Accelerating the Global Adoption of

CLIMATE-FRIENDLY AND ENERGY-EFFICIENT REFRIGERATORS

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

U4E POLICY GUIDE SERIES

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FOREWORD

In 2015, in developing countries and emerging economies, residential refrigerators accounted for approximately 10 per cent of global electricity consumption in households. In those countries the number of refrigerators in use is expected to double to just under two billion in the next 15 years. In developing countries a market transformation to climate-friendly and energy-efficient household refrigerators can attain energy savings of more than 60 per cent.

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", with the potential to reduce countries' greenhouse gas (GHG) emissions, generate significant economic benefits and improve people's wellbeing. High efficiency appliances can reduce countries' GHG emissions, generate significant economic benefits, enhance energy security, and improve people's wellbeing.

Building on the success of the en.lighten initiative, the UN Environment, the Global Environment Facility (GEF), UN Development Programme (UNDP), CLASP, the International Copper Association and the Natural Resources Defense Council launched the United for Efficency (U4E) initiative in 2015. The initiative supports countries in their transition to energy-efficient appliances and equipment, including lighting, room air conditioners, residential refrigerators, electric motors and distribution transformers. 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 also with the GIZ Green Cooling Initiative to ensure best practices in the cooling sector are considered.

The U4E initiative serves as a platform to build synergies among international stakeholders; identify global best practices and share this knowledge and information; create policy and regulatory frameworks; address technical and quality issues; and encourage countries to develop national- and/or regional efficient appliance strategies.

This guide is published as part of U4E and focuses on residential refrigerators. It guides policymakers on how to promote energy-efficient refrigerators in their respective national markets. It is based on the Integrated Policy Approach, which has been used around the world to bring about sustainable and cost-effective market transformation.

This guide was developed in a holistic process with participation from over 20 organisations. This included international organizations, environmental groups, international refrigerator 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.

The guide is part of a series of U4E guides on five product groups. The other reports in the series cover lighting, room air conditioners, electric motors, and distribution transformers. An additional overarching report, "Policy Fundamentals Guide," provides crosscutting, general guidance critical to the establishment of a successful energy efficiency programme.

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.

U4E United for Efficiency

THIS REPORT FOCUSES ON **CLIMATE-FRIENDLY AND ENERGY-EFFICIENT REFRIGERATORS**

OTHER GUIDES IN THIS SERIES INCLUDE:

AND AN OVERARCHING FUNDAMENTAL GUIDE:

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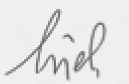

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EXECUTIVE SUMMARY

The refrigerator is the most popular household appliance in use in developed countries as it represents the most convenient and safe means to preserve food. A refrigerator is one of the first appliances to be bought once an electricity connection becomes available. Thus, the number of refrigerators in use in developing and emerging economies is projected to double to just under two billion in the next 15 years.

Based on the country and policy assessments developed by the U4E Initiative for 150 developing countries and emerging economies, this prospective growth requires a market transformation to energy-efficient products to ensure:

Annual Energy Savings (electricty consumption): around 150 TWh = annual amount of electricy consumed by Thailand in 2012

Lower Emissions: around 90 million tonnes of carbon dioxide (CO_2) emissions annually = 20,000 round trips from Nairobi to New York

Financial Savings: $14 billion = Google's profits in 2015.

Refrigerators have multiple environmental impacts, which can be summarised as:

1. Indirect impact because of the electricity they consume, which results in carbon emissions and other harmful pollutants from electricity generating plants that burn fossil fuels;
2. Direct impact from release of gases used as refrigerants and in insulating foams (Hydrofluorocarbons, HFC; and other fluorinated gases, F-gases), particularly when the refrigerator is disposed of. Some older F-gases damage the earth's ozone layer; and many cause a global warming. Some F-gases are several thousand times as potent as CO_2.

Direct and indirect impacts are combined into a Total Equivalent Warming Impact (TEWI), which is measured in terms of carbon dioxide equivalent (CO_2e). For old designs of refrigerator-freezer, 60 per cent of impacts were indirect and 40 per cent were direct emissions although the proportions and totals have changed significantly over time: With climate-friendly hydrocarbon (HC) gases[1] - which are used for refrigerant and foam-blowing agents - on the rise in the last years (in regions such as the European Union, EU), the relative impact of direct emissions has gone down. Nevertheless, in many countries F-gas based refrigerants are still widely used in refrigerators, thereby impacting the climate. Indirect (energy-related) impacts are less than one third of what they were for older appliances. Developing countries with unregulated markets dominated by old technology refrigerators can attain energy savings of more than 60 per cent (see section 1.1).

Furthermore, refrigerators are high electricity consumers in households. The range of efficiency is very large. Old appliances consume up to three times more energy than the best new models and contain the environmental legacy of highly damaging GHG and/or ozone damaging gases. “Product dumping” is also a risk in some economies. This is why household refrigerators, freezers and combined refrigerator freezers are often one of the first appliances to be subject to energy efficiency regulations in a country setting up environmental policies.

UN Environment encourages countries to follow a five-stage integrated policy approach for transforming their respective markets toward higher energy efficiency:

- **Standards and Regulations (Minimum Energy Performance Standards, MEPS)**—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 from which to ensure the success of any efficient refrigerators 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**—addressing high first-cost challenges with efficient refrigerators, looking at economic instruments, fiscal instruments and incentives, such as rational electricity prices and tax breaks. Also consider financing incentive mechanisms that help address the initial incremental costs such as through dedicated funds, electric utility on-bill financing, and pay-as-you-save schemes based on shared savings transactions through Energy Service Companies.
- **Monitoring, Verification and Enforcement (MVE)**—successful market transition depends on effective monitoring (i.e. verify product efficiency), verification (i.e. verify declarations of conformance); and enforcement (i.e. actions taken against non-compliant suppliers) of the MEPS. Enhancing the capacity of various countries and the sharing of information and skills between countries and across regions provides an effective means through which to promote best practice, quickly and thoroughly.
- **Environmentally Sound Management of Refrigerator Products**—HFCs and other hazardous substance content standards should be established in line with global best practice in order to minimize any environmental or health impact. Special attention should be given to the development of a legal framework for environmentally sound, end-of-life activities.

This guide provides advice on effective policy. It provides practical assistance to make the transition and secure improvements to household refrigeration design, safe manufacture, deployment and end-of-life management such as recycling and disposal. The guide helps governments ensure that every refrigerator sold in their economy has a minimum impact on the environment.

To guarantee a smooth and quick transformation, UN Environment recommends developing a national energy-efficient appliance strategy. It brings parties together to develop a clear vision and policy goals. To expand upon elements of the generic integrated policy approach outlined above, these elements specific to refrigeration should be carefully considered:

1. Governments should consider basing their policies on a new and globally relevant test method IEC 62552:2015. It is adaptable to local climates and storage temperatures, achieves good reproducibility and cheaper tests, and is less prone to cheating;
2. A second key element is to ensure that both refrigerant and foam-blowing agent gases used have zero ozone depletion potential (ODP) and a Global Warming Potential (GWP) as low as practicable (which means GWP 20 or less in the case of household refrigerators);
3. Old refrigerators must be safely removed from the market and from homes at the end of their life. They have poor energy efficiency and contain environmentally damaging F-gases. Treatment requirements related to the refrigerant gases and foaming agents used in refrigerators should be established in line with global best practice in order to minimize the environmental or health impacts. Special attention should be given to the development of a legal framework for environmentally sound, end-of-life disposal or recycling.

Multiple Benefits

The transition to climate-friendly and energy-efficient refrigerators brings multiple benefits:

- Reduced electricity bills for households; overall energy savings for the economy
- Less stress on the electricity grid, particularly as grids expand into rural areas[2], freeing up capacity to supply more people
- Increased trade in high quality appliances improves the economy and can possibly increase manufacture, along with job creation
- New appliances have refrigerants and foam-blowing agents that significantly lower GWP, and for which the majority of global production is neither fluorinated or chlorinated, thereby minimising the legacy costs for recycling and safe disposal
- Efficiency policies that guard against damage to the environment and economy from the import of used, poor quality and inefficient refrigerators

For more information on the approach see Chapter 8 for a brief overview or the U4E Fundamental Policy Guide for a complete description.

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ACRONYMS AND ABBREVIATIONS

CDM .... Clean Development Mechannism

CFC .... Chlorofluorocarbon

CLASP .... Collaborative Labelling and Standards Programme

DSM .... Demand Side Management

EC .... European Commission

EU .... European Union

GDP .... Gross Domestic Product

GEF .... Global Environment Facility

GW .... Gigawatt

GWP .... Global Warming Potential

HC .... Hydrocarbon

HCFC ....Hydrochlorofluorocarbon

HFC .... Hydrofluorocarbon

IEA4E .... International Energy Agency Energy-efficient End-use Equipment (Technology Cooperation Programme)

IEC .... International Electrotechnical Commission

kWh ....Kilowatt-hour

MEPS .... Minimum Energy Performance Standard

MVE ....Monitoring, Verification and Enforcement

NAMA .... Nationally Appropriate Mitigation Actions

ODP .... Ozone depletion potential

QR code .... Quick Response Code

S&L .... Standards and Labels

SEAD .... Super-efficient Equipment and Appliance Deployment initiative

U4E .... United for Efficiency

UNDP .... United Nations Development Programme

UN ENVIRONMENT .... United Nations Environment Programme

UNIDO .... United Nations Industrial Development Organisation

UNFCCC ....United Nations Framework Convention on Climate Change

US .... United States of America

W... Watt

1. INTRODUCTION

This guide helps a country make the transition to climate-friendly and energy-efficient household refrigerators. It is aimed for those who are developing policies and other environmental initiatives.

The guide provides advice on effective policy, practical assistance to make the transition and on how to secure improvements to refrigerator design, safe manufacture, deployment and end-of-life management such as recycling and/or disposal. It helps governments set MEPS and other policies to ensure that every refrigerator sold in their economies is efficient. The guide also provides advice on setting up product labelling, so citizens can make informed choices.

In summary, the guide:

QUANTIFIES the potential energy and cost savings that can be achieved by switching to more energy-efficient and climate friendly refrigerators	**PROVIDES** a roadmap of the main choices facing policy makers in this field	**EXPLAINS** the most important technical issues and barriers so that local priorities can be identified and suggests strategies to overcome them	**GUIDES** the reader to additional sources for more detailed guidance, analytical tools and funding to fully develop the necessary plans and put them into action	**USES MANY REAL EXAMPLES** from developing economies that have made or are making their way through the transition, to demonstrate the real-life practical steps to making progress

The U4E Fundamentals Guide sits as a companion guide to this report. It provides information on topics cutting across all the products covered under U4E.

While there are challenges to be addressed; however, many economies have made the transition to reap the full benefits of policies that transform markets to climate-friendly and energy-efficient household refrigerators. Those benefits include: lower electricity bills for families; less stress on the expanding electricity grid; reduced GHG emissions; less emission of ozone-depleting gases from old appliances at recycling; and improved trade through a market for better quality appliances that is harmonised with other major economies. This guide will help governments make this a reality.

The scope of appliances covered is "household refrigeration" powered by grid electricity:

REFRIGERATORS
(one or more chilled compartments, generally at various temperature zones between 0°C and 14°C, and which may include an ice-making section)

FREEZERS
(one or more frozen compartments, usually between -18°C and -6°C)

FRIDGE-FREEZERS
(combination of both chilled and frozen compartment(s) in the same appliance)

1.1 WHAT ARE CLIMATE-FRIENDLY AND ENERGY-EFFICIENT REFRIGERATORS?

Refrigerators impact the environment in two main ways:

1. **Indirect impact by consuming energy during use.** More energy-efficient refrigerators consume much less electricity to cool food. This reduces carbon emissions and other harmful pollutants from electricity generating plants that burn fossil fuels. Electricity generating plants are one of the major sources of man-made CO_2 in the atmosphere;
2. **Direct impact from release of gases used as refrigerants and in insulating foams (particularly F-gases).** When these gases are released, either during use or when the refrigerator is disposed of, they can have direct impacts: (1) they damage the earth's ozone layer if the gas has an ODP other than zero (ozone is a component of an important layer of the atmosphere which protects the earth from damaging solar radiation); (2) the gases have a global warming effect from the gas being in the atmosphere. This impact is quantified as their GWP, and some are several thousand times as potent as CO_2; (3) the refrigerants, if they are fluorinated and released to the atmosphere, decay to form long lasting substances harmful to the environment (such as trifluoroacetic acids and carbonyl fluoride).

INDIRECT:

DIRECT:

For fridge-freezers in developed economies in the 1980s, just over half of the climate-related impacts are indirect. However, the typical proportions and totals have changed significantly over time, as shown in Figure 1. For these older appliances, direct impacts used to be equivalent to ten years of energy usage. For the best new refrigerators, the direct impacts are close to zero because the direct impacts of both refrigerant and foaming agent are completely avoided by use of alternatives with GWP less than 20 and zero ODP. This must be combined with improved end-of-life management. See Table 8 for details of these impact estimates.

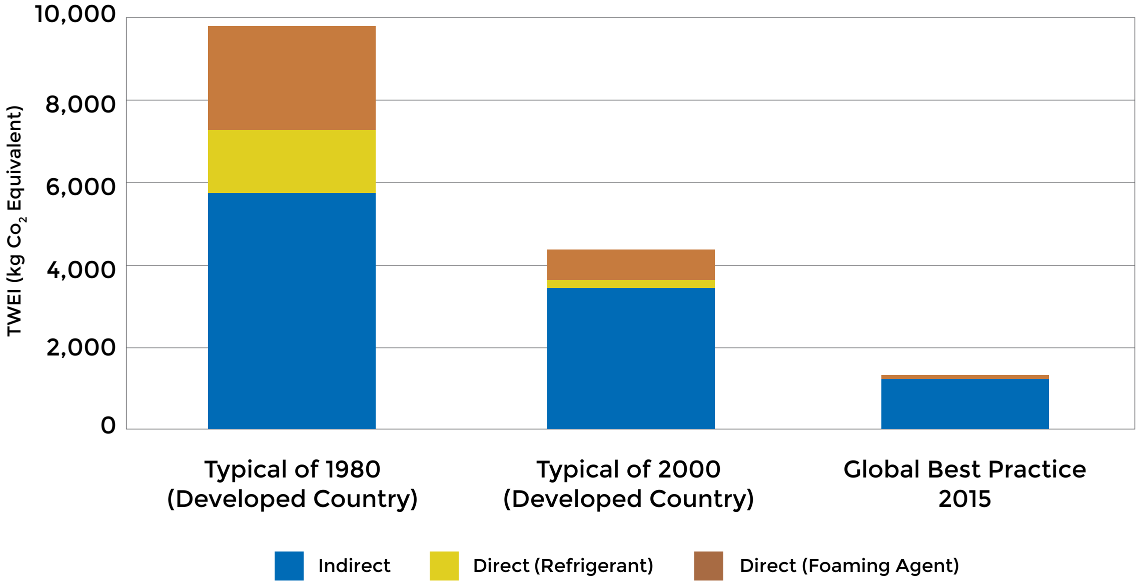


Figure 1. Breakdown of the lifetime carbon-related environmental impacts of a typical fridge-freezer in developed economies in the 1980s, in the year 2000 and global best practice of 2015 (assumes global average carbon factor for electricity)

How Much Electricity do Refrigerators Generally Use?

