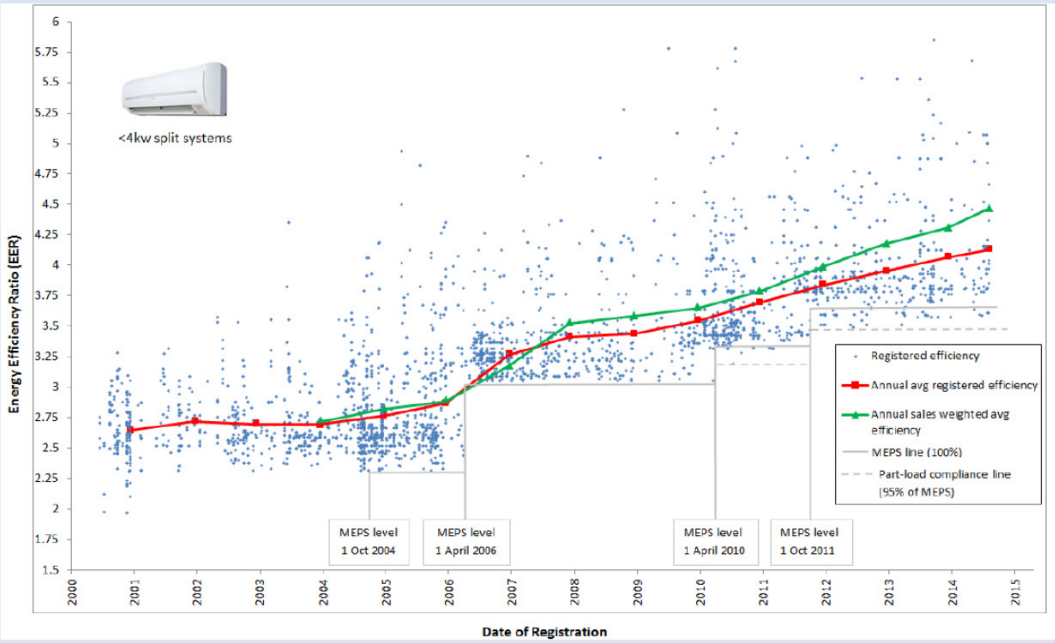
- **Adopt a regional testing standard:** The international standard *IEC 60879:2019 Comfort fans and regulators for household and similar purposes – Methods for measuring performance* could be adopted (CLASP and IIEC, 2020) as the regional standard and aligned through adoption across the AMS.
- **Capacity building for testing laboratories:** Increase the number of laboratories which do performance testing of fans using the harmonised test standard. Perform training, capacity building and round robin testing for testing facilities.
- **Develop harmonised MEPS for fans and a ladder approach for ASEAN:** Initial development of the regional harmonised MEPS could be supported through a combination of benchmarking analysis based on existing MEPS in the European Union China, India and the AMS (CLASP and IIEC, 2020). Analysis should also take into account the energy efficiency of the current market in setting the ladder steps and MEPS improvements over time. An initial phase could be voluntary, to ensure that manufacturers can adapt to the new MEPS requirement, transitioning to a mandatory requirement (CLASP and IIEC, 2020).

- **Support MEPS with MV&E programmes:** MEPS will deliver only the modelled benefits with MV&E programmes to support and ensure good compliance with standards. This is discussed further in a dedicated section below.

Case study: Ramping up air conditioner standards and labelling in Australia, New Zealand and India

MEPS have had a significant impact on the efficiency and innovation of the air conditioner markets of Australia and New Zealand (who work together to deliver a single, integrated programme on energy efficiency standards and energy labelling for equipment and appliances - Equipment Energy Efficiency (E3) program), where cooling can account for 20% to 50% of building energy use, depending on the climate zone. Due to a gradual ratcheting up of standards, today's least efficient air conditioners sold on the markets of the two countries are more efficient than the most efficient model available in 2001.

The effect of MEPS on the energy efficiency of new air conditioner sales in Australia



IEA 4E TCP (2021), Achievements of Energy Efficiency Appliance and Equipment Standards and Labelling Programs: 2021 update.

India, the first emerging economy to have a common rating plan for fixed-speed and variable-speed room air conditioners, has been successively ratcheting up MEPS since 2006, when a voluntary energy label for fixed speed air conditioners was launched. The label features a star rating that ranges from 1 to 5 in which five stars indicates the highest efficiency.

This voluntary label became mandatory in 2009 and in 2015 coverage was extended to include variable-speed air conditioners. The same year, a new methodology was introduced to factor in temperature variations across India's Note: COP = coefficient of performance different climate zones. Over time, MEPS were gradually increased, so that air conditioners with a 5-star label in 2009 would receive only a 1-star label in 2018. This represented a 35% increase in stringency at the 1-star level and 45% at the 5-star level.

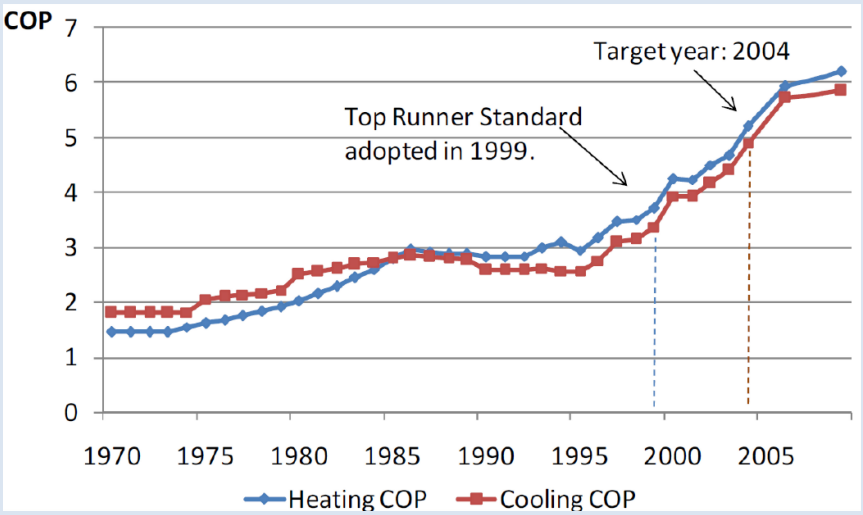
In addition to increasing efficiency, this systematic approach also helped shift the market with inverter AC penetration, increasing to 30% in 2018 from less than 1% in 2015. The average Energy Efficiency Ratio (EER) and Indian Seasonal Energy Efficiency Ratio (ISEER) of air conditioners sold increased by nearly 30% from financial year 2011/12 to financial year 2017/18.

Source: IEA (2019), The Future of Cooling in Southeast Asia; see also CLASP (2019), Cooling in a Warming World: Global Markets & Policy Trends.

Case Study: Japan Top Runner Programme

Japan adopted the Top Runner Programme in 1990. This Programme is a set of mandatory energy efficiency standards for 21 products for which the minimum standard is set periodically, using the most efficient products as a baseline for the future minimum standard. It pushes manufacturers to continuously improve the energy efficiency of their products, which in turn shifts the market change towards increasingly efficient products.

Energy efficiency trends of new air conditioners in Japan (2.8kW)



Note: COP = coefficient of performance.
Source: IEA 4E TCP (2021), Achievements of Energy Efficiency Appliance and Equipment Standards and Labelling Programs: 2021 update.

There is a significant change in annual energy efficiency improvements for heating and cooling products after the adoption of the Top Runner Standard. From 1970-1995 (before the Top Runner Standard was introduced in 1999) there was an annual rate of 1.2% and 2.8% efficiency improvement for cooling and heating appliances, respectively. From 1995-2006, the annual rate of efficiency improvement for cooling and heating appliances increased significantly to 7.9% and 6.6%, respectively. This significant improvement can be seen once the Top Runner Standard was adopted, highlighting the positive impact the programme has had in contributing to market transformation towards energy-efficient air conditioners.

Source: IEA 4E TCP (2021), Achievements of Energy Efficiency Appliance and Equipment Standards and Labelling Programs: 2021 update.

Harmonisation of testing and energy efficiency evaluation standards

Harmonisation of testing and energy efficiency calculation standards will continue to be crucial in promoting sustainable cooling in the AMS. Regional harmonisation of testing, energy efficiency evaluation and calculation standards, supported by mutual recognition agreements[2] (MRA) and aligned or regional product registration systems, facilitates cost-effective cooling energy efficiency improvements. Economies of scale are created, in turn reducing administrative burdens and costs by avoiding the need for re-testing air conditioners and fans for every market in the region. Harmonisation efforts also support local manufacturers in gaining access to new export opportunities across the ASEAN region and beyond.

Harmonisation also supports regional co-operation on MV&E initiatives to help ensure that the product performance claims from importers, manufacturers and test laboratories are correct and deliver the intended benefits to consumers, the energy system and environment.

In parallel to this roadmap project, with the support from the Japan-ASEAN Integration Fund, ACE is delivering a project on the “Promotion of higher efficient air conditioners in ASEAN through harmonisation of standards and strengthening of market verification and enforcement capabilities (Phase I)”. This regional project aims to achieve the harmonisation of testing standards and evaluation methods related to the energy performance of air conditioners in the ten AMS.

[2] An MRA is a trade agreement in which states agree to recognise the legal decisions of other state(s). They facilitate access to markets by allowing the assessment of a product’s test standard in one country compared to that in another.

The United for Efficiency (U4E) initiative of the United Nations Environment Programme, the International Institute for Energy Conservation and the Lawrence Berkeley National Laboratory (LBNL) are supporting the initiative to: :

- Adopt ISO 16358 as a single standard for evaluating the energy efficiency performance of fixed speed and inverter room air conditioners across the AMS.
- Update the Regional Policy Roadmap for Room Air Conditioners (RAC) MEPS implementation with a timetable to increase MEPS over time.
- Build capacity of testing laboratories in the region through round robin testing.

Current status

Currently, almost all of the AMS have adopted the ISO 5151 air conditioner test standard and the ISO 16358:1 evaluation and reporting standard. Several AMS have created their own national test standards aligned to the ISO 5151 standards.

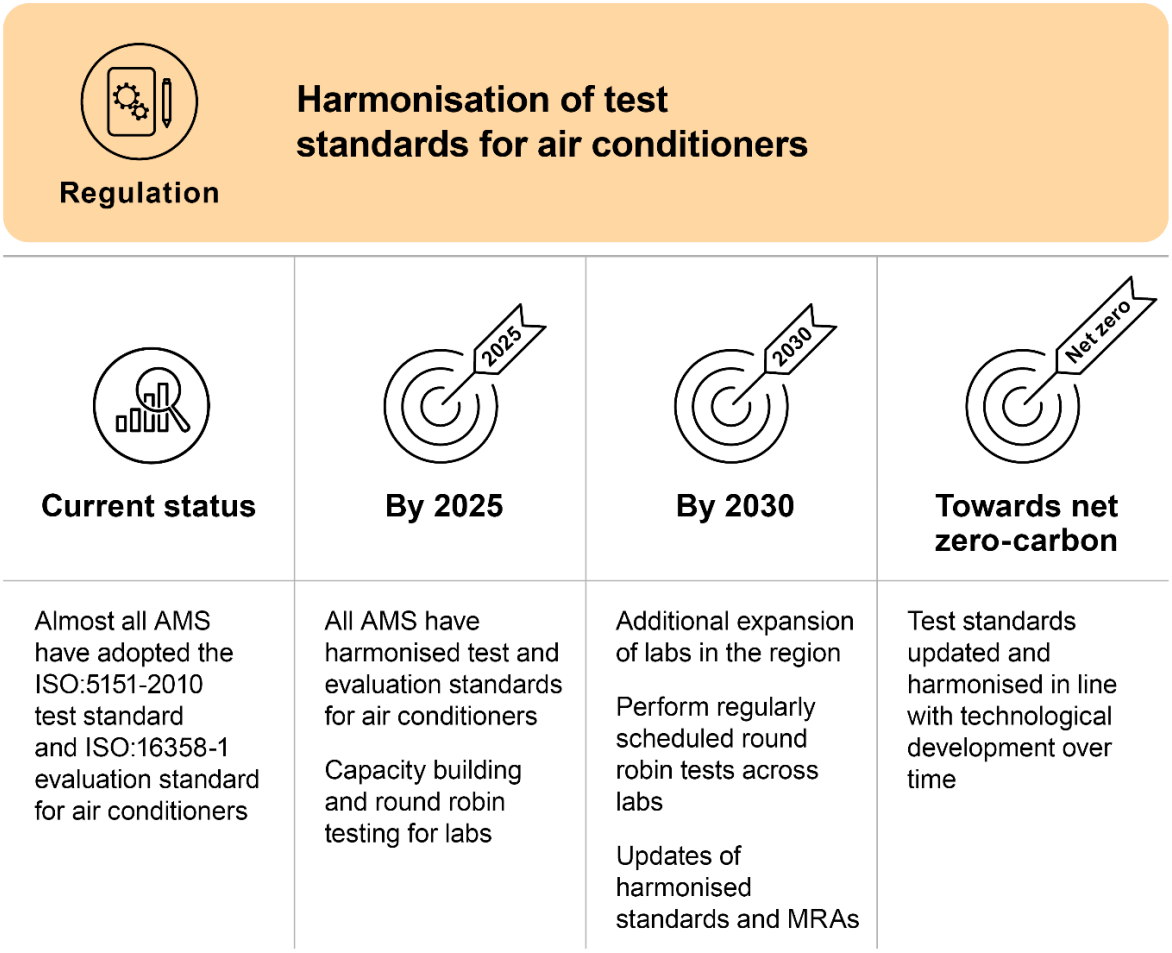
For fans, Viet Nam, Malaysia and Indonesia use national test standards which are aligned with the international standard IEC 60879: TVCN 7827 2007; MS 1220:2010 and MS 2574:2014; and SNI IEC 60789:013, respectively.

Current status of testing and evaluation standards

Country	ISO:5151-2010 AC Test Standard	ISO:16358-1 AC Evaluation Standard	Fan Test Standard	Fan Evaluation Standard
Brunei Darussalam	Adopted			
Cambodia				
Indonesia	Adopted	Adopted	SNI IEC 60879:2013	
Lao PDR	Adopted	Adopted		
Malaysia	Adopted	Adopted	MS 1220:2010	MS 2574:2014
Myanmar	Planning to adopt in 2021	Planning to adopt in 2022		
Philippines	Adopted	Adopted		
Singapore	Adopted			
Thailand	Adopted	Adopted	TISI 92-2536 TISI 127-2536	
Viet Nam	Adopted	Adopted	TCVN 7827: 2007	

Sources: Some policy information provided by the ASEAN Centre for Energy and the following reports; Department of Standards Malaysia (2014), Minimum energy performance standards (MEPS) for domestic fan;; Department for Standards, Metrology, and Quality Viet Nam (2015), National Standard TCVN 7825:2015; Thailand Environment Institute (2011), Thai Green Label (Electric Fan).

