



# Accelerating the Global Adoption of ENERGY-EFFICIENT AND CLIMATE-FRIENDLY AIR CONDITIONERS

UN Environment - Global Environment Facility | United for Efficiency (U4E)



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# FOREWORD

In 2015, room air conditioners accounted for approximately 20 per cent of the residential electricity demand in 150 developing and emerging countries. In those countries, the number of room air conditioners in use is expected to increase to 1,5 billion in the next 15 years. Air conditioning makes up a significant portion of household energy demand in particular in regions with hot climates where periods of high use correlate with peak demand.

Over 40 countries around the world have already implemented regulations for air conditioners. By expanding similar regulations to more countries, the market transformation to climate-friendly and energy-efficient room air conditioners can result in significant energy savings.

Because of this potential, the United Nations Secretary-General's Sustainable Energy for All (SEforALL) initiative identified energy-efficient appliances as a "high-impact opportunity." They have the potential to reduce countries' greenhouse gas (GHG) emissions, generate significant economic benefits, enhance energy security, and improve people's well-being.

Building on the success of the en.lighten initiative, the UN Environment, the Global Environment Facility (GEF), United Nations Development Programme (UNDP), CLASP, the International Copper Association and the Natural Resources Defense Council launched the United for Efficiency (U4E) initiative in 2015. The initiative supports countries in their transition to energy-efficient lighting, appliances and equipment. Manufacturing partners lending their support to the initiative include ABB, Arçelik, BSH Hausgeräte GmbH, Electrolux, MABE, Osram, Philips Lighting, and Whirlpool Corporation. Among others, the U4E initiative cooperates with the GIZ Green Cooling Initiative to ensure best practices in the cooling sector are considered.

The guide is part of a series of United for Efficiency reports on five product groups. The other reports in the series cover lighting, refrigerators, electric motors, and distribution transformers. An additional overarching report, "Policy Fundamentals Guide", provides cross-cutting, general guidance critical to the establishment of a successful energy efficiency programme.

This guide focuses on room air conditioners and is intended to provide policy makers with information and best-practice case studies on how to promote energy-efficient and climate-friendly room air conditioners in their respective national markets.

The guide is structured around the "U4E Integrated policy approach". It is a proven, comprehensive



policy-driven approach to transform markets, lower energy-bills, improve environmental quality and reduce greenhouse gas emissions.

This guide was developed in a holistic process with participation of over 20 organisations.

This expert group included international organisations, environmental groups, international manufacturers, government officials, and academic institutions. Our

experience is that the sort of credible guidance resulting from a balanced expert group is effective in reducing uncertainty, and measurably helps countries adopt energy policies that make economic sense and help reduce GHG emissions.

It is our hope that decision makers will use the information in this report to select the right policies for the coming decades.

**This guide was developed in a holistic process with participation from over 20 organisations.**



**THIS REPORT FOCUSES ON ENERGY-EFFICIENT AND CLIMATE-FRIENDLY AIR CONDITIONERS**



**OTHER GUIDES IN THIS SERIES INCLUDE:**



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# EXECUTIVE SUMMARY

Air conditioning can improve health, productivity and quality of life for people living in warm climates. Air-conditioning equipment, however, consumes resources during manufacturing, operation and disposal. As our economies grow and populations expand, the global demand for air conditioning will increase.

In 2015 air conditioners installed in 150 developing countries were responsible for 640 million tonnes of carbon dioxide equivalent (CO<sub>2</sub>e) emissions<sup>1</sup>, or approximately 2 per cent<sup>2</sup> of the global energy-related CO<sub>2</sub> emissions in 2014.

The global air conditioner stock is expected to increase from 660 million units in 2015 to more than 1.5 billion units by 2030, significantly increasing CO<sub>2</sub> emissions from this sector<sup>3</sup>. Additionally, the peak power demand from air conditioners can threaten the stability of electrical grids.

Beyond energy impacts, special consideration needs to be given to the environmental and safety impacts of the refrigerants, which are used to cool the air in the refrigeration cycle. The potential release of refrigerants during manufacturing, servicing, operation, and disposal at the end of their useful life have a significant impact on both the environment and climate.

Putting in place policies that curb the energy and environmental impacts from air conditioning will transform the market and improve lives. When seeking to transform their respective markets towards higher energy efficiency, this guide encourages countries to follow a five-step U4E Integrated policy approach<sup>4</sup>:

- **Standards and Regulations** – cover a collection of related requirements defining which products can be sold and those that should be blocked from the market. Standards and regulations form the foundation for ensuring the success of any efficient air conditioning market transition strategy.
- **Supporting Policies** – are necessary to ensure the smooth implementation of standards and regulations and to achieve a broad public acceptance. Supporting policies include labelling

schemes and other market-based instruments, often initiated and promoted by regulatory incentives; and information and communication campaigns that inform end users in order to change or modify their behaviour.

- **Finance and Financial Delivery Mechanisms** – address high first-cost challenges with efficient air conditioners. These can include fiscal instruments and incentives that impact prices, such as tax breaks, as well as financing structures that overcome initial costs such as energy service companies, revolving funds and electric utility on-bill financing schemes.
- **Monitoring, Verification and Enforcement (MVE)** – successful market transition depends on effective monitoring (i.e. measurement and reporting of product efficiency), verification (i.e. verification of declarations of conformance); and enforcement (i.e. actions taken against noncompliant suppliers) of the regulations. Enhancing the capacity of various countries and the sharing of information and skills between countries and across regions provides an effective means to promote best practice quickly and thoroughly.

- **Environmentally Sound Management** – treatment requirements related to air conditioners and their refrigerant gases should be established in line with global best practice in order to minimise any environmental and health impact. Special attention should be given to the development of a framework for environmentally sound, end-of-life disassembly, disposal or recycling for air conditioners no longer in use.

The guide offers an overview of all the key elements for transforming a national market towards more energy-efficient and climate-friendly air conditioners through the application of the U4E Integrated policy approach. It is intended to be used together with the U4E Fundamental Policy Guide and country assessments to create robust and cost-effective policies.

The guidance provided is meant to be flexible, rather than prescriptive. Each country should consider, and make decisions on the basis of its specific priorities and circumstances. For more information on the approach see Chapter 8 for a brief overview or the U4E Fundamental Policy Guide for complete description.

All relevant stakeholders should be involved to jointly determine priorities and the pathways to

achieve objectives. The process should be led by governments or regional institutions with methodological support, guidance and technical advice provided by the U4E (and/or other) experts.

This guide covers the major impacts of air conditioners related to:

- **Energy Consumption**—to reduce the costs, peak load impact and indirect carbon impact (the carbon emissions caused by fossil fuel based power plants) through reduced energy consumption by setting high standards for energy efficiency that are suitably competitive and easily

comparable with those already established in other economies.

- **Leakage of Refrigerants and their ozone depletion potential (ODP) and global warming potential (GWP)**—covering their selection from the various alternatives considering safety, improved service, maintenance, and end-of-life management.

Energy-efficient air conditioners offer governments one of the most cost-effective ways to advance technology, reducing peak load, lowering customer bills and supporting the phase-out of harmful and non-climate-friendly refrigerants.

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**The process should be led by governments or regional institutions with methodological support, guidance and technical advice provided by the U4E (and/or other) experts.**



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## ACRONYMS AND ABBREVIATIONS

APF .....	Annual Performance Factor	kW .....	Kilowatt
ASEAN SHINE .....	Association of South East Asian Nations – Standards Harmonization Initiative for Energy Efficiency	MEPS .....	Minimum Energy Performance Standards
ASHRAE .....	American Society of Heating, Refrigerating and Air-Conditioning Engineers	MLF .....	Multilateral Fund for the Implementation of the Montreal Protocol
BEE .....	Bureau of Energy Efficiency, India	Mt .....	Megatonnes (10 <sup>6</sup> tonnes)
CDM .....	Clean Development Mechanism	MRA .....	Mutual Recognition Agreement
CEM .....	Clean Energy Ministerial	MVE .....	Monitoring, verification and enforcement
CO <sub>2</sub> .....	Carbon dioxide	MW .....	Megawatt
CSPF .....	Cooling Seasonal Performance Factor	NAMA .....	Nationally Appropriate Mitigation Actions
DSM .....	Demand Side Management	NGO .....	Non-governmental organisation
ECREEE .....	ECOWAS Centre for Renewable Energy and Energy Efficiency	O&M .....	Operation and Maintenance
EER .....	Energy Efficiency Ratio	OECD .....	Organisation for Economic Co-operation and Development
EPR .....	Extended producer responsibility	PAS .....	Publicly Available Specifications
ESCO .....	Energy service company	PFI .....	Private Finance Initiative
FAQ .....	Frequently Asked Questions	PPP .....	Public Private Partnership
GEF .....	Global Environment Facility	QR .....	Quick Response (QR code)
GWP .....	Global warming potential	SEAD .....	Super-efficient Equipment and Appliance Deployment
HCFC .....	Hydrochlorofluorocarbons	SEforAll .....	Sustainable Energy for All initiative
HFC .....	Hydrofluorocarbon	SEER .....	Seasonal Energy Efficiency Ratio
HFO .....	Hydrofluoroolefins	TWh .....	Terawatt-hour
IEA .....	International Energy Agency	U4E .....	United for Efficiency
IEC .....	International Electrotechnical Commission	UNDP .....	United Nations Development Programme
INDC .....	Intended Nationally Determined Contributions	UNEP .....	UN Environment
ISEER .....	Indian Seasonal Energy Efficiency Ratio	\$ .....	United States Dollars
ISO .....	International Standardisation Organization		



# 1. INTRODUCTION

The demand for air conditioners is increasing rapidly across the world, especially in regions with hot climates. The sales and ownership of air conditioners is growing significantly in emerging economies such as Brazil, India, Indonesia, and Mexico as the standard of living improves.

Air conditioners are a major source of household energy consumption and peak power demand, especially on hot summer days. They are a key driver of growing GHG emissions. This is because air conditioner refrigerants have a significant climate impact, and their electricity consumption increases GHG emissions from fossil fuel power.

Meeting the growing electricity demand from air conditioners is a challenge to policymakers. However, it also presents a unique opportunity for energy savings and GHG reductions through well designed regulations. Policymakers around the world are exploring ways to transform their markets to find cost-effective, energy-saving measures to respond to consumer demand.

This guide, focused on the transition to energy-efficient and climate-friendly air conditioners, supports the policymaking process. It was designed through a holistic process with participation of an expert taskforce on air conditioners, formed by over 20 organisations, including international organisations, environmental groups, international manufacturers, government officials, and academic institutions.

The guidance provided in this document is meant to be flexible, rather than prescriptive. It addresses the energy use of air conditioners together with refrigerants. They both have a significant impact on the climate. In addition, the choice of refrigerants can impact the appliance's power consumption.

The scope of this document encompasses household air conditioners, including window air conditioners, non-inverter split air conditioners, inverter split air conditioners, multi-split air conditioners and portable air conditioners.

Countries have specific local contexts that should be kept in mind. Each country is encouraged to analyse its own market, consider the guidance in this document, and then make policy decisions that are based on its specific priorities and circumstances.

## 1.1 WHY LEAPFROG TO ENERGY-EFFICIENT, CLIMATE-FRIENDLY AIR CONDITIONERS?

Air conditioners are typically a priority product for energy efficiency regulations. Over 40 countries have implemented standards and labelling regulations for air conditioners. Higher energy savings can be captured by expanding similar regulations to more countries and by improving the stringency of existing regulations in tandem with on-going improvements in air conditioner technology.

The primary environmental and climate impacts of air conditioners are:

- **CO<sub>2</sub> emissions from air conditioner energy consumption**

According to the U4E country assessments<sup>5</sup>, currently installed residential air conditioners in 150 developing countries were responsible for 640 MtCO<sub>2</sub>e emissions<sup>6</sup> in 2015<sup>7</sup>, which is equivalent to 2 per cent of global energy-related emissions in 2015, or 1 million flights from Nairobi to New York.<sup>8</sup> In 2015, the energy consumption due to air conditioners used in these 150 countries was higher than 880 TWh, equivalent to the electricity consumption of India in 2014.<sup>9</sup> Additionally, the peak power demand from air conditioners can threaten the stability of electrical grids.

Air conditioning accounts for around 30 per cent of current and forecasted summer load in warm climates (for example in California, US); and from 40 - 60 per cent of the total load in hot climates on summer days in metropolitan areas (such as Delhi, India).<sup>10</sup>

More power plants are needed to meet this growing peak power demand, resulting in increased CO<sub>2</sub> emissions. Plants must also be able to ramp up and down rapidly to meet the peak power demand. This may result in less efficient power generation and increase CO<sub>2</sub> and other types of pollution.

- **Release of refrigerants from air conditioners**

The potential release of refrigerants from air conditioners during production, installation, servicing, operation and at the end of their useful life also has a significant impact on the environment and climate. In much of the developing world, hydrochlorofluorocarbons (HCFCs) are still used as refrigerants and contribute to climate change and ozone depletion, although their use will be banned worldwide after 2030.<sup>11</sup>

As an alternative to HCFCs, hydrofluorocarbons (HFCs) are widely used in developed and in developing countries. While safe for the ozone layer, HFCs have high GWP and are among the fastest-growing GHGs, with emissions increasing by 10 - 15 per cent per year.<sup>12</sup>

To curb the growth of HFC emissions, parties to the Montreal Protocol agreed during the 28th Meeting of the Parties (MOP) in Kigali in October 2016 to globally phase down HFCs under the Kigali Amendment. This agreement comprises different baselines, freeze dates and HFC phase-down schedules for different country groups. The Kigali Amendment will enter into force at the beginning of 2019.<sup>13</sup>

Air conditioner technology has been evolving rapidly in the past decade toward higher efficiency. The most efficient air conditioners are over 50 per cent more efficient than average products on the global market.<sup>14</sup>

Climate-friendly refrigerants<sup>15</sup> with low GWP are also available in the market.<sup>16</sup> A transition to energy-efficient, climate-friendly air conditioners would significantly reduce the growth of global energy and peak power demand and avoid the leakage of high-GWP refrigerants. This would lead to reductions in

GHG emissions and other pollutants, and other economic, environmental and social benefits.

The benefits of transitioning to high efficiency air conditioners and low-GWP refrigerants are well documented in the U4E country assessment developed for 150 developing countries and emerging economies. The following are examples of them:

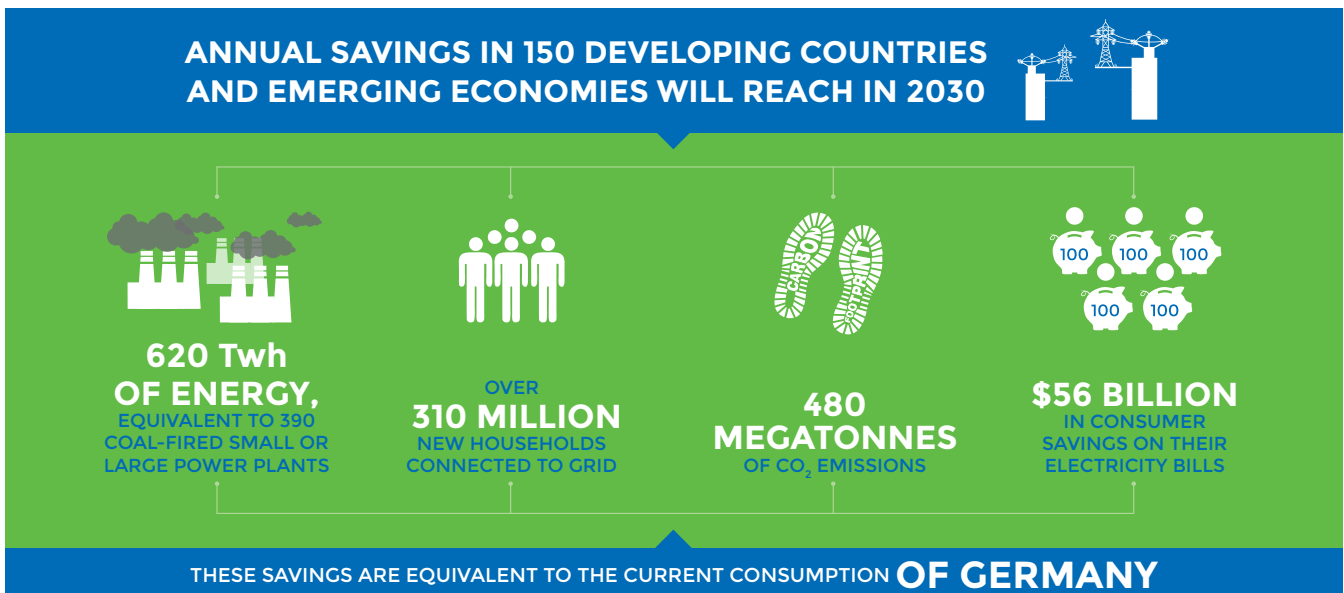
**Annual Energy Savings (electricity consumption):** An estimated 620 Twh/year of electricity<sup>17</sup> can be saved in 2030 if the best currently available technology for air conditioning is adopted.<sup>18</sup>

**Lower Emissions:** Improving room air conditioning efficiency (~30 per cent more efficient than current technology) in parallel with low-GWP refrigerants in these products could avoid up to 480 megatonnes of CO<sub>2</sub> in 2030.<sup>19</sup>

**Financial Savings:** Up to \$56 billion (\$ 17 billion only for India) can be saved cumulatively for consumers through 2030 by improving air conditioner energy efficiency policies.<sup>20</sup>

Many programmes facilitating the cost-effective transition to climate-friendly and high-efficiency air conditioners exist. These include the Super-Efficient Appliance Deployment (SEAD) initiative, the Green Cooling Initiative, and the Advanced Cooling Challenge<sup>21</sup> under the Clean Energy Ministerial (CEM).

Given the magnitude of air conditioners' energy consumption, and the benefits of switching to low-GWP refrigerants, policymakers should consider ambitious energy efficiency policies for air conditioners as part of their national strategies in reaching and exceeding their "Nationally Determined Contributions (NDCs)" under the Paris Agreement.<sup>22</sup>



## 1.2 THE INTEGRATED POLICY APPROACH

Some barriers (see Table 1) need to be taken into account at the design phase of a market transformation programme to ensure they do not inhibit the success of the initiative.

BARRIER	DESCRIPTION	EXAMPLES
FINANCIAL	Magnitude of the first cost relative to incumbent less efficient appliances	<ul style="list-style-type: none"> <li>• Higher relative upfront cost of high-efficiency air conditioners, affecting affordability, especially to low-income consumers</li> <li>• Lack of sustainable financing schemes</li> <li>• Lack of incentives to local manufacturers to promote sales of efficient air conditioning products</li> <li>• Lack of enhanced producer responsibility (EPR) schemes requiring manufacturers to include the costs of recycling and disposal of the appliances in the sales price.</li> </ul>
MARKET	Market structures and constraints that prevent efficient product investments and energy saving benefits	<ul style="list-style-type: none"> <li>• Competition through low-cost, low-efficiency products</li> <li>• Limited availability of affordable high-quality products</li> <li>• High import costs or tariffs</li> <li>• Split incentive—landlord/tenant discrepancy (building owner/manager buys product, tenant pays utility bill)</li> <li>• Negative impact on local manufacturers and related industries.</li> </ul>
INFORMATION AND AWARENESS	Lack of information provided on efficient technologies and their energy savings benefits	<ul style="list-style-type: none"> <li>• Lack of air conditioner-related knowledge and skills among policymakers, air conditioning system designers, importers, suppliers, operation and maintenance (O&amp;M) facility managers</li> <li>• Poor promotion of efficient air conditioner products</li> <li>• Low level of public awareness of the technologies and their benefits</li> <li>• Non-uniformity and technical detail in metrics (e.g. energy efficiency ratio (EER), seasonal energy efficiency ratio (SEER), and coefficient of performance (COP)) new to, or difficult to understand by, policymakers or consumers.</li> </ul>

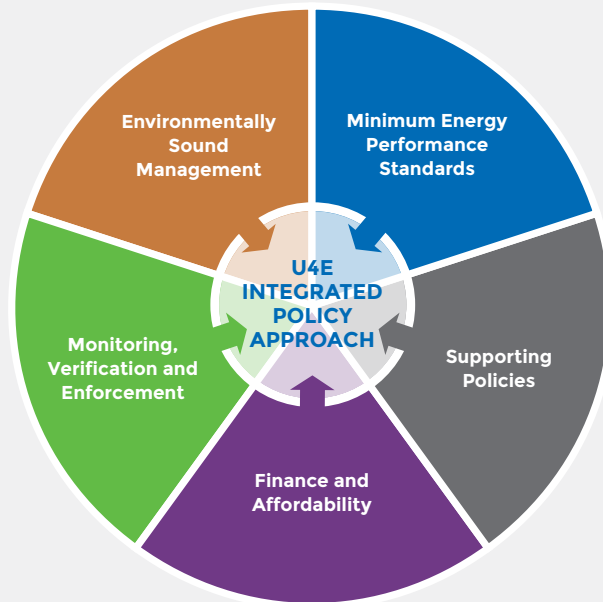
**Table 1.**  
Barriers to the adoption of energy-efficient air conditioners

BARRIER	DESCRIPTION	EXAMPLES
REGULATORY AND INSTITUTIONAL	Structural characteristics of the political and legal system that make it difficult to promote efficient air conditioners	<ul style="list-style-type: none"> <li>• Lack of policies and practical experience to train local air conditioner manufacturers</li> <li>• Lack of policies encouraging energy-efficient air conditioners - regulatory, monitoring/verification, enforcement</li> <li>• Lack of warranties to ensure product quality;</li> <li>• Lack of regulations requiring installation and maintenance by certified and trained personnel</li> <li>• Restrictions on the use of flammable low GWP refrigerants-based air conditioners (even where these appliances are optimised with regard to charge minimisation and additional safety features)</li> <li>• Lack of standards/code of best practice to guide installation, servicing and disposal of air conditioners with flammable refrigerants.</li> </ul>
TECHNICAL	Lack of resources and infrastructure for certifying and promoting efficient air conditioners	<ul style="list-style-type: none"> <li>• Lack of adequate or accredited testing facilities</li> <li>• Limited resources to monitor, verify and enforce national regulations</li> <li>• Lack of technical capacity for local suppliers to provide quality components, materials and product parts and for manufacturers to produce energy-efficient air conditioners</li> <li>• Lack of trained and certified technicians to properly install and service air conditioners with flammable refrigerants.</li> </ul>
ENVIRONMENTAL AND SAFETY RISK PERCEPTION	Concerns over environmental, safety or health relating to air conditioner technologies	<ul style="list-style-type: none"> <li>• Lack of collection and recycling schemes for reuse, recovery and treatment at end-of-life</li> <li>• Lack of public information about the safety of efficient air conditioner technologies in comparison to other widely deployed technologies and risks.</li> </ul>

Many countries have implemented market-transformation policies to promote high-efficiency air conditioners. Market transformation towards high-efficiency air conditioners requires broad coordination and effort among a wide spectrum of market actors, including policymakers, manufacturers, suppliers, retailers, and consumers. Policies should address the above barriers and complement each other to maximise effectiveness.

To address these issues, UN Environment recommends an integrated policy approach incorporating the needs and priorities of public and private sectors and civil society. The approach has five elements that guarantee a sustainable transition to efficient air conditioners.





**Figure 1.**  
Integrated policy approach for a rapid transition to energy-efficient air conditioners

## Standards and Regulations

Standards and regulations refer to a combination of measurement methods and policy measures. They define the minimum performance levels that must be met in order for a given product to be sold in an economy. Regulations, which are sometimes referred to as minimum energy performance standards (MEPS), represent the cornerstone of the integrated policy approach. They are the basis on which policymakers build a successful energy-efficient air conditioner transition strategy.

UN Environment encourages countries to consider mandatory performance requirements when looking at regulations for air conditioning products. The requirements should include minimum levels for energy efficiency and noise levels, and a maximum limit for the GWP and ODP of the refrigerants. Additional product information may be provided related to power consumption, rated lifetime, cooling capacity and restrictions on refrigerant type to ensure ozone and climate safety.