Electricity consumption varies widely by type, size and age of appliance and, in particular, what MEPS were in effect in that economy when it was sold. A survey of homes in an African developing country, which at that time had no refrigerator regulations, showed that refrigerators were typically using 1,200 kWh per year.[3]

A similar study in a major emerging economy[4] concluded that, before regulations, a typical combined fridge-freezer (280 L net volume) consumes 700 kWh per year in homes. In contrast, a combined fridge-freezer of average efficiency for economies with suitable MEPS consumes 350 to 450 kWh per year. This can be cut to 250 kWh per year by more stringent MEPS being planned for some economies.

Table 1 shows the MEPS levels in force for a very common type and size of appliance in example economies. The best available fridge-freezers in the EU of 280 L net volume consume 160 kWh per year, with no sacrifice having to be made by the user as they are every bit as effective at cooling food. The relative sizes of these indirect impacts are shown in Figure 1.

Climate-Friendly and Energy-Efficient Refrigerators

A ‘climate-friendly’ refrigerator means one that uses refrigerant and foam-blowing agent gases with GWP of 20 or less and zero ODP. Such refrigerators now account for the vast majority of sales in the EU.

An “energy-efficient” refrigerator-freezer of 280 L internal volume (being the most common type and size of appliance) means one with good practice efficiency of less than 370 kWh per year[5] under standard conditions. In addition to setting a policy to ensure at least this minimum level of performance, aspiring economies can consider implementing supporting policies to encourage best practice appliances of this type and size that consume as little as 160 kWh per year. See also section 7.2 for further examples of the environmental impacts of refrigerators.

1.2 IMPLEMENTATION APPROACHES TO TRANSFORM MARKETS

To guarantee a sustainable transition to efficient refrigerators, UN Environment recommends an integrated policy approach incorporating the needs and priorities of public and private sectors and civil society. The integrated policy approach has five elements (see Figure 2).

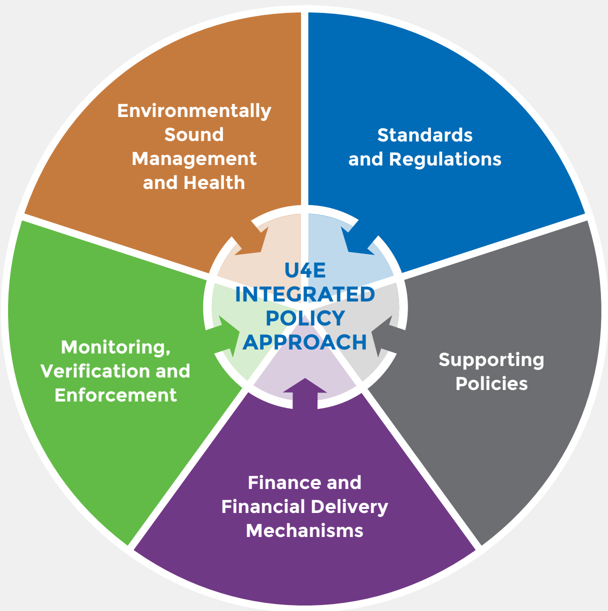


Figure 2. Integrated policy approach for a rapid transition to efficient appliances

Standards and Regulations (MEPS)

Standards and regulations are a combination of measurement methods and policy measures. They define minimum efficiency levels that are set based upon the economics of the local market and what type of appliances can be made available. MEPS set the bar under which no products can be sold, and represent the foundation from which to ensure the success of any climate-friendly refrigerators' transition strategy.

Supporting Policies

Supporting policies are essential to ensure the smooth implementation and maximum impact of MEPS and encourage broad public acceptance. They include energy-labelling schemes encouraging research and design (R&D) assisting manufacturers to improve their production facilities and financial incentives, as well as information and communication campaigns informing end users in order to change or modify their behaviour.

Finance and Affordability

Some higher first-cost challenges occurring during a transition to efficient refrigerators can be addressed by implementing economic and fiscal instruments and incentives, or other financing structures including electric utility on-bill financing schemes. Such schemes often aim to establish higher sales of best performing appliances.

Monitoring, Verification and Enforcement (MVE)

The success of the market transformation depends on effective monitoring, control and testing to ensure enforcement and compliance with MEPS. Otherwise, substandard products could continue to enter the market and undermine savings and consumer satisfaction. Substandard products put producers that choose to comply at a disadvantage, further damaging the chances of success.

Environmentally Sound Management and Health

Refrigerants and insulation foaming agents should be specified in line with global best practice. This minimises any environmental and health impacts, and simplifies recycling. Special attention is needed to ensure a legal framework encouraging environmentally sound management of both legacy and future appliances at end of their life, including waste recovery and design for disassembly or reuse.

2. REFRIGERATOR MARKET AND TECHNOLOGY TRENDS

WHAT?	An overview of refrigerator technology; a description of recent changes and forecasts for emerging technologies.
WHY?	Provides the background context on technology and markets affecting all the subsequent discussion and decisions that will need to be made.
NEXT?	**Some key questions to keep in mind:** • What is the typical performance level and F-gas content of refrigerators (foam and refrigerant) in use and those on sale in your market now? • How significant are imports of used or substandard refrigerators to the market? • What would the implications be for the electricity grid if refrigerator stock increased four-fold, unregulated, within 15 years? • What extra institutional capacity is needed to deal responsibly with the F-gas legacy of chlorofluorocarbons (CFC), Hydrochlorofluorocarbons (HCFC) and Hydrofluorocarbons (HFC) appliances at end of life and for repairs? • What are the benefits to your market from matching the standards of your major trading partners? Or from matching the best standards in the world?

2.1 TECHNOLOGY AND TRENDS

Most refrigerators use polyurethane foam insulation (which contains a gas), and the vast majority of refrigerators use a compressor and refrigerant gas to create the cooling. A very small per centage of refrigerators use absorption technology to create the cooling effect; these are much less energy-efficient but run silently and so are often used, for example, as hotel room refrigerators.[6]

Significant scope remains for further improvement of refrigerator efficiency both in developed and in developing countries. Improvements can be achieved through many separate measures, but the main improvements are:

1 INSULATION

The most important energy-saving technology is improved insulation. 60 per cent of the heat leakage into a refrigerator comes in through the walls and door[7]

2 COMPRESSORS

Compressors with much improved efficiency compared with those of ten years ago are available globally, with little cost impact

3 CONTROLS

Improved controls, especially for appliances with two or more compartments and for variable speed drive (invertor) controls for compressors

Many other aspects can contribute to efficiency. Improved door gaskets, reduced heat transfer at the edge of panels (which account for nearly 30 per cent of heat transfer), better fans and slightly larger heat exchangers, better and thicker insulation, variable speed drives for compressors and the choice of refrigerant are examples.

Vacuum insulated panel (VIP) technology appears in some premium products. Such panels offer effective insulation at less than one-fifth the thickness of polyurethane foam. Use of VIP is limited because it is significantly more expensive than polyurethane foams.

Most of these technologies are available to developing country markets in imported refrigerators and, in some economies, as locally manufactured options.

Refrigerants

Ozone-damaging refrigerants were successfully phased out of manufacture in all economies in 2008. The F-gases replaceing them had zero ODP, but often had high GWP. The use of high GWP refrigerants in refrigerators is forbidden in some major economies such as the EU.

A transition to alternative refrigerants, such as HCs, with both zero ODP and GWP as low as is practicable[8], is complete in European countries and underway in China as well as some other industrialised countries.

Authoritative advice and assistance supporting developing countries in this transition in available. The focus is on dealing responsibly with the risks of managing the bulk quantities of flammable HC refrigerants in factories. For further information see also section 7.

Foam Blowing Agents

The insulating foam for the majority of refrigerators is made by aerating a plastic polyurethane ("PU") resin with a gas. PU itself is harmless in terms of ozone depletion and climate change, but the gas used for foaming can be problematic if it has a high GWP and/or any ODP. Technologies for recovering foam-blowing agents when recycling appliances are important. Crushing foam in a sealed chamber and collecting the gas is an example of such a technology.

In developing countries, HCFCs (which are ODS) are still used in insulation foams. This can continue up until 2030. The majority of new refrigerators use cyclopentane, which is a HC gas with GWP of 11, and is of little environmental or waste disposal concern, thus making its disposal simpler compared to when F-gases are present. Virtually all refrigerators made in the EU since 2010 use cyclopentane in the insulation. Care is needed for the use of HCs in manufacturing foam because of their flammability. See also section 7.4 on making the transition to very low GWP foaming agents.

2.2 MARKET TRENDS

2.2.1 GROWTH OF STOCK IN DEVELOPING COUNTRIES AND EMERGING ECONOMIES

Refrigerators are one of the first appliances sought by households as electricity becomes available to them. Ownership levels grow almost as fast as the electrical grid connections. The projected total stock of refrigerators in use in 150 developing countries and emerging economies is shown in Figure 3. Furthermore, in the figure stock trends for three developing countries/ emerging economies are represented. The stock of refrigerators across these countries is due to double from 1 billion to nearly 2 billion by 2030. Most of the additional refrigerators will go into homes that never had a refrigerator.[9]

Figure 4 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 Lawrence Berkely National Laboratory (LBNL) in California, and updated by the partners.

Figure 3. Growth in the total number of refrigerators in use for 150 developing countries and emerging economies

Source: U4E

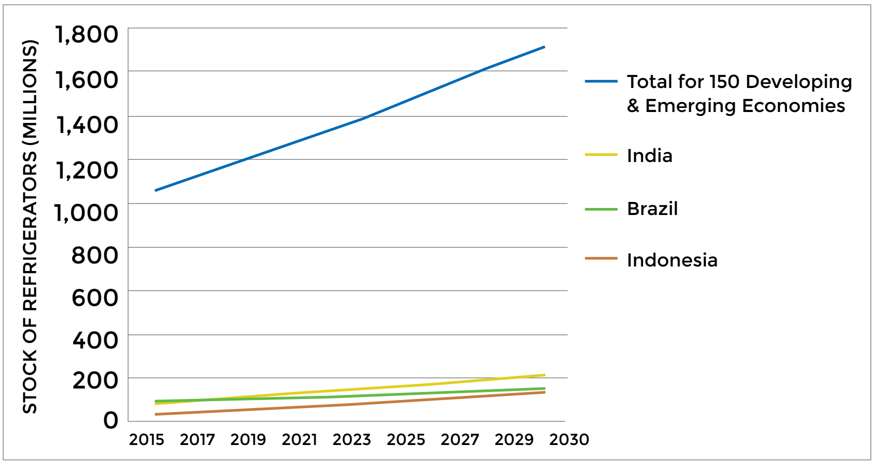
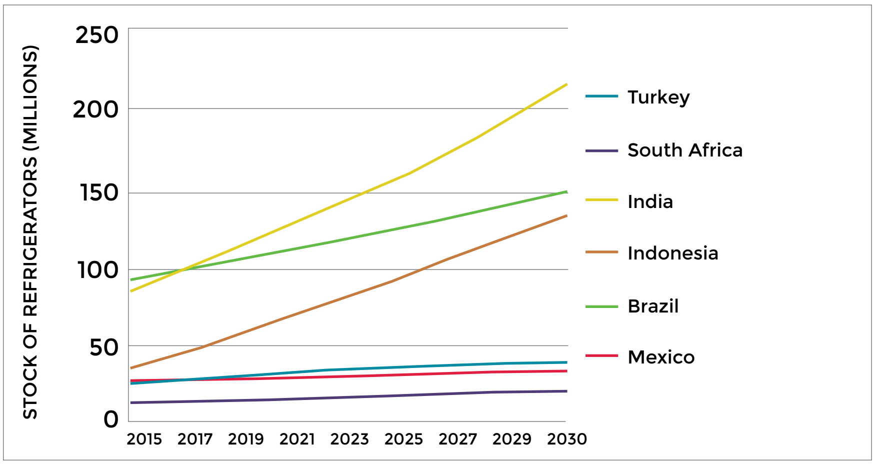


Figure 4. A projection to be added to the national stock in 6 example developing countries from 2015

Source: U4E Country Assessments



2.2.2 TYPE OF PRODUCTS MANUFACTURED AND USED

The typical appliance size varies widely between economies. India and China have historically used smaller appliances than developed countries. 90 per cent of their sales are of less than 250 L (2008 data). In comparison, Latin America sales had over 30 per cent with more than 350 L. For most economies of the world, the refrigerator-freezer is now dominating sales. Figure 5 shows a snapshot of the global breakdown of refrigerator and freezer internal volume.

Typical internal volumes are growing for most developing and emerging economies. They have stabilised for most developed countries after years of growth because a larger storage volume generally means higher appliance energy consumption.[10] The most common type and size of appliance is generally a refrigerator-freezer with an internal (adjusted) net volume of 280 L.

Policies should avoid steering consumers toward appliances larger than they need. Some of the achievable energy savings are reduced if the typical size of appliances grows. MEPS are usually set as energy consumption from a calculation using storage volume and some other characteristics.[11]

Sales of freezer-only appliances have been at 10 to 20 per cent of the combined sales of refrigerators and fridge-freezers for most economies in the previous decade. This is higher for both Western Europe and North America at around 25 per cent. These freezers are an addition to the home's fridge freezer.

Specialty fridges such as wine coolers and absorption type remain at only a few per cent of sales. They are not addressed in this guide.

Global manufacture of refrigerators is concentrated in China, Mexico, Thailand, Turkey, the EU and the United States (US), which together account for over 80 per cent of the global trade value in household refrigerators. All of the main producer nations have refrigerator regulations in place for units sold in their own economy. They can supply appliances meeting a good standard of energy efficiency.

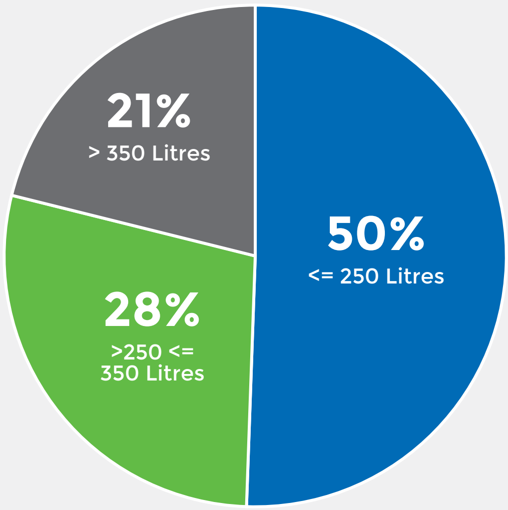


Figure 5. Global sales of fridges and fridge-freezers broken down into small, medium and large sizes by internal volume.[12]

Source: GfK 2008, as published by IEA[13]

2.3 THE MARKET FOR USED PRODUCTS

There are two types of markets for used appliances that policymakers need to consider:

- **Large scale imports of used products from other economies**, often referred to as "product dumping," when the products have bad economic or environmental consequences;
- **The "secondary market,"** where appliances are passed or sold to other households or kept as a second refrigerator.