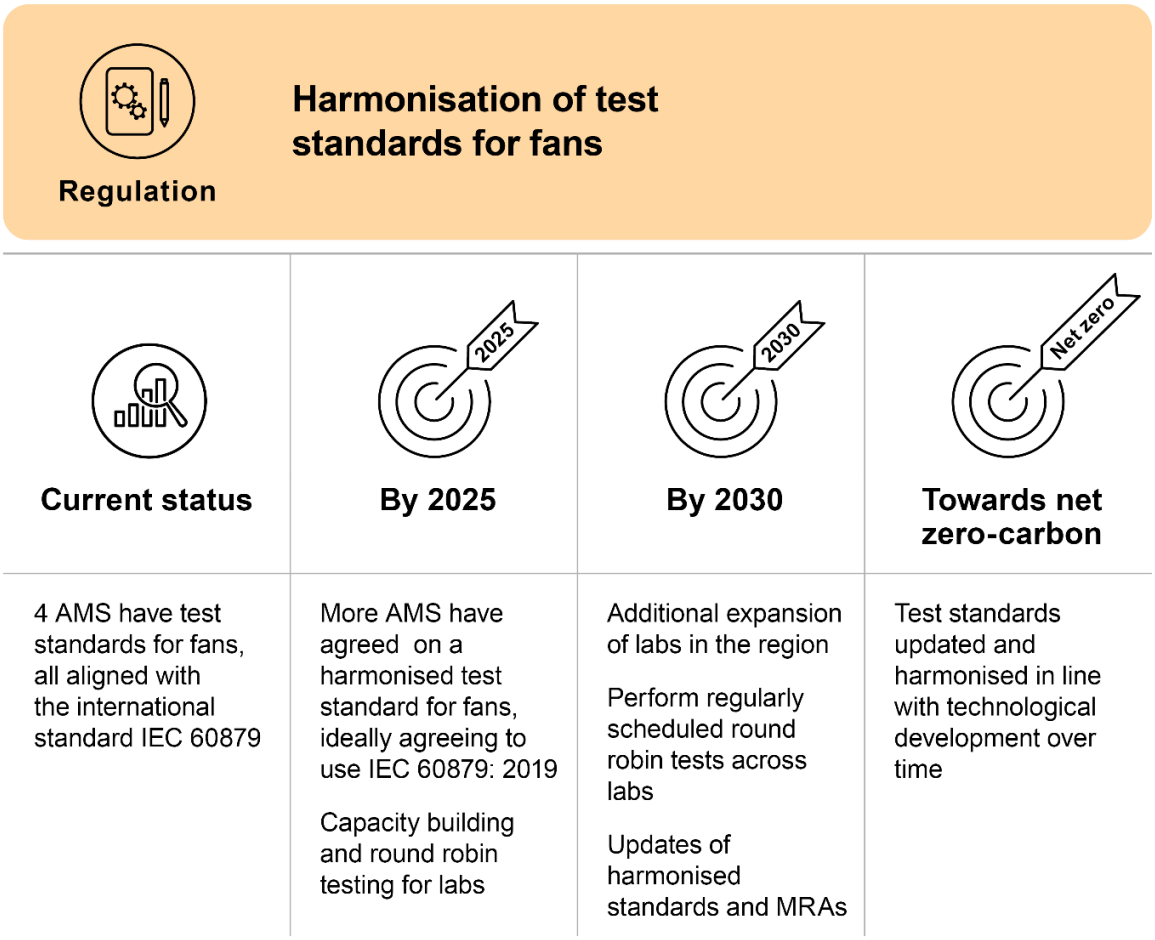
Timelines



Near-term actions to support co-ordination and policies for the harmonisation of testing and energy efficiency evaluation standards for air conditioners

- **Harmonising test standards and evaluation standards:** Aligning test standards and evaluation standards of ISO:5151 and ISO:16358-1 for air conditioners across the AMS helps support efficient and sustainable air conditioning across the region.
- **Capacity-building programmes for testing laboratories:** Regional capacity building programmes help support test laboratories, while round robin testing helps to build shared and aligned testing capability between laboratories across the region, further supporting harmonisation and MRA goals.

Near-term actions to support co-ordination and policies for the harmonisation of testing and energy efficiency evaluation standards for fans



- **Agree on regional testing standards for fans:** agreeing on a common regional testing standard, based on *IEC 60879:2019 Comfort fans and regulators for household and similar purposes – Methods for measuring performance*, can support the sale of efficient, sustainable and quality fans across the region. The AMS can adopt this by implementing national standards based on IEC 60879:2019.
- **Capacity-building programmes for testing laboratories:** Regional capacity building programmes will help to support test laboratories in gaining experience at testing against a new aligned test standard, and round robin testing can help build shared and aligned testing capability between laboratories across the region, further supporting harmonisation and MRA goals.

Monitoring, verification and enforcement

MV&E programmes play an important role in ensuring that the expected energy efficiency gains and multiple benefits from MEPS and labelling programmes are

delivered in reality. MV&E programmes incorporate a combination of education and capacity-building activities to support good compliance, while identifying and remediating cases of non-compliance through penalties and other measures to strengthen the effectiveness of mandatory MEPS and energy labelling schemes (U4E, 2021b).

Current status

Seven AMS are currently delivering MV&E programmes. Of this group of seven countries, Indonesia, Malaysia, the Philippines, Singapore, Thailand and Viet Nam have national registry systems for energy efficiency information relating to air conditioners. Most governments employ periodical market surveillance as a key feature of their MV&E programmes. However, the frequency and timetables for market surveillance activities are not determined through strong regional co-ordination.

Current status of MV&E Programmes

Country	MV&E Programmes for air conditioners	MV&E Programmes for fans	Product registries
Brunei Darussalam			
Cambodia			
Indonesia	Registration and periodic market surveillance		Yes
Lao PDR			
Malaysia	Consignment test and periodic market surveillance	Consignment test and periodic market surveillance	Yes
Myanmar	Five-year periodic market surveillance		
Philippines	Periodic market surveillance		Yes
Singapore	Registration and Periodic market surveillance		Yes
Thailand	Yearly market surveillance and verification		Yes
Viet Nam	Yearly market surveillance and verification		Yes

Source: ASEAN SHINE (2015), Promotion of Higher Efficiency Air Conditioners in ASEAN: A Regional Policy Roadmap.

Timelines

Current status	By 2025	By 2030	Towards net zero-carbon
Almost all AMS have MV&E strategies for air conditioners	All AMS signed the MRA for air conditioners Roll out of regional MV&E strategy for air conditioners All AMS have product registries for air conditioners and fans Development of a regional product registry is underway which links with national product registry systems	All AMS signed the MRA for air conditioner and fan testing Roll out of regional product registry Perform regularly scheduled market surveillance Roll out of regional MV&E strategy for fans	MV&E strategies continue to evolve over time, expanding to cover additions such as demand response capabilities and refrigerant requirements for air conditioners

Near-term actions to support co-ordination and policies for air conditioners and fans

- **Adopt a regional MV&E framework for air conditioners, and a subsequent framework for fans:** A regional MV&E framework was suggested in the Promotion of higher efficiency air conditioners in ASEAN: a regional policy roadmap, outlining several actions to help develop a regional MV&E programme. U4E's guide on Ensuring Compliance with MEPS and Energy Labels, also provides practical advice for policy makers on establishing and operating MV&E frameworks.
- A regional MV&E programme can play an instrumental role in supporting energy-efficient and sustainable space cooling, helping to ensure that all air conditioners and fans sold within the region comply with regional MEPS and energy labelling

requirements. A cohesive regional framework for MV&E will include: guidelines for market surveillance, auditing, compliance and verification activities, and information-sharing between national authorities; an MRA between the AMS on accepting results from testing laboratories; and the development of a regional product database and common guidelines for information required for submission.

- As part of future efforts, an MV&E programme focussed on refrigerants, or the integration of this into existing MV&E efforts, could also be deployed to monitor the use of and transition towards low-GWP and efficient air conditioners.
- **Develop regional MRAs for air conditioners, and an MRA for fans at a later date:** The Guidelines for the Integration of Energy Efficiency into the ASEAN Sectoral Mutual Recognition Arrangement for Electrical and Electronic Equipment Framework (ASEAN EEEMRA) (ACE, 2019a), which were endorsed at the 37th ASEAN Ministers on Energy Meeting (37th AMEM), provides a framework for regional acceptance of energy efficiency testing results and regional registration requirements. An MRA could be agreed upon by all of the AMS to help facilitate testing and acceptance of test results across the region by 2025. An MRA for fans could be agreed by 2030.
- **Develop a regional product registry and database:** as mentioned in the Guidelines for the Integration of Energy Efficiency report, a regional product database or registry could be developed. ASEAN could aim for a 2025 start date for air conditioners, and aim to have fans included by 2030. The development of a regional database could be streamlined by using the national registry data of each AMS (where available) and provide a common registration number or identification code for air conditioners and fans sold in the region. Capacity-building and training plans for customs and enforcement officers would help to ensure the understanding and streamlined use of a regional database. U4E has developed a Prototype Product Registration System for Air Conditioners and Refrigerators and has published supporting documents.
- **Capacity building for testing laboratories:** The number of laboratories to perform performance testing of fans using the harmonised test standard can be increased. Perform training, capacity building and round robin testing for testing facilities.
- **Market surveillance:** A regional network can be developed to perform regular market surveillance to ensure that all products being sold in the market are following the MEPS, by performing testing and verification for random products.

Information

Information

Policy measure	Current status	By 2025	By 2030	Towards net zero-carbon
Labelling	Almost all AMS have energy labelling programmes for air conditioners, but only some for fans	Mandatory air conditioner labelling adopted. Labels start to include more information and QR codes	Mandatory labels for fans adopted, as appropriate All AMS labels have explored including QR codes Regional guidelines developed to include refrigerant information on labels	All air conditioner and fan labels include QR codes Air conditioner labels include information on the GWP of refrigerants
Endorsement labels and high energy performance standards (HEPS)	Present in some AMS	A regional basis for endorsement label and HEPS energy efficiency levels is explored based on a regional product ladder for air conditioners	All AMS have adopted harmonised endorsement labels and HEPS lists with increasing stringency to qualify. An adoption of fans labels follows in the future, as appropriate	A regional low-GWP refrigerant endorsement label could be considered for air conditioners to support a consumer led shift towards net-zero carbon goals
Information, education and training, and air conditioner audit programmes	Programmes are present in some AMS.	More AMS explore, develop and implement information, education and training as well as air conditioner audit programmes.	Widespread adoption of programmes, and audit and air conditioner tuneup programmes increase to address replacement and maintenance.	Programmes across AMS focus increasingly on retrofit and maintenance of older air conditioner systems with efficient and no/low GWP refrigerants.

Labelling

Product labelling programmes for air conditioners and fans support consumers in making better informed purchasing decisions. Based on a combination of the upfront costs and operating costs of different models labels can also help provide the basis for a range of incentive programmes, and also include information on whether a product includes lower GWP refrigerant gases, as highlighted by the US Energy Star programme which publishes lists on refrigerators with lower global warming potential refrigerant gases.

Labelling programmes have evolved over time. One development is the use of quick response (QR) codes and/or smartphone applications which can provide more detailed information on product comparisons for consumers and more accurate lifetime cost estimates. Examples of these systems can be seen in Australia, China, the European Union and India. Indonesia's recently launched air conditioner comparison tool application assists households compare models before purchasing and assess the difference in electricity bills from different models. As well as helping consumers make informed choices, these advancements also support market surveillance and compliance activities, and can support better tracking of products at end-of-life.

Labelling programmes can typically be divided into two categories: comparative labels that help consumers compare the energy performance of different products; and endorsement labels that provide consumers with a mark of high-performance. This section focusses on comparative labels.

Current status

A mix of voluntary and mandatory labelling for air conditioners and fans exists across the AMS, with some countries' labelling regulations still under development.

Current status of comparative labelling programmes for air conditioners in ASEAN

Country	Regulatory Status	Metric
Brunei Darussalam	Mandatory	Weighted COP
Cambodia		
Indonesia	Mandatory	CSPF
Lao PDR	Under development (Voluntary)	CSPF
Malaysia	Voluntary	CSPF
Myanmar	Under discussion	CSPF
Philippines	Mandatory	CSPF
Singapore	Mandatory	Weighted EER
Thailand	Voluntary	CSPF
Viet Nam	Mandatory	CSPF

Note: The energy labels mentioned above are also applicable for fans in Indonesia (from 2022), Malaysia, Thailand, and Viet Nam.
Sources: Policy information provided by the ASEAN Centre for Energy; ASEAN SHINE (2015), Promotion of Higher Efficiency Air Conditioners in ASEAN: A Regional Policy Roadmap; CLASP (2021), Air Conditioner Labelling in Thailand: Key Findings and Recommendations Policy Brief; Green Development Center Viet Nam, http://en.greendc.vn/energy-label-bid8.html; Indonesia, Ministry of Energy and Mineral Resources (2021), Minimum Energy Performance Standards and Energy Efficiency Labels for Fans, Decision of the Minister of Energy and Mineral Resources No.114.K/EK.07/DJE/2021; Indonesia, Ministry of Energy and Mineral Resources (2021), Minimum Energy Performance Standards and Energy Efficiency Labels for Air Conditioners, Decision of the Minister of Energy and Mineral Resources No.103.K/EK.07/DJE/2021.

Timelines

Information

Labelling programmes

 **Current status**	 **By 2025**	 **By 2030**	 **Towards net zero-carbon**
Almost all AMS have energy labelling programmes for air conditioners, but only some for fans	All AMS have implemented mandatory energy labels for air conditioners Labels for air conditioners will start to include additional information regarding smart and demand-response enabled devices QR codes which links product details on websites found on the labels are starting to become common	AMS have implemented mandatory energy labels for fans, as appropriate All AMS labels have explored including QR codes to link to further information or comparison tools Regional guidelines on including information on GWP of refrigerants in air conditioner labels has been developed	All air conditioner and fan labels include QR codes Air conditioner labels include information on the GWP of refrigerants

Near-term actions to support co-ordination and policies for air conditioners and fans

- **Align labelling energy efficiency levels across the region based on a product ladder:** In order to build on local consumer recognition accumulated over time, it is important for the AMS to retain their own local appliance energy labels. There are benefits to aligning the energy efficiency levels that sit behind each energy star rating/tick level in labels across the region as part of a ladder approach also incorporating MEPS. This could see mandatory labels for air conditioners introduced by 2025 across all AMS and for fans by 2030.