Countries should define the regulations' parameters, stringency and implementation periods. Regulations should be cost-effective, and the degree of stringency

applied to the market may impact the product costs. Regulations may also refer to product labelling requirements. These standards and regulations can also form the basis of other supporting policies, such as labelling, incentives and procurement policies.

## Supporting Policies

Supporting policies reinforce the smooth implementation of regulations (MEPS) and standards. They can also help secure a broad public and private sector acceptance of the transition to energy-efficient air conditioning.

A combination of complementary policies and measures is recommended. Market-based instruments containing elements of voluntary or mandatory action (e.g. labelling, online registration database, smart-phone apps, Quick Response codes), and information and communication campaigns informing end-users can be considered.

Where using flammable refrigerants, policies addressing safety concerns in the manufacture, transportation, storage, installation, servicing and disposal need to be considered (with, for example, the National Ozone Units).

## Financing and Financial Delivery Mechanisms

Financing and financial delivery mechanisms must be addressed to ease the transition to more efficient technologies. High first-cost challenges of energy-efficient air conditioners represent a barrier.

Economic and fiscal instruments and incentives, including electricity pricing policies and tax breaks, may be considered. Financing incentive mechanisms helping to address the initial incremental costs such as through dedicated funds, electric utility on-bill financing; as well as “pay as you save” schemes based on shared savings transactions, should be considered.

## Monitoring, Verification and Enforcement

The success of energy efficiency policies depends on an effective system of monitoring, control, and testing. This ensures enforcement and compliance with regulations and standards.

Unless effective market surveillance systems are in place, substandard products risk entering markets, reducing energy and financial savings. Poor quality products may disappoint consumers who may avoid these products in the future. Substandard products also create an uneven playing field, penalising producers who comply with the mandated standards.

Governments need to integrate monitoring, verification and enforcement (MVE) activities into their national air conditioner

market transformation programmes. To enhance market enforcement capacities, policymakers should consider which tools and activities can support their efforts and meet their programme needs. Sharing of information and skills between countries and across regions can promote best practice, create additional capacity, and increase effective resource use.

## Environmentally Sound Management of Air Conditioners

Refrigerants and other hazardous substances should be managed in line with global best practice in order to minimise any environmental or health impact. If one doesn't already exist, special attention should be given to the development of a legal framework for environmentally sound service, maintenance, and end-of-life activities, including waste recovery and design for disassembly/reuse (i.e. circular economy).

Policy and rigorous legislation should be instituted before the establishment of formal collection channels and recycling facilities. Such best practice policies include enhanced producer responsibility schemes, where manufacturers include the costs of the end of life collection and recycling of the appliances in the sales price. These costs are used to fund the proper end-of-life collection and treatment of the appliances. In addition, government and industry should raise awareness amongst consumers to encourage appropriate recycling and avoid landfill disposal.

## 1.3 GUIDE OVERVIEW

The guide offers an overview of key elements for transforming a national market toward more energy-efficient and climate-friendly air conditioners through the application of the integrated policy approach.

### Chapter 2

**Air Conditioner Markets and Technology** – gives an overview of air conditioning technology – touching on the product and refrigerants used; provides a description of some of the recent changes that are now driving changes in the market. It provides an overview of the market (end-use sectors) and trends in air conditioner technology.

### Chapter 3

**Standards and Regulations** – provides an overview of the test methods and metrics used to measure the performance and quality of air conditioning appliances that are used in product regulations. It also provides a summary of the MEPS, which include energy efficiency requirements but can also include performance-related requirements relating to lifetime, cooling capacity, power and refrigerant.

### Chapter 4

**Supporting Policies** – offers a synopsis of the two main areas of supporting policies, product labelling as well as communication and education activities. The labelling summary explores the different types of labels, including comparative and endorsement labels. The communication and education section focuses on the critical aspect of empowering stakeholders with information, enabling them to understand how they can benefit from least life-cycle cost.

### Chapter 5

**Financing and Delivery** – addresses the critical issue of overcoming first-cost barriers to market adoption, including topics such as financing sources, approaches and stakeholders. Areas covered include

energy service companies, lender finance, bulk procurement schemes, electric utility programmes and multilateral development institutions.

### Chapter 6

**Market Monitoring, Verification and Enforcement** – discusses the importance of MVE, from both a manufacturer's and consumer's perspective. Discusses the critical role of government in establishing and maintaining a robust market surveillance programme.

### Chapter 7

**Environmentally Sound Management** – provides a summary of recommended refrigerants and how to manage them; the importance of recycling and disposal of used air conditioners; the benefits of collection and recycling, and possible financing mechanisms.

### Chapter 8

**Implementation** – provides a summary of the process governments may choose to follow to implement a policy-driven market transformation in their respective national markets.

### Chapter 9

**Resources** – presents an overview of reports/resources and energy-efficient air conditioner programmes and initiatives from around the world, including a high-level summary, Internet links and additional information.

Finally, the report offers supporting materials in the Annex, including an example of a regional harmonization model and procedures in Annex A, and information on designing a communications campaign in Annex B.

## 2. AIR CONDITIONER TECHNOLOGIES AND MARKETS

WHAT?	This chapter provides an overview of air conditioner technologies; an introduction to air conditioner fundamentals and a description of the main air conditioner components. It explains; an overview of the most popular air conditioner types in the residential sector and an overview of the market and the barriers faced.
WHY?	Provides the background context on technology and markets affecting all the subsequent discussion and decisions that will need to be made.
NEXT?	<p>Some key questions to keep in mind:</p> <ul style="list-style-type: none"> <li>• What types of air conditioners are available in my country and should be subject to regulations?</li> <li>• How significant are imports of used or substandard air conditioners to the market?</li> <li>• What are the market barriers to more efficient air conditioners in my country, and how can I overcome these?</li> <li>• Who are the stakeholders in our national supply chain, non-governmental organisation (NGO) community and others who would be interested in a national initiative?</li> <li>• What extra institutional capacity do we need to deal responsibly with our legacy of HCFC and HFC appliances?</li> </ul>

## 2.1 AIR CONDITIONER TECHNOLOGIES

This section provides a high-level overview of air conditioner technologies to help ensure there is a good understanding of the technologies being considered within the scope of any regulation. The various types of

air conditioners available in the residential sector provide the same service, cooling indoor air, but their level of performance, installation requirements and other features differ greatly.

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### 2.1.1 INTRODUCTION TO AIR CONDITIONER FUNDAMENTALS

Air conditioning appliances improve thermal comfort and air quality in indoor spaces by lowering temperature and humidity. The cooling process is based on the application of a refrigeration cycle removing unwanted heat from an area and transfers it to another area, by using an external source of energy. In general, air conditioners use an electric driven vapour compression cycle.

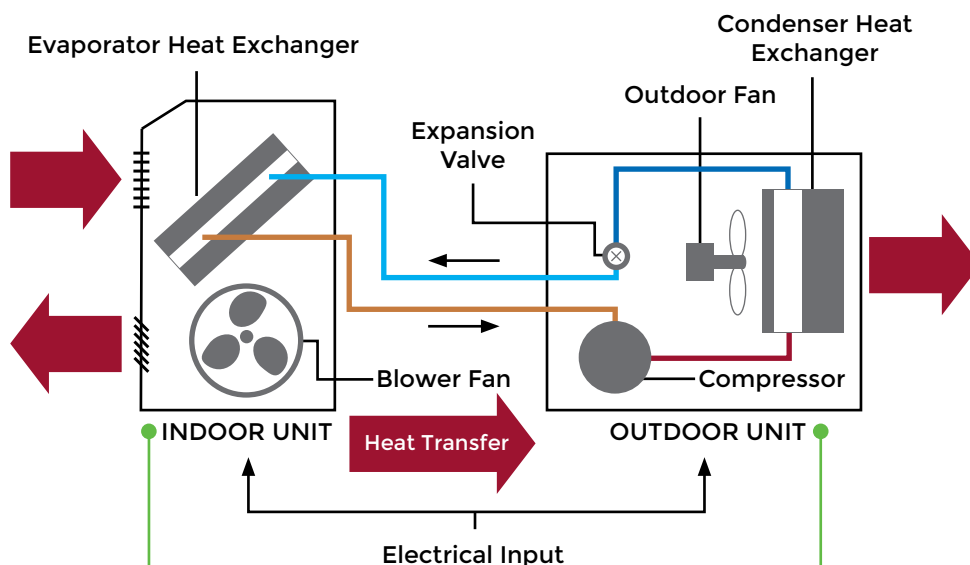
The vapour compression cycles are performed by refrigerants, in a process comprising four sequential steps: 1) compression; 2) condensation; 3) expansion; and 4) evaporation. In air conditioners, the cooling effect is used to lower the temperature of indoor air passing through the evaporator coil, while the absorbed heat is rejected outdoors by the condenser coil (see Figure 2).

## 2.1.2 MAIN AIR CONDITIONER COMPONENTS

The main components of a split air conditioner, the most widely used type, include an indoor unit installed inside the room to be cooled and an outdoor unit

installed outside the room in open space. In addition, a tubing connects the indoor and outdoor units carrying the refrigerant.

**Figure 2.**  
Basic air conditioning vapour compression cycle



### Indoor Unit

The indoor unit produces the cooling effect inside the room. It is a box-type housing in which some parts of the air conditioner are enclosed: the evaporator coil, air filter, cooling fan, drain pipe, and louvers or fins.

- The **cooling fan or blower** sucks the hot and unclean air from the room, and supplies cool and clean air back by passing it over the cooling coil and air filter.
- The **air filter**, located just before the cooling coil, removes dirt particles from the room air and helps supply clean air to the room.

### Outdoor Unit

The outdoor unit contains some parts of the split air conditioner: compressor, condenser<sup>23</sup>, condenser cooling fan and expansion valve.

- The **compressor** compresses the refrigerant and increases its pressure before sending it to the condenser. During this process, heat is generated in the compressor and removed through heat exchangers to the outdoor ambient.
- The **condenser** removes the heat from the refrigerant. It is made of coiled copper or aluminium tubing, which has a high rate of conduction. It is covered typically with aluminium fins so the heat from the refrigerant can be removed at a faster rate.
- The **condenser cooling fan**, located in front of the compressor and the condenser coil, blows surrounding air from the open space over the compressor and the condenser with the aluminium fins, thus cooling them.
- The **expansion valve** is used to lower the temperature and pressure of the refrigerant.

## 2.1.3 AIR CONDITIONER TYPES

The scope of this guide includes the most popular types of residential air conditioners. These are window air conditioners, non-inverter split air conditioners, inverter split air conditioners, multi-split air conditioners, and portable air conditioners.

This guide focuses on cooling only applications and mainstream products available in the market. Evaporative coolers, which have low market shares, and heat pumps, which serve mostly for heating or combined heating and cooling are not covered in the guide. They are not universally applicable technologies.

### Window Air Conditioners

In window or wall type air conditioners (also called single-package, or package terminal air conditioners) all the components, i.e. the compressor, condenser, expansion valve, and cooling coil; are enclosed in a single housing. They are easy to install, and can be removed and stored

during the off-season. The cooling capacities tend to be smaller, and some units may be noisier than other types when operating. They are generally less efficient and, due to size constraints, have fewer options to improve efficiency.



#### ↑ ADVANTAGES OF WINDOW AIR CONDITIONERS

- Lower purchase price
- Easy to install
- Can be placed either in windows or wall openings.

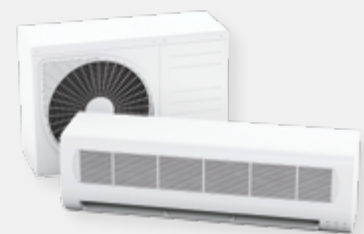
#### ↓ DISADVANTAGES OF WINDOW AIR CONDITIONERS

- Lower efficiency
- Noisier operation
- Improper installation can result in significant air leakage.

### Non-Inverter Split Air Conditioners

Split air conditioners include an indoor and an outdoor unit, connected by refrigerant piping. They dominate air conditioner sales. In addition, they are up to 30 per cent more efficient given the hot side is separated from the cold side, without heat transmission between them (unlike window

air conditioners). These systems may be larger in capacity and are generally installed by trained technicians. Non-inverter split air conditioners refer to systems with a fix speed compressor where the unit turns on and off to maintain room temperature.



#### ↑ ADVANTAGES OF NON-INVERTER SPLIT AIR CONDITIONERS

- More efficient than window air conditioners
- Quieter operation as the compressor sits in the outdoor unit

#### ↓ DISADVANTAGES OF NON-INVERTER SPLIT AIR CONDITIONERS

- Typically higher purchase price than window air conditioners
- Installation requirements
- Space requirements for outdoor units.



## Inverter Split Air Conditioners

Split air conditioners using a compressor controlled with a variable speed drive (VSD)<sup>24</sup> are also known as inverter units. The difference between inverter and fix speed air conditioners is that the former can vary the speed of the compressor, delivering precise cooling as required. Inverter units are

more efficient when operating at part-load (i.e. not at their maximum capacity). Since most systems are designed to meet cooling conditions occurring rarely, operation at part-load is more frequent, making inverter split air conditioners more efficient than non-inverter units.

### ↑ ADVANTAGES OF INVERTER SPLIT AIR CONDITIONERS

- More efficient than non-inverter split air conditioners
- Achieves desired temperature quicker and no temperature fluctuations
- Quiet operation as compressor sits in outdoor unit.

### ↓ DISADVANTAGES OF INVERTER SPLIT AIR CONDITIONERS

- Typically higher purchase price than non-inverter split air conditioners
- Installation requirements
- Space requirements for outdoor units.



## Multi-Split Air Conditioners

Multi-split packaged air conditioners contain numerous indoor units (typically up to four

units) connected to a single outdoor unit. They are used to cool multiple rooms.

### ↑ ADVANTAGES OF MULTI-SPLIT AIR CONDITIONERS

- Multiple indoor units using one outdoor unit
- Can be installed in various zones/rooms
- Separate controls for different zones/rooms
- Easy installations without the need of ductwork
- Easy to be customise to meet different needs.

### ↓ DISADVANTAGES OF MULTI-SPLIT AIR CONDITIONERS

- No redundancy since all indoor units rely on one outdoor unit
- High purchase price.



## Portable Air Conditioners

A portable air conditioner is a self-contained unit, similar to a window air conditioner. It is typically designed with wheels to allow it to be moved. Water condensed from the

portable air conditioner may be collected in a bucket for manual removal, drained through a gravity hose, or evaporated and exhausted with the condenser process air.

### ↑ ADVANTAGES OF PORTABLE AIR CONDITIONERS

- Lower purchase price
- Can be moved from room to room
- Easy to install.

### ↓ DISADVANTAGES OF PORTABLE AIR CONDITIONERS

- Typically less efficient: lower efficiency at hot climate / better efficiency if outdoor air temperature is low
- Noisier operation
- Water needs to be removed manually.




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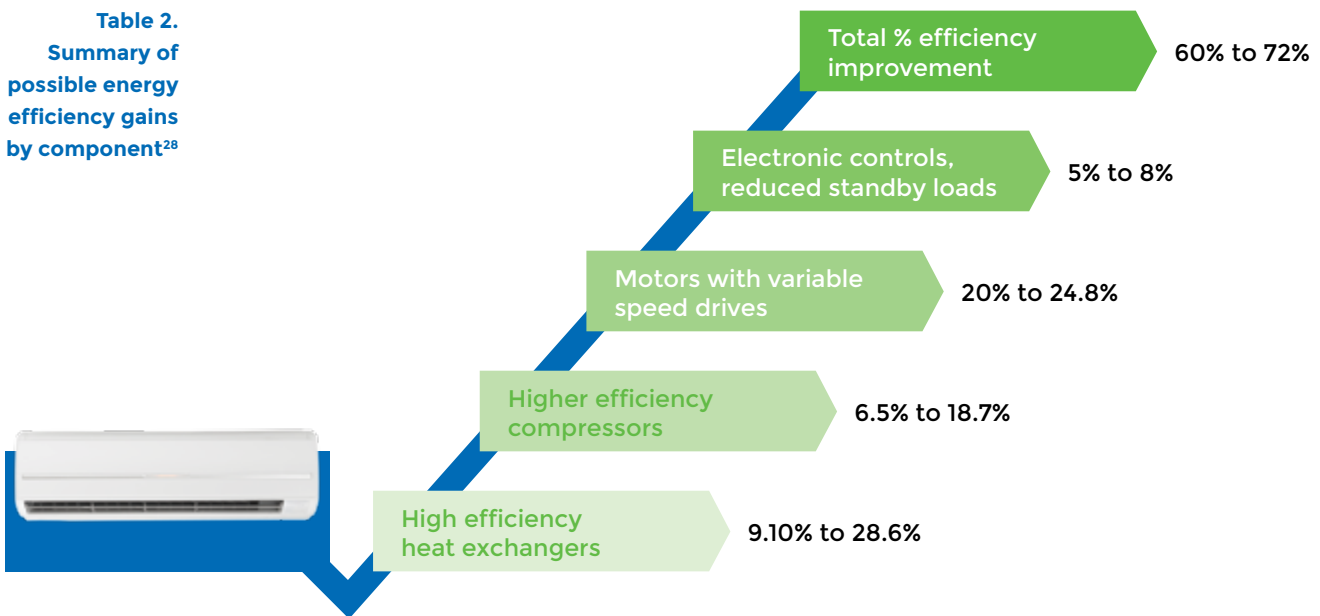
Typical characteristics of air conditioners in the residential sector (window, non-inverter, inverter, multi-split and portable air conditioners) vary significantly across different regions and countries. Air conditioners in the residential sector have an average capacity of 4 kW (from 2 up to 12 kW), an average energy efficiency measured as the Energy Efficiency Ratio (EER) of 3.0 – 4.0.<sup>25</sup>

## 2.1.4 POSSIBLE ENERGY EFFICIENCY GAINS

There are multiple options to improve energy efficiency of air conditioners. They include the use of more efficient technologies and components such as inverter/variable speed compressors, fans, heat exchangers, expansion devices, and refrigerant fluids. If applied together, these improvement options could save between

60 - 72 per cent of energy compared to a base case model (defined as a non-inverter split air conditioner model developed for the European Commission<sup>26</sup>). In general, higher costs and size constraints are some of the barriers to include more efficient components in air conditioners.<sup>27</sup>

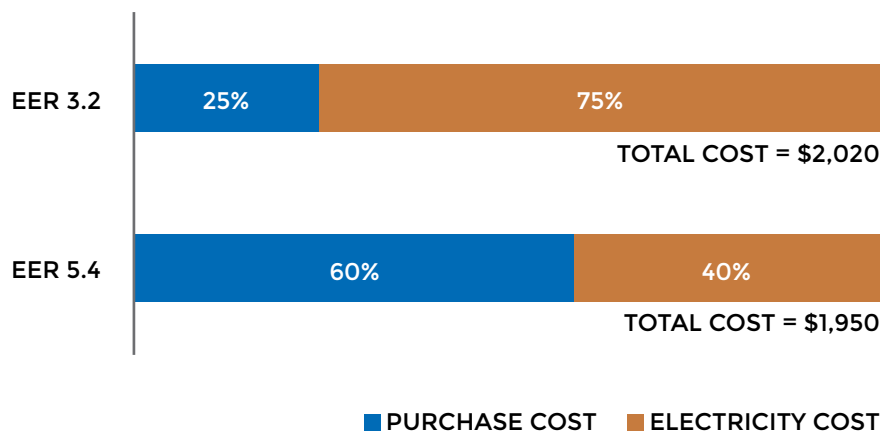
**Table 2.**  
Summary of possible energy efficiency gains by component<sup>28</sup>



However, the initial higher cost of a more efficient product is in general offset by savings over the electricity bills. For instance, as shown in Figure 3, a comparison of the total life-cycle cost of air conditioners

with various efficiencies in India, a 1.5 tonne capacity less efficient air conditioner (EER = 3.2) costs slightly more over the lifetime than a more efficient (EER 5.4) unit.<sup>29</sup>

**Figure 3.**  
India's 1.5 tonne air conditioner total life cycle cost



## 2.1.5 REFRIGERANTS IN USE IN AIR CONDITIONERS

Refrigerants used in air conditioners have changed over the years as they have become controlled substances under the Montreal Protocol<sup>30</sup> due to damage they cause to the ozone layer and the climate system. HCFCs, the last-generation refrigerants commonly used in air conditioners, are scheduled to be totally phased out in developed countries by 2030 and in developing countries by 2040. Non-ozone depleting HFCs are commercially available alternatives to HCFCs. While they do not deplete the ozone layer, HFCs are potent GHGs, hundreds to thousands of times more powerful in trapping heat in the atmosphere than CO<sub>2</sub>, pound-for-pound.

Since the HCFC phase-out was agreed, annual HFC consumption has increased at a rate of 10 – 15 per cent per year<sup>31</sup>, raising alarm to their potential contribution to rising global temperatures. Avoiding production and use of HFCs by using technologically feasible low-GWP substitutes could avoid as much as 0.5 °C warming by the end of the century<sup>32</sup>. In order to reduce production and consumption of these powerful greenhouse gases, the parties to the Montreal Protocol unanimously adopted the Kigali Amendment in October 2016, agreeing to add HFCs to the list of controlled substances and approving a timeline for their gradual reduction by 80 – 85 per cent by the late 2040s.

Under the Paris Agreement, countries have also pledged to reduce GHG emissions through mitigation actions described in their nationally determined contributions (NDCs). Close to half the parties of the United Nations Framework Convention on Climate Change (UNFCCC) have mentioned HFCs in their NDCs<sup>33</sup> – a clear sign that the mitigation of HFCs is necessary to achieving GHG emissions reductions. For instance, Nigeria's NDC strategy refers to: “the adoption of standards for imported equipment, in

particular in the field of refrigeration and air conditioning where there is a risk of dumping of HCFC and HFC installations that are being phased out in OECD countries.”<sup>34</sup>

Manufacturers are considering alternatives to transition to climate-friendly refrigerants in room air conditioners (i.e. substances with zero ozone depleting potential and low GWP). These alternatives, including propane (R-290), HFC-32 (R-32), and HFC/hydrofluoroolefins (HFO) blends; pose a lower climate burden. They display different characteristics affecting their environmental performance, energy efficiency, safety and cost. Table 3 illustrates the properties of the various refrigerant classes such as GWP, impact to energy efficiency, patent implications, ISO 817 safety classification, environmental impact and usability. The refrigerant options mapped out include:

- **HCFC-22**, used to be the refrigerant of choice and will be fully phased out by 2040;. HFC-410A, has been deployed as a non-HCFC alternative to HCFC-22. Its use will be increasingly restricted under the Kigali Amendment to the Montreal Protocol.
- **HFC-32**, has been deployed as a non-HCFC alternative to HCFC-22 and as a lower-GWP alternative to HFC-410A but with a GWP of 675 to be restricted under the Kigali Amendment.
- **R-444B, R-446A, R-447B, R-452B and R-454B**, are HFO blends currently developed as lower GWP alternatives to HFCs but with GWPs ranging from 300 to 680 to be restricted under the Kigali Amendment;
- **R-290**, known as propane, a non-HFC alternative with a GWP of 3 and high flammability.