Appliances' potentially high GWP and ozone-depleting gases will increase the effort needed for the recycling of appliances and cause greater environmental impact. The electrical safety of such used appliances is also a serious concern for affected economies. Dumping can be prevented by an appropriate legal framework combined with enforcement and institutional structures that prevent poor and old products from entering a country. See the case study on Ghana that follows at the end of this section.

Product Dumping

Product dumping can refer to under-priced products; however, appliances of poor efficiency and/or containing problematic gases are of concern in this context. This can undermine policy progress and cause a serious environmental legacy for an emerging economy.

The legacy impact includes much higher energy consumption, which is locked into the electrical grid for 15 years or more.

"Second Life" Appliances

The "second life" of appliances is generally less problematic than large scale "dumping". It does undermine regulations and delays achieving the aims of regulations, through extending the working life of poor performing old appliances. Take-back and incentive or replacement schemes can be effective to safely and permanently remove such products from the market and ensure their replacement by much better ones (see section 5.2.6 and section 7.5).

Take-back and incentive or replacement schemes can be effective to safely and permanently remove used products from the market and ensure their replacement by much better ones.

CASE STUDY: Introduction of MEPS and Labels, Ghana

MEPS, Labels and Import Restrictions Secure Savings
The market in Ghana was previously dominated by imported used and inefficient refrigerating appliances mostly coming from Europe. The Ghanan government's estimates showed that consumers in Ghana could save over $100 per year in energy costs from new and better refrigerators, which would offer a payback of less than three years. MEPS and labels were introduced in 2009 with labelled refrigerators being evident in shops from June 2011 as importers adapted to the new regulations.

The import of old and used appliances persisted. More households were paying high running costs, and national efficiency improvements were undermined. The government introduced a ban on importation of used refrigerating appliances in June 2013. This was successful. The proportion of imported appliances fell dramatically, and businesses making or importing compliant goods could prosper, bringing further economic benefits to the country.

MVE to Uphold Standards
MVE initiatives to ensure the success of MEPS and labels in Ghana have gone through three phases since the MEPS of 2009:

PHASE 1: Ensuring that all appliances are energy labelled. This had to happen before arrival in Ghana as virtually all were imported. The simple and effective public education messages via TV, radio and newspapers were: "no label - no good" and, regarding the label star rating scheme, "more stars = more efficient = more money in your pocket".

PHASE 2: Documentation of performance. As the label was getting fully established, the focus shifted to appliance test reporting, seeking documentation from third party accredited test laboratories.

PHASE 3: Check testing. The government started compliance checks as a testing laboratory was installated in 2014. Samples are picked from both the port of entry and the market to verify the claim made on the test reports, especially for products that gave rise to doubts. If the test fails, the importer must recall appliances from the market and remove all of the product from Ghana, including unsold stock. All of this is done at the expense of the importer.

Safe Removal of Old Appliances from the Market: F-Gas Reclaim Trucks
The safe disposal of old refrigerators was a major challenge in Ghana. Most were left to rust untreated and release their F-gases (refrigerants and foam-blowing agents) into the atmosphere. As part of a wider GEF-funded project on transforming the Ghana market for refrigerators that started in 2011, the government of Ghana worked with suppliers, retailers and trade bodies including maintenance technicians to educate the refrigeration appliance industry on procedures for the collection and disposal of appliances and ODSs.

Through a Public Private Partnership (PPP) two ODS collection and disposal facilities for used appliances were established. One of the partners used a mobile recycling unit, including all the necessary equipment on board. It accessed remote areas to recover refrigerants. Training workshops on the substitution of CFC refrigerants with HCs in refrigeration systems were organized for the maintenance technicians nationwide. Over 650 technicians were trained on safe gas recovery practices to minimise direct damage to the atmosphere from refrigerants.

As a result of the various policy measures regarding household refrigerators, Ghana is on track to save 400 GWh per year in avoided electrical consumption in the medium term.

For more information click here.

2.4 PERFORMANCE TRENDS

Energy consumption of refrigerators varies according to their internal volume and the temperature at which their compartments are operated.[14] If other factors are equal, then consumption is higher for a bigger internal volume and higher for lower compartment temperatures. A refrigerator in a hot climate will also use more energy than the same refrigerator when operated in a cool climate.

Refrigerators were one of the very earliest household appliances to be subject to MEPS and energy labels. Improvements have been tracked for more than two decades in several economies, including the US and Australia. The electricity consumption of a typical US refrigerator has fallen by 70 per cent since its peak in the 1970s, while the average internal storage volume has risen and the cost of appliances in real terms has actually fallen (US Department of Energy data). Similar long-term studies in Australia have shown consistently falling prices concurrent with improving efficiency, and that even aggressive MEPS in 2005 in Australia had no discernible effect on that trend (EES 2016).

Historical refrigerator efficiency data from different economies around the world cannot easily be compared due to test method differences. A major IEA 4E study in 2014 calculated the necessary adjustment factors for major developed economies.[15] This study showed how rates of improvement of efficiency are being sustained for refrigerator-freezer combination units. Similar improvements are seen for most other refrigerator types. Refrigerator-freezers in the US and Canada showed a drop in energy consumption of over 25 per cent in the three years following the MEPS of the year 2000; subsequent MEPS achieved similar levels of improvement. Policies in Japan cut energy consumption by nearly 35 per cent in ten years; the EU cut average energy consumption by 25 per cent in the ten years to 2014. Markets that are initially unregulated can expect to achieve levels of improvement much higher than this, due to the likelihood of the market being dominated by appliances of very poor efficiency.

The IEA study showed that the average annual energy consumption of new refrigerator/freezer combinations across Australia, Canada, the EU and the US is converging toward a range of 250 – 400 kWh/year. This follows from a spread of 450-800 kWh/year in 1996. Typical high efficiency new fridge-freezers with a total net volume of between 300 and 400 L consume less than 200 kWh/year under test standard conditions. The very best new fridge freezers consume around 160 kWh/year (one such model has an internal volume of 280 L).

3. STANDARDS AND REGULATIONS

WHAT?	An overview of the test methods and metrics used to measure domestic refrigerators performance. A summary of MEPS, that include energy requirements and sometimes requirements on refrigerant gases and foaming agents.
WHY?	Provides information on MEPS, the first part of UN Environment's Integrated Policy Approach, which is the cornerstone of market transformation.
NEXT?	**Some key questions to keep in mind:** • Can you use the new International Electrotechnical Commission (IEC) measurement standard? What would be the pros and cons of doing so? • How ambitious can MEPS be for your economy? By when can you expect to match the best MEPS in the world? From where would the efficient appliances need to be delivered? • Can you signal future tier(s) of MEPS so that industry can plan and minimise economic impact? • What role can energy labels play? • What requirements would be appropriate concerning refrigerant gases and foaming agents?

3.1 TEST METHODOLOGIES AND PERFORMANCE METRICS

Since February 2015 there has been a globally relevant test methodology for household refrigerators, called IEC 62552: 2015 *Household refrigerating appliances–Characteristics and test methods*. It can be used worldwide for policy purposes. This standard enables manufacturers to derive fair and comparable figures for annual energy consumption (kWh/year), and to make suitable calculations for local climate conditions and policy needs based on two tests (one at 16°C and one at 32°C ambient).

ECONOMIES ARE RECOMMENDED TO CONSIDER BASING THEIR POLICIES ON:

IEC 62552: 2015 flexibile for adaptation of results to suit local climate and internal storage temperatures, good reproducibility, shorter test duration and costs (for most refrigerator types) and less prone to cheating.

Economies are recommended to consider basing their policies on IEC 62552: 2015. A growing number of major economies have already done this. IEC 62552: 2015 is favoured because it includes flexibility for adaptation of results to suit local climate and internal storage temperatures but ensures comparability of results between economies. Compared with its predecessor test standards, it achieves good reproducibility, shorter test duration and costs (for most refrigerator types) and is less prone to cheating.

However, not all economies are aligning. Some differences remain between test methods. For example, the US test method[16] has differences in the way defrost energy is measured and other factors that vary by appliance type. This means that Mexico, for example, is unlikely to adopt IEC 62552: 2015 at present due to their strong trade links with the US.

Guidance on setting up of laboratories to test to IEC 62552: 2015 can be found in Annex A of IEC 62552-1 Household refrigerating appliances–Characteristics and test methods–Part 1: General requirements. Further guidance is available via IECEE, in particular under their Certified Body scheme. See also section 6.4 for details on the use of regional testing facilities.

Once a sound test method has been chosen, manufacturers can provide performance data that can be compared on a fair basis. This is usually measured in terms of kWh of energy consumption per 24 hours per unit voloume, or kWh per year/volume. Policymakers can, in turn, use this test method and performance data as the basis of their national minimum efficiency requirements. As noted before, the energy consumption will vary significantly by type and size of refrigeration appliance and policies usually set MEPS and labels differently for each main type of refrigeration appliance. For instance, the energy use increase with the refrigeration appliance volume and that can be defined by a smooth, continuous equation or via “bins”.

3.2 MEPS

MEPS are mandatory regulations that remove the poorest performing appliances from the market. As long as they are enforced effectively, MEPS are the fastest and most cost-effective way to raise the market average performance level.

MEPS may also be used to address performance issues other than energy, such as how effectively a washing machine washes the clothes. Some require certain performance-related functionality or features, such as automatically switching off a "fast-freeze" mode after a certain number of hours.

Copious evidence suggests that refrigerator markets in Australia, China, EU, Mexico, and the US and many other economies have been totally transformed by the combined effect of MEPS and energy labels. Introducing MEPS has been shown to reduce annual energy consumption of a typical refrigerator by at least 30 per cent and up to 60 per cent (as long as the measures are suitably enforced). The consumer will save money for the entire lifetime of the refrigerator (typically 15 years). Even where electricity prices are subsidised or where electricity is taken unmetered, the savings are substantial for the utility and government in avoided generation and lower investment in generating capacity and infrastructure.

A fear sometimes expressed is that MEPS may cause prices rises and make appliances unaffordable. However, the existence of MEPS is only one of many factors affecting price, and it is impossible to generalise on this important issue. Amongst the complicating factors is the proportionally lower price impact of MEPS in economies with a larger average refrigerator size, compared with an economy that generally uses small refrigerators. If MEPS are set using the analysis summarised in the steps below, they should represent the lowest life-cycle cost point for the consumer and the specific economy.

MEPS certainly do not always push prices up. Evidence shows price stability through new MEPS or price reductions following a similar evolution as before the MEPS were introduced (particularly in mature and competitive markets).

ADVANTAGES
OF MEPS:

- Provide high certainty to deliver energy savings (as long as they are effectively enforced)
- Use in conjunction with governmental fiscal measures, such as financial incentives
- Encourage innovation and investment in R&D to create new and more efficient appliances
- Adjusted periodically as performance improves and
- Can be designed to maximise consumer benefits with very low per unit transaction costs.

DISADVANTAGES
OF MEPS:

- Energy-efficient appliances may not be widely available at the outset. Time for supply chain adjustment must be allowed
- The initial cost of energy-efficient appliances may be greater and
- Local manufacturers (and maybe importers) may need time and, in some instances, technical or financial support to adjust designs and manufacturing practices.

Please review the UN Environment report **DEVELOPING MINIMUM ENERGY PERFORMANCE STANDARDS FOR LIGHTING PRODUCTS** for more information.

To gain support for the MEPS programme, stakeholders should be involved from an early stage. This should include, for example, standards institutions and agencies, certification and accreditation bodies, test laboratories, manufacturers, suppliers and distributors, technological institutes and environmental and consumer organisations.

Source: published by en.lighten, June 2015 "Developing Minimum Energy Performance Standards for Lighting Products, Guidance Note for Policymakers"

Before MEPS are adopted, cost-benefit analyses must be performed to ensure they are set at a level providing a positive economic benefit to consumers. The likely impact on the wider economy (manufacturing, for example) must also be considered.

The following summary of the steps to establish a MEPS programme is adapted from the UN Environment publication on MEPS for lighting products.

Overview of Generic Steps to Develop MEPS

1. **Establish a legal framework:** Review existing legislation and establish the legal framework and political commitment;
2. **Appoint an administrative agency:** Assess existing institutional capacity for developing, implementing and maintaining the policy. Assign one government agency to develop and implement an overall standards and labelling plan;
3. **Engage stakeholders:** Identify the relevant people who should be interested and invite them to participate.

Product-Specific Steps

1. **Gather required data:** Develop a plan and collect the data necessary for technical and market analysis to support the programme (on sales, technology, supply chain, appliance usage);
2. **Conduct an economic analysis:** Use cost-effectiveness analysis to help decide how ambitious the measures could be (looking at the cost savings achieved by users versus any increase in appliance cost in the medium term);
3. **Harmonise testing:** To the greatest extent possible, harmonise energy performance test methods with those of trading partners (such as via IEC 62552, see section 3.1) to ensure transparency on performance levels and reduce barriers to trade;
4. **Set MEPS levels:** Determine a technically feasible and cost effective level for the efficiency requirement that is appropriate for the local market (using also the economic analysis above); invite stakeholders to comment and refine the MEPS as necessary; secure political support; publish a regulatory notice and specify the future date(s) when MEPS will take effect so that the market can prepare;
5. **Review and update the standards** every few years to ensure they remain appropriate to maintain improvements.

Harmonisation of MEPS

Harmonising the test method, metrics and even MEPS thresholds with those of trading partner economies can bring trade advantages. Once standards are harmonised, products legal for sale in one economy can become legal for sale in the partner economy. This was a significant factor in why refrigerator manufacturers in Mexico were so supportive of the process to develop their country's MEPS in line with the US.

Harmonisation of MEPS can also avoid the costs of duplicating testing, managing noncomparable performance information, and other administrative burdens. Buyers usually end up with access to a wider choice of goods and better prices.

Regional cooperation can also reduce total costs to economies that cooperate by sharing resources for technical analysis, product testing, market monitoring and many other aspects. Coordination can be achieved through consensus-building and bilateral activities, having clear primary contact points in each country to lead on local activities and developing communication links between stakeholders. Only best practice for MEPS standards should be considered for the harmonisation process to avoid letup of implementation.

Regional cooperation can include:

- **Developing a regional efficient refrigerators roadmap** to identify areas of cooperation and ways to share resources and build regional markets for efficient appliances
- **Harmonizing specifications and standards** including mutual recognition of certification
- **Coordinating and sharing market MVE activities**
- **Expanding test facilities** to reduce costs and build a network of testing professionals
- **Establishing regional resources** for environmentally sound management, including collection and recycling schemes and information programmes
- **Sharing resources, capabilities and facilities** within the region to make all more effective.