- **Consider innovation in labelling through QR codes to link to more information and tools:** QR codes on appliance energy labels for air conditioners and fans can help to link to comparison websites and more information on products. With the click of a button on a smartphone, consumers could resolve information barriers to energy efficiency. For example, a QR code could take consumers to an appliance comparison tool that helps them compare the lifetime costs (operational energy use and upfront cost) of different models.
- **Provide additional information on energy bill savings:** Including information on the energy bill savings of an efficient product compared to MEPS or a market average product helps to promote energy-efficient air conditioners and fans. Such information could be printed on labels directly, or disseminated via online information and product comparison tools accessible via a QR code.
- **Include information on the GWP of refrigerant gases used in air conditioners:** This would help residential, corporate and government consumers obtain the necessary information to choose more environmentally friendly appliances at the point of purchase. It would also help corporate and government clients specify low-GWP products in procurements lists and strategies.
- **Include information on whether an air conditioner is a smart, demand-response enabled device:** This is an important step towards digital, flexible and low carbon energy services which will improve grid stability, support renewable energy and lower system and consumer energy bills in the future. Including this information on labels (or via QR codes) can support consumers when they purchase appliances. At the point of sale, they can sign up to flexibility, demand response and demand management services.
- **Implement labelling that compares both inverter and non-inverter air conditioners using the same system**: As suggested by CLASP, different energy rating label scales, metrics or testing requirements for inverter and non-inverter (otherwise known as variable and fixed speed) air conditioners risk misleading consumers (CLASP, 2021). For example, under a differentiated system, an energy-efficient inverter air conditioner may receive a lower star rating than a less efficient non-inverter air conditioner.
- **Market surveillance is required to support compliance:** Market surveillance programmes help ensure that products sold in stores and online correctly display the required energy labels.

Endorsement labels and High Energy Performance Standards

Endorsement labels and High Energy Performance Standards (HEPS) are generally voluntary labels which signify that a product is one of the most efficient products available in the market. These labels can make it easier for consumers to identify the most efficient air conditioners and fans and boost manufacturers' sales through a stamp of approval via a government endorsement label for super-efficient products. These labels are usually provided in addition to energy rating

labels. HEPS and endorsement labels can also provide a transparent basis for incentive programmes, be they government or bulk procurement programmes, or financial incentives.

Current status

Endorsement labels and HEPS can be found in a number of the AMS, including the Philippines, Singapore, Thailand and Viet Nam.

Current status of endorsement labels and HEPS

Country	Endorsement Labels	HEPS
Brunei Darussalam		
Cambodia		
Indonesia		
Lao PDR		
Malaysia		
Myanmar		
Philippines	Green Choice Philippines Scheme	
Singapore	Green Label Singapore	
Thailand	Green Label Thailand	Energy Efficiency Labelling No.5
Viet Nam	Highest Energy Efficiency Product of 2020	

Sources: ASEAN SHINE (2015), Promotion of Higher Efficiency Air Conditioners in ASEAN: A Regional Policy Roadmap;
APEC (2015), Compendium of Energy Efficiency Policies of APEC Economies Thailand
Australian Government – Department of Industry (2014), Energy Efficiency Appliance Labelling in Vietnam – Summary of Findings;
Department of Alternative Energy Development and Efficiency, Ministry of Energy Thailand (2010), Energy Efficiency Standards and Labelling Measures in Thailand: Air Conditioner.

Timelines

Information

Endorsement labels and HEPS

 **Current status**	 **By 2025**	 **By 2030**	 **Towards net zero-carbon**
Several AMS have endorsement labels, and Thailand has HEPS	A regional basis for voluntary endorsement label energy efficiency levels and HEPS based on the suggested product ladder approach is explored for air conditioners	A regional basis for voluntary endorsement label energy efficiency levels and HEPS based on the suggested product ladder approach is explored for fans All AMS have adopted the harmonised endorsement label and HEPS levels for air conditioners, with increasing stringency as time goes by. Adoption of fans labels follows in the future, as appropriate	A regional low-GWP refrigerant endorsement label could be considered for air conditioners to support a consumer led shift towards net-zero carbon goals

Near-term actions to support co-ordination and policies for endorsement labels and HEPS

- **Establish harmonised energy efficiency levels for endorsement labels and HEPS across the region:** Label designs and communication materials should remain tailored to each country's local context, language and culture, maintaining established brand recognition. However, as for MEPS and energy labels, there are market benefits to aligning levels of energy efficiency for fans and air conditioners at a regional level that become eligible to receive voluntary endorsement or HEPS labels. This could be explored by 2025 as part of air conditioner product ladder development, and by 2030 for fans. The stringency of these labels should be adjusted over time as product ladders improve.

- **Update product registries (where required) to include appliances that meet endorsement label and HEPS thresholds:** As endorsement labels and HEPS lists can be used by government and corporate green procurement programmes to specify eligible purchases, updated product registries can support a range of other programmes to support the purchase of high efficiency appliances. These lists can also be leveraged in the design and delivery of a range of other types of incentive programmes that can deliver improvements in energy-efficient and sustainable cooling.
- **Consider HEPS and endorsement label efficiency levels while developing regional product ladders to harmonise test standards, MEPS and labelling:** This can help to streamline and fast track the process for governments and regulators across ASEAN.

Information, education, training and energy audits

Information, education and training programmes can play an important role in sustainable space cooling policy. Public information campaigns can help to improve consumer recognition of energy labels and make sustainable purchasing decisions.

Public information programmes can also deliver significant energy savings and GHG reductions through campaigns to recommend comfortable but more sustainable temperature settings. For example, since 2005, Japan's Ministry of Environment has been delivering the highly successful Cool Biz public information campaign encouraging households and businesses (and building managers) to set summer air conditioners to 28 degrees Celsius while supplementing air conditioning with sustainable cooling solutions such as fans, and to dress appropriately for the season.

Home energy report programmes can deliver behavioural improvements in the use of space cooling appliances and peak demand reductions. Education and training programmes can support appliance manufacturers and retailers to understand the regulatory environment surrounding MEPS and labelling requirements as a form of proactive compliance, and can also support sales staff to advise customers on energy-efficient purchases that factor in the operating costs of air conditioners and fans.

Cooling audit programmes can also support building owners and managers in conducting regular maintenance and tune-ups of air conditioning systems and building management systems.

Case studies examining the benefits of efficient and sustainable space cooling projects can also play an important role. For example, case studies could explore the return on investment for chiller upgrades and energy monitoring systems, providing businesses with the confidence to invest in digital technologies and cooling upgrades.

Current status

Information, education, training and air conditioner audit programmes are currently present in some of the AMS.

Country	Information Programmes	Education Programmes	Training Programmes	Mandatory Audit Programmes
Brunei Darussalam		Brunei Students' Energy Club		
Cambodia	National workshop on National Cooling Action Plan (NCAP) Development Energy savings Siem Reap	*Green Learning Room	Training to perform energy audits	
Indonesia	Directorate General of New, Renewable, and Energy Conservation – Ministry of Energy and Mineral Resources (MEMR) Energy Conservation Data & Information Book 2020 Public service Advertisement Sticker and banner, comic, energy saving guide	Regulation of Minister of Energy and Mineral Resources (MEMR) No.14/2021 on the Implementation of Minimum Energy Performance Standards (MEPS) for Energy Consuming Appliances and Equipment Center for Human Resources Development for Electricity, New Energy, Renewable Energy, and Energy Conservation : Work Fast, Carefully, and Productively (esdm.go.id) Technical guidance and socialisation of energy conservation Energy saving campaign Goes to campus Public service Advertisement Sticker and banner, comic, energy saving guide	Center for Human Resources Development for Electricity, New Energy, Renewable Energy, and Energy Conservation : Work Fast, Carefully, and Productively (esdm.go.id) National Training and Certification for technicians, auditors, and planners on "Safe and Efficient Use of Hydrocarbon Refrigerant R290": Installation, Maintenance and Service (bilateral co-operation between Indonesia and Germany (GIZ Green Chillers NAMA Project)	Government Regulation No.70/2009 on Energy Conservation Regulation of Minister of Energy and Mineral Resources (MEMR) No.14/2012 on Energy Management

Country	Information Programmes	Education Programmes	Training Programmes	Mandatory Audit Programmes
Lao PDR	Consumer awareness and behavioural programme under the Demand Side Management and Energy Efficiency Phase II – Lao PDR (2003-05)			
Malaysia		Centre for Education, Training, and Research in Renewable Energy and Energy Efficiency (CETREE)		Efficient Management of Electrical Energy Regulations
Myanmar				
Philippines	National Energy Efficiency and Conservation Programme (NEECP) Government Energy Management Programme Awards			
Singapore		Singapore Certified Energy Manager (SCEM) Programme and Training	ESCO [Energy Services Company] Accreditation Scheme	
Thailand	Green Classroom		Training Courses on Energy Technology and Efficient Energy Management Training Courses on Air Conditioners	
Viet Nam	VNEEP (National Energy Efficiency Programme) Vietnam National Press Award for Energy Efficiency			Mandatory Energy Audit and Management for Major Energy Users

Notes: *under development.

Timelines

Information

Information, education, training, and energy audits

 **Current status**	 **By 2025**	 **By 2030**	 **Towards net zero-carbon**
Some programmes are present in some AMS	Capacity building for manufacturers and retailers to develop and sell high efficiency air conditioners and fans Information campaigns are explored and developed to encourage the purchase of energy efficient cooling appliances, and for sustainable operation of cooling air conditioners Energy auditor training is developed to support cooling audits	Information, education and training programmes focused on energy efficient cooling have become widespread across AMS Air conditioner audit and tune-up programmes have become more widespread in the region	Information, education and training programmes increasingly focus on the maintenance and the retrofit of old air conditioner systems with energy efficient and low-GWP refrigerant systems

Near-term actions to support co-ordination and policy for information, education, training and energy audits

- **Trial public information programmes to set summer air-conditioning at higher temperatures:** This could follow the approach of Japan's Cool Biz programme, including weather and temperature-appropriate norms for workplace

attire, and any trial should build in evaluation, measurement and verification to assess the impacts on energy use and peak demand in targeted buildings and districts. A complementary information or capacity-building programme should also be targeted at building managers in order to facilitate programme success.

- **Explore the rollout of home energy report programmes:** Across the world, home energy report programmes have been proven to be successful in delivering a small amount of energy savings or peak demand savings across a large group of households. These programmes could be utilised to focus on savings through sustainable cooling behaviour, employing social comparison and norming techniques.
- **Explore the introduction of air conditioning and cooling system programmes across the region:** By requiring audits of air conditioning and cooling systems at regular intervals or certain trigger points within a building's lifecycle (such as point of sale, lease or major renovation or refurbishment), building owners and managers will receive information on the performance, efficiency and cost of their cooling system. Audits can encourage better maintenance of air conditioners, minimise refrigerant and cooling leakage and support regular adjustment of settings to ensure systems keep working at the rated capacity. They can also support the installation of better building management systems, or help support the business case for upgrades to cooling systems. While more suitable and cost-effective for larger buildings such as residential medium and high-rise apartment buildings and office buildings rather than single dwelling homes, such programmes can play an important role in a sustainable cooling policy ecosystem.
- **Consider the development of case studies to support the business case for efficient and sustainable cooling:** Case studies rich with data on the project, costs and benefits, technologies, systems and energy savings can support businesses within each AMS to understand how new or retrofits to cooling systems can benefit them.

Case study: Home Energy Reports

Home Energy Reports are a form of information programme that can help deliver energy savings and peak demand reductions from household space cooling by using social comparisons. Home Energy Reports increase awareness of household energy consumption patterns, and prompt reductions in energy use. The reports aim to present energy consumption information in a simple and compelling way, so that consumers can clearly see the link between their behaviour and their energy bills. Feedback on historical energy consumption allows consumers to track the evolution of their own energy use and see how it relates to specific appliances. Social comparisons are leveraged in benchmarking

one's energy consumption against that of similar households. Some reports have also been tied in with SMS-based alerts to achieve peak demand reductions.

In 2015, Malaysia's national utility Tenaga Nasional Berhad, in collaboration with the Ministry of Energy, Green Technology and Water trialled a home energy report programme. Home Energy Reports sent were sent to 450 000 consumers, in this first programme for the region. Report recipients were found to achieve energy savings of 1-3% relative to control group members, or about 50 000 MWh (Sachar et al., 2019).

Source: Users TCP and IEA (2020), Behavioural insights for demand-side energy policy and programmes: An environment scan.

Case study: Singapore's building cooling audits programme

As part of the 3rd Green Building Masterplan released by the Singapore Government's Building and Construction Authority in 2014, key initiatives included mandatory periodic energy audits of a building's cooling systems. This initiative supports regular checks to ensure that cooling systems are maintained and operating efficiently throughout a building's lifecycle, and can support compliance with minimum standards. This initiative was designed to apply to existing buildings that had undergone major energy use change on and after 2 January 2014, and complements other initiatives including minimum sustainability standards for existing buildings.

Source: Building Construction Authority, Singapore Government (2014), 3rd Green Building Masterplan.

Incentives

Policy measure	Current status	By 2025	By 2030	Towards net zero-carbon
Rebates, grants and tax incentives	Programmes are not widespread in AMS	Programmes are explored by AMS and a number of programmes delivered to support energy efficient space cooling	Programmes implemented at scale across AMS to drive energy efficient cooling	Programmes drive super efficient new purchases, maintenance and retrofits. Also support safe degassing and low-GWP refrigerant space cooling technologies
Loan programmes, on-bill finance and other finance	Some finance offerings across ASEAN for sustainable and efficient cooling	AMS scopes ways to attract and deploy international development, public and private finance for sustainable cooling business models	Loan and finance programmes and business models are common across AMS to support sustainable and affordable cooling	Finance and loan programmes have supported achieving net-zero cooling appliances
Bulk and public procurement programmes	Bulk procurement and energy efficient public procurement programmes not widespread in AMS	AMS explore including energy performance criteria in government procurement policies Bulk procurement programmes considered and piloted in some AMS	Government procurement guidelines in place and improve with ladder and expand to sub-national government. Bulk procurement programmes widespread to support appliance efficiency	Government procurement includes building requirements and ESCO contracts. Both public and bulk procurement driving retrofits of cooling to low-GWP options
Manufacturing and innovation grants	A few programmes have been delivered in the region	Manufacturing and innovation grants explored to support achieving product ladder targets cost-effectively	Manufacturing grants have supported manufacturers across AMS to produce super efficient air conditioners and fans. Innovation grants increasing	Manufacturing and innovation grants supported all cooling appliances sold across ASEAN to be energy efficient and using low-GWP refrigerants
Market-based mechanisms and energy efficiency obligation programmes	Programmes not widespread in AMS	AMS have explored options and some AMS have implemented programmes	Several AMS have implemented a form of these programmes, and those that have not opted for other large-scale incentive programme	Market-based mechanisms and energy efficiency obligations support retrofit, replacement and safe degassing of old space cooling equipment
Equity programmes	Programmes not widespread in AMS.	Equity and affordable cooling programmes explored in some AMS.	Programmes are piloted and implemented across some AMS.	Programmes expanded over time to reach more households and support renewable energy-powered cooling and low-GWP solutions.