REFRIGERANT	HCFC-22	HFC-410A	HFC-32	R-444B	R-446A	R-447B	R-452B	R-454B	HC-290
GWP	1810	2090	675	300	460	570	680	470	3
REFRIGERANT EFFICIENCY	High	Low	High	Medium	Medium	Medium	Medium	Medium	High
HIGH TEMPERATURE SUITABILITY	✓	X	✓	✓	✓	✓	✓	✓	✓
COST OF REFRIGERANT <sup>39</sup>	Low	Medium	Low	High	High	High	High	High	Low
SUBJECT TO PATENT ON: • SUBSTANCE • APPLICATION	No Yes	Yes Yes	No Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes	Yes Yes	No Yes
ISO 817 SAFETY CLASSIFICATION <sup>40</sup>	A1 No flame Propagation	A1 No flame Propagation	A2L Lower Flammability	A2L Lower Flammability	A2L Lower Flammability	A2L Lower Flammability	A2L Lower Flammability	A2L Lower Flammability	A3 Higher Flammability
OTHER ENVIRONMENTAL IMPACT/ DEGRADATION PRODUCTS <sup>41, 42</sup>	HF, HCl <sup>43</sup> and CO <sub>2</sub>	HF and CO <sub>2</sub>	HF and CO <sub>2</sub>	TFA <sup>44</sup> , HF and CO <sub>2</sub>	TFA, HF and CO <sub>2</sub>	TFA, HF and CO <sub>2</sub>	TFA, HF and CO <sub>2</sub>	TFA, HF and CO <sub>2</sub>	H <sub>2</sub> O and CO <sub>2</sub>
SAFETY AND ENVIRONMENTAL REQUIREMENTS AND USE RESTRICTIONS	National safety regulations must be followed. International safety standards such as ISO 5149 <sup>45</sup> , IEC60335-2-40 <sup>46</sup> and IEC 60335-2-89 along with ISO 817 safety classification should be adhered to.								
ENVIRONMENTAL CONTROLS AND USE RESTRICTIONS FOR AIR CONDITIONERS AND HEAT PUMPS DUE TO GWP	Globally subject to HCFC phase-out	Sec-toral use capped and/or subject to sub-sec-tor bans in some countries due to GWP	No ban for air conditioners. Substance is subject to controls under Montreal Protocol Kigali Amendment.	No ban for air conditioners. Substance is subject to controls under Montreal Protocol Kigali Amendment.	No ban for air conditioners. Substance is subject to controls under Montreal Protocol Kigali Amendment.	No ban for air conditioners. Substance is subject to controls under Montreal Protocol Kigali Amendment.	No ban for air conditioners. Substance is subject to controls under Montreal Protocol Kigali Amendment.	No ban for air conditioners. Substance is subject to controls under Montreal Protocol Kigali Amendment.	No ban

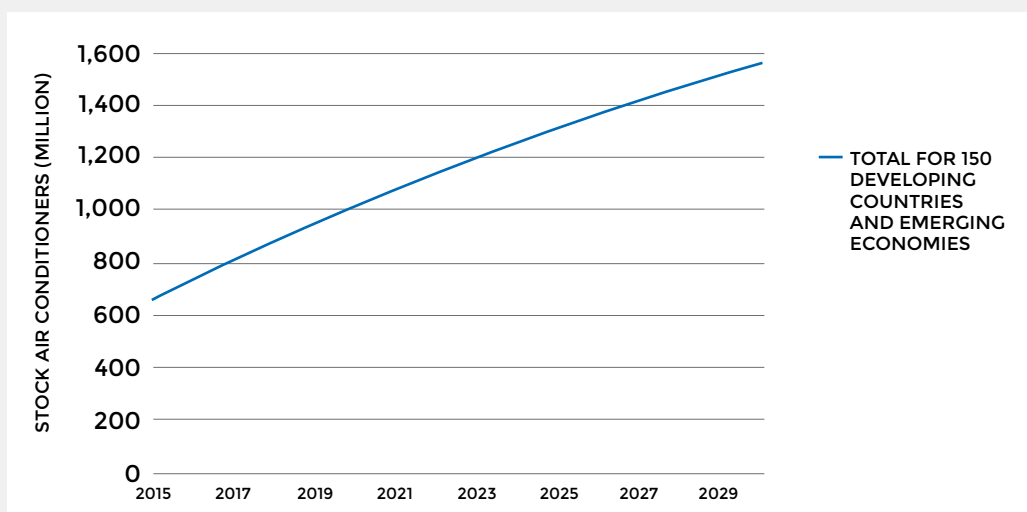
**Table 3.**  
Overview of refrigerant options and implications<sup>35</sup>

## 2.2 MARKET DEVELOPMENTS

### Air Conditioners Stock

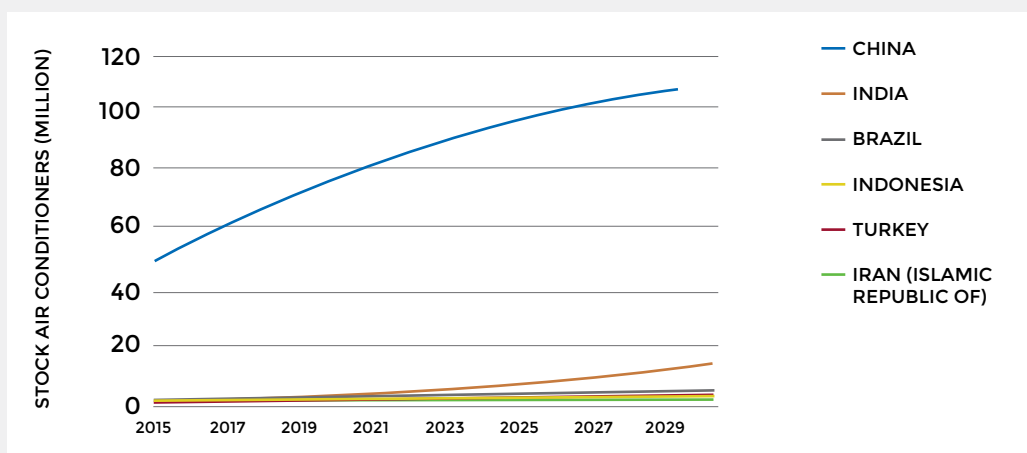
Demand for air conditioners is on the rise and is expected to accelerate in the coming decades. Ownership levels grow almost as fast as the electrical grid connections. The projected total stock of air conditioners in use in 150 developing countries and emerging economies is shown in Figure 4. The stock of air conditioners across the world is expected to reach 1.5 billion by 2030. Figure 5 shows the projected count of appliances added to stock after 2015 for six example developing countries.

The analysis of growth and consumption of appliances has been published by UN Environment in Country Assessment sheets covering 150 different developing countries and emerging economies. The model used for the Country Assessment is called the Policy Analysis Modelling System (PAMS), developed by LBNL, and updated by the U4E partners.



**Figure 4.**  
Growth in the total number of air conditioners in use for 150 developing countries and emerging Economies

Source:  
U4E Country Assessments



**Figure 5.**  
A projection of the cumulative number of air conditioners to be added to the national stock in six example developing countries in 2015

Source:  
U4E Country Assessments

## Air Conditioner Sales and Growth

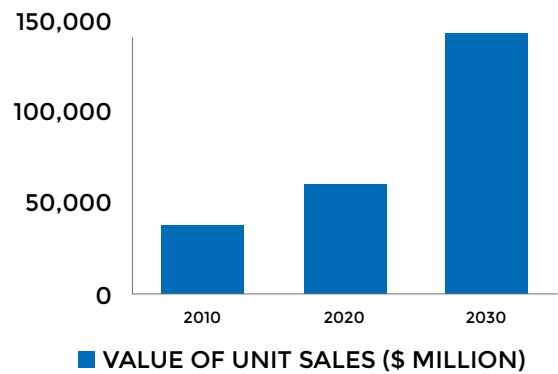
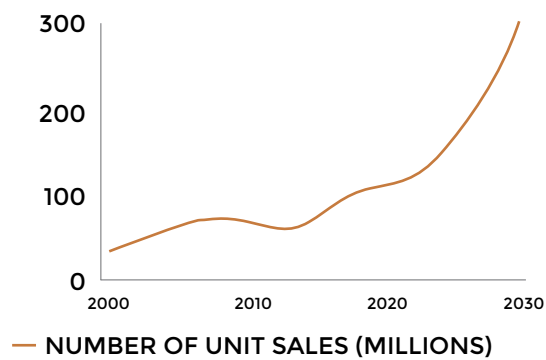
According to the Green Cooling Initiative, global annual air conditioner sales were over 60 million in 2014 and are expected to reach about 300 million in 2030.<sup>47</sup> This growth is mostly driven by countries with rising incomes and large metropolitan areas

located in warm to hot climates, such as Brazil, China, India, Mexico, South Africa, and economies in South East Asia and the Middle East. The price of air conditioner equipment worldwide has gone down, making it more affordable and accessible even in places without year-round cooling requirements.

**Figure 6.**  
Global unitary  
air conditioner  
sales

Source:  
Green Cooling  
Initiative 2016c  
[64,000,000 units  
sales corresponds  
to 2014]

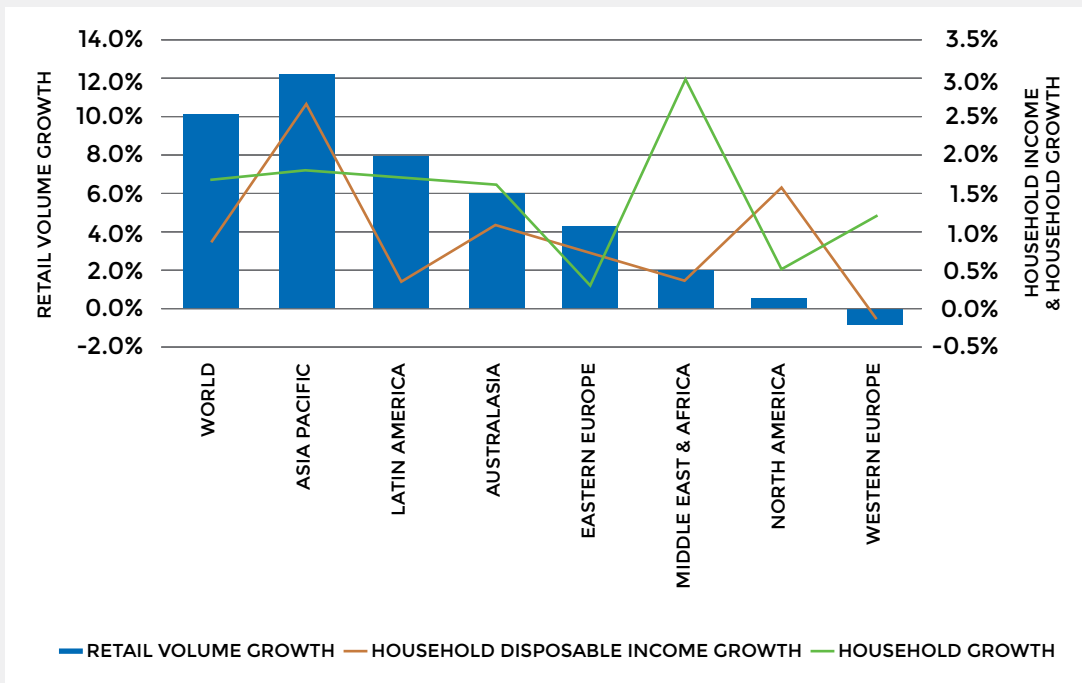
UNIT SALES  
64,600,000



The market for split air conditioners is growing the fastest, representing 88 per cent of worldwide room air conditioner sales. The market for window air conditioners is declining or disappearing in some countries. Window air conditioners are still very popular in the US, where they accounted for more than 90 per cent of room air conditioner sales in 2014. Inverter split air conditioners are widely available in markets such as the European Union (EU), Japan, and the US, and are

gaining popularity in China, India and other developing economies. Portable air conditioners are less popular worldwide; however, there are growing concerns in some economies about their increasing market share due to their lower cost and easy installation.

Air conditioner markets worldwide are growing at an average pace of 10 per cent per year, with fastest growth in Asia Pacific (12 per cent) and Latin America (8 per cent).



**Figure 7.**  
Air conditioner market growth across the world and per region, 2013 to 2014

Source:  
Euromonitor, 2016

## Second-Hand Market

In countries where imports of second-hand appliances are not banned, a portion of air conditioners in the market correspond to used products coming from other countries. This is the case in some economies in the Economic Community of West African States (ECOWAS) where imports of second-hand products mainly from Europe are still prevalent.

A study in Ghana found that from all the imported appliances entering the market, at least 35 per cent were second-hand products that have to be repaired or rejected. Figures for air conditioners have not been reported separately from other appliances.<sup>48</sup>

## Production and Demand

China dominates the production of air conditioners. It produces about 67 per cent of the world's air conditioners. Almost half of China's production is exported. Thailand, the world's second largest manufacturer, exports 90 per cent of its production. Other countries with a large manufacturing sector are Brazil, India, Japan, Malaysia, Japan, and

the Republic of Korea. Production in both Japan and the Republic of Korea mostly meets the local demand.

In terms of markets size, the largest market is China with 38 per cent of the global demand of air conditioners. It is followed by markets in Asia (excluding Japan and China) and North America, with 17 per cent and 10 per cent of the demand respectively.

Worldwide, about 750 million air conditioning units are in use. In 2014 this resulted in 1,650 TWh of electricity consumption, equivalent to 1,150 Mt of CO<sub>2</sub> emissions. When emissions from these air conditioners' refrigerants are considered, the overall emissions amount to about 1,450 Mt of CO<sub>2</sub>. This accounted for approximately 4.5 per cent of energy-related CO<sub>2</sub> emissions worldwide in 2014.<sup>49</sup>

Given the anticipated growth in production and demand, refrigeration and air conditioning equipment emissions including heat pumps will almost double from 2020 – 2030, making up about 11 per cent of global emissions. Over half of these emissions will come from air conditioners.



### 3. STANDARDS AND REGULATIONS

WHAT?	This chapter provides an overview of the test methods and metrics used to measure air conditioners energy performance; as well as a summary of minimum energy performance standards (MEPS), which include energy requirements and sometimes refrigerants requirements (e.g. limits to GWP).
WHY?	Provides information on determining and setting MEPS, the first part of U4E's Integrated policy approach which is the cornerstone of market transformation.
NEXT?	<p>Some key questions to keep in mind:</p> <ul style="list-style-type: none"> <li>• What is the status of performance and test standards in my country?</li> <li>• Do we have accredited testing facilities for air conditioners or can we partner?</li> <li>• Which would be better for our country—technology neutral or technology-specific requirements?</li> <li>• How can I regulate air conditioners to account for different technologies, local climate conditions, and refrigerants in use?</li> <li>• What level of ambition would be appropriate; should we have a second tier set in the future so industry gets a clear signal on what to follow?</li> </ul>



### 3.1 PERFORMANCE METRICS TESTING STANDARDS

The International Organization for Standardization (ISO) standard, ISO 5151 has been adopted by most countries as a reference test standard for measuring air conditioners' cooling capacity and efficiency. However, not all economies are aligned with ISO 5151, and some differences remain between test methods. North American countries<sup>50</sup> follow standards set by the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE), which means that Mexico and some South American countries are unlikely to adopt ISO 5151 at present due to their strong trade links with North America.

The Energy Efficiency Ratio (EER) and the Seasonal Energy Efficiency Ratio (SEER) are the two main types of metrics

in use internationally to rate the energy efficiency of air conditioners. The EER is the ratio of the cooling capacity and the power consumed when measured at full load (i.e. measures efficiency at a single point—the maximum cooling capacity or the design point). The SEER is designed to rate part-load performance (i.e. efficiency is measured considering variations in the outdoor air temperature and the effect of the cooling load). SEERs are designed to be representative of local climates, building types, and user behaviour, and thus variations in the calculation of the metric used in the various economies exist. An alternative name to the SEER is the cooling seasonal performance factor (CSPF).

ECONOMY	NATIONAL TESTING STANDARD	REFERENCE TEST STANDARD	METRIC USED
AUSTRALIA	AS/NZS: 3823-2013	ISO 5151	AEER*
CHINA	Fixed speed: GB/T 7725-2004 Variable speed: GB/T 7725-2004, GBT 17758-2010	ISO 5151	EER for fixed speed SEER** for variable speed
EU	EN 14825	ISO 5151	EU SEER
INDIA	Fixed speed: IS 1391-1992 with all amendments Variable speed: 16358-1:2013	ISO 5151	EER*** for fixed speed Indian SEER for variable speed
JAPAN	JIS B 8616:2015 for commercial ACs JIS C 9612: 2013 for Room ACs	ISO 5151, ISO 16358*****	APF****
REPUBLIC OF KOREA	KS C 9306:2011	ISO 5151, ISO 16358*****	CSPF
US	10 CFR 430, Subpart B, Appendix F	Consistent with ASHRAE Standard 16/69	US SEER
VIET NAM	TCVN 7830:2015	ISO 5151, ISO 16358*****	CSPF

**Table 4.**  
**Overview of unitary air conditioning energy-efficient standards and metrics used around the globe**

\* Annualised version of the EER that deducts standby power

\*\*SEER is used for air conditioners with cooling function only; Annual performance factor (APF) is used for air conditioners with both cooling and heating function.

\*\*\*The standards for fixed and variable speed air conditioners will be merged in 2018, and ISEER will be used for both categories.

\*\*\*\*Annual Performance Factor (APF) is similar to the SEER

\*\*\*\*\* ISO 16358 provides a calculation method for seasonal performance factor and refers to ISO 5151 as testing method

## Testing Standards

The ISO 5151 testing standard specifies how to measure the cooling capacity and efficiency of air conditioners using stipulated test conditions. Condition T1, which specifies indoor and outdoor temperatures at moderate climates, is used by most countries.

The ISO 16358 is a newer standard based on the ISO 5151 test points. It allows for fixed speed and inverter air conditioners to be rated under the same metric and product category, capturing part-load savings from inverters, and provides flexibility in adoption of a country specific temperature bin (i.e. a representation of the country's year-round cooling demands).

ISO 16358 was adopted as an ISO standard in 2013, and some countries like India have already adopted it in their regulations. The test points required by ISO 16358 for fixed-speed, two-stage, multistage and variable speed air conditioners are based on the ISO 5151 T1 climate condition, facilitating its adoption because additional testing is not required. Only two test points are required for a fixed speed capacity or variable speed capacity air conditioner.

Test procedures are based on two testing methods to measure energy performance of air conditioners: the calorimeter room method and the indoor air enthalpy method. ISO 5151 specifies both test setups for energy and capacity determination. However, the testing methods display differences related to accuracy and the cost of the laboratory setup.<sup>51</sup> The calorimeter room method offers high accuracy at a higher testing time and cost of tests, while the indoor air enthalpy method requires a less expensive laboratory with shorter testing times but lower accuracy. The indoor air enthalpy method is sufficiently accurate for large capacity air conditioners but not enough for small capacity units.

## Performance Metrics

The energy efficiency of an air conditioner is generally expressed by its coefficient of performance, also called Energy Efficiency Ratio (EER). The EER is the ratio of the cooling capacity and the power consumed when measured at full load (i.e., at the maximum deliverable cooling capacity of the air conditioner). This EER has been the basic parameter used to indicate the energy performance of air conditioners in MEPS and energy efficiency labelling regulations.

Given that air conditioners typically operate at full load for only a small number of hours in the cooling season, EER is often not the best representation of air conditioner performance especially for variable speed systems since it does not take into account performance at part-load. Some countries (China, EU, India, Japan, Republic of Korea, US) have transitioned to the Seasonal Energy Efficiency Ratio (SEER) as a metric to rate performance and capture part-load performance.

The SEER represents the expected overall performance of an air conditioner for a typical year's weather in a given location. Instead of being evaluated at a single operating condition, the SEER is calculated with the same indoor temperature, but over a range of outside temperatures over the course of the cooling season.

Countries should consider whether to adopt an EER or an SEER metric based on the local context (climate, market share of inverter air conditioners, verification testing requirements, among others).

An EER metric can be a first step in countries where MEPS are implemented for the first time, while an SEER (considered a more complicated metric) could be adopted in countries where standards are already in place and a metric that considers seasonal performance would achieve higher energy savings.

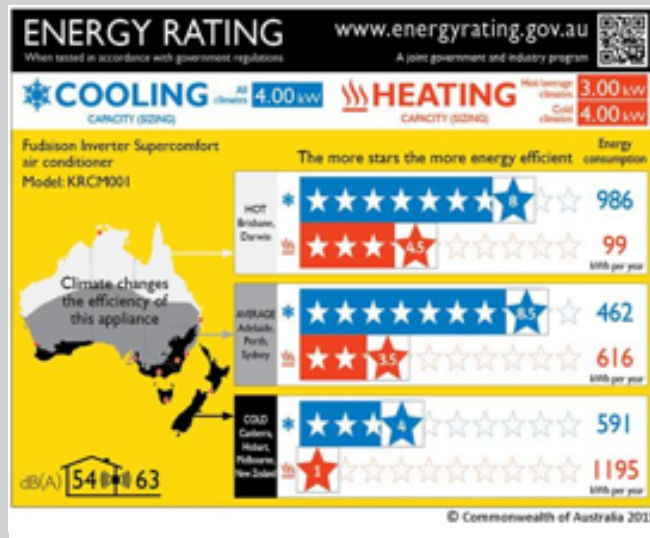
Some regulators are also considering climate variation among locations within the country or region, in addition to considering air conditioner performance at part-load by the

use of an SEER metric. Regulators following this approach define representative climate zones and parameters to rate efficiency appropriate for each location.

## CASE STUDY: Zone-Based Energy Labelling System, Australia

The Equipment Energy Efficiency (E3) Committee in Australia is examining the use of a zone based energy efficiency labelling system for some products, including air conditioners. The rationale is to allow for meaningful comparisons of energy efficiency, running costs and key performance attributes across technologies, relevant to the location of Australian consumers.

For more information [click here](#).



## 3.2 MINIMUM ENERGY PERFORMANCE STANDARDS

The acronym “MEPS” has been used for decades to refer to mandatory performance requirements of regulated products.

Derived from the phrase “minimum energy performance standards,” MEPS originally focused almost exclusively on reducing energy consumption. However, over time and with the expansion of regulatory programmes to address quality and performance issues, MEPS came to be associated with more than simply energy consumption.

MEPS offer a highly cost-effective policy option that establishes an “efficiency floor” for products sold within a country. Models not meeting the minimum efficiency requirements may no longer be imported or sold after the effective date of implementation of the standard. In most countries suppliers or retailers are allowed to sell the stock imported prior the policy entered into force.

MEPS encourage manufacturers to improve the efficiency of their products or to innovate and develop more efficient technologies, when applied in conjunction with supporting policies. Before MEPS are adopted, cost-benefit analyses must be performed to ensure the associated regulatory measures provide economic benefits to consumers. Stakeholders must also be consulted to guarantee their buy-in to the policy.

### Advantages:

- Mandatory aspect provides a high degree of certainty for delivering energy savings paired with an effective compliance regime
- Can avoid the dumping of appliances with low energy efficiency into a country and thereby create economic and energy savings to the economy
- Minimise governmental fiscal and political impact compared to legislative actions, such as subsidies and levies
- Create a stimulus for manufacturers to invest in research and develop new, more efficient air conditioners
- Can be adjusted periodically as air conditioners improve or new technologies become available
- Can be designed to maximise consumer benefits with very low per unit transaction costs; and
- Can reduce peak demand and in some cases frequency of brownouts, and reduce amount of new power plants needed to meet growing local electricity demand.

### Constraints:

- Energy-efficient air conditioners may not be widely available in the local market; and, the variety of product offerings may be limited
- The initial cost of energy-efficient air conditioners may be greater than the less efficient units they are replacing
- Suitable and accredited testing facilities are required to ensure air conditioners comply with MEPS; and,
- Production of air conditioners by local manufacturers will be affected (i.e. availability of good quality raw material and components, better manufacturing techniques etc.). Sufficient preparation time must be built into schedules.

One or more of the above constraints may be magnified in some developing markets. Although desirable, it may not be immediately practical to establish MEPS that are as stringent as those of developed nations.

When setting MEPS, policymakers need to consider a full range of potential impacts to ensure that the policy is ambitious enough to achieve maximum energy savings and remain cost-effective. Often times, a series of technical, economic, and market analyses are conducted to inform the policy-setting process. For example, the decision making of the US standards is based on a series

of analyses ensuring the US DOE will set technologically feasible and economically justified standards with which maximum improvement in energy efficiency is gained. Each analysis produces results on the policy impact of a particular market actor and feeds into the decision making of the final policy.

ANALYSIS	OBJECTIVE
ENGINEERING ANALYSIS (COST-EFFICIENCY CURVES)	Investigate the technology options to improve energy efficiency and each options cost-effectiveness
ENERGY USE ANALYSIS	Analyse the impact on the national energy use
LIFE-CYCLE COST (LCC) ANALYSIS	Analyse the impact on individual consumers Purchase, operation and maintenance cost and savings cost for individual purchasers
NET PRESENT VALUE (NPV) ANALYSIS	Analyse the impact on the nation (all consumers)
MANUFACTURER IMPACTS AND INDUSTRY NET PRESENT VALUE (INPV) ANALYSIS	Analyse the impact on the manufacturers
CLIMATE CONSIDERATIONS	Analyse the impact on climate through a Total Equivalent Warming Impact (TEWI) analysis or a Life Cycle Climate Performance (LCCP) model.