It is not usually accurate and sometimes not possible to directly compare the stringency of MEPS levels between different countries unless differences in test method and product types are taken into account. This has been carefully done in an IEA 4E Benchmarking report for refrigerator MEPS up to 2014 across various refrigerator configurations for Australia, Canada, the Republic of Korea, and the US. For another perspective, MEPS for six Asian countries plus Australia are compared in an Australian Government report. Comparative levels as they apply to a typical 280 L internal volume fridge-freezer (top/bottom configuration) are shown in Table 1. This illustrates the range of levels already in place for some example economies. Each country must determine the level most appropriate for its own circumstances, taking into account best practice.

Some developing countries have successfully "leapfrogged" to MEPS levels close to those of economies that have had MEPS for many years. However, this choice must depend on the local circumstances. See the Fundamentals Guide for more considerations of regional harmonisation of MEPS.

Table 1. Comparison of the mandatory MEPS levels for a 280 L fridge freezer (a very common type and size of appliance) in various economies.[17]

*Source: Ref (regulations and standards (MEPS) levels read from Figure 2 of the report at 437 L adjusted volume with no further adjustment).

**Source: Ref (assumes China Type 5 fridge-freezer and Thailand type "<450 L"; no further adjustment made, simple annual consumption read from Figure 8 of the report at 437 L adjusted volume).

ECONOMY	EQUIVALENT ANNUAL ENERGY CONSUMPTION LIMIT DERIVED FROM MEPS LEVEL (KWH/YEAR)
EU (2014)*	355
AUSTRALIA (2009)*	455
SWITZERLAND (2011)*	355
US (2014)*	325
CHINA**	510
THAILAND**	625

Regulating Other Non-Energy Requirements

Issues surrounding the regulation of refrigerants and foam-blowing agents are discussed in sections 7.3 and 7.4. There are other nonenergy issues that should be considered, including the internal volume of the refrigerator and freezer compartment(s). Care must be taken in how information is presented to ensure that buyers are not confused or distracted from the main energy information.

Some regulations (such as in the EU) impose requirements making refrigerators easier to disassemble and recycle at the end of their life. They cover labelling of harmful components and making them easy to extract, as well as permanent marking on the cabinet itself to show which refrigerant and foam-blowing agent are used.

There are examples of MEPS concessions being given for appliances such as air conditioners using low GWP refrigerants.[18] Such concessions are not applied to refrigerators because the alternative refrigerants are well suited to household refrigerators and are highly efficient. Therefore, countries are advised against setting less stringent MEPS levels for refrigerators with low GWP refrigerants or foams, and to preferably set policy that prevents high and medium GWP gases being used in refrigerators.

CASE STUDY: MEPS Development in Action, Mexico

Mexico's National Commission for the Efficient Use of Energy (CONUEE) launched MEPS for refrigerators in 1994. CONUEE has updated the stringency of the standard twice since then (in 1997 and in 2002) and extended the scope to additional appliance types in 2012. Between 2000 and 2014, the refrigerator market in Mexico has more than doubled in size. The MEPS have been important in managing total electrical demand in the country.

The Mexican standardisation programme has followed a strategy of harmonisation with US programmes across several home appliance types, including the use of either identical or similar test procedures, product classifications and metrics. Harmonisation between Mexico and the US has not been complete because of differences in product types sold. The participation of manufacturers in developing energy efficiency standards has been important because of the necessary investment to meet the new standards.

For a typical 280 L refrigerator-freezer in Mexico, the first MEPS in 1994 achieved a 24 per cent cut in consumption from 700 kWh per year to 532 kWh per year. It brought performance much closer to the MEPS level of the US. The second tier of MEPS made a further cut of nearly 20 per cent and matched the US MEPS of that time. The US MEPS became 22 per cent more stringent in 2001, and Mexico followed suit in 2002. Hence, between 1993 and 2002, typical consumption was cut by over 50 per cent, from over 700 kWh per year, down to less than 340 kWh per year.

Retail prices showed no detectable increase in the costs for refrigerators in the period 2000 to 2013. In real terms the prices stayed constant as manufacturers took advantage of economies of scale and other improvements to keep prices down.

National benefits included peak electrical demand reduction by one GW by 2015 and four TWh of savings for users in 2015*. MEPS were seen as positive by manufacturers and other market stakeholders, as they created a level playing field and led to technology improvements, stimulated innovation and have ensured that energy efficiency is now one of the five most important factors considered by the Mexican consumer when purchasing a refrigerator.

MEPS have also prevented the import of used appliances to the national market. This has helped Mexican manufacturers, an important national industry. One downside was that compliant appliances manufactured in Mexico were less price-competitive when being sold into the other parts of Central America that don't yet have MEPS. Simpler appliances with poorer efficiency could undercut prices.

Refrigerators Substitution Programme
The government of Mexico launched a refrigerator substitution programme in 2009 offering consumers both a loan (for purchase), and a subsidy of up to $60 towards disposal of the old refrigerator. Appliances replaced must be older than 10 years, the replacement must meet the prescribed efficiency class, and financing is paid through the electricity bill.

Fideicomiso para el Ahorro de Energia Electrica (FIDE) operates the scheme, National Financiera – Banca de Desarrollo finances it, and the debt is collected by the Comision Federal de Electricidad. The Ministry of Environment ensures the proper disposal of the old refrigerators. From 2009 to 2012, 1.8 million appliance substitutions were requested. The program was estimated to deliver savings of more than 300 GWh/year, corresponding to more than 150,000 tCO_2e, equivalent to removing 30,000 cars per year from Mexican roads.

* For more information click here.

CASE STUDY: Introduction of Labels and MEPS, Turkey

Labels and MEPS Transform the Market

In Turkey, the gradual year-on-year improvement of the market under the influence of labelling, MEPS, and some other supporting policies has been documented by the Turkish Home Appliance Manufacturers' Association since the year 2000.

In 2000, only 15 per cent of sales were of class A, with the balance spread across classes B, C and D. Improvements in efficiency meant that by 2010, classes C and D had disappeared from the market.

In 2011 Turkey introduced the first tier of its MEPS. They are a close transposition of the earlier EU regulation. This first tier removed all C and D label appliances and the 10 per cent of sales that were rated class B. The second tier of MEPS, introduced in 2012, meant that all appliances had to be class A or better. This led to a sudden jump in sales to the A+ and A++ classes.

This rapid transition posed a challenge both to manufacturers and also to regulatory enforcement authorities. Compliant appliances had a higher price in the early stages, which sustained demand for cheaper appliances with lower labels classes, despite them being officially banned.

Training for MVE

The UNDP/GEF project 'PIMS 4014 for a Market Transformation of Energy-efficient Appliances in Turkey' enabled Turkey to upgrade their energy efficiency testing capacity through laboratory investment, staff training and a testing programme.

A structured enforcement and verification program was established with adequately trained staff and other resources:

- Training of 300 field inspectors on eco-design and labeling market surveillance
- Training of MoSIT HQ on Management of Market Surveillance Programme (MVE)
- Market surveillance programme
- Laboratory investment (accredited by TÜRKAK)
- Inventory
- Upgrading
- Training of testing staff.

The project also established a market monitoring database to monitor energy consumption and GHG emissions caused by appliances.

4. SUPPORTING POLICIES

WHAT?	An overview of product labeling, communication and outreach activities. Product labelling explores the different label types, including endorsement and comparative. The communication discussion focuses on stakeholder empowerment through information.
WHY?	Provides information on supporting policies, the second part of UN Environment's Integrated Policy Approach, and which is critical for securing public support and accelerating the transformation of markets.
NEXT?	**Some key questions to keep in mind:** • What labelling schemes exist or have been tried in my country in the past? • Which national label will be the most effective way to communicate appropriate choices to consumers? • Can we adopt existing labelling schemes with proven validity and effectiveness? • How to secure correctness of the claims on the label, or compliance to the criteria for affixing the label? • Has our country convened an energy efficiency communications campaign in the past? If so, what worked and what did not work? Are there lessons to be learned from other communications campaigns that could help? • Who would lead a national campaign in our country promoting energy-efficient and climate-friendly refrigerators? What partners would be needed? What impact could the campaign have?

4.1 ENERGY LABELLING

Product labelling is one of the most direct and effective means of delivering information about energy efficiency to consumers. It serves to make consumers aware of the products that are most energy-efficient, in contrast to MEPS that only remove the least efficient models from the market.

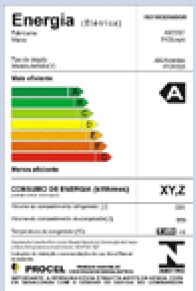
Through better consumer information, energy labelling is used to pull more energy-efficient appliances into the market and increase their market share. Beyond consumer information itself, energy labels are an important basis for other supporting and financing instruments, such as education, financial incentives (rebates, grants) and financing (loans), as well as green public procurement. When implemented well, it is also one of the most cost-effective energy efficiency policy measures for consumers, industry and government.

4.1.1 GENERAL CONSIDERATIONS FOR THE DEVELOPMENT OF LABELS

There are two major groups of labels: endorsement labels and comparative labels. They can be complemented by the display of product information, either directly on a fiche attached to the product or through a digital vehicle like a Quick Response (QR) code. These different types of labels are presented in details in the Fundamentals Policy Guide that has been prepared by UN Environment and provides a cross cutting, fundamental level of information on the different aspects of putting in place a MEPS and labelling program.

Table 2 and the following sections present an overview of the pros and cons of each option, with a few base-cases and good practice examples for implementation. Mandatory and voluntary labels are different tools that can sometimes be implemented in parallel.

Table 2. Advantages and constraints of mandatory and voluntary labels

TYPE OF LABEL	ADVANTAGES	CONSTRAINTS
MANDATORY LABELLING (typically comparative label)  Example: Brazilian comparison label	• Provides consumers with relevant information on all products • Enables consumers to make an informed purchasing decision taking energy efficiency into account • Can serve as a basis for other instruments such as financial schemes, rebates, subsidies • Widespread recognition of a label provides a strong market incentive for energy efficiency • Use mandatory labels to effectively prepare local manufacturers before the enforcement of MEPS • Design programmes to accelerate the pace of market evolution and adoption of new, highly energy-efficient technologies.	• Significant investment in time and effort to build awareness with end users and retailers • Mandatory programmes tend to be more rigid than voluntary programmes and if they are poorly designed (e.g. in favour of large appliances, do not take into account some important features), they can create additional market barriers • Transparent monitoring required to ensure fair participation and effective enforcement.
VOLUNTARY LABELLING (typically endorsement label)  Example: Mexican endorsement label	• Provides consumers with relevant information to select products above a certain level of energy efficiency • Can serve as a basis for other instruments such as financial schemes, rebates, subsidies, etc. • Don't impose any burden on manufacturers who are not willing to participate • Requires less legislation and analysis compared with mandatory programmes because they don't represent a threat to any market players.	• 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 • Does not ensure that all market players will engage with the programme and therefore is less inclusive than a mandatory label to prepare the market for MEPS • Offers low incentive for non labelled products to improve • Lacks an incentive to go to higher efficiency than required for endorsement • Requires transparent monitoring to ensure fair participation and effective enforcement.

The choice between putting in place a voluntary or mandatory scheme, or both, should be based on market research and the exact design (including shape, colours, classes, text). The specific cultural context and potential pre-existing labels or marks of quality will play an important role in the consumers' perception and response to the label.

Focus groups are the best way to test consumers' comprehension of a label, and whether it effectively impacts their purchase decision. Such groups are an investment but can have a significant impact on what the scheme delivers over the long term.

The paper 'A Multi-Country Comparative Evaluation of Labeling Research', published by CLASP in 2005, presents a wide range of labelling research led in various countries and for various purposes. It concludes on the value added by label research and on the best methods to adopt. More recently, CLASP conducted research for BEE to support the design of a new endorsement label. It summarises the value added by label research and on the best methods to adopt. More recently, CLASP conducted research for the Bureau of Energy Efficiency, Government of India (BEE) to support the design of a new endorsement label. This work is presented in the 2013 report 'Designing A Super-Efficient Appliance (SEA) Label' for Super- Efficient Equipment Program (SEEP).

4.1.2 COMPARATIVE LABELS

Comparative labels typically bring more information to the consumers than endorsement labels. They are typically mandatory, as the objective is to enable consumers to compare all products on the markets. Voluntary comparative labels do exist, for example, in Thailand. Typically manufacturers only want to label appliances with the highest rating, which means that it actually works as an endorsement label.

In order to keep the label understandable, accurate and relevant over time it is necessary to maintain a visible differentiation between products offered on the market. However, if the label reaches its objective, the market will overtime be pulled towards a better efficiency. The only two strategies are to have an open scale or to periodically rescale the label.

CLOSED SCALE

EXAMPLES: A to G scale, number of stars, numerical with 1 being the most efficient.

A closed scale needs to be rescaled periodically as efficiency of products on the market evolves. This involves some additional burden and the risk of confusion during transition phase needs to be addressed through communication. However, if well maintained, this option offers the best representation of the market. If rescaling is not done, the label ceases to be representative of the market and becomes misleading in the long term.

OPEN SCALE

EXAMPLES: Energy Efficiency Index, yearly consumption, numerical with 1 being the least efficient.

With an open scale, there is no need to rescale the label to ensure differentiation of better products when the market has evolved. However, visual elements of the label would typically have to be updated as the lower end of the scale becomes obsolete. If this visual update is not done, the label ceases to be representative of the market and becomes misleading on the long term.

Good Practices for a Comparative Closed Scale Label

Where the choice is made to implement a comparative closed scale label, some practices, adopted by an increasing number of economies, should be considered:

- **The bottom of the scale should be the MEPS level** (where relevant);
- **Where performance distribution is homogeneous on the market, the difference between the classes should be a geometric progression**, for example, a 20 per cent increase in efficiency between two classes;
- **Set best efficiency class on the market at the time of the definition of the scale to be a little beyond the middle of the range**, leaving the top class(es) empty;
- **Try to ensure that only a limited number of products on the market will achieve the second best class until the next review**—typically between three and five years (based on estimates of technology progress in this timeframe).

Figure 6. Examples of label designs: The European A to G scale, Chinese 1 to 5, Thailand's 5 to 1 and Mexican Per centages

Design of the Label

For the label to effectively and positively impact purchase decisions, it is critical to make sure that consumers understand it correctly and easily. What is an appropriate design is very culture dependant and can significantly vary between countries. Focus groups are the most reliable way to test consumers' comprehension of a considered design, colours, symbols, pictograms and their potential impact on purchase decision. Figure 6 illustrates some of the variety of label design.