Rebates, grants and tax incentives

Rebates, grants and tax incentives can all be deployed as effective ways to drive improvements in the energy efficiency of new air conditioners and fans on the market. They can also be used to drive the retrofit, service and replacement of old inefficient products. These types of incentives can be developed to be performance-based with higher incentives the higher the energy efficiency of the product.

A rebate programme to provide a discount for energy-efficient cooling appliances can provide an incentive for manufacturers, retailers and/or consumers to purchase sustainable models. Rebates are often designed to deliver small discounts to a large number of end-consumers, who can claim their rebate from the government programme by providing proof of purchase and completing the application form. A rebate programme can drive effective recognition and promotion of high efficiency products, raising their profile with end-consumers and across the supply chain.

Grant programmes can typically be deployed to deliver larger financial incentives to a smaller number of recipients, compared to a rebate programme. Grants can be used as an incentive for larger cooling efficiency projects, such as for building cooling audits, maintenance or retrofit projects for larger residential buildings, non-residential buildings, or for aggregated projects, such as to social, public and affordable housing organisations, community organisations, for school upgrades, or from a national government to regional and local governments. Grants can also be linked to cooling system audits and linked to upgrades to chillers, advanced metering or building management systems.

Tax incentives provide governments with an alternative approach to drive improvements in cooling efficiency. Such incentives can be provided to individuals or businesses investing in sustainable cooling products and services via tax deductions or credits for expenses incurred. Tax incentives can also be targeted at different points of the supply chain, encouraging manufacturers for producing, or appliance retailers or service providers for selling energy-efficient cooling appliances. As tax incentives leverage the existing taxation system, they do not require the establishment of new administration and compliance procedures.

Some tax incentives can have equity implications, as informal workers, and those in the lowest-income quintile are less likely to have taxable incomes with which to claim a deduction. However alternative tax incentives, such as reduced VAT for highly-efficient air conditioners and fans or higher tax on the least efficient options, provide a tax incentive for consumers that do not rely on taxable income and a tax rebate.

Current status

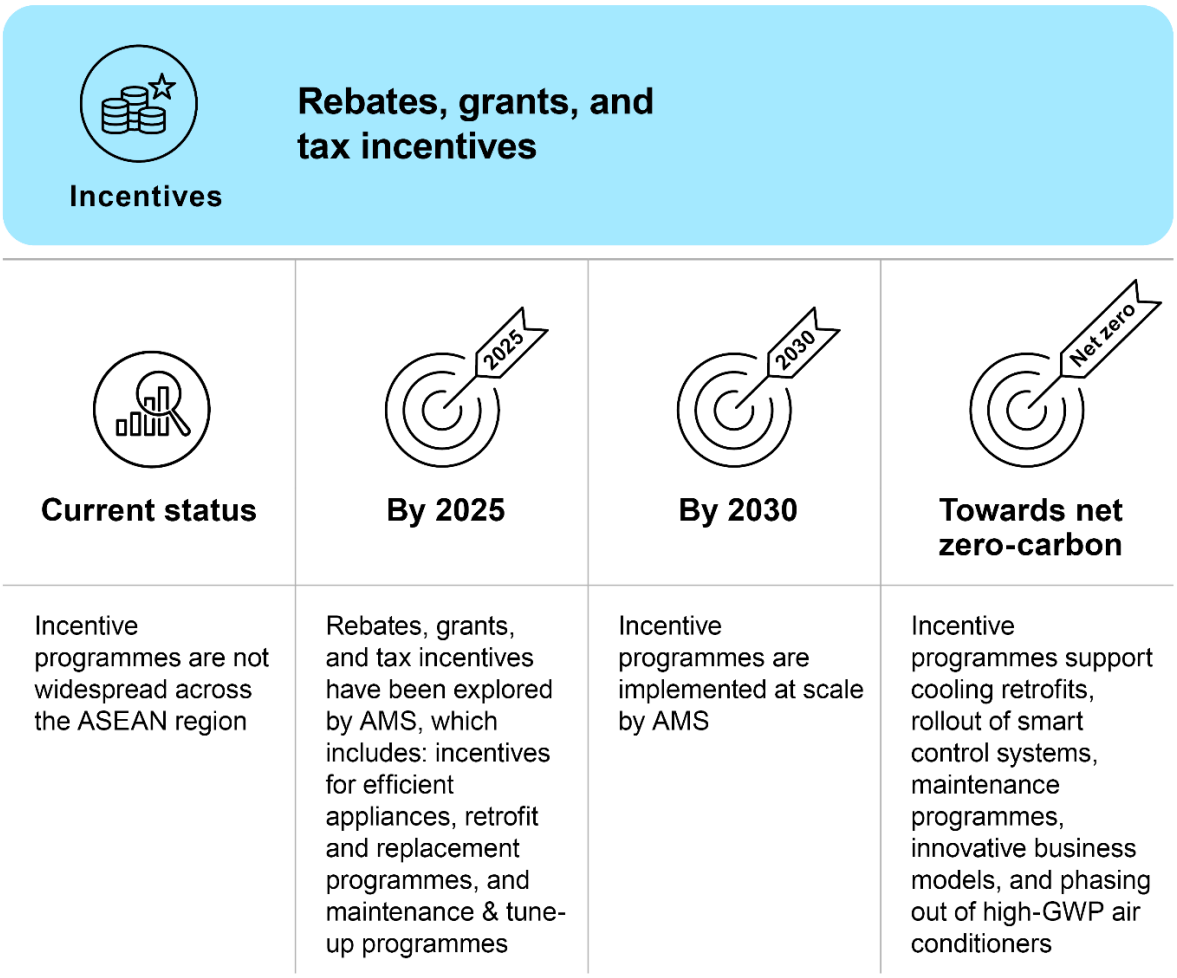
Rebates, grants and tax incentives for energy-efficient and sustainable space cooling are not currently widespread in ASEAN.

Current status of rebates, grants and tax incentive programmes

Country	Rebates	Grants	Tax Incentives
Brunei Darussalam			
Cambodia			
Indonesia		Viability Gap Fund	
Lao PDR			
Malaysia	Sustainability Achieved Via Energy Efficiency (SAVE 2.0)	Energy Audit Conditional Grant (EACG) – Commercial & Industry	Green Investment Tax Allowance (GITA) Assets and Projects Green Income Tax Exemption (GITE) Services and Leasing
Myanmar		Subsidy for energy audits	Import of clean energy technologies
Philippines			Pioneer Incentives (if the project is registered as a Pioneer Project/Enterprise)
Singapore		Green Mark Incentive Scheme: • Existing Buildings • Existing Buildings and Premises • Gross Floor Area • Design Prototype SGBC BCA – Zero Capital Partnership Scheme	
Thailand	Rebate Programmes	Direct Subsidy of equipment costs (ENCON Fund) Demand Side Management (DSM) Subsidy 20/80 and 30/70 programme Demand Side Management for Cooling System	*Tax incentive from ENCON Fund Measure for Improvement of Production Efficiency
Viet Nam			Energy Audit and Energy Efficiency Incentives

Notes: *Tax incentive from ENCON Fund* = Inactive since 2018.

Timelines



Near-term actions to support co-ordination and policy for rebates, grants and tax incentives

- **Consider how incentive programmes can support ambitious product ladder improvements in standards (MEPS) and labelling:** Incentive programmes can deliver short-term impacts to drive improvements in energy-efficient and sustainable cooling by shifting the market towards high-efficiency appliances. This can work hand in hand with product ladders, paving the way for improvements to MEPS and labels to remove the worst-performing products from the market, and driving market transformation.
- **Explore the introduction of rebate, grant and tax incentive programmes:** These programmes support efficient new air conditioners and fans, cooling retrofit and replacement programmes, as well as maintenance and tune-up programmes. There are advantages to each programme type to be explored based on the local context. For example, a tax incentive programme can be simpler for governments to deliver through the existing tax administration processes and systems. On the other hand, while a rebate or grant programme may require new programme

guidelines and administration to be established by governments, it can be easier to place a limit on the total amount of incentives provided over a period of time.

- **Link incentive programmes to energy labelling and endorsement label/HEPS programmes:** Governments can leverage existing labelling and testing requirements under energy labelling schemes, endorsement labels and HEPS to set eligibility thresholds for rewarding high-efficiency appliances. Policy makers and programme designers may wish to set performance-based incentives which provide a greater reward for higher efficiency products.
- **Consider the benefits of air conditioner replacement incentive programmes:** Appliance incentive programmes designed around replacing products are able to ensure that the old, inefficient stock is retired, recycled and safely degassed, rather than entering the second- hand market. This can help to deliver energy saving benefits and GHG benefits and create more jobs in the removal, degassing and recycling of air conditioners by taking a cradle-to-cradle approach.
- **Consider grant programmes or tax incentives tackling air conditioning and cooling retrofits for larger buildings:** Cooling upgrades for larger buildings are often more complex and expensive, and may require bespoke engineering solutions. Governments can consider dedicated grant programmes or tax incentives to support cooling retrofits in larger existing buildings, whether residential, commercial or mixed use.

Case study: Appliance rebates in Malaysia – Program Sustainability Achieved Via Energy Efficiency (SAVE) 2.0.

In calendar year 2021, the government of Malaysia delivered the Sustainability Achieved Via Energy Efficiency (SAVE) 2.0 Program to provide financial incentives for energy-efficient air conditioners, and refrigerators. Delivered by the Sustainable Energy Development Authority, alongside the Ministry of Energy and Natural Resources and the Energy Commission, SAVE 3.0 has RM30 million allocated to offer around 140 000 households an e-rebate of RM200 for the purchase of four or five-star energy-efficient and locally-made air conditioners and refrigerators through partnering appliance retailers.

The SAVE 2.0 Program had two main objectives: to increase the number of energy-efficient appliances in the market (four and five-star); and to increase public awareness of the bill- saving benefits of efficient appliances and encourage households to purchase them. As of April 2021, SAVE 2.0 had already supported 40 000 households to purchase energy-efficient appliances.

Running from 2011 to 2013, the RM45 million initial round of the SAVE Program provided rebates to households and businesses for energy-efficient air conditioners and refrigerators, and rebates to replace old chillers. The SAVE Program delivered rebates for around 65 000 air conditioners, 72 000 refrigeration

tonnes of cooling capacity of chillers, and 100 000 refrigerators. The 2011 to 2013 round of the SAVE Program resulted in electricity savings of 306.9 GWh, RM78.4 million in energy bill savings, and reduced GHG emissions by 208 705 kt CO_2-eq, as well as supporting more energy-efficient products to enter the local market. The Malaysian Government has just extended the programme for another year and will include more products in 2022.

Note: 1RM [Ringgit Malaysia] equals c. 0.24 USD [5 January 2022].

Source: Government of Malaysia, information available at the Sustainable Energy Development Authority (SEDA) of Malaysia website

Digitalisation and Cooling – a growing opportunity for investment and incentives

Digital connectivity allows us to monitor appliances and equipment continuously, and to connect them to the grid. This makes it increasingly possible to shape flexible demand to match it with available supply. During the hours when supply is scarce or electricity networks are congested, connected devices such as smart air conditioners can be automatically switched off or run at a lower load. These connected devices can reduce or shift consumption to other periods when supply is abundant, or at times of lowest GHG emissions, for example, when the sun shines, the wind blows or when there are no technical problems with the electricity grid. As cooling increases, and is expected to account for a large share of peak load in hot countries (up to 40% of peak load in ASEAN in 2040), digitalisation and flexibility of cooling demand represents a major opportunity.

IEA estimates that the potential for demand response in buildings is over 4 000 TWh (IEA, 2020b). However, the majority of this potential remains untapped. This is where digitalisation has a role to play in harnessing small-scale, distributed and otherwise unavailable energy system flexibility.

Digitalisation can support connected devices, such as air conditioners, to be managed through automated and smart systems, and in a way that does not require daily or active participation from the consumer. In the US, demand-response programmes based on smart and connected thermostats provided around 1 GW of flexible capacity in 2018 (Smart Electric Power Alliance, 2019).

A study conducted in China on how cooling in a nearly zero-carbon office building can provide energy flexibility, demonstrated that automated control strategies are critical to efficient consumption shifting. In the examined building, rule-based controls as compared to traditional day and night set-back controls helped curtail the peak power and the peak energy demand by 55.6% and 54.0%, respectively (Fei Lu et al., 2021).

Digitalisation can also support the use of targeted behaviour change programmes using communications and incentives to unlock demand flexibility services. For instance, Baltimore's Smart Energy Rewards program in the United States, has enrolled 1.1 million homes. The programme automatically enrols any customer who installs a smart meter with an option to opt out. Participants are notified the day before of "energy savings days", typically, hot summer days. If they manage to reduce their consumption these days, they receive a credit on their next bill. Seventy per cent of the enrolled households effectively participate in shifting peak loads.

Loan programmes, on-bill finance and other finance

Loan programmes and on-bill finance have the ability to overcome upfront-cost barriers to energy efficiency, encouraging more efficient space cooling choices. There is also a range of other financial instruments that can be used to support efficient and sustainable cooling, including the role governments or international banks can play to de-risk loans and support lower-interest rate loans. Finance can play an important complementary role in other incentive programmes.