**Table 5.**  
Analyses to inform MEPS and their objectives

MEPS should be designed considering the local context and standard vocabulary to avoid unintended outcomes, such as disadvantaging more efficient air conditioners, or, unintentionally exempting inefficient types. Governments should establish a system to regularly monitor the market when air conditioner MEPS are implemented. A schedule indicating upcoming revisions to efficiency levels can also be a useful tool to give ample notice to manufacturers and importers of expected increases in MEPS. For instance,

India publishes a multi-year schedule with updates to energy efficiency levels every two years.<sup>52</sup>

To be effective, MEPS must be carefully applied. Performance levels and other requirements must be determined by technological developments and market trends for air conditioners. Where feasible, national MEPS requirement levels should take into account regional conditions and international benchmarks.

## CASE STUDY: Product Data Availability and the Advanced Cooling Challenge

Air conditioner performance data are usually dispersed across manufacturers' websites and government product registries, making it difficult to access and evaluate. The Advanced Cooling Challenge of the Clean Energy Ministerial is developing a database, using web-scraping technology, to improve accessibility to data on current availability and price of most efficient air conditioners on the global market for particular climate and economic conditions.

For more information [click here](#).



Performance levels and programme requirements need stakeholders' input to gain their support and participation. Programmes should involve stakeholders from the government, private sector and civil society, including: government standards and test agencies, customs, standardisation institutes, certification and accreditation bodies, test laboratories, manufacturers, suppliers and distributors of air conditioners, technology research institutes and environmental and consumer organisations.

Once established, MEPS programmes should be monitored, evaluated, updated, and revised regularly. The most important factor for programme success is a functioning system of monitoring, control, and testing facilities capable of ensuring product compliance. Programmes should be monitored to ensure all manufacturers and importers comply with the requirements, so as to ensure a fair and complete market transition. Other policies informing and educating the public, as well as financial measures helping address the initial cost of more efficient air conditioners, can help to launch and establish a MEPS programme for air conditioners.

MEPS for air conditioners have been designed following various approaches:

- **Technology-specific vs. Technology Neutral.** MEPS requirements are different for the various technologies or a single set of requirements is defined regardless of the technology. There are some advantages of following a technology neutral approach; a single MEPS for non-inverter split air conditioners and inverter split air conditioners rewards designs achieving higher efficiency levels independent of the technology used. However, window air conditioners should have a different efficiency level as there are size constraints (window, wall or the console) to achieve the same degree of efficiency compared to split air conditioners.
- **Cooling Capacity.** MEPS can vary depending on the cooling capacity, or a single MEPS is defined independent of the unit's cooling capacity. There are some advantages to have MEPS based on the capacity. Lower capacities have higher efficiency compared to the higher capacity units. More stringent requirements for smaller units yield higher energy savings.

- **Climate Zones:** Different climate zones in the same country can have different MEPS requirements in order to consider operation at different temperatures and variations in hours of use, or MEPS can be the same for all climate zones within the same country or region. Differentiating among climate zones allows regulators to consider locations with higher use of air conditioners where more stringent MEPS will yield higher energy savings and still be cost-effective.<sup>53</sup>
- **Refrigerant Requirements:** MEPS can include limits to the GWP of the refrigerant used or bans on specific refrigerants. Countries are advised against setting less stringent MEPS levels for air conditioners with low GWP refrigerants but to preferably set policy that prevents high and medium GWP gases being used in air conditioners or to have other incentives to promote air conditioners with low GWP refrigerants.

MEPS are not the only mechanism with which to achieve substantial energy savings from the use of air conditioners. Energy-efficient architecture, which considers orienting and designing buildings properly, adopting techniques and resources to protect walls and windows from direct solar radiation, and applying natural and efficient lighting, can reduce the cooling load of air conditioning systems and have a far greater impact reducing air conditioner GHG emissions than MEPS alone.

### MEPS and Refrigerant Transitions

Refrigerant transitions have typically been accompanied by improvements in energy efficiency. The Montreal Protocol, responsible for controlling ozone-depleting substances and with the Kigali Amendment also HFCs, funds refrigerant transitions through its Multilateral Fund (MLF).<sup>54</sup>

Energy efficiency improves during transitions. Manufacturers revise outdated designs using best practices and new components compatible with new refrigerants. The result is 'unavoidable technology upgrade' – by switching refrigerants, air conditioners become more efficient through better design and new components.

Manufacturers in developing countries are financially supported for adopting these improvements. The MLF funds the incremental costs for the conversion of production lines and pays manufacturers a proportion of the increased operating costs, if applicable, for a period of time.

Countries interested in establishing MEPS should consider synchronising new standards with Montreal Protocol phase-out activity to maximise the energy efficiency synergy explained above. For example, major agreed cuts in HCFC consumption will be required for all developing countries in 2020 and 2025. Setting MEPS compliance dates close to those dates will significantly ease the manufacturer burden of MEPS compliance. This will ensure the best environmental outcomes.

The Parties to the Montreal Protocol under the Kigali amendment have preliminarily agreed to leave open the possibility that the MLF may directly fund energy efficiency improvements while phasing down HFCs. Manufacturers in developing countries would be compensated for more than just 'unavoidable technology upgrades'. They would be eligible for reimbursement for some component upgrades made specifically to improve air conditioner energy efficiency. Stringent MEPS would reinforce the case for MLF-funded efficiency improvements, further maximising the synergy between refrigerant and efficiency improvements.

### 3.3 HARMONIZATION OF MEPS

If MEPS are to be adopted in a country or regional market, stakeholders should consider whether or not to harmonise with existing air conditioner MEPS in their region or with the air conditioner MEPS of a large market with which they have trade relationships. If a country in a trading region chooses to adopt MEPS not compatible with its neighbouring markets, this could be disruptive to the supply chain and may increase the cost of energy-efficient air conditioners for all parties. This could occur due to the added costs to manufacturers of needing to perform different or additional tests, creating unique labels and catalogue numbers for each market; and tracking, keeping inventory and shipping country-specific air conditioner products.

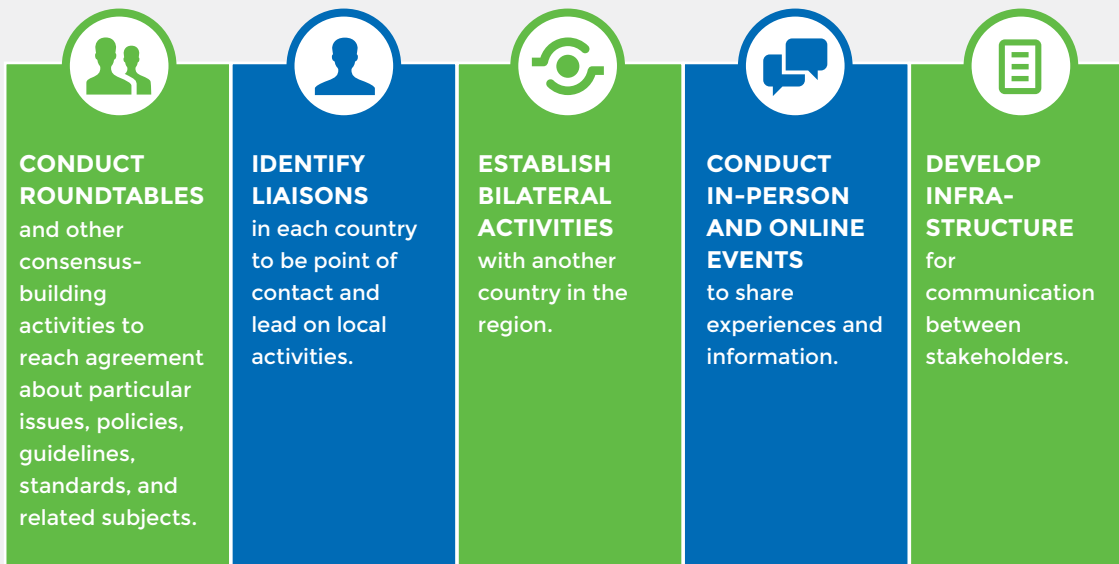
Harmonization of MEPS offers many benefits. It allows countries, private sector and consumers to avoid the costs of test duplication, and non-comparable performance information and requirements. Stakeholders benefit from the removal of this administrative trade barrier and are able to leverage the better prices and choice of goods associated with the larger economies to which they are harmonised. If countries have different requirements, it is difficult and time consuming for a manufacturer to carry out the necessary tests for each specific country. Harmonization enables multiple national markets to be accessible for the cost of only one test.

Achieving a transition to more efficient air conditioners through harmonization has limitations if levels are initially set too low (i.e. not stringent enough to increase performance), or too high (i.e. unattainable). For this reason, working within a region and with different organisations (e.g. government, private sector, civil society) can result in more effective outcomes.

Regional efforts should avoid harmonization at the lowest denominator and encourage participating countries to set MEPS levels nationally at a higher level. Regional cooperation can achieve positive results by sharing resources and information for energy-efficient air conditioners policies and programmes. Many energy-efficient air conditioners programmes are initiated each year at local, national and regional levels, which can inadvertently duplicate effort, conflict, or cause confusion. A regional cooperation initiative helps to coordinate such programmes so they do not conflict and achieve cost-effective results. An example of such a regional initiative and its framework is provided in Annex A under the ECOWAS Standards Harmonization Model (ECOSHAM) and Standards Harmonization Procedures.



For a successful regional cooperation initiative, consensus among the stakeholders is important. The following are some suggestions for promoting regional cooperation:



For promoting energy-efficient air conditioning, regional cooperation can include:

- **Develop a regional roadmap** for efficient air conditioners to identify areas of cooperation and ways to share resources and build regional markets for efficient air conditioners.
- **Establish or harmonise specifications or standards** that include energy performance and other criteria.
- **Coordinate around monitoring, verification and enforcement activities**, e.g. verification of labels, mutual recognition of test results, or sampling and checking MEPS compliance.
- **Expand and share air conditioner test facilities** to reduce costs, and build a network of professionals, with some countries potentially specialising in certain aspects of testing.
- **Establish and share regional resources** for environmentally sound management, including collection and recycling schemes, destruction of chlorinated or fluorinated refrigerants and information programmes.<sup>55</sup>
- **Pool resources and make use of the available structures and capacities** within regions to improve the effectiveness, mutual reinforcement, and synergy between the various country programmes, making them more cost effective and impactful.

Regional coordination and planning is also crucial for the success of projects that are large, complex, have cross-border and trade implications, or require addressing by more than one government.

## CASE STUDY: ASEAN SHINE Regional Air Conditioners' Harmonization Initiative

Association of Southeast Asian Nations' (ASEAN) SHINE aims at increasing the market share of higher efficient air-conditioners in ASEAN member countries through harmonization of test methods and energy efficiency standards, adoption of common MEPS, and changing consumer purchasing attitudes in favour of energy-efficient air-conditioners.

The initiative is achieving these goals through the following actions:

- Establishment of the EU-ASEAN Energy Efficiency Standards Harmonization Initiative
- Harmonization of standards for testing methods
- Development of harmonised energy performance standards for ASEAN countries and adoption of a regional policy roadmap
- Putting national policies in place to enforce the standards (MEPS), mobilising air conditioner manufacturers in support of the national policy, create awareness among end-users (households), creating an enabling environment for conformity assessment and market compliance, and having a time-bound plan for the progressive increase of MEPS over time
- Providing capacity building for testing laboratories and air conditioner manufacturers
- Engaging consumers via awareness campaigns.

For more information [click here](#).





## 4. SUPPORTING POLICIES

WHAT?	<p>This chapter outlines a range of product labelling, promotion, and communication and outreach activities. Product labelling explores the different label types, including endorsement and comparative. The communication discussion focuses on stakeholder empowerment through raising awareness and disseminating information.</p>
WHY?	<p>Provides information on supporting policies, the second part of U4E's Integrated policy approach, and which is critical for securing public support and accelerating the transformation of energy-efficient air conditioner markets.</p>
NEXT?	<p>Some key questions to keep in mind:</p> <ul style="list-style-type: none"> <li>• What appliance labelling schemes exist or have been tried in my country in the past?</li> <li>• Which type of label will be the most effective way to communicate appropriate choices to consumers? What criteria should be included on the label?</li> <li>• What other approaches could prove effective in my country?</li> <li>• Has our country convened an energy efficiency communications campaign in the past? If so, what worked and what didn't work? Or, are there lessons to be learned from other communications campaigns that could help?</li> <li>• Who would lead a national campaign in our country promoting clean and efficient air conditioners? What partners would be needed? What impact could it have?</li> </ul>



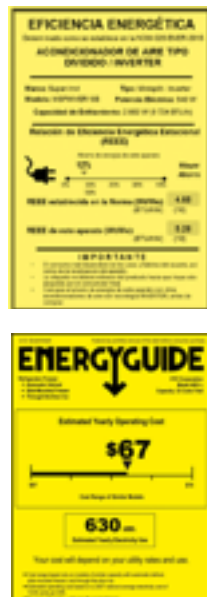

## 4.1 LABELLING

Product labelling is one of the most direct and effective means of delivering information about energy efficiency to consumers. Energy labels are also an important basis for other supporting and financing instruments, such as education, financial incentives (rebates, grants) and financing (loans), as well as green public procurement.

When implemented well, labelling is one of the most cost-effective energy-efficient policy measures. Labelling programmes are most successful if combined with other policy instruments, as defined in the integrated policy approach. Separate requirements to include energy label information in advertisements and different requirements under labelling for retailers, manufacturers and installers can exist.

There are, generally, three major groups of labels – endorsement, comparative and informative. Comparative labels have two major subgroups, continuous comparative and categorical comparative. Table 6 provides the categories and brief description of these four types of labels.

Labels should be designed for the needs, benefit and convenience of consumers. Market and consumer research should be conducted or focus groups should be convened when designing labels. These tools should be easy to understand and may be supplemented with additional user communications materials. An air conditioner label could include information on EER or SEER, and refrigerants in use. Regular review of the market and of labelling tiers is important to ensure continued impact of the energy label.<sup>56</sup>

TYPE	ENDORSEMENT LABELS	COMPARATIVE – CATEGORIES	COMPARATIVE – CONTINUOUS	INFORMATIONAL
INFO	For products that meet or exceed a specified set of criteria; recognises premium models in the market; including most efficient, or climate-friendly refrigerants	Facilitate comparison between products on energy or other performance aspect in a discrete set of categories	Similar to comparative – categorical, but replaces the A to G or Star rating with a continuous sliding scale	Provides data on product performance or attributes (e.g. capacity, sound) but doesn't attempt to scale or rank
SELECTION	Voluntary	Mandatory	Mandatory	Mandatory or Voluntary
EXAMPLES	Eco-Logo; Germany Blue Angel 	Ghana Star Label European A to G; 	Mexican Energuide US EnerGuide 	QR code 

**Table 6.**  
General types  
of product  
labels used  
around the  
world

The success of any labelling scheme depends on its credibility. Whether the public trusts the information on the packaging is crucial. Less reputable

companies may be tempted to abuse the label by claiming compliance while being unable or unwilling to invest in the necessary quality measures.

## 4.1.1 MANDATORY LABELLING

Mandatory labelling schemes are government regulations that require the placement of labels on products. These labels provide end users with information about the product's energy performance. This empowers end users to make informed choices and choose products with high levels of efficiency and quality. To develop and implement a mandatory labelling programme to its fullest potential, government officials and stakeholders must combine various features to develop or adopt a programme that is most suitable to their country's specific needs.

The market should also be assessed to determine whether a mandatory approach is suitable and implementable. The following common good practices can help ensure successful implementation of a comparative label:

- Setting the MEPS level at the bottom of the scale (where relevant)
- Where performance distribution is homogeneous on the market, using a geometric progression to differentiate labelling tiers - for example +20 per cent efficiency between two classes
- Setting (current) best efficiency class on the market beyond the middle of the range, leaving the top classes empty to raise ambition for future products coming to the market
- Aiming to have a limited number of products on the market achieving the second best class within a determined review period (based on estimates of technology progress) to reduce need for revision.

### Advantages:

- Provides consumers with relevant information on energy-efficient, high quality products
- Can serve as a basis for other instruments such as financial schemes, rebates, and subsidies
- Widespread recognition of a label provides a strong market incentive for energy efficiency
- Programmes accelerate the pace of market evolution and adoption of new highly energy-efficient technologies.

### Constraints:

- Significant investment in time and effort to build awareness with end users and retailers
- Mandatory programmes are more rigid than voluntary programmes and if they are poorly designed, they can create additional market barriers
- Requires transparent monitoring to ensure fair participation and effective enforcement
- Quantification of impact may be difficult since the impact of a programme depends on consumer awareness and market adoption.

## 4.1.2 VOLUNTARY LABELLING

Voluntary labelling programmes engage product suppliers who label their energy-efficient air conditioners to inform end users about product performance. Greater awareness of energy performance enables end users to make informed purchasing decisions and contribute to developing a stronger market for energy-efficient products.

Voluntary labelling is effective if combined with integrated awareness campaigns that demonstrate the benefits of energy-efficient air conditioners to purchasers and manufacturers. Only highly efficient and climate-friendly air conditioners are likely to be labelled because manufacturers and retailers have no incentive to label low-efficiency air conditioners. Voluntary labelling programmes can serve as an interim step toward mandatory programmes, particularly if a country is new to labelling or has limited resources.

### Advantages:

- Provides consumers with relevant information on energy-efficient, high quality products
- Can serve as a basis for other instruments such as financial schemes, rebates and subsidies
- Voluntary air conditioner labelling programmes are cost-effective means to encourage energy savings
- The resulting energy savings are relatively simple to quantify and can be easily verified
- Voluntary programmes require less legislation and analysis compared with mandatory programmes because they are non-binding and non-regulatory.

### Constraints:

- Requires a considerable investment in time and effort to build awareness with end users and retailers
- Requires a large investment to persuade manufacturers to participate, as non-participation can erode confidence in the programme
- Have a market sampling scheme to verify labelled products and ensure that labelled products perform as claimed.

## CASE STUDY: Voluntary Comparative Energy Label, Thailand

Thailand has been encouraging consumers to choose efficient products since the inception of its demand-side management programme in 1993, using the Thai No.5 Energy Label. Participating manufacturers can use the No.5 Energy Label on their products, which indicates the efficiency of the products rated from 1-5 (where 5 indicates very energy-efficient). The label also includes a QR code which links to a product database, and informs compliance activities.

Split type air conditioners have been a focus of the programme since 1995, requiring manufacturers and importers to test their products in order to affix the correct energy efficiency rating. In 2015 inverter-type air conditioners were added to the programme. The energy efficiency ratings on the label are rescaled over time in order to reflect market conditions and encourage innovation. The label includes the following features:



For more information [click here](#).





## 4.2 USING OTHER REGULATIONS TO ADDRESS AIR CONDITIONER ENERGY DEMAND

In addition to appliance energy performance standards and labels, energy demand from air conditioners can be optimised through improvements made to the building shell (insulation, low solar heat gains, passive cooling, etc.), to installation, and even using smart controls and thermostats to

make an air conditioner run most efficiently and effectively. There are many resources available to support these efforts, including the Sustainable Energy for All initiative's energy efficiency platform on building efficiency.<sup>57</sup>

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## 4.3 AWARDS AND CAMPAIGNS

Initiatives in the form of awards or campaigns can help incentivise innovation amongst air conditioner manufacturers. They offer a voluntary approach to engage industry and retailers in transitioning the market to more efficient air conditioners. These policies can serve as high-level platforms to showcase manufacturers' ability to meet consumer demand for feature-rich, energy-efficient products providing top-quality services while reducing energy costs.

Awards competitions or campaigns demonstrate the levels of efficiency possible today. They shine a spotlight on innovative new technologies that can further the boundaries of efficiency and slash energy consumption.

Awards can be granted in the form of endorsement labels to demonstrate "best in market," by either qualifying for a high-performance programme or winning competitions. In a competitive scheme, a programme specification is established. Suppliers enter the competition to ideally earn the accolade from participation and potentially winning the competition. The G-8's Clean Energy Ministerial established the Super-Efficient Equipment and Appliance Deployment (SEAD) Global Efficiency Medal in 2012 and has been conducting global competitions on various products, including lighting, televisions and electric motors.<sup>58</sup>

## 4.4 COMMUNICATION AND EDUCATION

Awareness raising campaigns support the promotion of and transition to more energy-efficient air conditioner technologies through good governmental policies and programmes. In addition to these, changes in end-user behaviour can also contribute to energy savings, by making end-users more “energy aware” through communication and education programmes. Changes in energy conservation, lifestyle, awareness, low-cost actions, and small investments will all contribute to the overall energy savings.

Communication campaigns should accentuate the positive. They should focus on the range of benefits and outcomes that end users will enjoy as a result of seeking out and selecting efficient air conditioners. Even programmes with effective MEPS and labels can fail if not complemented by a well thought out communications programme. Labels can prove fruitless if they are too complex and not well communicated to their users, both manufacturers and consumers.

When developing a communications campaign, it is important to consider:

- What are the barriers to take up of efficient air conditioners and what interventions can address these?

- Who is the target audience?
- What budget is available for communications efforts?

More information on designing a communications campaign is available in Annex B. Identifying what the barriers are will help determine what interventions are required, and to whom they should be targeted. For example, if consumers are not purchasing energy-efficient air conditioners, consumers will require more information through tools and buying guides; and retailers will require training to inform them. If consumers are not using their products effectively, electric utilities can provide tips and tricks to their customers on how to reduce energy consumption. If manufacturers or installers are unaware of the types of technologies available, they will require training to be able to acquire and build or install energy-efficient and climate-friendly air conditioners. Key audiences and valuable communication tools are outlined below.

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### 4.4.1 TARGET AUDIENCES

Correctly identifying the target audience for a communications campaign, and tailoring the messaging to that audience is critical. To succeed, efficient product campaigns should emphasise the benefits most relevant to their target audience, focusing on messages

including: monetary savings; national pride; energy efficiency and energy savings; convenience; environmental responsibility; political and economic advantages. Table 7 provides information on who these audiences are and their interests.