Observing the colour scheme and classes designation of just three comparative models from China, the EU, and Thailand shows how interpretation can vary between cultures. For example, green and red are used to indicate the most and least efficient products in the EU and Chinese labels. Red, as opposed to green for the rest of the scale, is used to indicate the class of the considered product in Thailand's label. A to G letters are associated to school grades in Europe, and the scale therefore could not have been reversed without risking to cause major misunderstandings. In the Chinese and Thailand's labels, however, numbers are used rather than letters. In the case of the Chinese label, 1 is the best performing class, whereas it is the least efficient class in Thailand's label.

Inclusion of Additional Information on the Label

Comparative labels invite consumers to compare products through an energy class or through more absolute values. Typically, these values are yearly energy consumption and, in a few cases, yearly operating costs. Displaying the average yearly energy consumption on the label is generally recommended as it ensures more transparency.

Besides energy-related information, some labels present complementary information about the main features of the refrigerator (e.g. volume of the different compartments, noise emissions, type of gas included in the refrigerator), or include a digital vehicle like a QR code or the address of a website through which consumers can find out more information about the product or compare it to others.

Figure 7 shows the information on volumes of the refrigerator, freezer compartments and on the noise volume as displayed on the European Energy Label for domestic refrigerators. All information presented on the label should be of interest to consumers, and this can be confirmed by consumer research that tests the comprehension and purchase impact. Such research is important as there is a risk in making the label less readable and undermining its impact on purchase decision if it is too crowded with information.

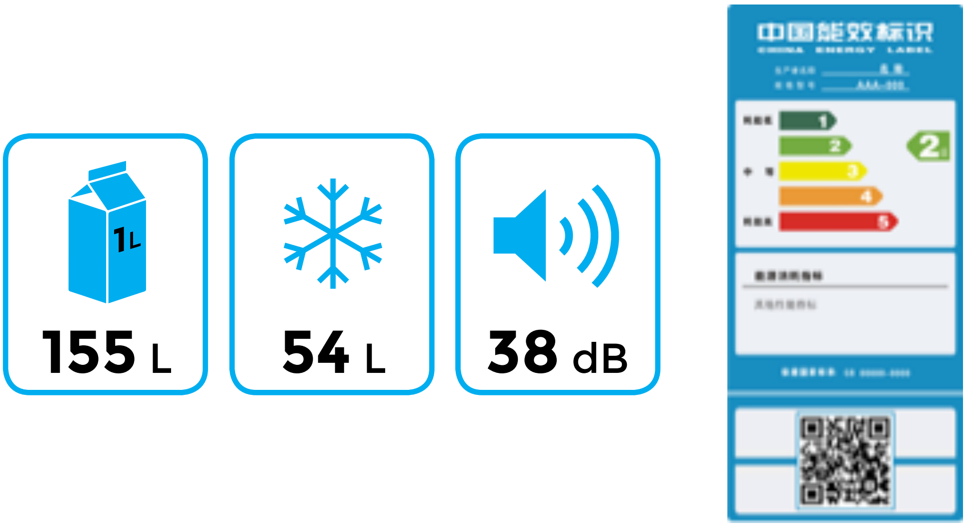


Figure 7. Additional information on the EU Energy Label and the updated China Energy Label with QR code

4.1.3 ENDORSEMENT LABELS

Endorsement programmes engage product suppliers who label their energy-efficient refrigerator products to inform end users about their superior 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.

Endorsement labels are, by definition, voluntary, as a product that does not fulfil the energy efficiency requirements cannot be labelled but can still be put on the market. As this label will not be visible on all products sold on the market, it will only be effective if it is combined with integrated awareness campaigns demonstrating the benefits of energy-efficient appliances to purchasers and manufacturers.

In order to effectively pull the market toward more efficient products and be a basis for complementary policy tools, endorsement labels should only differentiate products that are significantly above average. The criteria have to be updated as the energy efficiency of products on the market improves.

Voluntary or endorsement labelling programmes serve as an interim step toward mandatory programmes. They can also be maintained in parallel with mandatory comparison labels and MEPS, as a special award for the best products on the market.

CASE STUDY: Mandatory Star Rating, Refrigerators; BEE, India

India's energy-labelling programme offers significant benefits to consumers, enabling them to reduce their energy bills by providing critical information on energy use at the time of purchase. BEE is working to promote the efficient use of energy and its conservation across India.

The number of stars on a refrigerator can vary from 1 to 5, with more stars indicating higher energy efficiency and more savings for consumers. From January 2010, the labelling programme was made mandatory for frost-free refrigerators, room air-conditioners, distribution transformers and linear fluorescent tubes.

For more information click here.

From Voluntary to Mandatory
A voluntary comparative labeling program was launched in 2006 for refrigerators. The label became mandatory in 2010 for four products. An endorsement label was launched in 2011 to complement the comparative label.

Designing the Label
The design of the label was tailored to the local culture following extensive research including a large-scale survey, focus groups and expert consultation. In the end the impact on consumer understanding of specific variations among the draft designs was quantified.

Source: A Multi-Country Comparative Evaluation of Labeling Research, CLASP, 2005

For more information click here.

Rescaling: Star Rating lan
Instead of publishing one set of thresholds for the five star classes, the BEE published an eight-year "Star Rating Plan" for refrigerators, which defines the initial levels as well as the next three rescales, taking place every two years. This ensures a regular update of the scale without having to revise the regulation.

4.2 COMMUNICATION AND EDUCATION

Awareness-raising communication campaigns support national strategies to promote energy-efficient refrigerators through good governmental policies and programmes. In addition to these, changes in end user behaviour (not opening the door too frequently and for too long, storing food in closed containers to avoid humidifying the air in the refrigerator) can also contribute to energy savings, by making end users more "energy aware" through communication and education programmes.

Changes in energy conservation, through awareness and behaviour changes, low-cost actions and small investments like replacing the gasket will all contribute to the overall energy savings. Experience shows that for energy efficiency, as for other sectors like health, communication and education activities need to be carried out over long periods of time for behaviour changes to be largely adopted and permanent.

Correctly identifying the target audience for a communications campaign and tailoring the message to that audience is crucial. This section therefore focuses on identifying the main potential audiences and their interests, and broader considerations on how to design a communication campaign are presented in Annex B. Figure 8 depicts the four major target audiences for a communications campaign around energy-efficient appliances, with some examples of the stakeholders who can be found in those major groups.

Figure 8. Major target audiences for a communications campaign on energy-efficient refrigerators

- Governments (energy, trade and industry, climate, environment)
- Electric Utilities
- Standards organisations
- Customs authorities
- Testing labs
- Trade unions
- Lobbying organisations – environmental advocacy, industry associations

- Manufacturers
- Industry associations
- Wholesalers and retailers
- Specifiers
- Building owners and managers
- Recyclers

- Media
- Research and training institutes
- Universities

- Customers
- Civil society
- Consumer and community associations

Table 3 provides more information on the communication interests of these major target audiences. It includes their primary interests and their areas of involvement with respect to energy efficiency for appliances.

How exactly various groups of stakeholders are engaged varies a lot between countries and should be defined taking into account the cultural context and available resources. For example, the US has a culture of documenting all decisions and rationale. All stakeholders listed above are invited to take part in the discussions to build a negotiated consensus. The Mexican process relies mostly on subsets of selected stakeholders gathered in technical committees.

Table 3. Communication campaign stakeholders and areas of interest and involvement

TARGET AUDIENCE	PRIMARY INTERESTS	AREAS OF INVOLVEMENT
INSTITUTIONS/ GOVERNMENTS • Governments (potentially several ministries) • Electric utilities • Standards organisations • Customs authorities • Testing labs • Trade unions • Lobbying organisations - environmental advocacy; industry association	• For refrigerators in particular, several ministries may be involved: industry, energy, climate, environment; each of which would have different interests • Reduce electricity use and GHG emissions through energy-efficient and climate-friendly appliances • Ensuring efficiency standards and product quality in market • Ensure competitiveness of local manufacturers on global markets • Promote market penetration.	• Support regulatory and legislative initiatives and policy implementation through available funding opportunities • Provide experienced support in identifying success factors for promoting efficient appliances and market transformation • Evaluate and monitor processes against established targets • Provide in kind support to regulatory and legislative initiatives and policy implementation through technical expertise • Institute green public procurement programmes where only top labelled products would be acceptable.
BUSINESS • Manufacturers • Industry associations • Wholesalers and retailers • Specifiers • Building owners and managers • Recyclers	• Promoting innovative, energy-efficient new technologies • Business prospects • Corporate responsibility • Reducing electrical consumption • Managing the end of life of refrigerators.	• Facilitate direct and indirect end-user communication • Guide key actors in promoting sustainable policies and transforming markets to efficient appliances • Provide best practice solutions at local, regional or international level • Provide guidance on technical feasibility and realistic time schedules.
END USERS • Customers • Civil society • Consumer and community associations • Environmental organisations	• Acquire information to make informed decisions about the savings associated with a switch to efficient refrigerators • Own energy-efficient products.	• Accept and utilise of energy-efficient appliances based on first-hand experience and affordability • Provide information about buying habits • Increase the market share of energy-efficient refrigerators, and sustain the change in consumption patterns.
MEDIA AND OTHERS • Media • Research and training institutes • Universities	• Increase awareness and develop knowledge about energy-efficient refrigerators among professionals and consumers.	• Disseminate information on energy-efficient refrigerators and their benefits (energy and environment) to consumers • Identify best practices and policies • Assist governments in implementing sustainable appliance policies • Publish formal and informal education and training materials.

5. FINANCE AND FINANCIAL DELIVERY MECHANISMS

WHAT?	This chapter addresses topics relating to the financing of energy-efficient refrigerators, including both sources of financing and implementation vehicles to facilitate delivery. Some of the topics covered in this chapter include overcoming first-cost barriers to market adoption, traditional and innovative financing mechanisms, energy service companies, bulk public procurement schemes and electric utility demand side management and on-bill financing programmes. This chapter covers both financing, relating to loans and other streams of money that have to be repaid, and funding referring to grants, rebates, tax incentives or whatever financial support that does not have to be repaid directly.
WHY?	Affordability of efficient refrigerators can be a market barrier, especially for low income residential consumers and municipalities. This chapter addresses how public finance, multilateral development finance, and climate finance, in coordination with the private sector, can help kick-start and broaden the market of climate-friendly refrigerators through macro and micro financial schemes, innovative market delivery and repayment mechanisms, and other approaches to leverage private sector investments in these sectors.
NEXT?	**Some key questions to keep in mind:** • Which economic policies or financial incentive programmes could be effective in facilitating market transformation in our country? • Which stakeholders should we engage to learn about financing opportunities, and work to encourage the creation of new market delivery mechanisms? • What new market-delivery mechanisms such as leasing schemes or other approaches could be effective in our country? • Are there bilateral or multilateral sources of technical assistance, grants or finance which would stimulate and accelerate the efficient refrigerators market?

Enabling a transition to energy-efficient refrigerators often requires policy interventions and financial incentives as well as raising awareness and building capacity. To be successful in achieving market transformation, countries need to follow an approach that will overcome any market barriers and mobilise private sector participation and investments. Governments can achieve this objective by creating a good regulatory framework, raising awareness and establishing an enabling environment that addresses both infrastructure and stakeholder alignment as well as facilitates the scaling up and national adoption of energy-efficient refrigerators.

Identifying and securing financial resources to support a market shift to efficient products can be difficult for some countries and sectors, such as low-income residential consumers. In order to capture the full potential, public finance has to be used in a manner that maximises the leverage of private sector capital and the criteria for incentives should be ambitious enough to represent a significant improvement compared to market average.

One potential challenge is to make sure that changes facilitated by subsidies actually last even after the subsidies are stopped. One way to do it can be to phase out subsidies in conjunction with the implementation of financing schemes and promotional programmes that tend to reduce prices of efficient equipment. In all cases, ideally, the whole life cycle of a programme should be considered in the design stage.

Advanced planning and the blending of financing sources with appropriate mechanisms, is essential to managing the financial ecosystem, including risk - and cost-sharing arrangements to address risks. In this context, 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, rebates or replacement schemes. Financing large-scale elements such as end-of-life recovery (trade-in) and recycling of old refrigerators can be refinanced nationally, through extended producer responsibility (EPR) approaches or other means.

It is important to keep in mind that some general mechanisms or the legislative framework in place in some countries can represent an obstacle to investment in energy efficiency in general or to some of the proposed mechanisms in particular. Policymakers interested in transforming the market towards climate-friendly refrigerators may want to consider addressing these barriers. An example of this type of barrier includes electricity price subsidies. These can distort the market and affect the lifecycle cost comparison between efficient and non-efficient products. Rather than facilitate electricity consumption, the aims of incentives should be to lower the price of high energy-efficient devices and support local industry to meet the standards (Montreal Protocol is starting with manufacturers, targeting conversion of local production lines).

This chapter on financing is divided into two main parts. The first part is a summary of the sources of funding which countries can access to raise funds. More detail on these sources can be found in the U4E Fundamentals Guide, which sits as a companion guide to this report and provides information on topics that cut across all the products covered under U4E, including funding. The second part of this chapter concentrates on the development and promotion of delivery mechanisms for financing to help facilitate market transition and deliver the critical components of change.

5.1 SOURCES OF FINANCE

Table 4. Illustration of funding sources, instruments and beneficiaries of supporting financing

Source: GIZ Proklima

Funding Sources	Delivery Mechanisms	Recipients
Domestic: • Public funds from the domestic budget • Through the Utility Demand Side Management (DSM approach **Private Sector:** • Private sector finance • Third-party financing • Performance contracting • Ethical/green investment funds **Non-Domestic:** • Multilateral: Multilateral Fund, the Green Climate Fund, Mulilateral Development Banks • Bilateral: German International Climate Initiative, Nationally Appropriate Mitigation Actions (NAMA) facility, EU Switch	**Grant:** • R&D grants/innovations • Incremental cost production • Top label grant incentives **Debt:** • On-bill financing/ exchange program • Risk sharing loan **Equity Funds:** • F-gas quota system • Take-back EPR scheme • Equity facilities/Energy Service companies (ESCOs)	**Manufacturer (Upstream)** **Reseller (mid-stream):** • Manufacturer outlets • Department stores **End User:** • Households • Government users • Corporate actors • Project developers

Several sources of finance exist to help support energy efficiency programmes, particularly for resource constrained countries. Some of these sources are presented in Table 4 and identified in this section. Readers 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 in general.