Current status

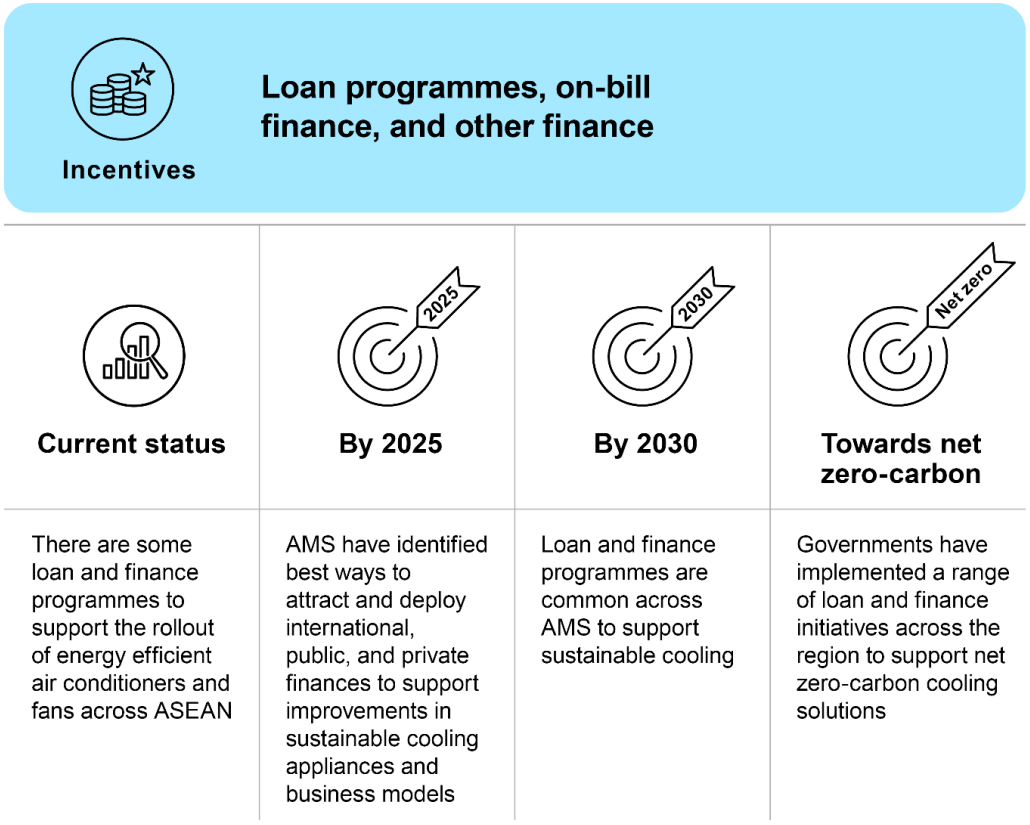
There is currently a number of loan programmes, on-bill finance and other financial instruments targeting the uptake of energy-efficient and sustainable space cooling in ASEAN. Cooling as a service (CaaS) business models are also being delivered to bundle finance and cooling services by organisations including BASE (the Basel Agency for Sustainable Energy) and Sustainable Development Capital LLP (SDCL).

Current status of loan programmes, on-bill finance and other finance

Country	Loan Programmes	On-bill Finance	Other Finance
Brunei Darussalam			
Cambodia			
Indonesia	Subordinated Loan Facility by PT. Sarana Multi Infrastruktur Loan purchase programme Linked deposit programme	Utility on-bill financing	Financial Lease, Instalment Sale, and Diminishing Partnership Programmes by PT. Sarana Multi Infrastruktur Joint Crediting Mechanism (JCM)

Country	Loan Programmes	On-bill Finance	Other Finance
Lao PDR			
Malaysia	Green Technology Financing Scheme	Energy Performance Contracting (EPC) in buildings	Credit guarantee
Myanmar			
Philippines			
Singapore		Pilot Building Retrofit Energy Efficiency Financing Guaranteed Energy Savings Performance Contracting Model	
Thailand	Energy Efficiency Revolving Fund		Equipment Leasing under ESCO Revolving Fund Joint Crediting Mechanism (JCM)
Viet Nam	Vietnam Environment Protection Fund (VEPF)		Joint Crediting Mechanism (JCM)

Timelines



Near-term actions to support co-ordination and policy for loan programmes and on-bill finance

- **Explore options to rollout loan and finance programmes:** Governments can play a number of roles in supporting loan programmes, as a direct or aggregator lender via revolving loan-funds, or by de-risking private finance to support preferential rates. The AMS could explore options for finance to support efficient and sustainable cooling solutions
- **Consider the role of private financial institutions in efficient and sustainable space cooling and how government can support them to roll out finance at scale**: private financial institutions are critical to the overall development of energy-efficient and sustainable space cooling equipment and solutions in ASEAN. Banks should be encouraged to be signatories to the UNEP Finance Initiative and the Equator Principles to support sustainable financing practices. These actions can support financial institutions to develop internal capacity to create and promote financial products such as green housing loans and issuance of green bonds as demonstrated by the Malaysian bank CIMB. Governments can also support private sector finance through a range of activities, including de-risking investments, the issuing of green bonds and accessing international finance options.

Case study: Cooling as a Service (CaaS)

Cooling as a service offers an innovative business model drawing on finance to offer customers energy-efficient and sustainable cooling services without the upfront cost.

One such example can be seen in a mixed-use development in India – at 1 Elpro Business Park, Pune – where a CaaS model has been used to provide cooling services to a retail centre, offices and residential and community spaces. The service provider, the Singapore-based company Kaer, has delivered an energy-efficient, zoned comfort, smart and digital solution, delivered through a centralised chilled water system powered entirely through solar energy. The CaaS model means that residents, office tenants, retail operators and other users pay for the cooling service they receive, and operation and maintenance are covered by their service provider, Kaer.

This type of business model helps service providers aggregate capital and finance for energy-efficient cooling services, helping to overcome upfront capital cost barriers and landlord-tenant split incentives often facing building owners.

Source: Basel Agency for Sustainable Energy (BASE) CaaS Initiative (2021).

Case study: Joint Crediting Mechanism (JCM) in Indonesia

The JCM is a bilateral agreement between the Japanese Government and a partnering country which provides grants to purchase highly efficiency Japanese products. The resulting CO_2 emission reduction credits will be shared between the two countries. This agreement is beneficial for both parties, as it helps ease the penetration of energy-efficient technologies for the partnering countries, and provides GHG reduction credits to help meet climate targets.

In Indonesia, Alfamidi, a large convenience store chain, installed efficient cooling technologies in its Greater Jakarta Area stores using the JCM scheme. The retrofit of air conditioners helped reduce energy consumption by 50% and increased customer comfort which led to an increase in sales.

Another example is Pakuwon Group, a property developer in Indonesia. They installed five new efficient chillers at their Tunjungan Plaza shopping centre in 2017 using the JCM scheme. The programme led to annual electricity savings of about 3.9 GWh, which greatly benefited the company in terms of operational cost savings.

Source: Sustainable Energy for All (2019).

Bulk and public procurement programmes

Bulk procurement and public procurement programmes can be effective incentive programmes for driving improvements in cooling energy efficiency in emerging economies.

Governments have significant purchasing power as a buyer of cooling appliances. For example, in OECD nations, total government spending accounts for an average of 12% of GDP, and can reach 30% of GDP in emerging economies. This provides governments with an important opportunity to drive energy efficiency improvements for air conditioners and fans and transform the overall market by including energy efficiency requirements above and beyond MEPS in public procurement policies and product lists.

By leveraging this purchasing power, public procurement programmes that include stringent energy efficiency requirements for cooling appliances tied to HEPS can provide manufacturers and suppliers with a strong incentive to deliver energy-efficient and cost-effective air conditioners, fans and cooling services at scale. This can provide manufacturers, suppliers and service providers with a clear signal to deliver more efficient products and services in order to win government contracts. It can also provide them with a baseload of demand for efficient products and services that can spill over to the rest of the market. Government procurement programmes can often include the publishing of approved equipment lists of appliances, leveraging HEPS lists and product labelling and registries. This bulk purchasing power can support improvements to MEPS and labelling in regional product energy efficiency ladders.

Bulk procurement programmes can go beyond procurement for government operations. These programmes can drive the bulk purchase of super-efficient air conditioners and fans through competitive tenders or auctions, in order to create economies of scale and significant cost reductions for consumers across the country. These could be run from within governments, through state-owned corporations, or joint ventures. They can also be paired with pay-as-you-go finance, in a super-ESCO (Energy Services Company) model. India's Energy Efficiency Services Limited (EESL) has successfully delivered bulk procurement programmes covering a number of appliances, including the UJALA lighting programme and the Super-Efficient Air Conditioning Programme.

Bulk procurement programmes can also be an effective way for governments to help to create demand for efficient cooling solutions at an affordable price for consumers. These programmes have been deployed successfully, often paired with low-cost finance or as part of super ESCO programmes.

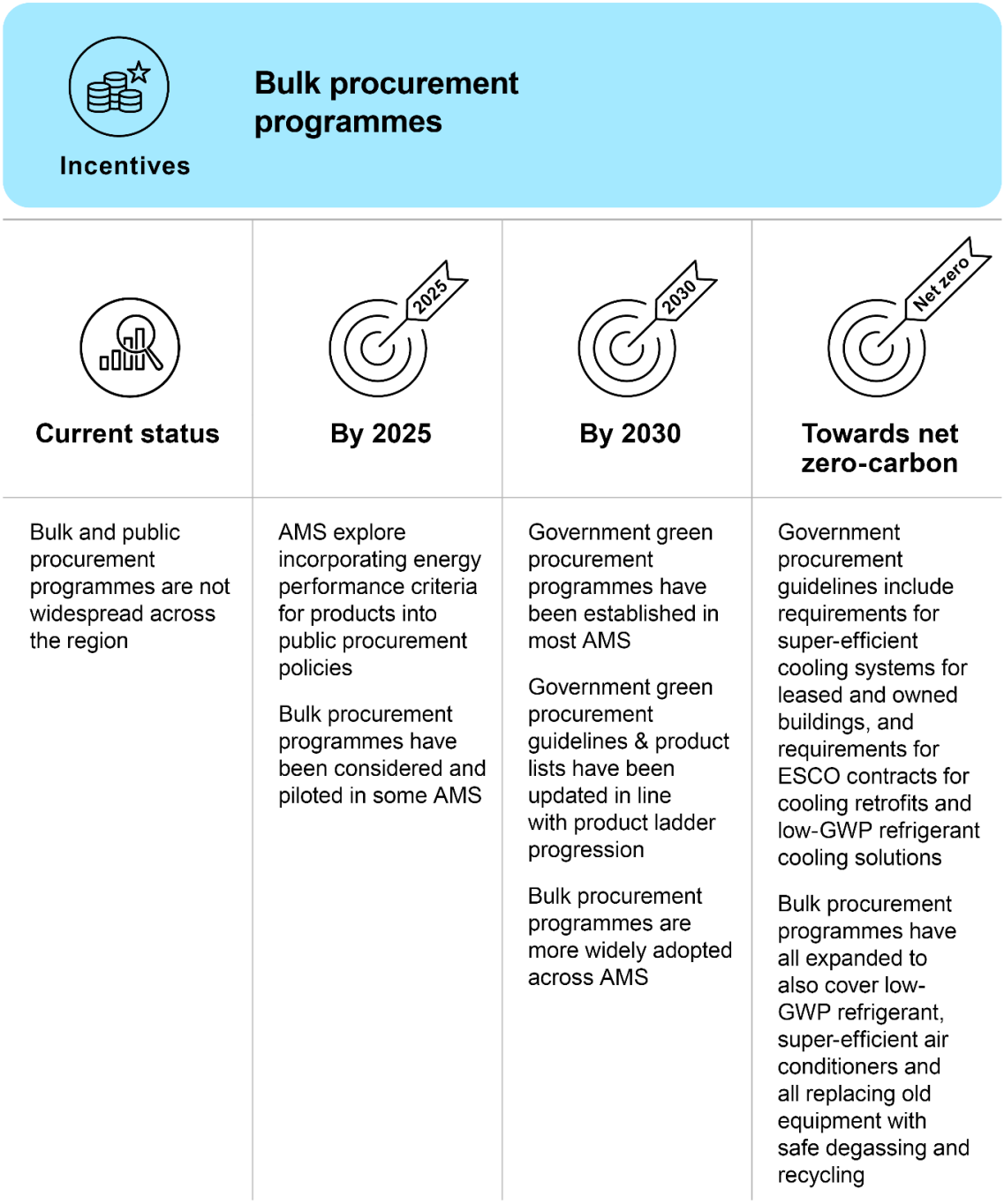
Current status

Bulk and public procurement programmes are not currently widespread in ASEAN. Examples of a public procurement programme include Thailand's Green Public Procurement Promotion Plan, which includes targets, a monitoring system and training for procurement staff. However, compliance with the policy is voluntary. Singapore also has the GreenGov.SG initiative which includes targets for green buildings and the procurement of efficient appliances and air conditioners.

Current status of bulk and public procurement programmes

Country	Bulk procurement	Public procurement
Brunei Darussalam		Mandatory standards for public procurement (2010)
Cambodia		
Indonesia		
Lao PDR		
Malaysia		Green Public Procurement
Myanmar		
Philippines		
Singapore		GreenGov.SG Initiative
Thailand		
Viet Nam		Savings Targets and Use of Equipment Lists for Procurement for Government Agencies

Timelines



Near-term actions to support co-ordination and policy for loan programmes and on-bill finance

- **Incorporate energy performance criteria into existing government procurement lists, guidelines and tender requirements:** Those AMS which already have general public procurement protocols in place could consider including requirements for cooling (and other appliances) purchased via lists or tenders that these appliances are highly energy-efficient models. This helps to

reduce government operating costs while helping to grow economies of scale in each country and across the region, and supporting market transformation.

- **Government procurement programmes can also support the ESCO market through space cooling retrofits to buildings owned and leased:** This helps to support the market for energy-efficient and sustainable cooling services and good building management systems, which has spillover benefits to the broader commercial building sector. Passive cooling and building fabric retrofits, as discussed in the sister-roadmap on Buildings and Construction, could also be integrated to deliver optimal energy efficiency at the "whole of building" level.
- **Consider the development of bulk procurement programmes for efficient fans and air conditioners:** Programmes such as EESL's UJALA lighting programme have proven through its LED-lighting programme the great potential for bulk procurement programmes to successfully deliver low-cost energy efficiency products at scale. A similar approach could be trialled by some of the AMS for fans, and EESL's air conditioner programme could also be replicated. This could be of significant environmental and economic benefit for those AMS with local manufacturing facilities for these products.

Case study: GreenGov.SG – government sustainability and public procurement programme

GreenGov.SG is an initiative aimed at improving the sustainability of the public sector in Singapore, by reducing carbon emissions and improving resource efficiency. GreenGov.SG is part of the Green Plan 2030, a 10-year plan aimed at implementing Singapore's commitments to the UN 2030 Sustainable Agenda.

Launched in July 2021, the GreenGov.SG initiative replaces the Public Sector Taking the Lead in Environmental Sustainability (PSTLES) initiative, introduced in 2006 and the PSTLES 2.0, introduced in 2014. Under PSTLES 2.0, they successfully delivered against a target to reduce electricity consumption in the public sector in FY2020 by at least 15%, compared to a FY2013 baseline.

The Greengov.SG consists of three pillars:

1. New and more ambitious targets: to peak public sector carbon emissions around 2025; to reduce water and energy use in 2030 by 10% from the average 2018-2020 levels, and reduce waste by 30% by 2030 from 2022 levels; and set public sector targets for buildings, IT, transport and solar.
2. Embedding sustainability into the government's core business: purchase and contract more efficient and sustainable equipment and services by introducing new green procurement requirements and evaluating sustainable characteristics in companies when running a tendering process.