**Table 7.**  
**Communication**  
**campaign**  
**stakeholders**  
**and areas**  
**of interest /**  
**involvement**

TARGET AUDIENCE	PRIMARY INTERESTS	AREAS OF INVOLVEMENT
<b>INSTITUTIONS / GOVERNMENT</b> <ul style="list-style-type: none"> <li>• Government</li> <li>• Electric Utilities</li> <li>• Standards bodies</li> <li>• Customs authorities</li> <li>• Testing labs</li> <li>• Trade unions</li> <li>• National Ozone Officers</li> </ul>	<ul style="list-style-type: none"> <li>• Reduce electricity use and GHG emissions through efficient appliances</li> <li>• Ensuring efficiency standards and product quality in market</li> <li>• Development of new products and effective distribution</li> <li>• Training and certification system of technicians</li> <li>• Demonstrate advanced technology through pilot programmes and demonstration projects.</li> </ul>	<ul style="list-style-type: none"> <li>• Support regulatory/ legislative initiatives and policy implementation through available funding opportunities</li> <li>• Provide support to identify success factors for promoting efficient appliances and market transformation</li> <li>• Evaluate and monitor processes against established targets</li> <li>• Support government exchanges to ensure coordination between energy efficiency and refrigerant policymakers</li> <li>• Provide training, certification, and monitoring of servicing technicians</li> <li>• Lead and promote market penetration of highly climate-friendly and energy-efficient appliances through green public procurement programmes.</li> </ul>
<b>BUSINESS</b> <ul style="list-style-type: none"> <li>• Manufacturers</li> <li>• Industry associations</li> <li>• Wholesalers and retailers</li> <li>• Specifiers</li> <li>• Building owners and managers</li> <li>• Servicing technicians</li> </ul>	<ul style="list-style-type: none"> <li>• Promoting innovative, energy-efficient new technologies</li> <li>• Business prospects</li> <li>• Corporate responsibility</li> <li>• Reducing electrical consumption</li> <li>• Servicing best practice to ensure safety and optimise product performance.</li> </ul>	<ul style="list-style-type: none"> <li>• Facilitate (in)direct end-user communication</li> <li>• Key actors in promoting sustainable policies and transforming markets to efficient appliances</li> <li>• Provide best practice solutions at local, regional or international level</li> <li>• Provide guidance on technical feasibility and realistic time schedules</li> <li>• Provide information on good practice training to accommodate new technologies.</li> </ul>
<b>END USERS</b> <ul style="list-style-type: none"> <li>• Customers</li> <li>• Civil society</li> <li>• Consumer and community associations</li> <li>• Environmental organisations</li> </ul>	<ul style="list-style-type: none"> <li>• Acquire information to make informed decisions about the savings associated with a switch to efficient technologies</li> <li>• Promote energy-efficient products</li> <li>• Increased access to energy.</li> </ul>	<ul style="list-style-type: none"> <li>• Acceptance and utilisation of efficient appliances based on first-hand experience and affordability</li> <li>• Provide information on buying habits</li> <li>• Increase efficient air conditioner consumption; sustain change in consumption patterns</li> <li>• Use skilled technicians to service products for safety and performance.</li> </ul>
<b>MEDIA AND OTHERS</b> <ul style="list-style-type: none"> <li>• Media</li> <li>• Research and training institutes</li> </ul>	<ul style="list-style-type: none"> <li>• Increase awareness and develop knowledge about energy-efficient air conditioners among professionals and consumers.</li> </ul>	<ul style="list-style-type: none"> <li>• Disseminate information on energy-efficient air conditioners to consumers</li> <li>• Identify best practices and policies</li> <li>• Assist governments in implementing sustainable appliance policies</li> <li>• Publish education/training materials.</li> </ul>

## 4.4.2 EDUCATION, TOOLS AND TRAINING

A multitude of resources can be made available to educate, train and inform the different target audiences listed above. Decision makers will need to determine which approaches best suit their needs and fall within their budgets, but the most impactful programme would incorporate all approaches into long-term communications strategies.

The budgets for each approach can vary, depending on the extent of materials developed or campaigns launched; and whether existing resources are used or adapted, or whether they are developed specifically for a national market. The government or international donors need not be the sole investor in communications activities. They may be funded by industry, civil society, or educational institutions.

**Education** is typically geared toward informing consumers about the value of investing in energy-efficient appliances. If possible, it is recommended to investigate what impacts consumer purchase decisions to understand where and how to invest in educational communications. Developing low-cost guidance materials, such as providing buying guides in store may be sufficient.

In Ghana, for example, the government has invested in communicating energy efficiency messages through various media, such as adverts, billboards, radio, and through the most popular television show to get across the energy efficiency message to consumers.<sup>60</sup>

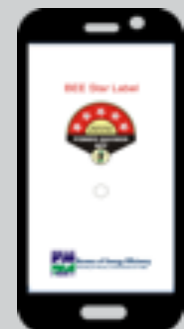
**Tools** such as online databases, mobile applications, energy saving calculators, “top product” websites<sup>61</sup> can be a very effective method for communicating the benefits of energy-efficient air conditioners and other products. Not only do these benefit consumers, who can access sufficient detail to make informed decisions on specific products; they can also serve as a valuable data collection tool for policymakers or competitive incentive to industry. While building up these tools from scratch might be costly, they offer strong value to government energy efficiency programmes. Various tools have also been developed to support developing programmes, such as the lites.asia prototype product registration system, which can be adapted for other products.<sup>62</sup>

### CASE STUDY: Communication Tools, India

India has developed a comprehensive set of communications tools, including a product database with a linked mobile application that users can easily use to check product energy performance at point of retail. Other countries, such as Thailand and Australia, have similar systems in place.

The Indian product database provides the gateway for manufacturers to register their products on the market and stay up to date with policies and government initiatives. Consumers can use both the database and the mobile application to compare energy efficiency and other features of products.

For more information [click here](#).



**Training** is an impactful measure to effect change to the supply chain when there is greater potential to transform the market before the product reaches the consumer. For example, manufacturers may require training on the latest innovative technologies; service technicians can be trained and certified to implement good practices for safe and efficient installation, operation and maintenance of air conditioners in consumer homes or businesses, and providing advice on

which units to purchase; retailers can be trained to understand the technical differences between air conditioners and communicate the benefits to their customers, the end users. Additionally, test laboratories can receive training to ensure they perform high quality testing to ISO or any other established national or regional standards. Funding for different types of training can be acquired from multiple sources, including government, industry, civil society.

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### **CASE STUDY: University Training, Mexico**

The Superior School of Apan, part of the Autonomous University of Hidalgo State in Mexico, trains engineering students interested in cooling and refrigeration technologies about the study, evaluation, calculation, design, operation and maintenance of refrigerating and cooling systems. The courses prepare students for the real needs of the refrigeration industry. For this reason, the National Association of Manufacturers of the Refrigeration Industry is a partner to the programme. Students visit their testing facilities and participate in conferences and other events to put their research skills into practice.

For more information [click here](#).

## 5. FINANCE AND FINANCIAL DELIVERY MECHANISMS

WHAT?	<p>This chapter addresses topics relating to the delivery of financing of energy-efficient air conditioners, including both sources of financing and implementation vehicles and mechanisms. Some of the topics covered in this chapter include overcoming first-cost barriers to market adoption, financing mechanisms, energy service companies, bulk public procurement schemes and electric utility Demand Side Management (DSM) programmes.</p>
WHY?	<p>Affordability of efficient air conditioners can be a market barrier, especially for low income residential consumers and municipalities. The energy consumed by air conditioners can also significantly contribute to peak load, which can impact not only on users of air conditioners but on all electricity consumers. This chapter addresses how public finance, multilateral development finance, and climate finance can help address this barrier through macro/micro financial schemes, innovative market delivery and repayment mechanisms, and other approaches to leverage private sector investments in these sectors, as well as demand response programmes to help manage electricity usage. Incentive programmes offer the possibility of tackling multiple barriers at once, including reducing peak load, removing inefficient products and high-GWP refrigerants from the market encouraging take up of energy-efficient and climate-friendly air conditioners.</p>
NEXT?	<p>Some key questions to keep in mind:</p> <ul style="list-style-type: none"> <li>• Which economic policies or financial incentive programmes could be effective in facilitating market transformation in our country?</li> <li>• Are there other barriers we should be addressing, through financing, replacement and demand response programmes?</li> <li>• Which stakeholders should we engage to learn about financing opportunities, and work to encourage the creation of new market delivery mechanisms?</li> <li>• What new market delivery mechanisms such as energy service companies, leasing schemes or other approach could be effective in our country?</li> <li>• Are there bi-lateral or multi-lateral sources of technical assistance, grants or finance which would stimulate and accelerate the efficient air conditioner market?</li> </ul>

Enabling a transition to energy-efficient air conditioners requires policy interventions and financial incentives. To transform markets countries need to overcome market barriers, increase local investor confidence, and mobilise private sector investments and participation. Governments can achieve this by raising awareness and establishing an enabling environment that addresses both infrastructure and stakeholder alignment, and facilitates the scaling up energy-efficient air conditioners and other technologies.

Identifying and securing financial resources to support a market shift to efficient air conditioners can be difficult for some countries and sectors such as low-income residential consumers and municipalities especially when these efficient air conditioners contain flammable refrigerants. In order to capture the full potential, public finance has to be used in a manner that maximises the leverage of private sector capital. Advanced planning and blending of financing sources with appropriate mechanisms is essential. This helps in managing the financial ecosystem, including risk- and cost-sharing arrangements.

Multilateral finance can further help in scaling up investments and expanding the impact. Such funding can be applied to develop MEPS as well as supporting policies like promotional schemes and rebates. Financing large-scale elements such as end-of-life recovery and recycling of used air conditioners could be sourced internally, through extended producer responsibility (EPR) approaches or other means.

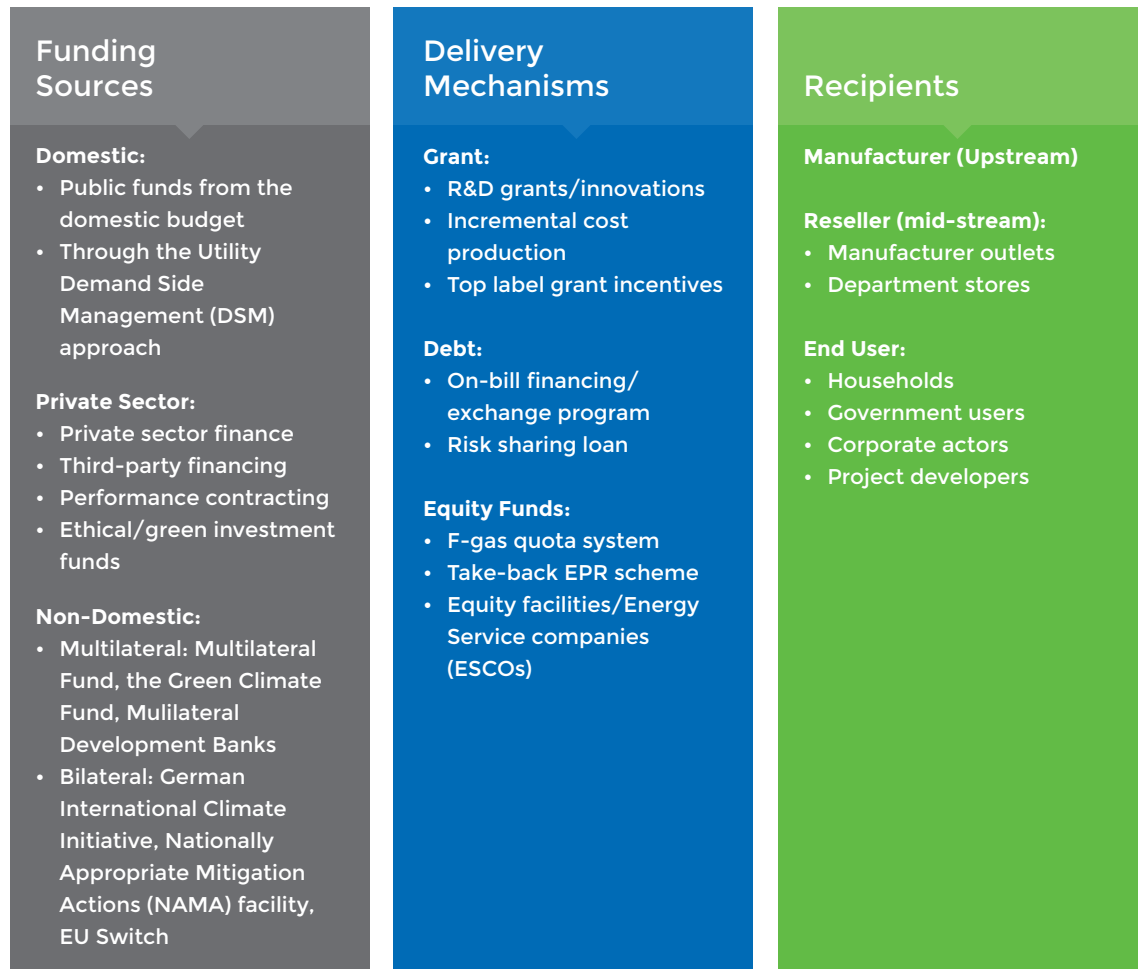
The high cost of meeting the increased energy demand from the growing number of air conditioners is a key driver for incentive programmes for air conditioners. Such programmes can address peak load on the electricity grid, improve energy efficiency of products, encourage the use of climate-friendly refrigerants, and ensure effective removal and replacement of inefficient products on the market.

There are a multitude of financing sources and delivery mechanisms that can be implemented to support the transition to energy-efficient air conditioners. Careful consideration is required to determine which are most appropriate for the national market.

Figure 8 summarises the different components of financing and delivery discussed in this chapter.

**Figure 8.**  
Funding sources, instruments and recipients of financing

Source: GIZ, 2016



## 5.1 SOURCES OF FINANCE

There are numerous sources of finance to help support energy efficiency programmes, particularly for countries that are resource constrained. This section briefly identifies some of the sources, and interested parties are directed to the U4E Fundamentals Guide, which provides an overview along with case studies and hyperlinks to various sources of finance for energy efficiency projects and programmes.

- **Domestic Sources of Finance**—the most direct way for governments to pay for energy-efficient air conditioner

programmes is to allocate public funds from the domestic budget. Another option is to involve electric utilities through the traditional Utility Demand Side Management (DSM) or Demand Response approaches, used to influence the electricity usage patterns of customers. The financial, technical, procurement capability and customer relationships makes utilities good partners to channel large scale financial incentives.



## CASE STUDY: Using Domestic Sources of Finance for Incentives, China<sup>65</sup>

To support the move to a higher level of efficiency, China's National Development and Reform Commission and the Ministry of Finance funded the "Promotion of Energy-Efficient Products to the Benefit of the People" programme from June 2009 to June 2013.

The programme had dual goals: boosting sales of home appliances to help the economy recover from the 2008 financial crisis and promoting energy-efficient products to "the benefit of the people." It encouraged consumers to buy energy-efficient products by lowering the up-front price of these products.

The programme also pushed manufacturers to modernise and improve production lines by offering an upstream subsidy. Over a period of 18 months, from June 2009 to December 2010, the central budget allocated RMB 16 B (\$2.4 billion) to subsidise more than 34 million energy-efficient room air conditioner units, 1 million energy-efficient cars, and 360 million energy-efficient light bulbs (China Energy label, nd-d). Air conditioners represented 72 per cent of the total budget, RMB 11.54 B (\$1.85 billion). The first round of the promotion programme ended on 31 May 2011; it was then extended to 1 June 2013.

For more information [click here](#).

- **Private Sector Finance**—commercial financial institutions are starting to understand the compelling aspects of energy efficiency. They are developing suitable financing mechanisms. The economics and financing of efficient air conditioning is attractive and offers air conditioning equipment vendors/suppliers and energy service companies (ESCOs) an incentive to invest in energy efficiency. Examples of private-sector finance include consumer credit loans to retail outlets dedicated to climate-friendly and energy-efficient air conditioners.
- **Non-domestic Sources of Finance**—some developing countries who do not have internal resources to finance technology efficiency improvements or large scale deployment programmes, may seek non-domestic sources of finance - e.g. World Bank, the Asian Development Bank, the European Bank for Reconstruction and Development. Non-domestic sources of finance can provide loans to governments (e.g. concessional funds) to help initiate phase-out programmes, raise investor confidence and attract private investors.
- **Climate Financing**—financing mechanisms designed to reduce CO<sub>2</sub> emissions provide grants and low-cost loans, which can be blended with other sources of finance to help scale up the implementation of energy efficiency programmes. Examples of climate financing include the Global Environment Facility (GEF), Clean Development Mechanism (CDM), Climate Investment Funds and the Green Climate Fund (GCF), and Nationally Appropriate Mitigation Actions (NAMAs). These financing schemes require measurement and verification of CO<sub>2</sub> emissions reduction in addition to energy savings.
- **Multilateral Fund**—in order to address the replacement of refrigerants in air conditioners, the Multilateral Fund (MLF) was set up to support implementation of the Montreal Protocol. The Fund provides financial support to developing countries to work toward the phase-out of ozone depleting substances, also encouraging positive energy efficiency outcomes, which include activities such as technical support for the national policy set up and enforcement, conversion of production

line to alternative based air conditioners, and training of servicing technicians. Industrialised member countries provide financial contributions to developing countries through the Protocol's Multilateral Fund. The multilateral fund provides financial resources to

implementing agencies (World Bank, UNDP, United Nations Industrial Development Organization UNIDO, UN Environment), and 20 per cent of their contributions can be provided through bilateral projects of donors.<sup>64</sup>

## 5.2 FINANCIAL DELIVERY MECHANISMS

Numerous delivery mechanisms utilise the aforementioned sources of finance to promulgate energy-efficient air conditioners. They have to overcome perceived risks from different stakeholders, thereby facilitating transactions that will lead to investments in energy-efficient, climate-friendly air conditioner programmes.

Efficient air conditioners are typically more expensive on a first-cost basis and less expensive throughout the life-cycle of the product. Financing schemes are a valuable tool for accelerating market adoption rates of more efficient products. The most impactful delivery mechanisms for air conditioners are those that are designed to capture wins in multiple areas, for example complimentary programmes focusing on reducing peak electricity demand, CO<sub>2</sub> and HFC emissions. Policymakers must carefully consider the barriers they are trying to

address before deciding which mechanism to adopt in their programme.

Examples of delivery mechanisms:

- Utility Demand Side Management, including On-bill financing; Rebates, etc.
- Energy Savings Performance Contracting through ESCOs, including Shared Savings, Guaranteed Savings and Annuity Based
- Bulk Public Procurement through Public Super ESCOs or Utilities
- Municipal Financing Delivery Model
- Public -Private Partnership Financing and Delivery Model
- New Business Models
- Trade-in or Replacement Programmes
- Microfinance
- Government Bonds and Tax Incentives.

### 5.2.1 UTILITY DEMAND SIDE MANAGEMENT

Utility demand side management (DSM) programmes offer effective solutions to address peak load and offer high returns on energy savings. On-bill financing refers to a loan made to a utility customer—such as a homeowner or a commercial building owner—the proceeds of which are then used by the utility customers to purchase new energy-efficient, climate-friendly appliances.

Typically, the utility customer pays off the costs of these new appliances through their

utility bill. An on-bill financing programme may be limited to particular types of customers, such as commercial building owners, commercial tenants, or residential homeowners. In most on-bill financing programmes, the loan funds are provided directly by the utility (or programme administrator), and the repayment risk is held by the same entity until the loan is paid off.<sup>65</sup>

### CASE STUDY: Demand Side Management Programme, India

In India, the Maharashtra Electricity Regulatory Commission was one of the first state regulatory commissions to adopt DSM regulations.<sup>66</sup> Reliance Infrastructure is one of Mumbai's DISCOMS, serving about 2.9 million customers. It provides discounted high-efficiency air conditioners for its commercial customers through a pilot programme, the Reliance Infrastructure 5-Star Split air conditioner scheme.

The Maharashtra Electricity Regulatory Commission approved the programme in October 2013, and it was launched in February 2014 with a two-year horizon. Its aims are energy conservation and providing value-added services to commercial-sector. Reliance Infrastructure customers. Air conditioners account for 60 per cent of commercial electricity consumption in Reliance Infrastructure's service territory. Reduction in peak electricity consumption is another important benefit of the programme.

See the Implementation Framework Regulations [here](#), and the Cost Effectiveness Assessment [here](#).



Source:  
SEAD, 2015

### CASE STUDY: Utility Demand Side Management Programme for Air Conditioners, Thailand

When the voluntary programme for energy-efficient air conditioners was first implemented by the Electricity Generating Authority (EGAT) of Thailand in 1996, a budget of 500 million Baht (~\$12.5 million) was invested in encouraging consumers to purchase air conditioners with a level 4 or 5 energy rating. Consumers were provided with interest-free loans of 5,000 Baht (~\$125) and 10,000 Baht (~\$250) respectively. Repayment of these loans was to be made within 20 months, through credit cards issued by banks participating in the programme.

Extensive interest-free loans from 5,000 Baht to 10,000 Baht and from 10,000 Baht to 20,000 Baht were also offered to customers purchasing air conditioners of 18,000 BTU upward labelled with energy efficiency ratings of 4 and 5 respectively. Again, repayment was expected within 20 months.

This extensive interest-free loan programme could only be implemented during February 1-28, 1998 due to the credit limitation policy of the Bank of Thailand to restore the economic recession of the country. The extensive interest-free loans were terminated and the initial approach was revived, but with repayments expected within a 10-month period.

In addition, to stimulate the market, a promotion bonus of 500 Baht (~\$12.) and 700 Baht (~\$17.) was also offered to retailers selling air conditioners with less than 18,000 BTU and 18,000 BTU upward with energy efficiency level 5 respectively. This campaign was implemented from time to time during January to April 1998.

For more information click [here](#).

Source:  
EGAT, 2016

## 5.2.2 ENERGY SAVINGS PERFORMANCE CONTRACTING THROUGH ESCOS

An ESCO is a commercial or non-profit business providing a broad range of turn-key energy solutions. These include energy audits, system designs and implementation of energy efficiency projects to commercial clients. ESCOs often act as project developers for a range of energy efficiency measures, assuming the technical and commercial risk.

The difference between ESCOs and other energy efficiency companies is that ESCOs use performance-based contracting, and their compensation is directly linked to the actual energy savings on the client site. Monitoring and evaluation is an important component of ESCO projects to verify that savings are achieved. They can help safeguard energy savings, particularly for developing programmes.

### CASE STUDY: ESCO Project for Air Conditioners, Indonesia

The Adi Husada ESCO in Indonesia undertook a project to retrofit old air conditioners by changing the refrigerants to hydrocarbons. The project managed to achieve energy savings and payback on the investment. As part of the project, an evaluation was carried out to measure the amperes of each retrofitted air conditioner before and after the change of refrigerants.

Source:  
Synergy  
Efficiency  
Solutions, 2016

Results showed a total savings of 22 per cent with a payback period of one year, with the air conditioners measuring at 451 Amps before the retrofit and 354 Amps after the retrofit.

## 5.2.3 TRADE-IN AND REPLACEMENT PROGRAMMES

Replacement schemes often take the form of direct rebates, where the purchase of new energy-efficient equipment is subsidised through a cash payment from the government to the customer, but trade-in can also be used as a condition for other delivery mechanisms. The principle is to replace inefficient air conditioners before the end of their useful lives with significantly more efficient, climate-friendlier air conditioners.

The advantages of this type of scheme are significant. Simple cash rebates may increase sales of efficient air conditioners

without necessarily taking the old appliances out of stock, as people tend to keep using their old appliances as second air conditioners, or they dump them, creating environmental concerns due to refrigerant leakage. This type of programme is eligible under the Montreal Protocol as it is an efficient way to ensure that appliances containing ozone depleting substances are properly decommissioned and recycled. These programmes are most effective if targeted to address both energy efficiency and refrigerants.

### CASE STUDY: Residential Sector Appliance Replacement Programmes, Mexico

In 2010, the Mexican government initiated a five-year Efficient Lighting and Appliances Project to increase the take-up of energy-efficient products, including air conditioners. The project was intended to lower household electricity bills; and to enhance energy security by avoiding new generation capacity, lowering fossil fuel consumption and reducing electricity subsidies.

Savings of over 9.5 TWh of electricity consumption were expected in 2015, while also improving standards of living for Mexico's poorer families. The project replaced a total of 1.6 million refrigerators and 200,000 air conditioners resulting in estimated savings of 2,590 GWh. The project, which was supported by a World Bank loan of \$251 million, had a total project cost of \$713 million (including consumer expenditures for more efficient appliances).

While innovative, lessons learned indicated the project resulted in a high rebound effect, with increased usage of the products by consumers. Requiring higher efficiency levels as part of the programme criteria could have bolstered the impact of the project.

For more information click [here](#).

Source:  
IEA, 2015 and  
SEAD, 2015

## 5.2.4 MICROFINANCE

Microfinance offers microloans to small businesses and households to help overcome the first-cost barrier to purchasing an energy-efficient appliance such as an air conditioner. Microfinance managers can link their loans to specific objectives, such as environmental protection, e.g. purchasing air conditioners that are both energy-efficient and use ozone friendly refrigerants.

This approach, often called “green microfinance,” is becoming more popular around the world, enabling action on challenges to the environment. Green microfinance is seen as a mechanism enabling microfinance institutions to achieve the triple bottom line: economic development, social inclusion, and environmental sustainability.

### CASE STUDY: Green Mortgage Loans, Mexico<sup>67</sup>

In Mexico, low-income households are being incentivised to purchase efficient equipment, including energy-efficient air conditioners, through the Program Infonavit Green Mortgage. The programme works by offering an additional loan to the mortgage loan specifically for the acquisition of energy-efficient equipment. The equipment must be more efficient than the minimum standards specified in the energy efficiency regulations. The amount of the loan is dependent on the monthly income of the recipient, who then pays back the loan along with the repayment of the mortgage loan.