- **Domestic sources of finance**–the most direct way for governments to pay for climate-friendly refrigerators 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) approach. The financial, technical, procurement capability and customer relationships can make utilities good implementers to channel large-scale financial incentive-based programmes to deploy climate- friendly refrigerators if structured appropriately;
- **Private sector finance**–commercial financial institutions are starting to understand the compelling aspects of energy efficiency and are developing suitable financing mechanisms. The economics and financing of efficient refrigerators is attractive and offers refrigerators vendors and suppliers an incentive to invest in energy efficiency which is recovered through energy savings. Examples are private sector finance, third-party financing, performance contracting, and ethical/ green investment funds. Not all mechanisms have been seen applied to refrigerators specifically, but refrigerators can be part of a package;

- **Non-domestic sources of finance**–some developing countries who do not have adequate public finance and resources to finance a technology phase-out or large scale deployment programme, may seek non-domestic sources of finance, including financing from the World Bank, the Asian Development Bank (ADB), the European Bank for Reconstruction and Development (EBRD). Non-domestic sources of finance can provide concessional funding to governments (including soft loans and guarantees) to help trigger market transformation through large scale deployment programs, along with initiating phase-out programmes, raising investor confidence and attracting private investors;

  Climate financing–financing mechanisms designed to reduce CO_2 emissions often 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 GEF, Clean Development Mechanism (CDM), NAMAs, and Climate Investment Funds. These financing mechanisms require measurement and verification of CO_2 emissions reduction in addition to energy savings;

  Multilateral Fund–the Multilateral Fund for the Implementation of the Montreal Protocol was set up to support implementation of the Montreal Protocol (see section 7.1). The rules for access to this Fund are quite specific. but refrigerator industries are one of the target groups that can benefit from it as the objective of this Multilateral Fund is to provide financial support to developing countries to work towards the systematic elimination or phase out of the production and consumption of ozone-depleting substances. Industrialised member countries provide financial contributions to developing countries through the Protocol's implementing agencies (World Bank, UNDP, United Nations Industrial Development Organization UNIDO, UN Environment). 20 per cent of their contributions can be provided through bilateral projects, the rest being paid to the Multilateral Fund for an Executive Committee and the Multilateral Fund Secretariat to allocate the funds per project which are then implemented by the various implementing agencies. The UN Environment Ozone Secretariat offers guidance on reporting. Its website includes background information and contact details of officials in each country that is party to the convention.

CASE STUDY: Conversion of Refrigerator Production Line Supported by GIZ Proklima and Liebherr

GIZ Proklima and the German company Liebherr assisted the Chinese refrigeration manufacturer Haier with the conversion of a production line from CFC to HC technology in 1995. For the implementation of the "Investment Project for Phasing out CFCs at Haier S.A., Qingdao," a total of $2.2 million in funds was made available through Germany's contribution to the Multilateral Fund of the Montreal Protocol and through the US Environmental Protection Agency (USEPA).

Through the project, the traditional foaming agent for polyurethane insulation, CFC-11, has been replaced with cyclopentane, and the refrigerant CFC-12 has been replaced with isobutane. Both are HCs. HCs do not deplete the ozone layer and do not contribute significantly to global warming.

The company reduced emissions by the equivalent of 205,500 tCO_2e a year by replacing CFC-12 with the HC isobutane. Additionally, 7,500 tonnes of CFC, equivalent to 22.5 million tCO_2e in emissions, have been avoided from 1995 to 2006. Considering the total project cost of $2.2 million, the actual cost for the reduction of one tonne of CO_2e was as low as $0.1.

5.2 DELIVERY MECHANISMS

There are numerous delivery mechanisms utilising the aforementioned sources of finance to promulgate climate-friendly refrigerators. These mechanisms have to overcome perceived risks from different stakeholders, thereby facilitating transactions leading to investments in climate-friendly refrigerators programmes.

Efficient refrigerators are typically more expensive on a first-cost basis and less expensive throughout the life cycle[19] of the product. Financing schemes are a valuable tool for accelerating the market adoption rates of more efficient products. The most impactful delivery mechanisms for refrigerators are those that are designed to capture wins in multiple areas, e.g. complementary programmes focusing on reducing CO_2 and HFC emissions and energy consumption. Policymakers must carefully consider the barriers they are trying to address before deciding on which mechanism to adopt in their programme.

Some examples of delivery mechanisms are:

- Utility Demand Side Management (On Bill Financing (OBF); rebates)
- Bulk Public Procurement through Public Super ESCOs or Utilities
- Municipal Financing Delivery Model
- PPP Financing and Delivery Model
- New Business Models, e.g. Lease to Own Model
- Trade-in
- Microfinance
- Government Bonds and Tax Incentives.

These delivery mechanisms can be used in various ways throughout the refrigerator supply chain to transform the market, via upstream, midstream and downstream programmes. Understanding the barriers a programme is trying to address is fundamental to the success of the delivery mechanisms and incentive programmes applied–incentive programmes need to be designed precisely to address the identified barriers. Understanding the barriers a programme is trying to address is fundamental to the success of the delivery mechanisms and incentive programmes applied. The different barriers and their advantages are outlined in Figure 9.

Manufacturing
UPSTREAM PROGRAMS

Barriers Addressed:
- Uncompetitive price
- Lack of available technology or component

Main Advantages:
- Lower transaction costs
- Multiplier effect on retail price

Distribution & Retail
MIDSTREAM PROGRAMS

Barriers Addressed:
- Lack of available technology or component
- Lack of information

Main Advantages:
- Increases retailers knowledge of energy-efficient products
- Meets customers at point of decision

Consumers
DOWNSTREAM PROGRAMS

Barriers Addressed:
- Uncertainty of savings
- Lack of information
- Limited access to capital

Main Advantages:
- Allows incentive to be directed to specific groups e.g., the low income
- Announcement effect*

Figure 9. Financing delivery schemes through the supply chain

Source: Stephane de la Rue du Can, LBNL

Utility Demand-Side Management

OBF refers to a loan made to a utility customer to enable the customer to purchase and switch to climate-friendly refrigerators. These schemes provide qualified utility customers with finance for energy-efficient appliance rebates and incentive programmes.

The loans issued are either interest-free or have very favourable terms. They are intended to cover costs incurred in connection with a qualified retrofit project. The consumer enjoys the energy savings accrued on the electricity bills.

The beneficiary of the loan (i.e. the consumer) pays off the loan through regular monthly payments on the utility bill until it is fully repaid.

An OBF programme may be limited to particular types of customers such as low-income families. In most on-bill financing programmes, the loan funds are provided directly by the utility (or programme administrator), and the repayment risk, which can also be insured, is held by the same entity until the loan is paid off.

Bulk Procurement

Bulk procurement refers to the purchase of a large volume of products by an organisation that then distributes those products directly to consumers, passing along the savings from the large purchase contact and supply-chain bypass. Bulk procurement projects are not intended to be sustained, long-term efforts. They are primarily individual projects intended to stimulate the market and rapidly accelerate the adoption of a given technology. The organisations implementing bulk procurement projects include electric utilities, government ministries and other organisations.

Bulk procurement is generally conducted using a competitive bidding process wherein the purchasing entity defines the technical and performance specifications of the products being promoted to ensure the programme will meet its energy efficiency goals. Bulk procurement programmes enable the purchasing entity to move up the supply chain, which lowers the cost. This results in a significantly lower final retail price to the consumer for a product that incorporates the features the government may want to promote.

Municipal Financing Delivery Model

Some municipalities around the world have sufficient creditworthiness so they are able to access capital from private markets directly. If they are in a secure financial position, the financing costs tend to be lower than other models considered due to their special status as a municipality or local government. However, the programmes can take a long time, depending on available municipal resources—in terms of both capital and people—to deliver the project.

PPP Financing and Delivery Model

PPPs emerged in the 1990s as a mechanism to enable governments to fund and operate services through contracts with private companies. They come in a wide variety of structures and formats. Finance can be sourced from either the public sources or the private sector, depending on the design of the partnership contract.

New Business Models

Leasing agreements establish a contract where the consumer rents the asset rather than purchasing it. The finance for the leasing contract may be derived from a financial institution, the equipment supplier, or other source.

The equipment supplier or leasing company will typically provide the installation and commissioning costs associated with the appliance. A country's tax laws will have some impact on how the lease operates. Climate-friendly refrigerators can for example be pushed forward through a preferential tax regime.

Trade-in and Early Retirement

Replacement schemes often take the form of direct cash rebate, but trade-in can also be used as a condition for other delivery mechanisms. The principle is to replace inefficient refrigerators (that are also likely to contain ODS or refrigerants with high GWP) before the end of their useful lives with significantly more efficient, climate-friendly refrigerators.

The advantages of this type of scheme are clear. Simple cash rebates would increase sales of efficient refrigerators without necessarily taking the old appliances out of stock, as people would often keep using their old appliances as second refrigerators. This type of programme is eligible under the Montreal Protocol because it is an efficient way to ensure that appliances containing ODS are properly decommissioned and recycled.

CASE STUDY: Utilities' Refrigerator-Replacement Programme, Brazil

Brazil has introduced several programmes to increase the energy efficiency of appliances. Electricity distribution companies are required to invest part of their revenues in energy efficiency programmes. Since 1998 these funds were often used by the distribution companies to invest in energy efficiency programmes to support low-income households. Frequently used programmes were refrigerator-replacement programmes. Around 30 per cent of Brazilian refrigerators are more than ten years old. Most of these old refrigerators belong to low-income households.

The programme aims to help low-income households save money and reduce energy consumption by replacing old, inefficient refrigerators at no cost to them. It also recycles the old modeles. From 2008 to 2010, 45 electricity distribution companies participated in the programme, replacing more than 380,000 refrigerators and saving 190,000 MWh/year and reducing peak demand by 23,000 kW.

For more information click here.

Microfinance

Microfinance offers microloans to small businesses and households to help overcome the first-cost barrier to purchasing an energy-efficient appliance, such as a refrigerator. Microfinance managers can link their loans to specific objectives, such as environmental protection, e.g. purchasing refrigerators that are 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 finance is often seen as a mechanism enabling microfinance institutions to achieve the so-called triple bottom line: economic development, social inclusion and environmental sustainability.

Tax Incentives

Tax incentives can help accelerate market adoption of energy-efficient refrigerators. These incentives can offer an attractive deal for consumers and can be very costefficient from a public finance point of view if constructed appropriately. They can also target manufacturers. These types of incentives stimulate the market, encouraging greater uptake of energy-efficient appliances, including refrigerators. Importing countries can use VAT rates as an incentive, lowering the rate for efficient models.

Rather than tax incentives, some governments have chosen to put in place tax penalties. These are used as disincentives for high-consuming appliances and typically as sources of funding for other parts of the market-transformation program.

6. MARKET MVE

WHAT?	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.
WHY?	Just as the police work to enforce the law, a government must also provide an entity to ensure the regulations and programmes created to transform their refrigerator market are followed. Policies and programmes without monitoring, verification and enforcement are unlikely to have any impact.
NEXT?	**Some key questions to keep in mind:** • How critical is market surveillance to ensuring the effectiveness and impact of the regulations? • Do you have the legislation and legal framework around which to structure market surveillance? • Do you already have a responsible Ministry or market monitoring entity to ensure products adhere to safety standards and requirements? If so, could this brief be expanded to include energy efficiency of refrigerators (and potentially other products)? Would this be the best option? • What are the financial requirements of a market surveillance programme? • Do you need to build a national test laboratory? Are there laboratories in neighbouring countries that can be used?

MVE is a core 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 10 highlights the fundamental aspects of MVE.

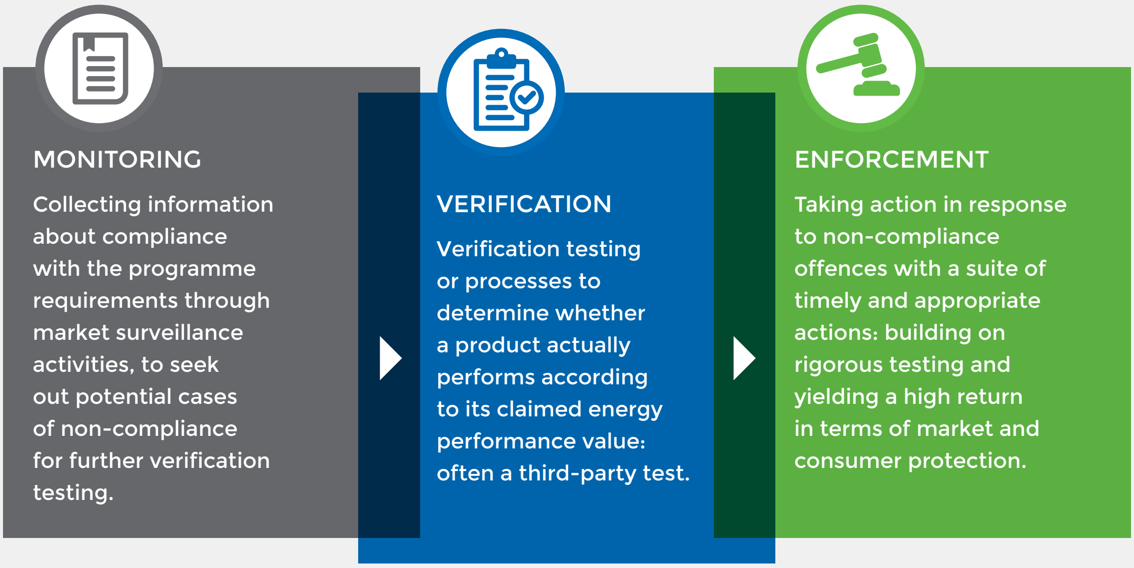


Figure 10. The MVE process

Effective MVE schemes ensure a level playing field. Manufacturers comply with standards and labelling programmes, enabling consumers and companies alike to benefit. Considering the three main stakeholders involved–industry, consumers and governments, MVE offers benefits to all, as depicted in Figure 11.

The goal of MVE is to ensure the integrity of market transformation programmes by minimising the negative costs associated with the sale of non-compliant products after the effective date of a regulation.

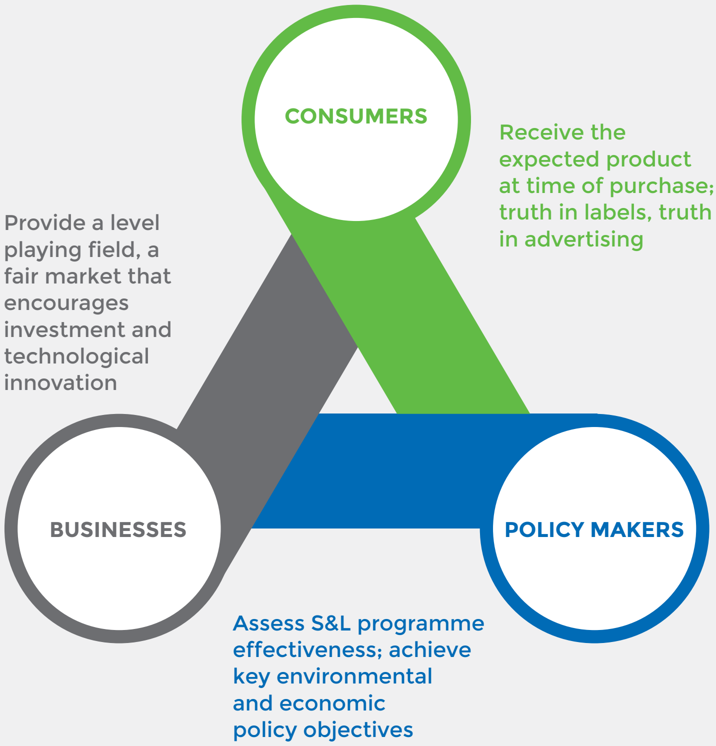


Figure 11. MVE benefits to stakeholders

Please review the UN Environment report **ENFORCING EFFICIENT LIGHTING REGULATIONS** for more information.