3. Engaging the public service to actively contribute to sustainability through knowledge sharing activities and awareness campaigns.

Within the GreenGov.SG initiative green public procurement is a key tool to drive energy efficiency improvements across the public sector, with targets ranging from deploying solar PV on all suitable premises, to making all new vehicle purchases with zero emissions from 2023.

A number of initiatives support improvements to building fabric and HVAC systems, such as energy efficiency targets requiring new and existing buildings (when undergoing a major retrofit) to achieve Green Mark Platinum Super Low Energy standards or equivalent where feasible, and existing public buildings will adopt an ESCO-model for chilled water and HVAC retrofits.

Other green procurement requirements for appliances, such as refrigerators, televisions, air conditioners, lighting and equipment will also drive energy efficiency improvements. Procurement requirements for public sector purchase of air conditioners under the GreenGov.SG initiative place the following requirements on agencies to drive energy efficiency improvements:

- Split-system air conditioner up to 10 kW: Minimum 5-ticks rating.
- Split-system air conditioner above 10 kW: Minimum 3-ticks.
- 3-Phase Variable Refrigerant Flow air conditioners: Minimum 3-ticks.
- All of them with Global Warming Potential ≤ 750.

These green procurement requirements help the government of Singapore to lead by example on efficient cooling within their own operations while helping to grow the demand and supply sides of the market for efficient and sustainable space cooling products and services beyond government operations too. This type of model could be replicated across the AMS.

Sources: Singapore Green Plan (2021), GreenGov.SG: Public Sector Leads The Way Towards A Low-carbon And Sustainable Future.

Case study: Bulk procurement of super-efficient air conditioners in India and Korea

Bulk procurement strategies can help facilitate the entry of higher efficiency products into the market.

India's Super-Efficient Air Conditioning Programme builds on the bulk procurement model developed under the successful large-scale UJALA lighting programme

delivered by Energy Efficiency Services Limited (EESL), a government joint venture company. Under the first phase of the programme commencing in 2019, EESL has aimed to distribute 50 000 super-efficient and climate friendly air conditioners across India by partnering with electricity distribution companies. These super-efficient air conditioners will have the highest 5-star rating, are nearly 44% more efficient than the 3-star models and reduce operating costs by up to 50%. These models also use R32 refrigerant, with a relatively low-GWP. EESL has set up an easy to use online platform (EESL Mart) to enable consumers to order air conditioners on a first come first served basis.

In Korea, products that acquire the highest grade of energy efficiency rating, which are those that operate with low standby power consumption or have smart functionality, can enjoy the privilege of priority purchasing through the government's Public Procurement Service. This can help customers know that they meet the requirements specified in building standards, and can attract tax incentives, loans through the Energy Use Rationalization Fund and testing fee waivers (MOTIE and Korea Energy Agency, 2015).

Both of these types of procurement measures provide policy makers with tools to deliver short term impacts while helping to transform markets towards higher efficiency products.

Sources: EESL (2019), About Energy Efficient ACs; EESL Mart (2019); MOTIE and Korea Energy Agency (2015).

Manufacturing and innovation grants

Manufacturing and innovation grants can support local manufacturers carry out facility and production line upgrades, as well as staff training and improvements required to manufacture quality super-efficient air conditioners and fans cost-effectively and at scale. Grants can also be awarded to manufacturers to produce cooling appliances only over a certain energy performance level (well beyond MEPS levels).

Innovation grants tend to focus more on the research, development and deployment (RD&D) of cooling technologies at earlier technology readiness levels (TRLs). These could help fund pilot or demonstration projects that could involve collaborations between academic and research institutions and governments.

Current status

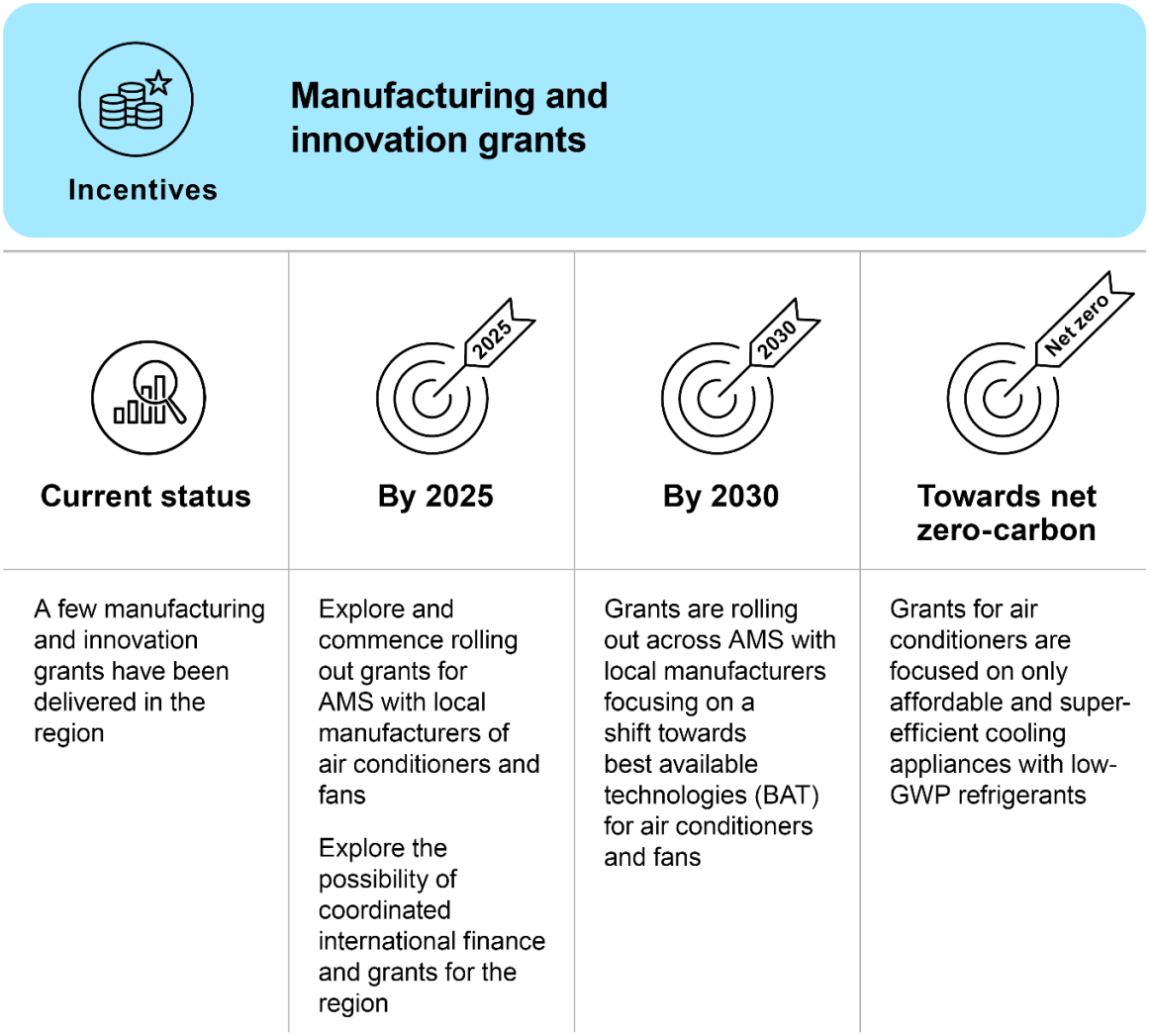
Manufacturing and innovation grant programmes for energy-efficient and sustainable cooling, air conditioners and fans are not currently widespread in ASEAN. However, there are examples of programmes, such as a World Bank

grant project to support 12 air conditioner manufacturers in Thailand in reducing the use of HCFCs and switching to lower GWP refrigerants, and a similar programme in Indonesia.

Current status of manufacturing and innovation grants

Country	Manufacturing grants	Innovation grants
Brunei Darussalam		
Cambodia		
Indonesia	Montreal Protocol Grant	
Lao PDR		
Malaysia	Green Technology Financing Scheme (GTFS)	Malaysia Electricity Supply Industries Trust Account (MESITA)
Myanmar		
Philippines		
Singapore		
Thailand	World Bank Grant Grants to transition to lower GWP refrigerant for manufacturers	
Viet Nam	Mandatory Energy Audit and Management for Major Energy Users	National Technology Innovation Fund (NATIF)

Timelines



Near-term actions to support co-ordination and policies for manufacturing and innovation grants

- **Consider how manufacturing and innovation grants can support local businesses, jobs and energy and climate goals**: Manufacturers are essential in providing energy-efficient and sustainable cooling, and in delivering employment and economic benefits to the region. The AMS with local air conditioner and fan manufacturers could consider how manufacturing and innovation grants can help these businesses prosper while meeting increasingly stringent energy performance standards to support energy and climate goals.
- **Conduct a review of successful manufacturing and innovation grant programmes in the region and internationally**. The AMS can explore how these programmes could be delivered at the national or regional level, leveraging local budgets and international finance.

- **Explore how international finance could support low-GWP refrigerant air conditioning and efficient and sustainable cooling in the region**: international finance will be critical to support climate change goals globally and in the ASEAN region. The AMS, individually or through ASEAN, could explore opportunities to further support the transition to efficient, sustainable and low-carbon cooling in the region by approaching international finance organisations with potential projects.

Market-based mechanisms and energy efficiency obligation programmes

Some market-based mechanisms and energy efficiency obligation programmes (called Energy Efficiency Resource Standards in the USA) can require the design, consultation and implementation of long-term programmes anchored in legislation and regulation. These programmes would generally have a broader focus on delivering energy savings, peak demand and GHG reductions beyond the end-use sector for space cooling appliances. These incentive schemes can be an appealing option for governments by providing a revenue stream for incentive programmes outside of government budgets, where programme budgets instead are linked to utility or other levies. These programmes can also provide long-term funding certainty to drive energy efficiency improvements.

Other market-based mechanisms such as auctions and ESCO models could possibly be established faster and with a more targeted focus on space cooling, if desired.

Current status

Market-based mechanisms and energy efficiency obligation programmes are not currently widespread in ASEAN.

Current status of market-based mechanisms and energy efficiency obligation programmes

Country	Market-based mechanisms	Energy efficiency obligation programmes
Brunei Darussalam		
Cambodia		
Indonesia	CLASP Market efficiency policies	Management of Energy Saving
Lao PDR		
Malaysia	Energy Performance Contracting Fund	

Country	Market-based mechanisms	Energy efficiency obligation programmes
Myanmar		
Philippines	Department Circular 2021-05-0011 Energy Service Companies (ESCO) Accreditation	
Singapore		
Thailand	ESCO revolving funds	
Viet Nam		Mandatory Energy Audit and Management for Major Energy Users

Timelines

Incentives

Market-based mechanisms and energy efficiency obligation programmes

Current status

Market-based mechanisms and energy efficiency obligation programmes are not widespread in the region

By 2025

AMS explore different options for market-based mechanisms and energy efficiency obligation programmes

Several AMS have run auction programmes to support sustainable cooling

Several AMS have taken measures to support ESCO models

By 2030

Several AMS have implemented some form of market-based mechanism or energy efficiency obligation programmes.

Other AMS have opted for alternative large-scale incentive programmes

Towards net zero-carbon

Programmes that support retrofit, replacement, safe disposal, and degassing of old and inefficient air conditioners and fans

Near-term actions to support co-ordination and policy for market based mechanisms and energy efficiency obligation programmes

- **Explore options for suitable market-based mechanisms and energy efficiency obligation programmes for the AMS's local context and needs**: Projects such as the soon to be completed APEC Best Practice Guidelines for Establishing and Enhancing Energy Efficiency Incentive (EEI) Schemes will provide useful and current information for policy makers.
- **Expand support for ESCOs across ASEAN and consider the role that auction programmes could also play:** ESCO models can already be found supported by government policy in some of the AMS. There is an opportunity to expand ESCO and service models across the region. Auctions to procure efficient and sustainable cooling services and upgrades could also support energy-efficient and sustainable cooling (for example for public buildings or public housing).

Case study: Partnering with ESCOs in the Philippines

Complying with the Energy Efficiency & Conservation Act and following the Department Circular No. DC2020-09-0018 on Guidelines, Rules and Procedures in the Administration, Classification, and Certification of Energy Services Companies, the Philippines government is performing energy efficiency projects with the help of ESCOs.

Supported by the Department Circular 2021-05-0011 on Guidelines for the Endorsement of Energy Efficiency Projects to the Board of Investments for Fiscal Incentives, the government spent 537.52 million Pesos for six space cooling energy efficiency projects. These projects resulted in a total annual savings of 17.4 GWh.

Note: 1 USD equals c. 51PHP (5 January 2022).

Source: Habitan, Artemio P. (2021), Opportunities Under the Energy Efficiency and Conservation Act. Energy Utilization Management Bureau of the Department of Energy.

Equity programmes

Equity programmes, to support low-income households in accessing affordable cooling, form a critical component of sustainable cooling policy. Cooling equity programmes can deliver multiple benefits. The main goals of such programmes are often to deliver much needed access to sustainable cooling and thermal comfort, as well as to improve energy affordability and reduce energy bills for low-income households. However, these programmes can deliver a number of other

benefits, including potential reductions in government energy subsidies, energy systems benefits (including energy security and reliability), reduced air pollution and improved health.

Equity programmes can be delivered through a combination of incentive programme design options, including grants and rebates and bulk procurement. These incentive options can all be paired with affordable finance, such as low or no-interest loans to help overcome the upfront cost barriers to energy-efficient cooling options faced by many low-income households. Some equity programmes build appliance replacement into the programme design, to help ensure that energy bill savings and peak demand reductions are achieved. For air conditioners, this can also ensure safe disposal of refrigerant gases, while also promoting product recycling.

Another design consideration for equity programmes is how to set eligibility criteria. They could be set by recipients of low-income energy subsidies or customers on low-income energy tariffs. They could also be embedded in energy utility hardship programmes or other welfare benefits. Tenants of public, social and affordable housing organisations can also be deemed eligible participants. Policy makers and programme designers may also choose to consider allowing community service organisations and charity groups to play a role in assigning eligibility for participation in equity programmes, as they will sometimes have households approach them for support due to financial hardship that may not otherwise meet eligibility requirements. Equity programmes would likely be funded through public budgets or through international finance.