The programme has been a success. In August 2016, the Mexican government announced plans to expand it under the Programme for Sustainable Integral Improvement in Existing Housing, run by the government-run Fideicomiso para el Ahorro de Energía Eléctrica (FIDE).

The programme will grant loans to low-income families to enable them to acquire more efficient and cleaner equipment, such as solar heaters, air conditioners, efficient lighting, windows, and more. The beneficiaries will receive a discount of up to 40 per cent of the cost of the efficient technology.

Source:  
Government of  
Mexico, 2016

## 5.2.5 GOVERNMENT BONDS AND TAX INCENTIVES

National government bonds and tax incentives offer an attractive deal for consumers and can be very cost-efficient from a public finance point of view. They can also target manufacturers. There are several different types of bonds that can be issued to promote investment in energy efficiency, including:

**(1) Tax Credit Bonds** – bond investors receive tax credits instead of interest payments;

**(2) Direct Subsidy Bonds** – bond issuers receive cash rebates to subsidise their interest payments; and

**(3) Tax-exempt Bonds** – investors avoid income tax on interest.<sup>68</sup>

These type of incentives stimulate the market, encouraging greater consumption of energy-efficient appliances, including air conditioners.

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## 5.2.6 LINKING PROGRAMMES WITH MULTI-LATERAL FUND ACTIVITIES

The MLF is encouraging the adoption of highly efficient refrigerant alternatives in products such as air conditioners. In addition, it is encouraging countries to

collaborate with other partners at the national level to promote the introduction of efficient alternative refrigerants that are adopted or introduced.



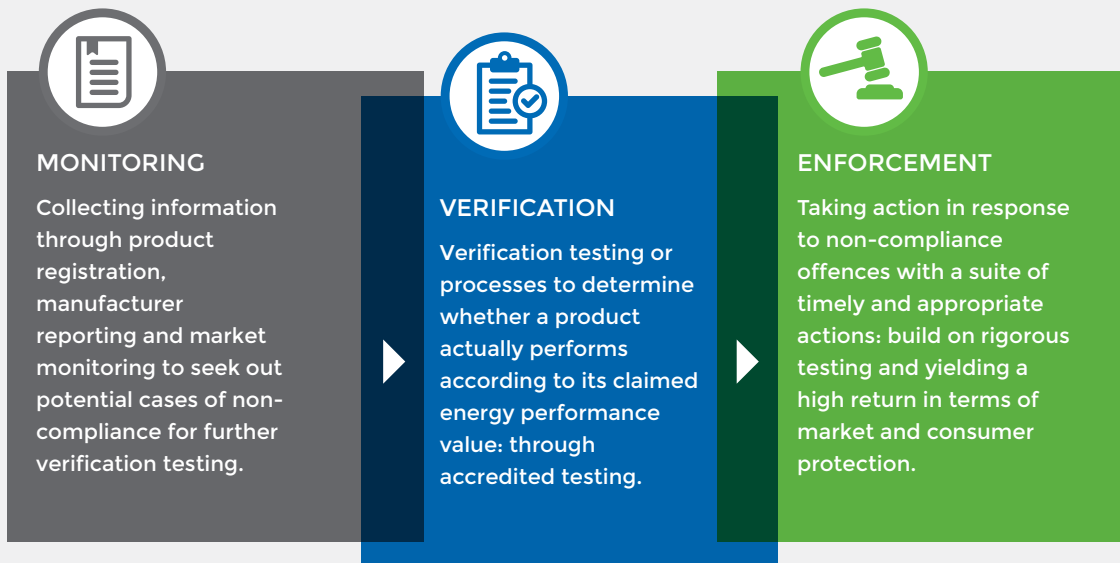
## 6. MARKET MONITORING, VERIFICATION AND ENFORCEMENT

WHAT?	Clarifies the critical importance of monitoring, verification and enforcement (MVE) to ensure a level playing field so businesses comply and consumers benefit. Highlights the centrality of government in establishing and maintaining a robust market surveillance programme.
WHY?	Just as police enforces the law and prevents crime, national governments should monitor, verify and enforce MEPS to ensure the policies and programmes that were created to transform their respective markets are followed. In the absence of MVE, policies and programmes would be implemented on a voluntary basis and, therefore, would be unlikely to have any impact. Robust MVE schemes are fundamental to achieving successful policy-driven market transformation outcomes.
NEXT?	<p>Some key questions to keep in mind:</p> <ul style="list-style-type: none"> <li>• How can market surveillance improve the effectiveness and impact of the regulations?</li> <li>• Do we have the legal framework around which to structure a complete MVE scheme?</li> <li>• Which government ministries oversee product safety standards and requirements? Could their function be expanded to include MEPS enforcement?</li> <li>• What are the costs and benefits of running a market surveillance programme?</li> </ul>



Market MVE is an indispensable component of the integrated policy approach. It revolves around monitoring markets, verifying

compliance and enforcing the regulation on companies that fail to meet them. Figure 9 highlights the fundamental aspects of MVE.



**Figure 9.**  
The market monitoring, verification and enforcement process

Effective MVE schemes ensure a level playing field, where manufacturers comply with standards and labelling programmes, enabling consumers and companies alike to benefit. MVE aims to ensure the integrity of market transformation programmes

by safeguarding the anticipated energy savings and environmental benefits; and by minimising the negative costs associated with the sale of non-compliant products after the effective date of a regulation.

## 6.1 PLANNING AND DEVELOPING AN EFFECTIVE MVE PROGRAMME

### Legal and Administrative Framework

When establishing a MVE scheme, it is important to have a strong foundation within the national legal framework encompassing legal authority, enforcement powers and penalties. The legal framework for an energy efficiency enforcement regime will depend on the national governance structure, on existing legislation and on the infrastructure and design of the MVE process.

Legal frameworks must clearly delineate responsibilities between the different

government agencies that implement MVE nationally. Including, for example, the agency responsible for coordinating the MVE scheme, and other agencies such as customs and standards/metrology that will have central roles.

The operational framework within which the enforcement authority operates should be as transparent as possible to improve compliance rates through clear communication and understanding of the MVE scheme.<sup>69</sup>

## Financing Monitoring, Verification and Enforcement Schemes

The costs of a national MVE scheme vary with the scope of the programme as well as local or regional factors, such as labour and services costs. In general, more resources are allocated toward addressing cases of non-compliance that have the greatest impact and occur frequently. Budget allocation should be a transparent, defensible, evidence-driven, and risk-based process.

The areas of an MVE scheme which incur costs include:

- **Establishment Costs**—setting up a main office and possibly field offices with new equipment<sup>70</sup>
- **Staff Costs**—hiring and training/capacity building the staff, covering key areas of administration, investigation and management and in specialist areas such as customs officials and test labs
- **Communications**—informing the market about the regulations, the MVE scheme and enforcement proceedings, as deterrence is highly cost effective
- **Legal and Enforcement Action**—the MVE agency needs to have (and be seen to have) sufficient funding to use its full range of legal powers.

The success of an MVE scheme will depend on identifying a secure and sustainable source of funding to carry out the scheme that will be maintained for a given market. Governments must assess what is equitable and feasible and construct a solution that will fit within their framework.

The most common source of funding is the government's own general operating budget. This does not need to be the only

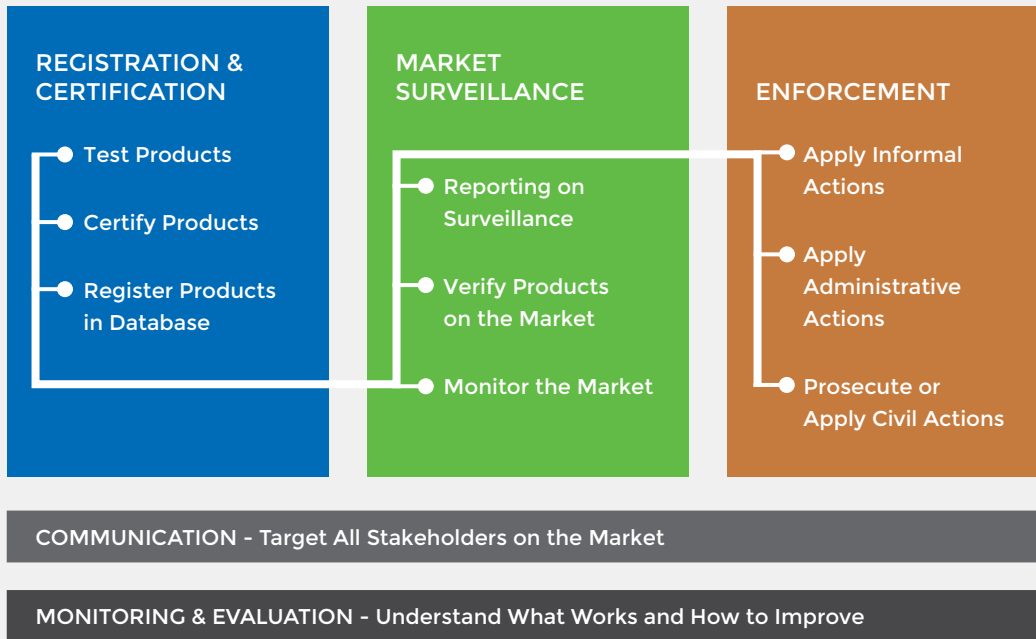
source of funding. Cost recovery from suppliers can also be another source, with many programmes around the world introducing cost-recovery elements to their schemes. Cost recovery can be partial or complete. It can be achieved through, for example, registration fees, certification fees, labelling fees, verification testing fees and enforcement fines.

Many programmes collect funds from suppliers during registration. This may take the form of an annual payment, a one-off payment for a specified period, or a higher initial fee followed by a smaller annual payment. Registration fees are generally levied on product models rather than brands or suppliers as this best reflects the costs involved. Australia, for example, charges a product registration fee based on the costs of testing the product. Air conditioners are the second most expensive product types to register based on their high costs of testing.<sup>71</sup>

Support for MVE schemes can also be derived from stakeholders in the market. Collaboration and cooperation with industry, civil society and other economies may provide additional resources, for example, through joint testing programmes, by providing expertise, supporting data collection and sharing, or even providing testing facilities. Prior to engaging in this form of collaboration, the cooperation goals need to be established. Some contributions may not be admissible as a foundation for legal action. For example, a conflict of interest in using industry funding to legally prove non-compliance of competitors in the market might exist.

## 6.2 IMPLEMENTING MONITORING, VERIFICATION, AND ENFORCEMENT STRATEGIES

There are typically three pillars to developing effective MVE strategies for ensuring compliance with product regulations (see Figure 10).



**Figure 10.**  
Key pillars of a successful compliance framework

Source:  
CLASP, 2015

## 6.2.1 REGISTRATION AND CERTIFICATION

### Compliance Certification

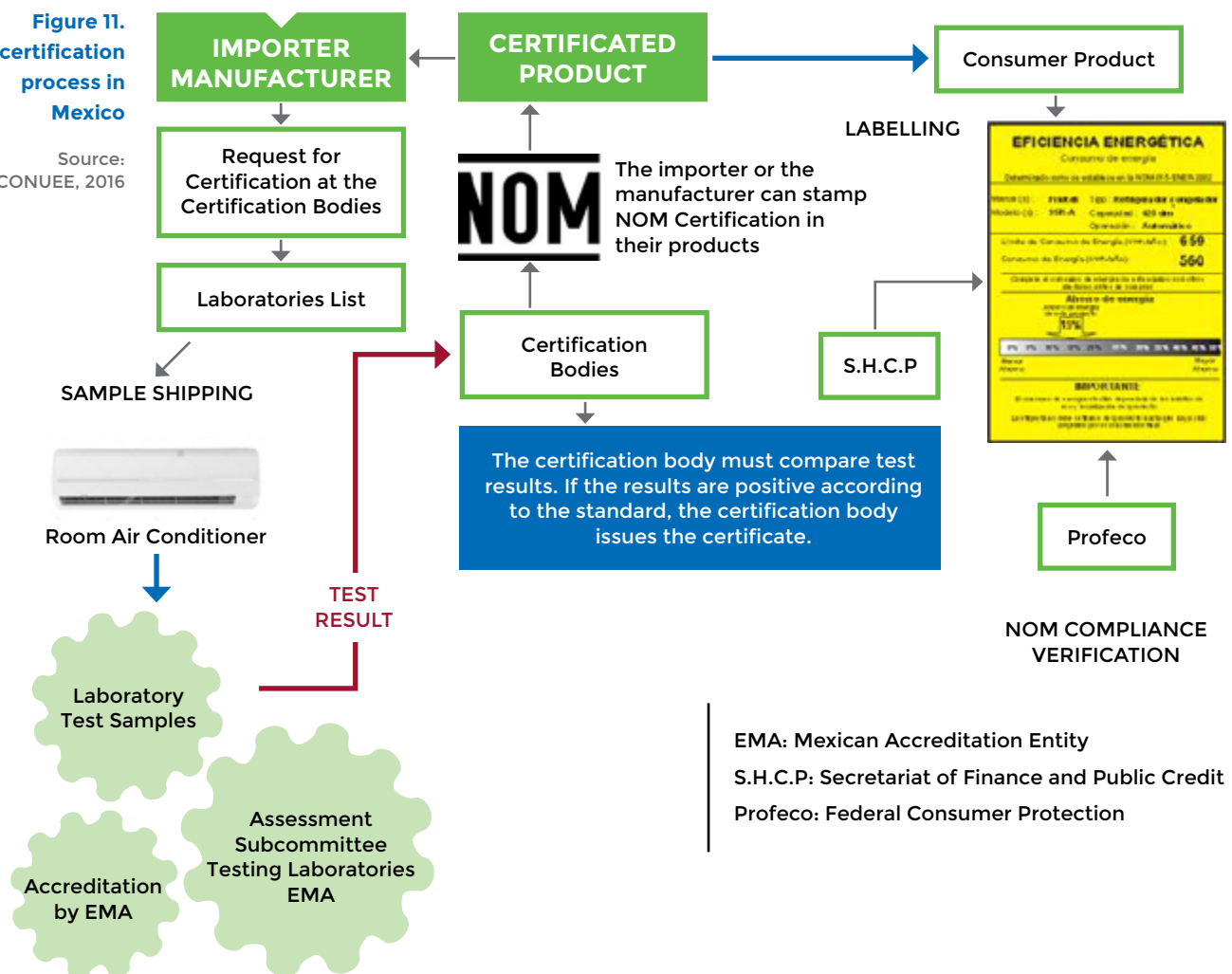
Suppliers and manufacturers of compliant products are given a mechanism by which to certify their products' compliance to the regulatory authority. Depending on the level of risk posed by the market or by the particular product, varying degrees of compliance certification, ranging from a self-certification or -declaration schemes to third-party testing can be required. Policymakers may discuss these compliance

certification options with the stakeholders in their country to determine the most reliable and cost-effective solution for them.

The certification process in Mexico is illustrated in Figure 11. The costs of certifying air conditioner products in Mexico are around \$8,000.<sup>72</sup> These costs include shipping, product testing costs, granting of appropriate documentation and certification.

**Figure 11.**  
The certification process in Mexico

Source:  
CONUEE, 2016



EMA: Mexican Accreditation Entity

S.H.C.P: Secretariat of Finance and Public Credit

Profeco: Federal Consumer Protection

## Product Registration Systems

Product registration systems offer an initial compliance gateway whereby suppliers register compliant products with the regulatory authority. The registration process usually requires manufacturers to report on annual sales per product type, submit test results for the products, and certify that the product performance meets the minimum energy performance standards (MEPS), and/or any labelling requirements, before the product can be placed on the market.

When governments set up product registration systems, they have to do so via legislative and/or regulatory authority. Mandatory and/or voluntary registration

systems are in place for products with MEPS or energy labelling in Australia, Canada, China, New Zealand, Singapore, Thailand and the US, among others.<sup>73</sup>

Registration systems can include information on energy performance data, technical product specifications, sales figures, and product prices. They are generally designed to meet the needs of many different stakeholder groups. They can be used by policymakers to support policy development and compliance tracking as well as communication; and to ensure level playing field with industry. Registration systems can also serve as a decision-making tool for consumers.<sup>74</sup>

## 6.2.2 MARKET MONITORING

One of the most critical functions of a government market surveillance authority is to conduct regular, on-going monitoring of the market to ensure the products being supplied to the market are compliant. The goal of this activity is to:

- Identify cases of non-compliance that are immediately visible (for example correct display of a label)
- Identify potential cases of non-compliance for verification testing
- Use monitoring results as a first step for engagement with industry to reach compliance.

The authority or other programme administrators are tasked with monitoring whether energy labels are accurately displayed on products, whether they meet MEPS requirements, and for checking refrigerant requirements. They can monitor products using different methods in different phases of the process:

- Upon certification or registration in **product registration systems**, checking product documentation
- **Screen testing** select products, to help target products for full verification testing
- **At customs**, ensuring all documentation for imported products is provided and meets requirements
- **In stores** to check energy labelling requirements are met
- On **online** retail websites, checking for energy efficiency information and labelling
- Via an enforcement **hotline** - monitoring consumer and competitor complaints
- Monitor results shared by other economies - **consider mutual recognition agreements**.

## 6.2.3 VERIFICATION PROCEDURES IN TEST LABORATORIES

Measurement of a product's performance provides the foundation for the effective implementation of energy-efficient air conditioner policies and regulations. Product testing constitutes the cornerstone of any product compliance certification report, whether for a voluntary or mandatory programme.

### Verification Testing

Verification procedures must be accurate and reliable in order to be enforceable. In some cases, multiple units of the same

model must be tested to prove non-compliance to an extent that enforcement action can be taken.

Testing air conditioner products can be expensive. Table 8 sets out a range of costs for testing air conditioners in different countries. Many variables and different requirements for number of products tested exist. The numbers in the table do not include the cost of product purchase.

**Table 8.**  
Costs of testing air conditioners in different regions

Source:  
U4E Air  
Conditioner  
Taskforce  
Contributions 2016

COUNTRY	COSTS OF TESTING (\$)	AIR CONDITIONER TECHNOLOGIES
AUSTRALIA	6,000	N/A
MEXICO	1,000	Inverter and non-inverter
	800	Mini-split and multi-split
	1,000 - 1,600	Variable
	1,600	Central
GHANA	2,200	Room
	5,500	Central
VIET NAM	1,500	Inverter (lower cost for non-inverter)

Careful consideration should be given to the verification-testing process as the costs involved for testing can be high. In some regions, specific procedures are set out to define how verification testing should be carried out to check for non-compliance with the regulations.

### Test Laboratories

Laboratories are expensive facilities to establish, commission, earn accreditation and maintain. Setting up test facilities for air conditioners is expensive, given the costs of testing equipment.

A certain minimum level of business generated by the market is needed to sustain the laboratory and ensure it has adequate revenue to operate. For countries with smaller economies, it may make sense to look at outsourcing their laboratory test needs to neighbouring countries or other entities until their economy grows, and they are able to justify direct investment in a domestic facility. One option is to encourage testing collaboration opportunities through mutual recognition agreements between governments, governments and test laboratories, and between test laboratories in different countries or regions.



### Test Laboratory Costs

Costs of setting up a laboratory for air conditioners include:

- Test equipment, including temperature controlled and psychometric chambers, calorimeter method and computer equipment
- Staff training
- Equipment maintenance (calibration).

**Total for first year: \$1 – 1.5 million**

Source: Based on estimates from Thailand and Viet Nam taskforce representatives in the U4E AC Taskforce

### Mutual Recognition Agreements

Establishing new accredited test laboratories or accrediting existing test laboratories in countries with no existing test facilities can support both the testing needs of the growing national appliance market and the requirements of the MVE process. Global manufacturers often sell their products on multiple markets and therefore have their products tested at least once (if not multiple times for different markets). These tests are often carried out in well-established and accredited test laboratories that are accredited by either national, regional, or international accreditation bodies, such as the International Laboratory Accreditation Cooperation.

Authorising the use of mutual recognition agreements (MRA) to accept foreign tested reports or results of tests is recommended. This reduces the burden of testing on government, importers, manufacturers, and test laboratories.

A MRA is a multilateral arrangement between one or more economies to mutually recognise or accept some or all aspects of another's conformity test

procedures such as test results and certification.<sup>75</sup> They provide conditions for one institution to accept conformity assessments for either certification or verification testing from another institution.

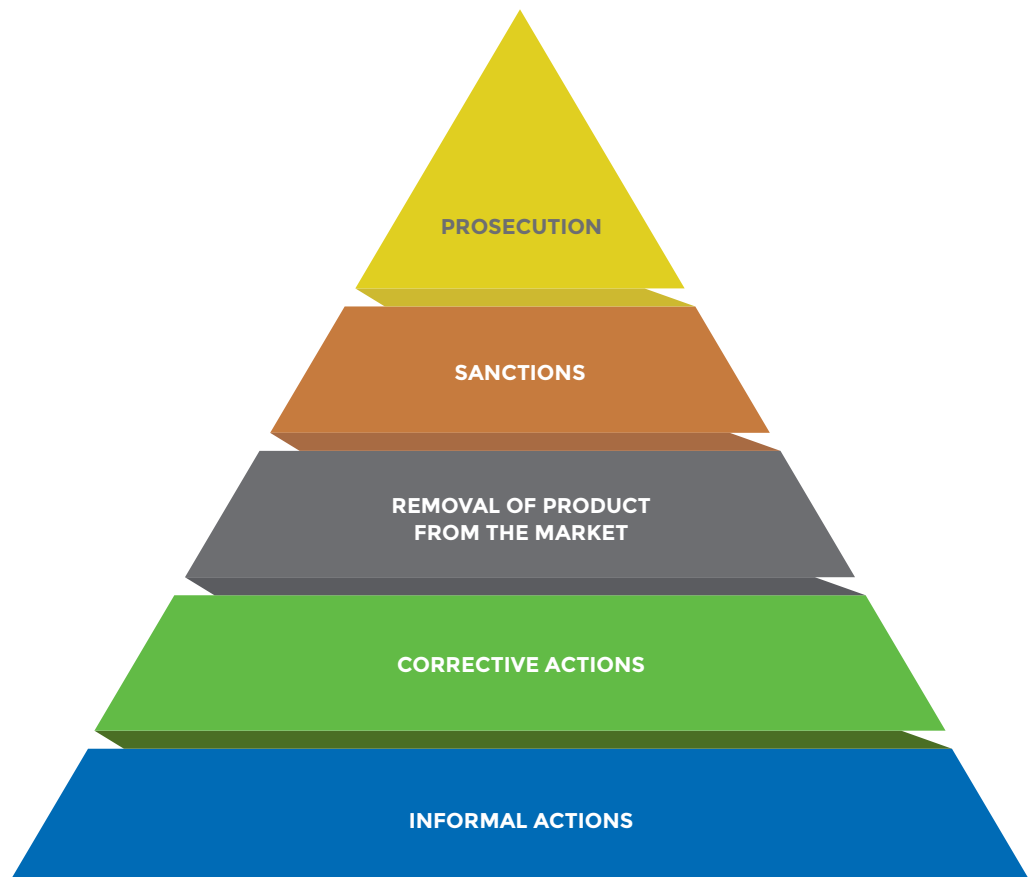
MRAs enable regulatory authorities to trust test laboratories (or conformity assessment bodies) that have not been directly approved or accredited by them but have been tested by their counterparts in other economies. In doing so, they can recognise test reports and certificates issued by these test laboratories or conformity assessment bodies, with the understanding that they are competent enough to assess products as conforming to the national standards and requirements.

MRAs simplify and promote cross-border trade for products that have to be tested and inspected in each market by facilitating access to each market. MRAs reduce or eliminate the delays and costs of multiple or duplicative testing, thereby enabling manufacturers and importers to market their products faster, while reducing their costs. The costs to the consumers may also be reduced.