6.1 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 agencies such as customs and standards and metrology. The framework could, for example, bestow the authority for an agency to issue fines and block the sale of non-compliant products from entering the market.

Overall, the operational framework within which the enforcement authority operates should be as transparent as possible. This improves compliance rates through clear communication and understanding of the MVE scheme. Section 2.1 “Building legal and administrative foundations for enforcement” of the Enforcing Efficient Lighting Regulations guidance note can be used for refrigerators, even though the focus of this note is on lighting.

An important aspect of MVE for refrigerators is that in addition to energy performance itself, refrigerant gases and foaming agents should to be part of the programme (if legal requirements have been set for these gases). In this case, MVE should at least cover information requirements which are crucial to facilitate recycling. Their nature and volume should be tested to determine their GWP and ODP.

If there are requirements for the treatment of appliance recycling operations, the treatment and recycling processes also need monitoring to ensure that treatment follows the requirements.

CASE STUDY: Building on Existing Product Safety Legislation, Cambodia

Cambodia currently has no legal framework in place for authorising the enforcement of non-compliance for energy efficiency. However, a regulatory framework exists for the Safety Label for Electrical and Electronic Household Products. This piece of legislation covers provisions for:

- Commercial fraud repression
- Actions against products or services which are likely to induce grave or imminent dangers
- Inspection procedures for quality and safety of products, goods and services
- Offences.

Although these provisions focus on product safety, they can be modified and adapted to address energy efficiency violations. The same agencies responsible for enforcement of product safety, the Ministry of Industry and Handicraft and the Ministry of Mines and Energy, can equally adapt their experience to enforce energy efficiency legislation.

6.2 FINANCING MVE SCHEMES

The costs of a national MVE scheme will vary with the scope of the programme as well as local or regional factors, such as labour and services costs. When planning how to allocate funding for an MVE scheme, the managing agency typically takes into account the relative scale of the harm caused (i.e. cost of wasted energy, loss of consumer confidence, the frequency of non-compliance).

Generally, more resources are allocated toward addressing cases of non-compliance that have the greatest impact and occur frequently. Budget allocation should be an evidence-driven, risk-based process that is transparent and defensible.

The areas of an MVE scheme that incur costs are listed below:

- **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
- **Establishment costs**–if deemed appropriate for the country to set up its own testing facilities: setting up a main office and possibly field offices with new equipment
- **Staff costs**–hiring and training/capacity building for staff (covering the key areas of administration, investigation and management, in specialist areas such as customs officials and - if appropriate - test labs).

Having a national laboratory can be an expensive asset. Not every country should necessarily set up their own testing facilities. See 6.4 Test Laboratories for more information on the costs and operation of test laboratories.

The success of an MVE scheme will therefore depend on identifying a secure and sustainable source of funding 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. Robust MVE schemes require good market awareness, sampling and testing.

The most common source of funding is the government's own general operating budget. However, this does not need to be the only source of funding. Cost recovery from suppliers in case of non-compliance can also be another source of funding, with many programmes around the world introducing cost recovery elements to their schemes. Cost recovery can be partial or complete and can be achieved through registration fees, verification testing fees or 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. In India, for example, the total fees a supplier must pay to the BEE increases with the number of models registered and the number of individual lamps of each model sold in India.

An increasing number of programmes require products to have third-party certification, from an independent body, as a condition of entry to the programme. While this is not cost recovery per se, it can reduce the costs of the programme because the system administrator is in effect delegating some of the responsibility for ensuring products initially meet the necessary requirements to third parties that are paid by the product suppliers. Third-party certification, however, does not ensure products continuously placed on the market are compliant. Third-party certification is only addressing the compliance at the initial placing on the market. Continuous market enforcement is essential to ensure compliance.

Support for MVE schemes can also be derived from stakeholders in the market. Collaboration and cooperation with industry or civil society 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 goals and limits need to be established, as some contributions may not be admissible as a foundation for legal action (e.g. there may be a conflict of interest in using industry funding to legally prove non-compliance of competitors in the market).

6.3 PRODUCT REGISTRY SYSTEMS

Product registration systems can offer an initial compliance gateway whereby suppliers register products with the regulatory authority. The registration process usually requires manufacturers to submit test results on the products and certify that the product performance meets the MEPS, and/or any labelling requirements, before the product can be placed on the market. Such registration systems can facilitate the market compliance controls but cannot replace it. The data fields typically recorded in these databases for domestic refrigerators include brand, model, category (for example refrigerator, refrigerator-freezer), volumes of the different compartments, climate class, nature and volume of refrigerant gases.

When governments set up product registration systems, they have to do so via legislative and/or regulatory authority. Mandatory registration systems are in place for products with MEPS or energy labelling in Australia, Canada, China, New Zealand, Singapore and the US, among others. Information included in these registration systems can include energy performance data, technical product specifications, sales figures, and product prices. The registration systems are generally designed to meet the needs of many different stakeholder groups, as shown in Table 5.

Table 5. Product registry system users and their potential needs

STAKEHOLDER	POTENTIAL USER NEEDS
POLICYMAKERS AND GOVERNMENT	Provides a record of baseline data to support policymaking; expands the evidence database for market surveillance; serves as a storehouse of ancillary information and data about products on the market.
MANUFACTURERS AND SUPPLIERS	Provides or facilitates declaration of conformity with regulatory/voluntary requirements; provides information about innovation in product design (fostering competition and innovation); strengthens brand credibility; helps to ensure a level playing field.
CONSUMERS	A database of product-specific information in the public domain; opportunity for advanced features through apps or other tools, doing product searches; enhances transparency of communication about product performance and related savings potential.
DISTRIBUTORS	Retailers can verify if products being supplied are registered and compliant with local laws.
OTHER PLAYERS	Registry information can be used to determine product performance for market pull programmes that incorporate financial incentives, subsidies and prizes.

For more information on product registry databases, see the recent UN Environment publication and the index of product registration databases published by SEAD. The following are examples of mandatory product registry databases:

1	2	3	4	5
Australia– Equipment Energy Efficiency Appliance and Equipment Database	US– Department of Energy's Compliance Certification Database	India– Star Label Product Database	Singapore– Database of Registered Goods	Brazil– Energy Efficiency / Consumption tables.

Sources: "Developing Lighting Product Registration Systems" Guidance Note, UN Environment, February 2016. Product Certification Databases, SEAD

6.4 TEST LABORATORIES

Measurement of the performance of a product, as part of a coordinated MVE strategy, provides the foundation for the effective implementation of climate-friendly refrigerators policies and regulations. Product testing constitutes the cornerstone of any product compliance certification report, whether for a voluntary or mandatory programme.

UN Environment recently published a report titled "Good Practices for Photometric Laboratories" that is intended to give guidance to practitioners who wish to establish a photometric laboratory or improve the conformance of an existing laboratory. The topics covered in this study include (a) traceability and accreditation; (b) calibration; (c) uncertainties; (d) testing processes; and (e) records and storage. Although this report is focussed on lighting, a large part of the presented material and recommendations is also valid for refrigerators. Table 6 depicts the essential elements for the reliable operation of a testing laboratory.

Although having a national laboratory can be a prestigious asset to manage, in reality laboratories are expensive facilities to establish, commission, earn accredited and maintain.

A certain minimum level of business generated by the market is needed to sustain the laboratory and to ensure it has adequate revenue to operate.

The costs of setting up a laboratory for refrigerator testing have been estimated for Indonesia:

- **Capacity:** can test three units simultaneously
- **Test equipment:** $150,000
- **Staff training:** $10,000
- **Equipment maintenance (calibration):** $5,000
- **Total for the first year:** $165,000
- **The yearly running costs** (such as staff costs, equipment maintenance) and costs of replacing equipment should also be factored in.

For countries with smaller economies, it may make sense to look at outsourcing their laboratory test needs to neighbouring countries or other entities[21] until their economy grows and they are able to justify direct investment in a domestic facility. Sharing of facilities themselves is not a common practice due to the difficulty of transporting refrigerators long distances. However, the same results can be achieved by simply sharing test results. This should be considered in particular for neighbouring countries that have similar products on their markets and have chosen the same test standard for their MEPS and labels.

The 2014 report Assessment of Verification Testing Capacity in the Asia-Pacific Economic Cooperation (APEC) Region and Identification of Cost Effective Options for Collaboration by the APEC Expert Group on Energy Efficiency and Conservation (EGEE&C) can be an interesting resource and starting point in evaluating the need for building in-country capacity and opportunities for collaboration.

Table 6. Essential elements for the reliable operation of a test laboratory

ELEMENT	ESSENTIAL ELEMENTS
TRACEABILITY AND ACCREDITATION	• Linking measuring equipment to SI unit • Accreditation for specific test procedures • Proficiency testing
CALIBRATION	• Externally calibrated reference thermometer and hygrometers • Internal equipment calibration • Monitoring laboratory conditions
UNCERTAINTIES	• Confidence intervals • Determining the uncertainty
TESTING	• General considerations • Ambient temperature maintenance considerations • Ambient humidity maintenance considerations • Standard package, depending on test standard used
HOUSEKEEPING	• Record keeping system • Refrigerator units identification • Storage conditions • Length of time • Refrigerator disposal

The breakdown of domestic refrigerators test laboratories by economy in the Asia-Pacific Economic Cooperation (APEC) region as presented in the 2014 report of the APEC Expert Group on Energy Efficiency and Conservation (EGEE&C) Assessment of Verification Testing Capacity in the APEC Region and Identification of Cost Effective Options for Collaboration is summarised in Table 7.

Table 7. Breakdown of domestic refrigerator test laboratories in the APEC economies

COUNTRY	CITY	NAME OF TEST LABORATORY
AUSTRALIA	Melbourne	Australian Gas Association
CANADA	Edmonton	PBR
CHINA	Guangzhou	TÜV SÜD
CHINA	Shanghai	Intertek
CHINA	Shanghai	BV LCIE
CHINA	Hong Kong	Jockey Club
CHINA	Taoyuan	TERTEC
REPUBLIC OF KOREA	Seoul	KTL
MALAYSIA	Selangor	Sirim QAS (EEST1, EEST2)
US	Hudson	Core Compliance
VIET NAM	Ho Chi Minh	QUATEST3

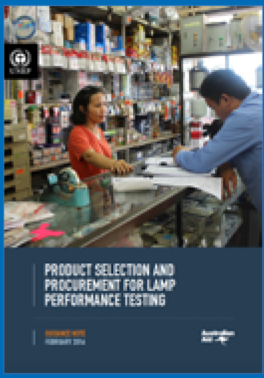
6.5 PROACTIVE COMMUNICATIONS

Communication is a critical element of any successful MVE scheme. For manufacturers, it helps to ensure they are aware of their legal obligations, and what happens if they were found to be non-compliant. For consumers, it lets them know that their government is working hard for them, ensuring that 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.

In order to achieve these programmatic outcomes, it is necessary for governments to develop a communications plan. This plan should be fine-tuned and appropriate for the domestic market, taking into account all the main stakeholders involved in the supply chain, and the importance of communicating key messages to them 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).

In addition to these communications tools, there are a number of tools, training activities and guidance that can be offered by governments, which will help improve rates of compliance. For example, governments can offer training courses explaining the regulatory requirements, they can maintain a regulatory hot-line or email service to answer questions that suppliers may have, they can publish a frequently asked questions (FAQ) website, and they provide guidance on compliance reporting and documentation requirements. All of these approaches will help to minimise the costs of demonstrating compliance and ensure higher compliance rates and more successful outcomes.



Please review the UN Environment report **PRODUCT SELECTION AND PROCUREMENT FOR LAMP PERFORMANCE TESTING** for more information.

6.6 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 that the products being supplied to the market are compliant. UN Environment recently published a report tailored for policymakers and enforcement agencies who wish to understand the performance of products in their market. This report focused on lighting, but the outlined principles can be applied to refrigerators. It discusses methodologies for cost-effective identification and selection of lamps for establishing a market baseline prior to regulation, as well as for identifying lamp models when conducting lamp testing for compliance in an already regulated market. It covers topics such as (a) defining the product scope; (b) selecting the procurement methodology; (c) transparency and traceability of procurement; and (d) packaging and transportation practices.

UN Environment has also studied the approach that laboratory personnel may follow when conducting testing. In another report, UN Environment provides recommendations for processes to follow for testing products, interpreting testing results, and using them to inform policy making. This testing report covers topics such as (a) identifying testing objectives; (b) determining where to test products; (c) adopting appropriate test standards; (d) selecting parameters to be tested; and (e) conducting testing and applying test results. The recommendations in this report are around identification of which type of products that should be monitored, determining how performance testing data is used, determining where the testing will be conducted (e.g. national, regional, third party) and ensuring that test results are accurate and correctly interpreted.

Please review the UN Environment report **PERFORMANCE TESTING OF LIGHTING PRODUCTS** for more information.

6.7 REGULATORY ENFORCEMENT

In cases of non-compliance, the enforcement authorities should carefully consider the degree of non-compliance. By doing this they can 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. 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. The bottom of the pyramid typically features more informal actions, while the top of the pyramid should reflect the most severe enforcement response to non-compliance (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.