Current status

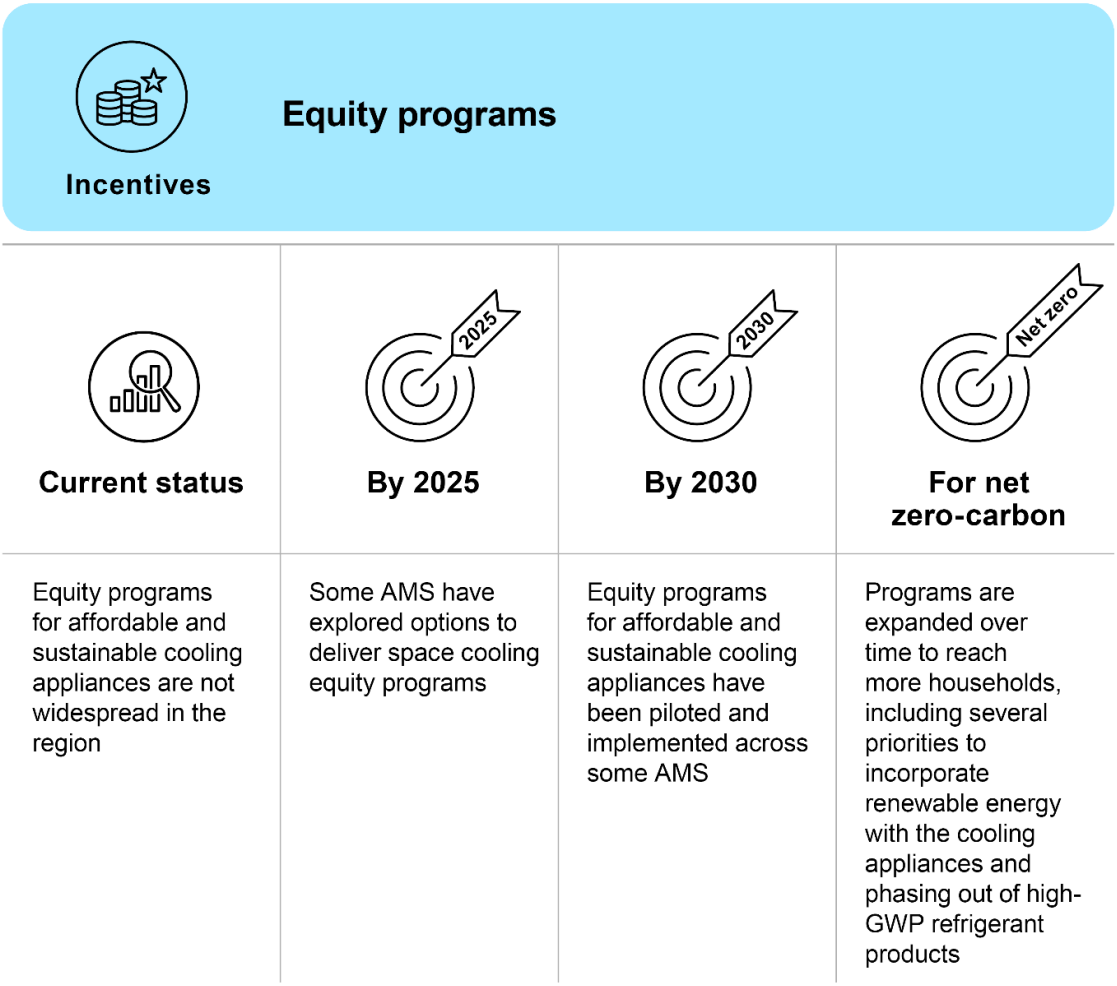
Equity programmes focussed on affordable, energy-efficient and sustainable cooling are not currently widespread in ASEAN.

Current status of equity programmes

Country	Equity programmes
Brunei Darussalam	
Cambodia	
Indonesia	Equity Investment Scheme by PT. Sarana Multi Infrastruktur
Lao PDR	
Malaysia	
Myanmar	

Country	Equity programmes
Philippines	Green Guide for Socialized Housing Projects in the Philippines (Green Guide)
Singapore	
Thailand	ENCON Funds
Viet Nam	

Timelines



Near-term actions to support co-ordination and policy for equity programmes

- **Learn from international best practices and tailor solutions to the local context:** ASEAN as a group or the AMS individually could explore international best practices and successful models that could be adapted by each national government and share this information. International finance and development

funding could potentially support a range of programme design options, which could draw on various mixes of incentives, finance, bulk procurement and super-ESCO models.

- **Explore opportunities to offset the cost of delivering efficient and sustainable cooling by factoring in related reductions in government spending on energy subsidies:** Many governments provide subsidised electricity rates for low-income households. Energy efficiency equity programmes focussed on appliance replacements can provide an opportunity to deliver improved energy services to households, lower their bills, all the while delivering energy system benefits and reducing government expenditures on energy subsidies.

Case study: Appliance replacement programme for low-income households in Mexico

From 2009 to 2018, Mexico ran a low-income household appliance replacement programme following the 2008-09 financial crisis. The programme provided low-income households with rebates and low-interest loans for purchasing new energy-efficient appliances, including refrigerators, air conditioners and lighting. The primary aim of the programme was to reduce household electricity use, an important public policy goal with energy subsidies covering over 95% of households in Mexico. Another programme objective was to reduce GHG emissions from both operational energy use and also by ensuring the appropriate disposal of refrigerant gases from old refrigerators and air conditioners.

The programme helped to replace nearly two million refrigerators and air conditioners, which along with lighting upgrades resulted in estimated savings of almost 700 gigawatt-hours (GWh) annually. Programme eligibility requirements restricted participation to low-income households receiving electricity subsidies, and had requirements that the refrigerators and air conditioners replaced had to be over ten years old.

As well as successfully supporting low-income households in obtaining improved refrigeration, thermal comfort and energy savings, the programme delivered the government energy subsidy savings of $22 million a year through the energy savings due to improved energy efficiency. The payback period for the programme to the government was under four years, and the scheme created more than 1 600 new permanent jobs and 10 500 new temporary jobs.

The energy savings resulting from the programme helped to avoid 3 400 kilotonnes of carbon dioxide equivalent (kt CO_2-eq) per year, while the programme captured, stored or destroyed ozone depleting refrigerant gases, thus avoiding a further 500 kt CO_2-eq of emissions annually.

Source: IEA (2020c), Sustainable Recovery.

Tracking policy progress

To facilitate knowledge sharing and progress, the AMS could report the progress against each of the policy measure areas at annual intervals. Tracking exercises should aim to be streamlined and aligned with other reporting against APAEC Phase II goals and subsequent ASEAN energy efficiency and conservation plans.

Policy, programme and impact evaluation is an important consideration for policymakers when designing any policies and programmes implemented to improve efficient and sustainable space cooling. Building evaluation planning into policy and programme design, and budgets helps to ensure that the right data and indicators of progress against policy outputs, outcomes and objectives can be collected as part of policy and programme delivery. This can support continuous improvement by measuring energy savings and other key indicators to ensure that policies and programmes are effective at delivering the desired improvements.

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Chapter 3. Conclusion and next steps

This roadmap explores the challenges that the ASEAN region is facing over the coming decades as space cooling demand in the region is set to grow at a fast pace. It also offers a range of policy measures available to governments at the national and regional levels to deliver growing cooling needs in an energy-efficient and sustainable manner.

The roadmap report recommends the adoption of an ambitious regional ladder for air conditioners, unifying a long-term trajectory for improvements to minimum energy performance standards (MEPS) and labelling, as the backbone of action, alongside complementary policies and measures to support the adoption, monitoring and enforcement of standards. Further, the report outlines a range of complementary policy measures for each ASEAN Member State (AMS) to consider as part of broader energy-efficient space cooling policy packages.

For countries where fans are expected to be fundamental in meeting mechanical space cooling demand over the coming decades, policy makers may also wish to implement a product ladder approach to drive energy efficiency improvements for fans.

While this roadmap provides analysis and advice on policy options to drive improvements in sustainable and energy-efficient space cooling on the journey from 2025 to 2030 and to net zero-carbon, the next steps must be taken by the AMS with ASEAN co-operation at the regional level to review and act on these recommendations. It is recommended that each AMS takes an integrated approach to transitioning to sustainable cooling that enables identification of synergies for more impactful solutions, effectively achieving national priorities and accelerating progress on international commitments. The transition to energy-efficient and climate-friendly cooling is crucial for the delivery of the commitments under the Paris Climate Agreement, achievement of Sustainable Development Goals and implementation of the Kigali Amendment to the Montreal Protocol simultaneously.

Recognising the challenge of exponential growth in cooling demand, a number of countries in Asia are developing long-term national cooling action plans (NCAPs). These countries include AMS such as Cambodia Indonesia, the Philippines, Thailand and Viet Nam, as well as the neighbouring nations Bangladesh and Sri Lanka.

Developing NCAPs for the AMS based on the recommendations and milestones presented in this roadmap would present an opportunity to synchronise regional action where possible and leverage the benefits of harmonised action.

Annex. A baseline of cooling policies and institutional frameworks

This annex elaborates on a baseline and the current status of space cooling policies in the ASEAN region, and also examines some of the institutional arrangements that support these policies.

An overview of national air conditioner and fan policies and regulations

Energy labelling

Air conditioners

The energy efficiency labelling of air conditioners is a method used to help provide energy performance information to customers and to increase market transparency. With the expectation that some customers will purchase more energy-efficient products, the energy efficiency information will allow customers to compare products in other ways apart from purchase price.

Air conditioner energy efficiency comparative labelling programmes

Country	Regulatory Status	Metric	Comparative Labels
Brunei Darussalam	Mandatory	Weighted COP	
Cambodia	Under development (Mandatory)	CSPF	
Indonesia	Mandatory	CSPF	
Lao PDR	Voluntary	CSPF	
Malaysia	Voluntary	CSPF	
Myanmar	Under discussion	CSPF	
Philippines	Mandatory	CSPF	
Singapore	Mandatory + Voluntary (Endorsement Label)	Weighted EER	

Country	Regulatory Status	Metric	Comparative Labels
Thailand	Voluntary	CSPF	
Viet Nam	Mandatory	CSPF	

Sources:ASEAN Centre for Energy Database; ASEAN SHINE (2015), Promotion of Higher Efficiency Air Conditioners in ASEAN: A Regional Policy Roadmap; Green Development Center Viet Nam, http://en.greendc.vn/energy-label-bid8.html

Country	Cooling Capacity (CC) Covered by Labelling	Star Rating	Star Rating Requirements
Indonesia	CC ≤ 7.9 kW	1 Star	3.1 ≤ CSPF<3.4
		2 Stars	3.4 ≤ CSPF<3.8
		3 Stars	3.8 ≤ CSPF<4.2
		4 Stars	4.2 ≤ CSPF<5
		5 Stars	CSPF≥5.0
Malaysia	CC ≤ 7.1 kW	1 Star	CC<4.5 kW, CSPF<3.1 4.5 kW ≤ CC ≤ 7.1 kW, CSPF<2.9
		2 Stars	CC<4.5 kW, 3.1 ≤ CSPF<3.3 4.5 kW ≤ CC ≤ 7.1 kW, 2.9 ≤ CSPF<3.1
		3 Stars	CC<4.5 kW, 3.3 ≤ CSPF<4.6 4.5 kW ≤ CC ≤ 7.1 kW, 3.1 ≤ CSPF<4.0
		4 Stars	CC<4.5 kW, 4.6 ≤ CSPF<5.3 4.5 kW ≤ CC ≤ 7.1 kW, 4.0 ≤ CSPF<5.1
		5 Stars	CC<4.5 kW, CSPF ≥ 5.3 4.5 kW ≤ CC ≤ 7.1 kW, CSPF ≥ 5.1
Philippines	CC ≤ 14.0 kW (planned for labelling)	1 Star	CC<3.33 kW, 3.08 ≤ CSPF<3.31 3.3 kW ≤ CC ≤ 9.99 kW, 2.81 ≤ CSPF<3.11 10.0 kW ≤ CC≤14.0 kW, CSPF ≤ 3.11
		2 Stars	CC<3.33 kW, 3.32 ≤ CSPF<3.55 3.3 kW ≤ CC≤9.99 kW, 3.12 ≤ CSPF<3.42 10.0 kW ≤ CC≤14.0 kW, 3.12 ≤ CSPF<3.42
		3 Stars	CC<3.33 kW, 3.56 ≤ CSPF<3.79 3.3 kW ≤ CC ≤ 9.99 kW, 3.43 ≤ CSPF<3.73 10.0 kW ≤ CC ≤ 14.0 kW, 3.43 ≤ CSPF<3.73
		4 Stars	CC<3.33 kW, 3.80 ≤ CSPF<4.00 3.3 kW ≤ CC ≤ 9.99 kW, 3.74 ≤ CSPF<4.00 10.0 kW ≤ CC ≤ 14.0 kW, 3.74 ≤ CSPF<4.00
		5 Stars	CC<3.33 kW, CSPF ≥ 4.01 3.3 kW ≤ CC≤9.99 kW, CSPF ≥ 4.01 10.0 kW ≤ CC ≤ 14.0 kW, CSPF ≥ 4.01
Singapore	CC ≤ 8.8 kW (casement and window)	1 tick	Casement and window: 2.90 ≤ $COP_{100\%}$<3.78
		2 ticks	Casement and window: 3.78 ≤ $COP_{100\%}$<4.29

Country	Cooling Capacity (CC) Covered by Labelling	Star Rating	Star Rating Requirements
			Single-split (non-inverter): $3.78 \leq COP_{100\%} \leq 4.29$ Multi-split (non-inverter): $3.78 \leq COP_{100\%} \leq 4.29$ Single-split (inverter): Weighted $COP \geq 3.78$ and $COP_{100\%} \geq 3.34$ Multi-split (inverter): Weighted $COP \geq 3.78$ and $COP_{100\%} \geq 3.34$
		3 ticks	Casement and window: $4.29 \leq COP_{100\%} < 4.86$ Single-split (non-inverter): $4.29 \leq COP_{100\%} \leq 4.86$ Multi-split (non-inverter): $4.29 \leq COP_{100\%} \leq 4.86$ Single-split (inverter): Weighted $COP \geq 4.29$ and $COP_{100\%} \geq 3.78$ Multi-split (inverter): Weighted $COP \geq 4.29$ and $COP_{100\%} \geq 3.78$
		4 ticks	Casement and window: $COP_{100\%} \geq 4.86$ Single-split (non-inverter): $COP_{100\%} \geq 4.86$ Multi-split (non-inverter): $COP_{100\%} \geq 4.86$ Single-split (inverter): Weighted $COP \geq 4.86$ and $COP_{100\%} \geq 4.29$ Multi-split (inverter): Weighted $COP \geq 4.86$ and $COP_{100\%} \geq 4.29$
		5 ticks	Casement and window: $COP_{100\%} \geq 5.50$ and standby power ≤ 4 Single-split (non-inverter): $COP_{100\%} \geq 5.50$ and standby power ≤ 4 Multi-split (non-inverter): $COP_{100\%} \geq 5.50$ and standby power ≤ 9 x N Single-split (inverter): Weighted $COP \geq 5.50$, $COP_{100\%} \geq 4.86$ and standby power ≤ 4 Multi-split (inverter): Weighted $COP \geq 5.50$, $COP_{100\%} \geq 4.86$ and standby power ≤ 9 x N
Thailand	CC ≤ 12.0 kW	No.5	CC ≤ 8 kW: Fixed Speed: 3.766 ≤ CSPF<4.056 Inverter: 4.396 ≤ CSPF<5.126 8 kW < CC ≤ 12 kW: Fixed Speed: 3.634 ≤ CSPF<3.924 Inverter: 4.103 ≤ CSPF<4.833
		No.5 – One Star	CC ≤ 8 kW: Fixed Speed: 4.059 ≤ CSPF<4.349