## 6.2.4 REGULATORY ENFORCEMENT

Enforcement authorities are recommended to consider the degree of non-compliance when addressing cases of non-compliance in order to respond with a proportionate enforcement action. The available enforcement actions should be flexible, enabling the enforcement authority to assess the non-compliance situation and initiate a proportionate action. For this reason, the penalties and powers of the enforcement authority should be set out in law. The toolkit of powers and actions should be further outlined in administrative procedures or operational guidelines.

Many enforcement authorities develop an “Enforcement Pyramid” to inform and manage their enforcement response strategies (see Figure 12). The pyramid can be populated to be most effective for the national enforcement strategy, in accordance with the legal requirements and resources available to the enforcement authority, and the characteristics of the programme and its participants and stakeholders. The bottom of the pyramid features more informal actions, and the top of the pyramid the most severe enforcement response to non-compliance.



**Figure 12.**  
Pyramid of  
escalating  
enforcement

For more information on effective enforcement schemes, please see a recent UN Environment report<sup>76</sup> that serves as a practical resource to policy-makers on the steps to follow when implementing a national enforcement programme.



## 6.2.5 PROACTIVE COMMUNICATIONS

Communication is a critical element of any successful MVE scheme. It helps manufacturers to ensure they are aware of their legal obligations, and what happens if they were found to be non-compliant. It lets consumers know their government is working hard for them, ensuring the national market for a given product offers a fair and level playing field. Communications can also be a powerful tool in gaining the respect of the regulated businesses, and improving compliance rates. For example, taking quick action to minimise market damage and making it visible, as a deterrent to others.

Governments need to develop a communications plan to achieve these goals. It should be fine-tuned and appropriate for the domestic market, taking into account all the main stakeholders involved in the supply chain. It should also include key messages about the requirements themselves, the risk of detection and sanctions, and any corrective action taken.

Governments may choose to list the number and frequency of surveys and tests, identify plans for future compliance work and publish information about their work. Some governments may also consider identifying products and brands that are non-compliant (also called the 'name and shame' approach) (See Figure 13 for an example).

Governments can also offer a number of tools, training and guidance that help to improve rates of compliance. They can, for example, offer training courses that explain the regulatory requirement; maintain a regulatory hot-line/email service to answer suppliers' questions, publish a frequently asked questions (FAQ) website, or provide guidance on compliance reporting and documentation requirements. All of these approaches will help to minimise the costs of demonstrating compliance and will help to ensure higher compliance rates and more successful outcomes.



**Figure 13.**  
Public notifications of non-compliance

### In India - Advert in the Hindustan Times

BEE notifies consumers about manufacturers' products that have failed random check-testing

## CASE STUDY: Market Surveillance Mechanisms for Air Conditioners, Viet Nam

Viet Nam's compliance mechanisms are intended to safeguard the anticipated benefits of the national labelling programme. Market surveillance efforts around retailers and manufacturers take place once a year, led by the Departments of Industry and Trade at the local provincial level.

Market monitoring ensures all eligible products are registered, and that the energy efficiency labels are placed correctly on products at the point of sale. It is the vendor's responsibility to ensure product labels are not misused or wrongly placed.

Verification testing is carried out to ensure the product's energy performance meets the declared values. Products are randomly selected from the market, and tested by designated laboratories. Manufacturers are responsible for the transportation of samples to the testing facility. The monitoring and surveillance activities are carried out by the Air Conditioning & Refrigeration Technical Science Association (VISRAE). Challenge testing can be carried out based on complaints filed towards products.

The provincial level Departments of Industry and Trade are also responsible for enforcement. Where a product is deemed non-compliant, the manufacturer is faced with various consequences including: educational initiatives; product confiscation; fines; termination of labelling or withdrawal of label certificate; compensation to adversely affected persons; or formal court enforceable undertakings.



Source:  
CLASP, 2015

For fraudulent use or misuse of labels, punitive actions are taken against both retailers and manufacturers. They are penalties of \$2,200 - \$3,100 or termination of label use.

For more information click [here](#).

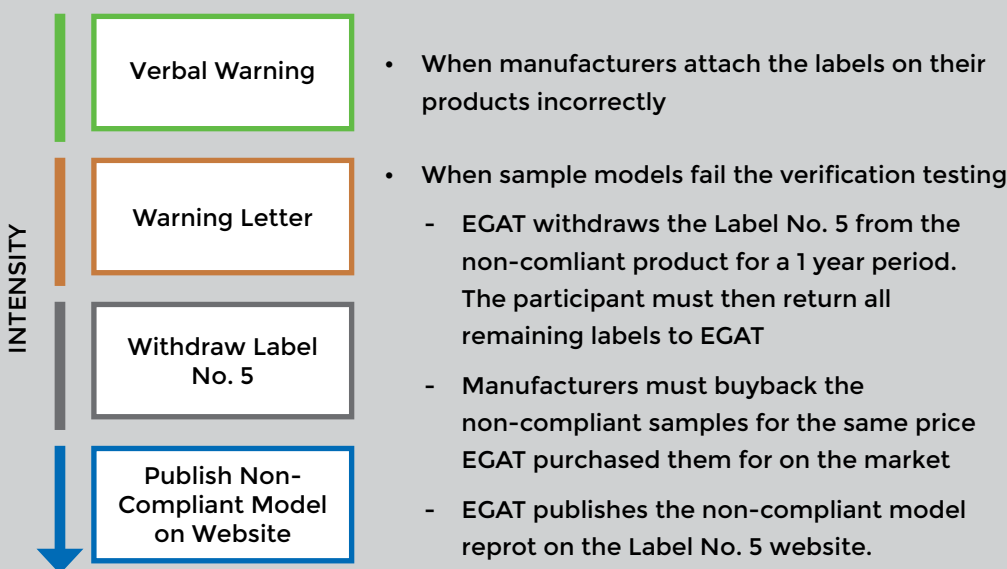
## CASE STUDY: MVE Scheme for the Voluntary Labelling Programme, Thailand<sup>77</sup>

The Electricity Generating Authority of Thailand (EGAT) is responsible for maintaining the credibility of the voluntary labelling programme and for protecting consumer rights. MVE implementation, carried out by a separate unit in EGAT to ensure credibility of the programme, has been ongoing since 2005. EGAT has assigned the Electrical and Electronics Institute (EEI), an accredited laboratory, as the programme's official testing laboratory.

As part of the market surveillance process, on an annual basis the highest rated products on the market (Energy Label No.5) are randomly tested to check for accuracy of the label. Concrete sources of funding are required for effective MVE implementation, and EGAT budgets approximately 5 million Baht (~\$166,000) yearly towards market surveillance activities, including testing.

Any appliances that fail to meet the claimed efficiency rating will be stripped of the label or have their efficiency rating level lowered. They are then prohibited from using the high rating in any information materials or adverts. Results of non-compliance are communicated via the [Energy Label No.5 website](#) and via the mobile app, accessed via the QR code on the energy label.

### Enforcement for non-compliance



As a voluntary labelling scheme, there is no law and regulation to support the MVE processes so penalties for non-compliance are not fully enforced. As a state-owned enterprise, some of EGAT's regulations do not support the MVE system, which requires more flexibility and efficiency in randomly purchasing products.

For more information click [here](#).

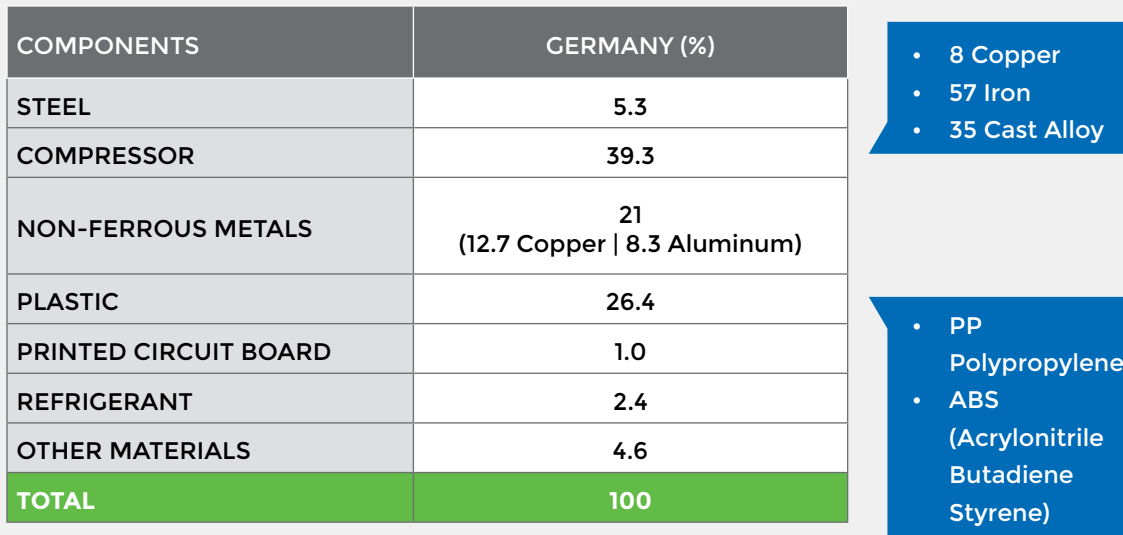


## 7. ENVIRONMENTALLY SOUND MANAGEMENT

WHAT?	This chapter provides a summary of the importance of recycling of used air conditioners, the benefits of collection and recycling and possible financing mechanisms.
WHY?	Air conditioners contain materials that can be recycled/recovered/reused, as well as some materials that could be hazardous if simply dumped in a landfill. The refrigerants used by air conditioners can have major impacts on the climate as some are potent greenhouse gases and thus require appropriate end-of-life treatment. By establishing a national collection and recycling scheme, a “circular economy” objective can be achieved.
NEXT?	<p>Some key questions to keep in mind:</p> <ul style="list-style-type: none"> <li>• Are there regulations in our country to manage electric and electronic waste and in the use of hazardous substances?</li> <li>• What waste collection and recycling schemes are already being conducted in our country?</li> <li>• Who are the critical stakeholders who would need to be informed and/or participate in planning an air conditioner equipment recycling scheme?</li> <li>• What are the financial requirements of such a programme and how can we find the resources to cover them (which approach will work best in our country)?</li> </ul>

Environmentally sound management incorporates the concept of a product's full life-cycle - from raw materials used in manufacturing through to end-of-life recovery and recycling. This approach gives regulators a suitable framework to analyse and manage the performance of goods and services in terms of their impact on the environment.

Some of the raw materials found on a typical air conditioner include steel, copper, aluminum, plastics, the refrigerant and others (See Figure 14). Applying life-cycle management principles to air conditioners would consider impacts of those materials in the product's full life-cycle.



**Figure 14.**  
Typical components of an air conditioner

Source:  
HEAT/ Wallek,  
Example from  
Germany, 2016

A life-cycle assessment usually concentrates on the following three stages:

- **Production:** focuses on the raw materials and production techniques involved in manufacturing the product, including hazardous substances. The production phase is a natural point of intervention for hazardous substance regulators in the product life-cycle. For example, harmful substances such as antimony, beryllium, cadmium, chlorine, brominated flame retardants and lead in solder can be found in printed circuit boards in air conditioners. The composition of the refrigerant used in the air conditioner, determined in the design phase, can have major impacts on the environment depending on its GWP.
- **Usage:** focuses on the environmental impact of air conditioners during the use phase. The operation of air conditioners results in indirect emissions (from electricity generation) and direct emissions (from refrigerant leaks and improper service and maintenance practices).
- **End-of-life:** focuses on the end-of-life management of air conditioners, highlighting current regulatory frameworks, examples of best practices in establishing, managing and financing end-of-life collection; recycling and environmentally sound management; and disposal. Harmful substances and refrigerants contained in air conditioners require special treatment at the end of life.

Optimisation across these stages requires minimising the environmental impacts that occur during each stage. The phase-out of inefficient air conditioners is an effective intervention from a "use" point of view, because it can offer a significant reduction in energy consumption; and, therefore, prevention of climate change through avoided GHG emissions and traditional pollution from fossil fuel power stations, such as air - and water pollution.

Use of climate-friendly refrigerants can avoid additional emissions during the operation, service, maintenance, and end of life of air conditioners. Training for service technicians to measure leakage can reduce direct emissions during the lifetime; and proper end-of-life treatment will prevent releasing additional emissions into the atmosphere when disposed of.

An integrated policy approach that follows the principles of pollution prevention

and environmentally sound management includes maximising energy efficiency from air conditioners and minimising GHG emissions from refrigerants at the design and manufacturing stages, while ensuring the sustainable management of used air conditioners. The Waste Electrical and Electronic Equipment (WEEE) Directive in the EU is an example of how the producer responsibility principle has been included in regulation.<sup>78</sup>

Five elements need to be taken into account in the implementation of environmentally sound management:



## 7.1 POLICY AND LEGAL FRAMEWORK

In order to have a national programme that is required and enforceable, governments must have a legal framework for electronic waste and hazardous waste management, as well as banned substances under international treaties such as the Montreal Protocol. This encourages the development of initiatives in the country or region for relevant international conventions.

The Montreal Protocol, signed in 1987, was designed to reduce the production and consumption of substances that deplete the ozone layer, including some refrigerants used in air conditioners. Hydrochlorofluorocarbons (HCFCs) will be phased-out globally by 2030.<sup>79</sup> The Kigali

Amendment adds hydrofluorocarbons (HFCs) to the list of substances controlled under the Protocol to be phased down.

Some economies already have implemented bans or regulations to phase down HFCs at a regional or state level. The EU F-gas regulation (2014)<sup>80</sup> will reduce allowable HFC sales to 79 per cent by 2030 against the baseline years 2009-2012 based on the GWP weight of the refrigerants, and will result in cumulative savings of 5 Gt CO<sub>2</sub> equivalents by 2050. California also released a proposed strategy that includes a ban on new air conditioning equipment using HFCs with GWPs of 750 or above starting in 2021.<sup>81</sup>

## CASE STUDY: HCFC Phase-Out Policies, China

China started implementing policies regulating ozone-depleting substances (ODS) in 1999. In 2010, the State Council formally approved the “ODS Management Regulation” which aimed to reduce and ultimately phase-out ODS. The regulation became effective on June 1, 2010. The legal basis for this regulation is the “People’s Republic of China Law on Prevention and Control of Atmospheric Pollution” first published in 2000.

Ministry of Environment is the principal national department responsible for this regulation. Other departments such as the State Council and the General Administration of Customs also have responsibilities in enforcing the regulation.

The regulation sets the legal framework for production, sales, consumption, import and export of ODS. It also includes the framework of supervision and inspection for ODS, as well as legal responsibilities of non-compliance. Under the ODS Management Regulation, a suite of various policies are in place to ensure the effectiveness and coverage of the regulation (Table 9).

		YEAR	
ODS MANAGEMENT REGULATION		2010	
ODS IMPORT AND EXPORT (I&E) MANAGEMENT		ODS I&E Permission	1999
		ODS I&E Permission (Amendment)	2014
HCFCs QUOTA MANAGEMENT	Production Sector	Production Quota Management	2012
		Sales Registration \ Data report	2012
	Consumption Sector	Consumption Quota Management	2012
CONTROL OF NEW PRODUCTION LINE		Circular on controlling the new HCFCs production line in production sector	2008
		Circular on controlling the new production line using HCFC in consumption sectors	2009
		Control on production line with HCFC as raw material	2015

**Table 9.**  
List of policies on ODS in China

Source:  
Zhong, 2016

Policymakers should consider regulations that limit the GWP of refrigerants used in air conditioners, in line with the international best practice standards, and agreements made by the parties under the Montreal Protocol and other international treaties.

Raising awareness among consumers about high-efficiency, climate-friendly air conditioners will help guide their purchasing decisions while verifying their compliance will minimise climate impacts.

When introducing new air conditioner-related laws, regulators should ensure adequate compliance with existing safety laws, for instance, the use of flammable refrigerants. International standards such as ISO 5149 and IEC 60335-2-40 introduce risk-reducing safety measures for the use of flammable refrigerants.

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## 7.2 INSTALLATION, SERVICE, AND MAINTENANCE

Proper installation and maintenance of air conditioners requires that installers and service technicians are trained to ensure the safe handling of flammable refrigerants and to reduce leakage during operation of air conditioners. Governments or industry bodies may set up schemes for certification of technician training, considering best practices for applying, handling and working with refrigerants.

A guidance for the proper setup of a training scheme for installers and maintenance technicians has been developed by GIZ.<sup>82</sup> The new European F-Gas Regulation (EU) No. 517/2014 requires mandatory training for

certifications handling F-Gases. Additionally, training on the use of F-Gas alternatives must be included in technician training.

In order to avoid safety hazards from the leakage of flammable refrigerants or emissions from the leakage of high-GWP refrigerants, manufacturers are offering refrigerant leak detection systems, such as sensors capable of detecting concentrations at low levels and network capabilities that allow monitoring and notification on real time. The sensors are mostly available for commercial systems but can monitor HCFC and HFCs.



## 7.3 END-OF-LIFE

### 7.3.1 COLLECTION SCHEMES

Improper handling, collection, storage, transportation or disposal of hazardous materials and waste can lead to the release of pollution that can persist in the atmosphere, soil and water. Collection and recycling programmes are important to ensure that used air conditioners and their components are treated and disposed in an environmentally sound manner and that the

large numbers of air conditioners in stock which already use high-GWP refrigerants would be recovered, treated and disposed. In addition, collection schemes can promote the recovery of other materials found in end-of-life air conditioners such as aluminium and copper that can have a higher value in the market.

#### CASE STUDY: “Old-for-New” Appliance Replacement Programme, China

From June 2009 to December 2011, the Chinese government implemented a national “Home Appliance Old for New Rebate Programme” which covered five products including air conditioners, televisions, refrigerators, washing machines and personal computers.

The objectives of the programme were 1) to stimulate domestic economy and spending; and 2) to improve resource utilisation, reduce environmental pollution, and promote the development of a circular economy.

The programme was first launched as a pilot in nine cities and provinces and later expanded to 28 cities and provinces. By trading in their old appliances to authorised collectors including home appliance retailers, chain stores, supermarkets, or waste collection companies, consumers could receive 10 per cent of the retail price of new appliances up to a maximum amount.

This programme successfully improved the recycling rate of appliances by appropriate collectors, avoiding significant environmental risks by inappropriate recycling and disposal of appliances.



Source:  
United Nations  
University -  
Institute for  
Sustainability  
and Peace,  
2013

## 7.3.2 RECYCLING AND DISPOSAL PROGRAMMES

Approaches for the environmentally sound management of used air conditioners should be coupled with technologies capturing and disposing of refrigerants. Further processing to recycle other components is

not only manageable but affordable under the appropriate system. Regulators can explore and adopt approaches encouraging the collection and recycling of used air conditioners.

### CASE STUDY: National Appliance Replacement Programme, Mexico

The Government of Mexico ran a replacement programme for room air conditioner units under the Programa Nacional de Sustitución de Equipos Electrodomésticos. Old air conditioners were collected from consumers and sent to scrapping centres for dismantling and recovery of the refrigerants, a “mandatory replacement” that ensured participating households did not continue to use the old product or sell it on the secondary market.

A budget of approximately \$30 per unit was added for collecting and recycling costs. The old units were transported to one of the 98 authorised collection and dismantling centres, where appliances were dismantled and the recovered metal and plastic were sold.

The scrapping centres are responsible for disabling the equipment by breaking compressor terminals, cutting evaporator and condenser coils, and destroying electric motor controls. The centre is also responsible for the environmental sound management of both used oil and refrigerant gas in accordance with the provisions and regulations established by the environmental authorities (Secretaría de Medio Ambiente y Recursos Naturales, Secretary of the Environment and Natural Resources).

Source:  
SEAD, 2015

These approaches should be adapted to national conditions. If effectively designed and managed, they can also create jobs in collection and recycling. Extended producer responsibility systems where all stakeholders share in the responsibility have proven to be most cost-effective. These systems can be funded in various ways, depending on country conditions and resources.

In countries where HFCs are recovered, they are either destroyed or subject to reclaim. Reclamation means processing recovered refrigerants to new products and verifying

by analysis that new product specifications have been met. The refrigerants can be sold as “virgin” material afterward.

However, the refrigerants need a purity of 99 per cent for reclaim. When different refrigerants are mixed in a cylinder, they cannot be treated and will be forwarded to final destruction. The only way to reuse mixed refrigerants is “cracking,” relying on a distillation process, for which there are only a few providers worldwide. Destruction costs generally represent the smallest financial burden of HFC management.

## 7.4 FINANCING OF END-OF-LIFE TREATMENT SCHEMES

Policy questions that decision makers should consider involve designing collection schemes that address when, to what extent and in what manner consumers pay. Regulators should look at the market and decide which stakeholders will support the programme. A number of regulatory initiatives, which can stipulate the collection and recycling of used air conditioners exist. They are in line with extended producer responsibility norms, requiring producers to set up the system that will facilitate the collection and recycling of products.

In a non-regulated system, the costs for collection and recycling are not assigned. Regulations should account for economies of scale, minimising the costs to the end user to ensure used air conditioners are sustainably collected and recycled.

Information to purchasers and transparency of system finance costs on collection and recycling is also essential for the effective development of these systems. Consumers who are aware that a product needs to be recycled will tend to change their behaviour resulting in increased rates of collection.

Principal financing mechanisms include:

- **Full Cost Internalisation** - reflecting individual producer responsibility, this mechanism establishes a direct incentive for competition and design improvement. Costs are passed to the end-user, but a company that can reduce its internal costs through process redesign can gain a market advantage.
- **Advance Disposal Fee Systems** - industry manages fees in a so-called “eco-fee.” In this system, a small portion of the purchase price of a product supports an end-of-life management system.
- **Deposit-Refund Systems** - some countries choose the traditional deposit-refund system, where consumers pay a deposit at the time of purchase. They receive the same amount as a refund when they return the used product to the collection system.
- **Regional Systems** - the establishment of regional systems can be the optimal solution in cases where national approaches are not financially viable to support recycling of air conditioners in one single country. For instance, suitable F-gas destruction facilities are costly, as they required substantial investment and operating costs.

## 8. PROGRAMME PREPARATION, DESIGN AND IMPLEMENTATION

In order to support governments in promoting energy efficiency and removing obsolete and energy intensive technologies from their markets, United for Efficiency has developed a step-by-step guide called “Fundamental Policy Guide: Accelerating the Global Adoption of Energy-Efficient Products”. This guide offers an overview of the key elements required to transform a national appliance market towards more energy-efficient products through the application of the U4E Integrated policy approach.

The Fundamental Policy Guide is cross-cutting for all United for Efficiency priority products including lighting, residential refrigerators, air conditioners, transformers and electric motors. The approach can also be expanded to other energy consuming products.

By following the approach outlined in the Fundamental Policy Guide, national governments and regional institutions can develop a clear vision and policy goals; identify specific objectives; and determine

the required processes (such as identifying resource requirements and responsibilities and tracking performance to ensure transparency). By establishing a systematic plan, regions and countries ensure that the approach adopted is coherent, and will save time, effort and resources.

While each section of the Fundamental Policy Guide is outlined in detail in the guide, the actual components in the strategy may vary according to each country’s situation and needs. Therefore the guidance should be adapted to meet the local context and needs.

The process should be led by governments or regional institutions with methodological support, guidance and technical advice from United for Efficiency (and/or other) experts. It should involve all relevant stakeholders to jointly determine priorities and the most appropriate pathways to achieve them.

The following is a brief overview of the Fundamental Policy Guide:

## Chapter 1

**Introduction** – provides an overview of the benefits of energy-efficient products and the U4E Integrated policy approach.

## Chapter 2

### How to Prepare for Programme

**Implementation** – introduces the organising bodies and overarching legislative and legal frameworks that need to be in place to operate an effective programme. It provides guidance on the resources required for implementing a programme and strategies for securing those resources. It also provides information on collecting data and prioritising products for inclusion in a programme.

## Chapter 3

### How to Design and Implement Market

**Transformation Programmes** – provides the basic steps to follow when designing and implementing market transformation policies—including market assessment, barrier analysis, regulations, standards, labels, awareness campaigns, and awards and recognition programmes. It provides case studies of effective implementation in countries across the world and recommendations for developing regional initiatives.