Country	Cooling Capacity (CC) Covered by Labelling	Star Rating	Star Rating Requirements
			Inverter: 5.129 ≤ CSPF<5.858 8 kW < CC ≤ 12 kW: Fixed Speed: 3.927 ≤ CSPF<4.217 Inverter: 4.836 ≤ CSPF<5.565
		No.5 – Two Stars	CC ≤ 8 kW: Fixed Speed: 4.352 ≤ CSPF<4.642 Inverter: 5.861≤ CSPF<6.591 8 kW < CC ≤ 12 kW: Fixed Speed: 4.220 ≤ CSPF<4.510 Inverter: 5.568 ≤ CSPF<6.298
		No.5 – Three Stars	CC ≤ 8 kW: Fixed Speed: CSPF ≥ 4.645 Inverter: CSPF ≥ 6.594 8 kW < CC ≤ 12 kW: Fixed Speed: CSPF ≥ 4.514 Inverter: CSPF ≥ 6.301

Note: Conversion from EGAT's energy labelling requirements in Seasonal Energy Efficiency Ratio (SEER) as specified in http://labelno5.egat.co.th/new58/wp-content/uploads/2019/shortforweb/air.pdf, CSPF = SEER/3.412.
Sources: Presentation on Standards and Labelling by MEMR, Policy Working Group Meeting, July 2020; National Environment Agency (NEA), Singapore, 2021;

Fans

The labelling system applied in Malaysia, Viet Nam and Thailand provides information regarding the energy performance of each product, where 5-star has the highest energy efficiency and 1-star has the lowest. Both Viet Nam and Malaysia have a mandatory labelling system, whereas Thailand's is still voluntary.

Each country uses different metrics for the labels. For example, Malaysia uses the coefficient of performance (COP), Thailand uses the performance rating (PR), while Viet Nam uses the EER comparison (R). In Malaysia and Thailand, the units used are m^3/min/W whereas in Viet Nam it is a unit-less value due to the R value being a ratio of measured EER with the minimum EER.

Fan energy efficiency labelling programmes

Country	Pedestal	Wall	Table/ Floor	Ceiling	Vented
Indonesia		blade sweep ≤ 305 mm 1-star = 0.60 ≤ Service Value ≤ 0.72 2-star = 0.72 ≤ Service Value ≤ 0.84 3-star = 0.84 ≤ Service Value ≤ 0.96 4-star = 0.96≤ Service Value ≤ 1.08 5-star = Service Value ≥ 1.08 blade sweep ≥ 305 mm 1-star = 1.00 ≤ Service Value ≤ 1.2 2-star = 1.20 ≤ Service Value ≤ 1.40 3-star = 1.40 ≤ Service Value ≤ 1.60 4-star = 1.60 ≤ Service Value ≤ 1.80 5-star = Service Value ≥ 1.80			
Malaysia		1-star = 2.50 ≤ COP ≤ 2.57 2-star = 2.58 ≤ COP ≤ 2.65 3-star = 2.66 ≤ COP ≤ 2.73 4-star = 2.74 ≤ COP ≤ 2.79 5-star = 3.00 ≤ COP	1-star = 0.93 ≤ COP ≤ 1.00 2-star = 1.01 ≤ COP ≤ 1.07 3-star = 1.08 ≤ COP ≤ 1.11 4-star = 1.12 ≤ COP ≤ 1.19 5-star = 1.20 ≤ COP		
Thailand			300 mm blade sweep 1-star = PR ≤ 0.75 2-star = 0.76 ≤ PR ≤ 0.92 3-star = 0.93 ≤ PR ≤ 1.00 4-star = 1.01 ≤ PR ≤ 1.09 5-star = 1.10 ≤ PR		300 mm blade sweep 1-star = - 2-star = - 3-star = 0.38 ≤ PR ≤ 0.39 4-star = 0.4 ≤ PR ≤ 0.41 5-star = 0.42 ≤ PR

Country	Pedestal	Wall	Table/ Floor	Ceiling	Vented
Viet Nam		1-star = 1.00 ≤ R ≤ 1.15 2-star = 1.15 ≤ R ≤ 1.30 3-star = 1.30 ≤ R ≤ 1.45 4-star = 1.45 ≤ R ≤ 1.60 5-star = 1.6 ≤ R			

Note: The requirements for Thailand given in the table are just an example of one fan diameter size.
Sources: Attorney General's Chambers Malaysia (2013), Electricity Regulations (Amendments) 2013
Department for Standards, Metrology, and Quality Viet Nam (2015), National Standard TCVN 7825:2015;
Thailand Environment Institute (2011), Thai Green Label (Electric Fan).

Appliance testing standards

Appliance testing standards

For air conditioners, all of the AMS have either adopted or are in the process of adopting ISO 5151:2010 for test procedures and ISO 16358 for evaluation standards following the harmonisation plan mentioned in the ASEAN SHINE Regional Policy Roadmap 2015.

For fans, the national testing standards of Indonesia, Malaysia and Viet Nam are well aligned with the international standard IEC 60879.

Testing and evaluation standards

Country	AC Test Standard	AC Evaluation Standards	Fan Test Standards
Brunei Darussalam			
Cambodia	ISO 5151:2010	ISO 16358-1:2013	
Indonesia	SNI 8560-1:2018 ISO 16358-1:2013	SNI 8560-1:2018 ISO 16358-1:2013	SNI IEC 60879:2013
Lao PDR	ISO 5151:2010	ISO 16358-1:2013	
Malaysia	MS ISO 5151:2012	ISO 16358-1:2013	MS 1220:2010 MS 2574:2014
Myanmar	Planning to adopt ISO 5151:2017 by 2022	Planning to adopt ISO 16358-1:2013 by 2022	
Philippines	PNS ISO 5151:2014	PNS ISO 16358-1:2014	
Singapore	ISO 5151:2010		
Thailand	TIS 2710-2558	TIS 2714-2558	TISI 92-2536 TISI 127-2536
Viet Nam	TCVN 6576: 2013	TCVN 10273: 2013	TCVN 7827: 2007

Sources: ASEAN Centre for Energy Database;
Department of Standards Malaysia (2014), Minimum Energy Performance Standards (MEPS) for Domestic Fan;
Department for Standards, Metrology, and Quality Viet Nam (2015), National Standard TCVN 7825:2015;
Thailand Environment Institute (2011) Thai Green Label (Electric Fan).

Harmonisation and mutual recognition

During the 37th ASEAN Ministers on Energy Meeting (37th AMEM), held in Bangkok, Thailand in 2019, a guideline to integrate the energy efficiency of air conditioners into the ASEAN Sectoral Mutual Recognition Arrangement for Electrical and Electronic Equipment Framework (ASEAN EEE MRA) was published. This integration aims to help reduce barriers of trade among the AMS and to increase energy efficiency efforts in the region, by adding energy efficiency requirements to the existing safety requirements mentioned in the ASEAN EEE MRA.

Testing laboratory capacity

There are currently ten air conditioner testing facilities in the region, consisting of four national facilities and six commercial facilities. All testing facilities are accredited with ISO/IEC 17025.

Air conditioner testing facilities

Country	National	Commercial	Type
Indonesia	2	2	Air-enthalpy
Malaysia	1		Balanced type calorimeter
Philippines		1	Air-enthalpy
Thailand	1	4	Air-enthalpy, balance & calibrated room type calorimeter
Viet Nam	1		Calibrated room type calorimeter

Source: ASEAN SHINE (2015), Promotion of Higher Efficiency Air Conditioners in ASEAN: A Regional Policy Roadmap

Monitoring and compliance

Currently, seven AMS enforce a verification system to help monitor and verify the MEPS of air conditioners. This process is crucial to ensure that the energy efficiency policies are being enforced on the ground to help increase the energy efficiency of air conditioners in the region.

MV&E Programmes

Country	MV&E Programmes for air conditioner	MV&E Programmes for fans
Brunei Darussalam		
Cambodia		
Indonesia	Registration and periodic market surveillance	Registration and periodic market surveillance

Country	MV&E Programmes for air conditioner	MV&E Programmes for fans
Lao PDR		
Malaysia	Periodic market surveillance	
Myanmar	5-year periodic market surveillance	
Philippines	Periodic market surveillance	
Singapore	Registration and Periodic market surveillance	
Thailand	Yearly market surveillance and verification	
Viet Nam	Yearly market surveillance and verification	

Source: ASEAN SHINE (2015), Promotion of Higher Efficiency Air Conditioners in ASEAN: A Regional Policy Roadmap; Indonesia, Ministry of Energy and Mineral Resources (2021), Minimum Energy Performance Standards and Energy Efficiency Labels for Air Conditioners, Decision of the Minister of Energy and Mineral Resources No.103.K/EK.07/DJE/2021.

ASEAN SHINE recommendations

Currently, the only available regional policy roadmap pertaining to air conditioners is the ASEAN SHINE Promotion of Higher Efficiency Air Conditioners in ASEAN: A Regional Policy Roadmap 2015 (ASEAN SHINE, 2015). It has the following recommendations for the AMS:

1. Harmonising Energy Performance Standards

    a. Harmonisation of Test Methods to ISO 5151:2010

    b. Harmonisation of Metrics to ISO 16358-1 which uses Cooling Seasonal Performance Factor (CSPF) for testing reports.

    c. Harmonisation of MEPS is applicable for both fixed speed and inverter units, with an EER of ≥ 2.9 W/W or ≥ 3.08 W/W CSPF by 2020.

2. Improving Testing Infrastructure

    a. Building capacity of existing testing laboratories, enhance capability and reduce difference in laboratory testing conditions. Provide the same standard of testing, provide training to increase the accuracy and reliability of tests and perform round robin testing with other existing testing laboratories.

    b. Establish mutual recognition agreements (MRA) to provide access for regional infrastructure and resources

3. Establishing a Regional Monitoring, Verification, and Enforcement (MV&E) Strategy

a. Co-ordinated Approach to Verification Testing. Provide testing on a regional level, to reduce the cost in testing the same air conditioner models at the national level

b. Establishment of a regional network. Co-ordination of market surveillance authorities in ASEAN to help increase information and compliance of products being sold in the region.

c. Industry Engagement.

d. Reporting to increase visibility and transparency of MV&E regimes.

e. Development of regional product database.

f. Increase access to competent laboratories.

4. Incentive Policies (consumer rebates, tax credits, loan financing and equipment replacement)

Mutual recognition agreements in ASEAN

In 2019, The ASEAN Centre for Energy (ACE) published Guidelines for Integration of Energy Efficiency into the ASEAN Sectoral Mutual Recognition Arrangement for Electrical and Electronic Equipment Framework (ASEAN EEE MRA), endorsed during the 37th ASEAN Ministers on Energy Meeting (AMEM). As current agreements such as the ASEAN EEEMRA and the ASEAN Harmonized Electrical and Electronic Equipment Regulatory Regime (AHEEERR) focus mainly on the safety, electromagnetic compatibility (EMC) and environment issues of appliances, the incorporation of energy efficiency testing and results is expected to commence in the coming years.

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Abbreviations and acronyms

AADCP II	ASEAN-Australia Development Cooperation Program Phase II
ACE	ASEAN Centre for Energy
AMS	ASEAN Member State[s]
APAEC	ASEAN Plan of Action for Energy Cooperation
ASEAN	Association of Southeast Asian Nations
ASEC	ASEAN Secretariat
BAT	best available technology
BEV	battery electric vehicle
CaaS	cooling as a service
CCUS	carbon capture, utilisation and storage
CDD	cooling degree days
CO	carbon monoxide
COP	coefficient of performance
COP26	2021 United Nations Climate Change Conference
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CSPF	cooling season performance factor
E4	Energy Efficiency in Emerging Economies Programme
EE&C-SSN	Energy Efficiency and Conservation Sub-Sector Network
EEFD	Energy Efficiency Division of the International Energy Agency
EER	energy efficiency ratio or rating
EMS	Directorate of Energy Markets and Security of the International Energy Agency
EPC	Energy Performance Contracting
ESCO	energy services company
GHG	greenhouse gas
GWP	global warming potential
HCFC	hydrochlorofluorocarbons
HEPS	high energy performance standards
HFC	hydrofluorocarbon
HVAC	heating, ventilation and air conditioning
IEA	International Energy Agency
IEC	International Electrotechnical Commission
ISEER	Indian Seasonal Energy Efficiency Ratio
ISO	International Organization for Standardization
JAIF	Japan-ASEAN Integration Fund
JMC	Joint Crediting Mechanism
K-CEP	Kigali Cooling Efficiency Program
LBNL	Lawrence Berkley National Labs
MEPS	minimum energy performance standards
MRA	mutual recognition agreements
MV&E	monitoring, verification and enforcement
NCAP[s]	national cooling action plans
NDC[s]	nationally determined contributions

NOx	nitrogen oxides
ODP	ozone depleting potential
OECD	Organisation for Economic Co-operation and Development
PM2.5	fine particulate matter
PV	photovoltaic
QR	quick response code
RAC	room air conditioning
RD&D	research, development and deployment
SDG	sustainable development goal
SE4ALL	Sustainable Energy for All
SEAD	Super-efficient Equipment and Appliance Deployment (SEAD) Initiative
SEER	seasonal energy efficiency ratio
SO_2	sulphur dioxide
TCP	Technology Collaboration Programme
TRLs	technology readiness levels
U4E	United Nations Environment Programme, United for Efficiency programme
UNEP	United Nations Environment Programme
UNESCAP	United Nations Economic and Social Commission for Asia and the Pacific
UHI	urban heat island
VAT	value-added tax
WEO	World Energy Outlook
WEER	Weighted Energy Efficiency Ratio

Units of measure

Btu/h	British thermal unit per hour
CC	cooling capacity
GW	gigawatt
GWh	gigawatt hour
Kt CO_2-eq	total greenhouse gas emissions of carbon dioxide equivalent
MWh	megawatt hour
TWh	terawatt hour
W	watt
Wh/Wh	watt-hour of cooling output per watt-hour of electricity input

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