## Chapter 4

### How to Make Efficient Products Affordable

– addresses the critical issue of overcoming first-cost barriers to market adoption, including topics such as financing sources, approaches and stakeholders. Topics covered include energy service companies, financing programmes, bulk procurement schemes, and electric utility programmes. This section also describes how countries with subsidised electricity tariffs can use innovative schemes to drive efficiency.

## Chapter 5

### How to Establish and Improve Compliance

**Programmes** – discusses the importance of monitoring, verification, and enforcement (MVE) schemes from both a manufacturer's and a consumer's perspective. It also discusses the critical role of government in establishing and maintaining a robust market surveillance programme.

## Chapter 6

### Environmentally Sound Management

– provides a summary of the importance of safe and sustainable recycling and disposal programmes. It also touches on the development of health and safety standards for products, particularly those with toxic or harmful components.

## Chapter 7

### How to Measure Success and Improve

**Programmes** – describes the key components of an evaluation framework to measure the results from market transformation programmes and then use those results to improve programmes.

## Chapter 8

**Resources** – presents reports and resources from energy-efficient appliance, equipment, and lighting programmes and experts around the world.



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## 10. RESOURCES

To support countries and regions in the development of efficient air conditioning activities and strategies the U4E initiative and its partners offers a wide array of practical tools including:

### Publications

- **Achieving the Transition to Energy-Efficient Lighting Toolkit** – delivers best practice guidance for policy development and provides technical and practical tools for those directly involved in national phase-out activities. This toolkit is available online in five languages: Arabic, English, French, Russian and Spanish.
- **Developing Minimum Energy Performance Standards for Lighting Products: Guidance Note for Policymakers** – this guidance note focuses on the development and implementation of minimum energy performance standards (MEPS) for energy-efficient lighting. It aims to be a practical resource for governments on the processes to follow when establishing MEPS in a national market.
- **Developing a National or Regional Efficient Lighting Strategy** – available in English and in Spanish. As discussed in Chapter 8 of this Taskforce Report, this guide offers national governments and regional institutions guidance on how to develop and implement a policy-driven efficient lighting strategy.
- **Developing Lighting Product Registration Systems: Guidance note** – provides practical guidance and examples to energy efficiency programme administrators on how to develop, operate and maintain a registration system for lighting products.
- **Efficient Lighting Market Baselines and Assessment: Guidance note** – provides practical guidance to policymakers and energy efficiency programme administrators on how to determine national baselines, use this data for market monitoring purposes, and how to monitor the market to continuously update the baselines.
- **Enforcing Efficient Lighting Regulations: Guidance note** – presents best practices for enforcing energy efficiency regulations for lighting products. It can be used as a practical resource by policymakers and enforcement bodies when developing or revising their enforcement regime.
- **Good Practices for Photometric Laboratories: Guidance note** – provides guidance on the operation of photometric laboratories to ensure that testing results are fully supported by evidence of the legitimacy of the measurement values obtained and to give confidence in the accuracy of these results and conformance with test procedures/conditions.

- **Guidebook for the Development of a Nationally Appropriate Mitigation Action Strategy on Efficient Lighting** – this guidebook provides step-by-step guidance on how to transform a National Efficient Lighting Strategy into a proposal for a Nationally Appropriate Mitigation Action.
- **Performance Testing of Lighting Products: Guidance note** – outlines the process for carrying out energy efficiency performance testing for lamps, and how to interpret and use the data. It is a practical resource for energy efficiency policymakers and programme administrators.
- **Product Selection and Procurement for Lamp Performance Testing: Guidance note** – provides guidance on the steps required when selecting and procuring residential lamps to undergo performance testing, including defining the product scope, selection methodology, and the procurement and tracking protocol.

## Online Tools

- **Prototype UN Environment-GEF U4E-en.lighten initiative Prototype Lighting Product Registration System** – This resource provides practical guidance for policymakers on how to design, establish, commission and maintain a robust and reliable registration system for lighting and other products. It primarily targets countries that wish to establish a product registration system either because they lack a system in any form, they are

considering upgrading from a paper-based system to an online registration system, or wish to upgrade an existing online registration system to include more features. A product registration system is an initial compliance gateway wherein manufacturers and importers register eligible products with the regulatory authority prior to market entry.

- **TopTen Comparison Tool** – this consumer-oriented online search tool presents the best appliances in various categories of products. The key criteria are energy efficiency, impact on the environment, health and quality. As a communication tool it helps to show how our energy consumption causes climate change and what we can do personally to reduce our impact. It is also a powerful instrument to influence manufacturers.
- **U4E Country Assessments** – used to analyse the potential benefits gained through the global adoption of efficient lighting, appliances and equipment. The reports provide estimates of potential energy savings, CO<sub>2</sub> reductions and financial gains. For all assessments regional results can either be compiled from the assessments of the constituent countries, or, in cases where U4E-en.lighten does not offer an assessment for each country, U4E-en.lighten can work with the region to develop estimates based on best available data.

- **World Bank e-learning in Energy Efficiency** – The e-learning programme has been developed under the City Energy Efficiency Transformation Initiative (CEETI) managed by the Energy Sector Management Assistance Program (ESMAP) and has benefitted from a collaboration between ESMAP, the World Bank Climate Change Group and the Online Learning Centre. The programme provides a series of learning courses to support city leaders enhance the energy efficiency and sustainability of cities around the world.

## Expertise and Collaborating Centres

- **ASEAN-SHINE** – The ASEAN SHINE is a Private-Public Partnership initiative of the UN Environment and the ICA. Its objective is to support ASEAN Member States in achieving their sustainable energy development objectives. The Air Conditioner Taskforce portal contains a wealth of information developed for ASEAN members to support development of their air conditioning programmes.
- **Cool Training** – GIZ Proklima promotes technology transfer and capacity development towards ozone layer and climate protection worldwide. With the experience and expertise gained from over 280 projects worldwide, GIZ Proklima has launched Cool Training – a series of international trainings on the safe use of natural refrigerants in room air conditioner appliances.

## Other Relevant Resources

- American Council for an Energy-Efficient Economy (ACEEE)**—ACEEE is a nonprofit, 501(c)(3) organization, acts as a catalyst to advance energy efficiency policies, programs, technologies, investments, and behaviours. Focusing on the US, ACEEE seeks to harness the full potential of energy efficiency to achieve greater economic prosperity, energy security, and environmental protection. ACEEE carries out its mission by: (1) conducting in-depth technical and policy analyses; (2) advising policymakers and program managers; (3) working collaboratively with businesses, government officials, public interest groups, and other organisations; (4) convening conferences and workshops, primarily for energy efficiency professionals; (5) assisting and encouraging traditional and new media to cover energy efficiency policy and technology issues; and (6) educating consumers and businesses through our reports, books, conference proceedings, press activities, and websites. ACEEE was founded in 1980 by leading researchers in the energy field. Since then it has grown to a staff of about 50. ACEEE focuses on energy policy (federal, state, and local), research (including programs on buildings and equipment, utilities, industry, agriculture, transportation, behaviour, economic analysis, and international initiatives).
- bigEE**—Is an international initiative by research institutes for technical and policy advice and public agencies in the field of energy and climate, co-ordinated by the Wuppertal Institute (Germany). Its aim is to develop the international web-based knowledge platform bigee.net for energy efficiency in buildings, building-related technologies, and appliances in the world's main climatic zones. The bigee.net platform informs users about energy efficiency options and savings potentials, net benefits and how policy can support achieving those savings. Targeted information is paired with recommendations and examples of good practice. To ensure there is targeted, quick and easy access, information about buildings, appliances and policies is presented in three different intuitive guides.
- CLASP**—CLASP improves the environmental and energy performance of the appliances and related systems, lessening their impacts on people and the world around us. CLASP develops and shares practical and transformative policy and market solutions in collaboration with global experts and local stakeholders. It is a non-profit international organisation promoting for energy efficiency standards and labels (S&L) for appliances, lighting, and equipment. Since 1999, CLASP has worked in over 50 countries on six continents pursuing every aspect of appliance energy efficiency, from helping structure new policies to evaluating existing programs.
- The Climate Group**—The Climate Group is an award-winning, international non-profit with offices in Greater China, North America, India and Europe. Our goal is to help leaders transition to a prosperous low-carbon economy, driven by the rapid scale-up of clean and renewable energy. We work in partnership with the world's most influential business, state, regional, finance and civil society leaders. For over a decade we have worked to demonstrate the economic and business case for the low-carbon economy and create the political conditions necessary for a strong global framework that addresses climate risks and maximizes climate opportunities. The global climate deal that has been struck at the Paris COP represents a new beginning: the chance to accelerate our low carbon future. They work with governments, businesses and investors to implement the Paris Agreement, holding them to account where appropriate through reporting mechanisms, and ensuring to bend the emissions curve downward to secure a thriving, clean economy for all.
- European Council for an Energy Efficient Economy (ECEEE)**—The ECEEE is a membership-based non-profit association. As Europe's largest and oldest NGO dedicated to energy efficiency, they generate and provide evidence-based knowledge and analysis of policies, and they facilitate co-operation and networking. ECEEE members are found among private

and public organisations, as well as among all those professionals from all sectors who share ECEEE's goals. ECEEE offers governments, industry, research institutes and citizen organisations a unique resource of evidence-based knowledge and reliable information. ECEEE promotes the understanding and application of energy efficiency in society and assists its target groups—from policy makers to programme designers to practitioners—with making energy efficiency happen. ECEEE is registered as a Swedish organisation and has its secretariat in Stockholm. ECEEE participates actively in the European policy-making process, the organisation participates in a number of EU policy making and advisory fora, and frequently comments on European energy policy through position papers and responses to public consultations. ECEEE has also held expert workshops and briefings for policy makers. It has co-operated with the European Commission, the Parliament and the EU presidency, to hold expert seminars. These institutions appreciate the competence and integrity offered by ECEEE's network of members.

- **GCI**—The aim of GCI is to establish a global Green Cooling Network, which will accelerate the transfer of environmentally friendly technologies in the refrigeration and air conditioning sectors to and within developing countries. The website offers

a knowledge base for green cooling technologies, data emission scenarios and a platform for the Green Cooling Initiative Network. Decision makers, technology suppliers and importers, research institutes, NGOs as well as government institutions are all invited to join. The Green Cooling Initiative is funded under the International Climate Initiative of the German Federal Ministry of Environment, Nature Conservation and Nuclear Safety and implemented by GIZ Proklima.

- **IEA**—The International Energy Agency is an autonomous organisation that works to ensure reliable, affordable and clean energy for its 28 member countries and beyond. The IEA's four main areas of focus are: energy security, economic development, environmental awareness, and engagement worldwide. Founded in response to the 1973/4 oil crisis, the IEA's initial role was to help countries co-ordinate a collective response to major disruptions in oil supply through the release of emergency oil stocks. The IEA has a staff of 260 enthusiastic professionals (energy analysts, modellers, data managers/statisticians, technicians, secretaries and support staff) working together on global energy challenges.
- **4E TCP**—the Efficient Electrical End-Use Equipment (4E) Technology Collaboration Programme (TCP) provides advice to its member countries on efficient appliances. The Collaboration develops

mapping and benchmarking reports for air conditioners. It brings together the governments of Australia, Austria, Canada, China, Denmark, France, Japan, The Netherlands, Republic of Korea, Sweden, Switzerland, UK and the US.

- **Super-Efficient Equipment and Appliance Deployment (SEAD) Initiative**—An initiative of the Clean Energy Ministerial, SEAD seeks to engage governments and the private sector to transform the global market for energy-efficient equipment and appliances. SEAD initiated an international collaboration of technical and policy experts in solid state lighting, which worked to promote alignment and improvements in the scope and stringency of international standards and labelling programmes. The collaboration participants included Australia, Canada, France, Korea, Mexico, the UK, and the US. Current SEAD member governments include Australia, Brazil, Canada, the European Commission, Germany, India, Indonesia, Korea, Mexico, Russia, Saudi Arabia, South Africa, Sweden, the United Arab Emirates, the UK, and the US, and China maintains an observer status.

## ANNEX A. ECOWAS STANDARDS HARMONIZATION MODEL (ECOSHAM) AND STANDARDS HARMONIZATION PROCEDURES

ECOWAS has a standardised process for standards harmonization, named the ECOWAS Standards Harmonization Model (ECOSHAM) and Standards Harmonization Procedures. The model and procedure were officially adopted by the Council of Ministers in 2012 (C/REG. 14/12/12). This framework builds the basis and foundation for all product standard harmonization effort in the region.

Under ECOSHAM, the Technical Management Committee (TMC) was established. TMC was responsible for the management of five Technical Harmonization Committees (THCs) who work together with 15 ECOWAS national standardisation bodies on the regional harmonization effort. For each harmonization proposal, a 7-stage process has to be followed before the harmonized standard come into force:

PROJECT STAGE	DESCRIPTION
0: PRELIMINARY STAGE	This stage is used when the Preliminary Work Item (PWI) is not mature enough for further processing. A PWI may advance to Stage 1 at the appropriate time.
1: PROPOSAL STAGE	THCs receive New Work Item Proposal (NWIP) and can either accept the proposal for future processing or reject it.
2: PREPARATORY STAGE	A project lead will be appointed at this stage and a Working Draft(s) (WD) will be developed.
3: COMMITTEE STAGE	Upon the acceptance of NWIP and WD by the member states, a Committee Draft(s) (CD) will be developed based on the member states' consensus and comments.
4: ENQUIRY STAGE	A public Draft Harmonized Standard (DHS) will be circulated by the THCs at this stage.
5: BALLOT STAGE	A Final Draft Harmonized Standard (FDHS) will be distributed by the THC to the national standardization bodies (NSB) for vote.
6: APPROVAL STAGE	The FDHS are submitted to the ECOWAS Commission for final approval from the ministers of the member states.

ECOSHAM harmonization framework can be a useful approach for other regions to consider in their regional harmonization work. Additional information regarding this framework can be found in the following links:

- [Regulation C/Reg.14/12/12 Adopting ECOWAS Standards Harmonisation Model & Procedures](#)
- [ECOWAS Standards Harmonization Model \(ECOSHAM\) and Standards Harmonization Procedures Document No. ECOSHP-01](#)

## ANNEX B. DESIGNING A COMMUNICATIONS CAMPAIGN

The success of any communication and awareness raising campaign depends on its design, specifically with regard to implementation and evaluation. The design phase of an effective campaign should involve the following elements:

ELEMENT	DESCRIPTION
SETTING THE OBJECTIVES	Objectives should be established in line with policy goals. The objectives should be specific, measurable, attainable, relevant and time-bound (SMART). They will determine the choice of communication tools and messages as well as evaluation parameters.
DETERMINING THE TIME AND DURATION OF THE CAMPAIGN	To identify the stages and length of the campaign, it is essential to take into account the phases which will accompany the legislative, regulatory and technical changes within a country or community. Public awareness campaigns should be designed in parallel with these activities.
UNDERSTANDING THE AUDIENCE	The target group guides the messaging and the outreach strategies, including the tools and communication channels utilised. Understanding the audience involves two main aspects - (1) stakeholder analysis and (2) audience selection and prioritisation.
IDENTIFYING COMMUNICATION TOOLS	For governments, the approach should persuade officials to formulate policy that promotes and maintains efficient air conditioner best practices. For business, practical tools such as online information and printed materials, new media, targeted training programmes, events and trade shows and design competitions. For the public, tools should be designed to shape thoughts, change an attitude, or induce action.
CRAFTING THE MESSAGES	The message should be as simple as possible and relevant to the audience. Messages should make the desired behaviour attractive and easy and demonstrate benefits to end-users. Usually, monetary savings are a strong motivator in all communications campaigns about efficiency, but in some developing countries, messages that tap into a sense of national pride may resonate as strongly. Likewise, environmental impacts could be the most effective messaging component in some cases.
DETERMINING IMPLEMENTATION AND MONITORING PARAMETERS	Following the communications plan while allowing for adjustments based on monitoring results as well as any circumstantial changes. Project management skills are needed to successfully manage the launch and on-going operation of the campaign. Diagnostic skills are used to recognise whether or not the campaign fulfils its expectations and goals. If the campaign falls short of its goals, then problems must be addressed in a timely manner.
CAMPAIGN EVALUATION	The evaluation process is the most critical phase for the successful implementation of a communication campaign. Evaluations conducted by independent bodies help to ensure an unbiased view.

All of the elements above are interrelated and dependent on the others. For example, the campaign objectives determine the audience, timing and duration which in turn, influence the selection of communication tools and messages and the allocation of resources.

**Table 10.**  
Communication  
campaign  
elements  
and their  
descriptions

## FOOTNOTES

- <sup>1</sup> U4E country assessments
- <sup>2</sup> Calculated based on CO<sub>2</sub> emission data released by IEA, 2016
- <sup>3</sup> U4E country assessments
- <sup>4</sup> Based on the en.lighten initiative: <http://learning.enlighten-initiative.org/integratedapproach.aspx>
- <sup>5</sup> For more information see: <http://united4efficiency.org/countries/country-assessments/>
- <sup>6</sup> These figures include indirect emissions only, as they do not account for refrigerant leakages.
- <sup>7</sup> U4E country assessments
- <sup>8</sup> International Civil Aviation Organization (ICAO) Environment <http://www.icao.int/environmental-protection/CarbonOffset>
- <sup>9</sup> Growth of Electricity Sector in India from 1947-2015 (PDF). Central Electricity Authority (CEA), India. [http://www.indiaenvironmentportal.org.in/files/file/growth\\_2015.pdf](http://www.indiaenvironmentportal.org.in/files/file/growth_2015.pdf)
- <sup>10</sup> LBNL, 2015
- <sup>11</sup> By 2030 97.5 per cent of the use will be banned with a 100 per cent ban after 2040.
- <sup>12</sup> Velders, 2015
- <sup>13</sup> Further information about the Kigali amendment see: <http://www.unenewscentre/Default.aspx?DocumentID=27086&ArticleID=36283&l=en>
- <sup>14</sup> LBNL, 2015
- <sup>15</sup> Information on various refrigerant types is detailed in Table 3 of this document
- <sup>16</sup> IGSD, 2014
- <sup>17</sup> A medium-sized power plant equates to approximately 500MW
- <sup>18</sup> SEAD, 2013. The 12 economies mentioned are members of the SEAD Initiative.
- <sup>19</sup> LBNL, 2015
- <sup>20</sup> U4E country assessments
- <sup>21</sup> CEM, 2016
- <sup>22</sup> For more information see [http://unfccc.int/paris\\_agreement/items/9485.php](http://unfccc.int/paris_agreement/items/9485.php)
- <sup>23</sup> Also referred to as heat exchanger.
- <sup>24</sup> Electronic motor controls have enabled substantial energy efficiency improvements on compressor and fan motors through variable-speed operation (US DOE, 2016)
- <sup>25</sup> A higher value of EER means higher efficiency.
- <sup>26</sup> European Commission, 2009
- <sup>27</sup> SEAD, 2013
- <sup>28</sup> Ibid.
- <sup>29</sup> Purchase costs in the figure consider average prices of air conditioner equipment available on the Indian market with the corresponding EER; electricity costs consider 1200 hours of use per year and an average electricity cost of 6 Rupees per KWh.
- <sup>30</sup> Montreal Protocol, 2016
- <sup>31</sup> IGSD, 2015
- <sup>32</sup> Xu et al., 2012
- <sup>33</sup> ICCG, 2016
- <sup>34</sup> NDC for Nigeria 2015
- <sup>35</sup> Table developed by GIZ Proklima, with inputs from the U4E Air Conditioners Taskforce experts, 2016
- <sup>36</sup> International Panel on Climate Change 4th Assessment Report 2007
- <sup>37</sup> Ibid.
- <sup>38</sup> Ibid.
- <sup>39</sup> While these are indicative of current costs, future costs of HC-290, HFC-32 and low-GWP blends will depend significantly on the scale of production due to the Kigali Amendment to the Montreal Protocol, and may be lower if sufficient scale is achieved.
- <sup>40</sup> A1 = lower toxicity and non-flammable; A2L = lower toxicity and lower flammability; A3 = lower toxicity and higher flammability
- <sup>41</sup> Danish Ministry of the Environment, 2014
- <sup>42</sup> According to comments received by Prof. Dr. Andreas Konrath
- <sup>43</sup> US Environmental Protection Agency, 1992
- <sup>44</sup> TFA as Trifluoro-acetic Acid
- <sup>45</sup> Refrigerating systems and heat pumps -- Safety and environmental requirements --
- <sup>46</sup> Household and similar electrical appliances - Safety - Part 2-40: Particular requirements for electrical heat pumps, air-conditioners and dehumidifiers
- <sup>47</sup> Global sales comprise residential and commercial unitary units although domestic units are the clear growth driver.
- <sup>48</sup> SBC e-Waste Africa Project, 2011



- <sup>49</sup> Green Cooling Initiative, 2016a,b,c.
- <sup>50</sup> Canada, Mexico and the US.
- <sup>51</sup> CLASP 2012
- <sup>52</sup> BEE, 2016.
- <sup>53</sup> This approach requires better awareness raising for suppliers that need to be wary of which products will be distributed for which region.
- <sup>54</sup> For more information see <http://www.multilateralfund.org/default.aspx>
- <sup>55</sup> The Basel Convention and many national laws establish strict guidelines for the movement of hazardous wastes to other countries. Exceptions can be made if certain conditions are met by the proposed programme. A country or group of countries planning to collaborate in the establishment of a regional recycling programme should consult with the Basel Convention Secretariat and its Regional Centres to obtain information and guidance.
- <sup>56</sup> For more information on this see the U4E Fundamental Policy Guide.
- <sup>57</sup> For more information see [http://www.se4all.org/energyefficiencyplatform\\_building-efficiency](http://www.se4all.org/energyefficiencyplatform_building-efficiency)
- <sup>58</sup> For more information see: <http://superefficient.org/Global-Efficiency-Medal.aspx>
- <sup>59</sup> For more information on developing communications campaigns see the U4E Fundamental Policy Guide.
- <sup>60</sup> See the Ghana Energy Guide promotional videos at: <https://www.youtube.com/channel/UCYc1vDprLth5hBAQv7PWA>
- <sup>61</sup> For more information see [www.topten.eu](http://www.topten.eu)
- <sup>62</sup> Access the tool at <http://www.lites.asia/news-and-events/news/news-alert-prototype-registration-system>
- <sup>63</sup> Prepared by LBNL for the U4E Air Conditioner Expert Taskforce, 2016
- <sup>64</sup> GIZ Proklima, 2006
- <sup>65</sup> NRDC, 2013
- <sup>66</sup> Maharashtra Electricity Regulatory Commission, 2010
- <sup>67</sup> CONUEE, 2016
- <sup>68</sup> Climate Bonds Initiative, 2016
- <sup>69</sup> For more information, see section 2.1 “Building legal and administrative foundations for enforcement” in the Enforcing Efficient Lighting Regulations guidance note.
- <sup>70</sup> Equipment may refer to general office equipment, as well as potential testing or product storage facilities
- <sup>71</sup> Ellis, 2012
- <sup>72</sup> CONUEE, 2016
- <sup>73</sup> See list of product registration systems at [www.superefficient.org](http://www.superefficient.org)
- <sup>74</sup> For more information on product registry databases, see “Developing Lighting Product Registration Systems” Guidance Note, February 2016.
- <sup>75</sup> IIEC, 1999, Motoomull 1999, Rath 1999
- <sup>76</sup> Enforcing Efficient Lighting Regulations, Guidance Note, UNEP, 2016. [http://www.enlighten-initiative.org/portals/0/documents/Resources/publications/Enforcing%20Efficient%20Lighting%20Regulations\\_February%202016.pdf](http://www.enlighten-initiative.org/portals/0/documents/Resources/publications/Enforcing%20Efficient%20Lighting%20Regulations_February%202016.pdf)
- <sup>77</sup> EGAT, 2016
- <sup>78</sup> European Commission, 2007
- <sup>79</sup> A 97.5 per cent reduction by 2030 and a 100 per cent phase-out by 2040.
- <sup>80</sup> European Commission, 2014
- <sup>81</sup> Air Resources Board, 2016
- <sup>82</sup> GIZ Proklima, 2012



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