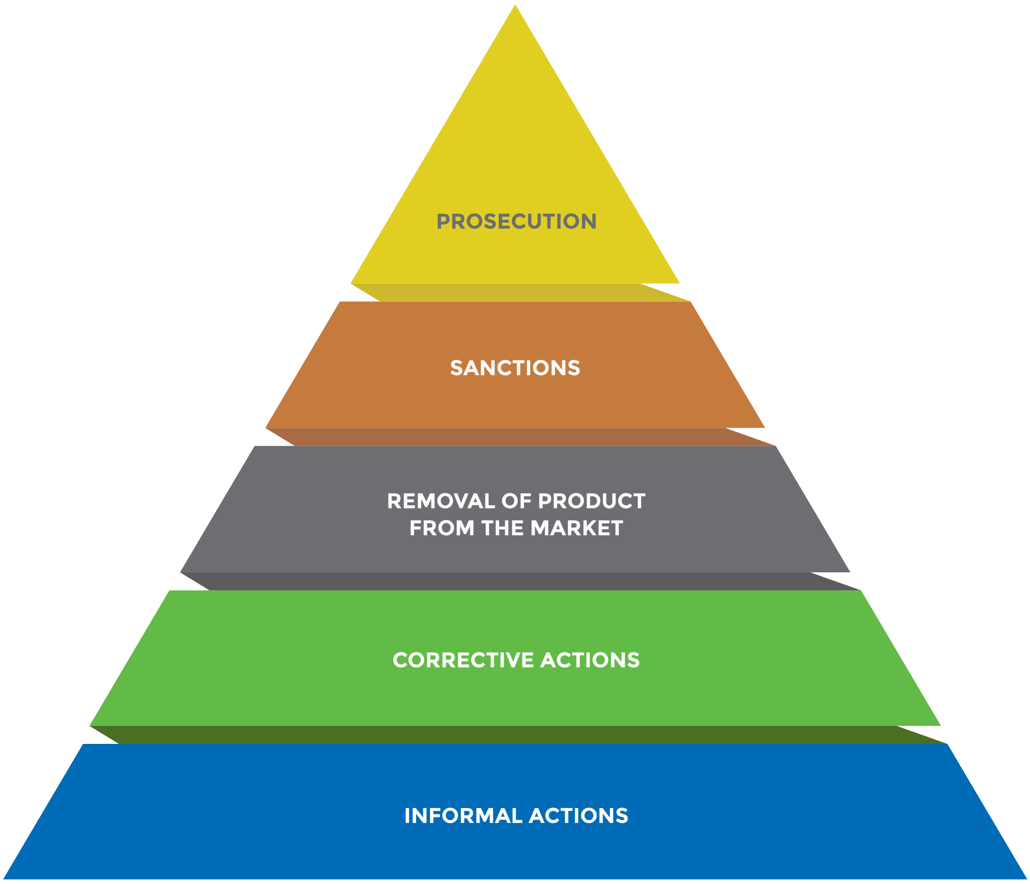


Figure 12. Pyramid of escalating enforcement

Source: UN Environment 2016.

For more information on effective enforcement schemes, please see a recent UN Environment report Enforcing Efficient Lighting Regulations, Guidance Note, UN Environment, February 2016 that serves as a practical resource to policymakers on the steps to follow when implementing a national enforcement programme. This report covers (a) legal and administrative foundation for enforcement; (b) enforcement budget and activity planning; (c) identifying types of non-compliance; and (d) communicating to stakeholders.

7. ENVIRONMENTAL SUSTAINABILITY AND HEALTH

WHAT?	Explains the main environmental impacts of refrigerators arising from F-gases and the low impact alternatives that are already widely available. Also provides advice on managing the safe removal of old appliances.
WHY?	Many old refrigerators contain CFC gases, which damage the ozone layer. Virtually all old refrigerators have high GWP F-gases and these must be safely destroyed or recycled to avoid further environmental damage. However, alternatives can be chosen for new refrigerators that completely avoid the major environmental impacts at the end of the refrigerator's life.
NEXT?	**Some key questions to keep in mind:** • How many old refrigerators do we have in use now, and what is their age profile and source? (to help estimate the size and type of F-gas bank) • What are the safety regulations affecting the use of refrigerants in our economy? • How can we help suppliers and manufacturers to transition to very low GWP alternatives? • What extra institutional capacity do we need to deal responsibly with our F-gas legacy of CFC, HCFC and HFC appliances?

ODP is the measure to quantify the potential to damage the ozone layer of a gas.

On the 15th of October 2016 in Kigali, delegates worked tirelessly day and night to negotiate and reach a deal on a timetable that would mandate countries to phase down the production and usage of hydroflourocarbons (HFCs) (Kigali Amendement to the Montreal Protocol.).

7.1 A GLOBAL POLICY TO PROTECT THE OZONE LAYER: THE MONTREAL PROTOCOL

F-gases have been used as refrigerants and foam-blowing agents in household refrigerators since the 1930s. However, the refrigerant gases most commonly sold were found to damage the earth's ozone layer as they included certain chlorinated compounds: CFCs are the most damaging but also HCFCs.

The potential to damage the ozone layer is quantified as the ODP of the gas (ODP zero causes no damage; ODP 1 is as damaging as CFC-11 (the reference level); some compounds have ODP of 10 or higher). F-gases and many other ozone-depleting compounds are controlled under the Montreal Protocol, an international agreement that was signed in 1987. The Protocol has been highly successful, with the almost-complete phase-out of ozone-depleting substances in progress (over 98 per cent of the ozone depletion potential). The phase-out of HCFCs is proceeding and will be complete in developing countries by 2030, other than a small per centage for servicing existing plant.

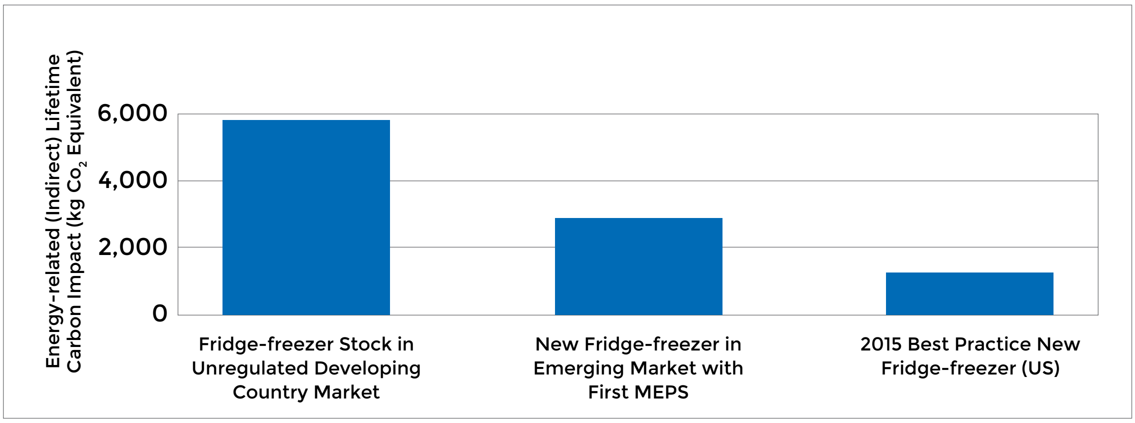
The very successful international cooperation under the Montreal Protocol is now focusing onto the phase down of HFCs.

7.2 DIRECT AND INDIRECT GLOBAL WARMING IMPACTS OF REFRIGERATORS

As noted in section 1.1, refrigerators have direct environmental impacts as a result of their refrigerant and foam-blowing gases and also indirect impacts as a result of the electricity they use from fossil fuel sources.

The energy-related (indirect) impacts can be significant, arising from the carbon emissions from electricity generation over the assumed 15 year life of the appliance (see Table 8 for details of underlying assumptions). As shown in Figure 13, the energy impact of a typical fridge-freezer in an unregulated market can be more than halved through the introduction of MEPS.

Figure 13. Energy related (indirect) carbon impacts for a typical family fridge-freezer of around 280 Ls net volume under three different scenarios. Calculations assume a life of 15 years and global average carbon factor for electricity (IEA, 2014) – see Table 8 for more assumptions.



The total global warming related impact of any refrigerating equipment is calculated as its TEWI, expressed in $kgCO_2e$, by adding together the direct impact and the indirect impact. Figure 14 shows the relative impacts for a typical old fridge-freezer in an unregulated market; for a typical economy with MEPS, and global best practice of 2015. The best practice figures are shown separately for the US and for the EU due to differences in how those markets have adopted low GWP refrigerants and foam blowing agents (Table 8 shows more of the assumptions underlying the TEWI calculations).

Compared with other cooling appliances, refrigerators typically have very low refrigerant leakage rates during normal use and so direct impacts during usage are low. However, as soon as a pipe in the circuit is fractured or cut the whole charge will escape within seconds. Under controlled circumstances, it is relatively simple to extract the gas into a special purpose storage container using typical refrigeration engineer tools (e.g. mobile recovery units with piercing pliers), although management of the gases thereafter to ensure their safe disposal needs careful policy attention. Compressor oil should also preferably be removed as it is saturated with refrigerant.

The risks and challenges from F-gas in the insulating foam are quite different. The gas is released gradually over decades as the foam disintegrates, but all of it will eventually escape. If the cabinet of a refrigerator or a freezer is mechanically stripped (e.g. removing the steel from the foam), gas will escape from the foam. Safe extraction of any harmful blowing agents from scrap refrigerators requires special large-scale waste recovery machinery.

In terms of relative sizes of direct and indirect impacts, it can be seen from Figure 14 and Table 8 that for an old fridge-freezer that is not recycled (and so all refrigerant and foam-blowing agent escapes) the direct impact is equivalent to ten years of its electricity usage-related GHG emissions.[22] Once MEPS are introduced and CFCs eliminated, direct impact has shrunk to the equivalent of four years of energy usage; the direct impacts of modern refrigerators (with HC gas for both refrigerant and foam) are negligible.

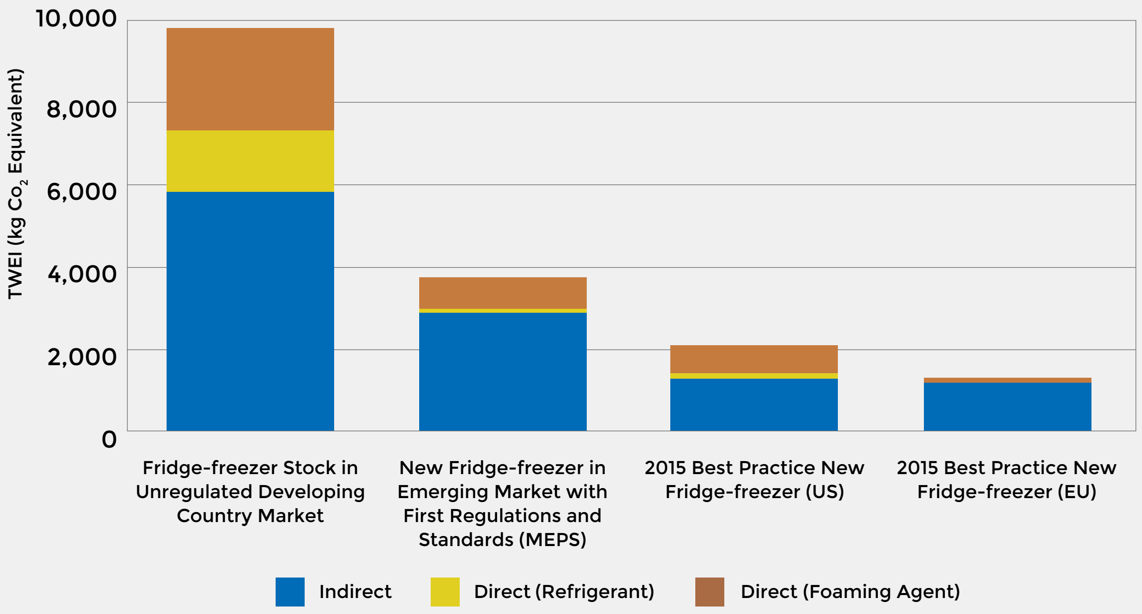


Figure 14. Direct and indirect impacts and TEWI for a typical family fridge-freezer of around 280 Ls net volume. Calculations assume a life of 15 years and that refrigerators are not recycled (all refrigerant and foam-blowing agent escapes to atmosphere). See Table 8 for more assumptions.

TECHNOLOGY LEVEL	DEVELOPING COUNTRY UNREGULATED MARKET	MEPS	TYPICAL US BEST PRACTICE OF 2015	TYPICAL EU BEST PRACTICE OF 2015
Annual energy consumption (kWh/year)	750	370	160	160
Refrigerant and (GWP*)	CFC 12 10200	HFC 134a 1300	HFC 134a 1300	HC 600a 3
Mass of refrigerant (g)	150	120	120	55
Foam blowing agent and (GWP*)	CFC 11 4660	HFC 245fa 858	HFC 245fa 858	Cyclopentane 11
Assumed mass of foam blowing agent (g)	530	815	815	563
Total indirect impact from energy use ($kgCO_2e$)**	5,830	2,880	1,240	1,240
Total direct impact from refrigerant and foam blowing agent (total release) ($kgCO_2$ e)**	4,000	860	860	10
TEWI rating (direct and indirect), ($kgCO_2e$)	9,830	3,730	2,100	1,250

Table 8. Direct and indirect impacts and TEWI for a typical family fridge-freezer of around 280 Ls net volume.
Calculations assume a life of 15 years and that refrigerators are not recycled (all refrigerant and foam blowing agent escapes to atmosphere).

*GWP figures (except HC 600a) are from Climate Change 2013, The Physical Science Basis, Working Group I Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. From: ipcc.ch/report/ar5/wg1/. Full report available from www.climatechange2013.org. The GWP of HC 600a[23] is generally accepted as 3 (for example by the refrigerant manufacturers).

**Calculated using global average carbon factor for electricity of 0.518 $kgCO_2$ per kWh (IEA, 2014).

7.3 REFRIGERANT OPTIONS AND IMPACT ON EFFICIENCY

The environmentally favourable option for refrigerators today is a HC refrigerant such as HC 600a (isobutane). Already at 2015, HC refrigerants are in half of new refrigerators produced around the world.[24] Virtually all of them use isobutane. 75 per cent of new refrigerators production by 2020 globally are projected to use a HC refrigerant.

As for the “other 25 per cent” of refrigerators, until recently it was assumed that these would use HFC-134a. However, a stronger move away from HFC refrigerants is now internationally regulated by the Montreal Protocol and its Kigali Amendment.

There is no energy efficiency loss in moving from an HFC (such as HFC-134a) to HC-600a; refrigerators with HCs are generally the most efficient on the market according to a consensus of manufacturers. The EU already phased out HFCs with GWP over 150 for household refrigerators in January 2015, alongside several other requirements to manage the safe removal of HFCs from the market such as monitoring F-gas sales and the training of technicians. This EU policy demonstrates global leadership, although its quota system is complex to administer.

The US EPA has recently proposed an intention to ban HFC 134a for household refrigerators from 2021. At least one other alternative low GWP refrigerant (an '"HFO"[25]) is emerging onto the market, but is not yet considered viable for household appliances as of 2015. National initiatives to phase out HFCs and high GWP gases are often instigated through NAMAs—see resources in section 8.

There is no need to use HCFCs that damage the ozone layer, have a high GWP and have been used as foam-blowing agents in household refrigerators. Well-proven alternatives exist. A further reduction in refrigerant choice is ongoing with the international regulation on the phase down of HFCs. The two main commercially available refrigerant choices for refrigerators at 2016 are summarised in Table 9.

HC refrigerants are an efficient and effective choice but are flammable. Factories, appliances, testing facilities and servicing infrastructure and staff training all need to be set up with refrigerant safety in mind.

HFOs are a potential option for the future but are not used commercially for household refrigerators yet. One low GWP refrigerant in use for some applications at 2016 is HFO-1234yf. There are known economic and environmental impacts of HFOs and, in particular, high costs for their purchase, waste management and destruction.

Comprehensive guidelines are available regarding the use of flammable refrigerants and for conversion of existing refrigerator manufacturing facilities to use HC refrigerants—see resources in section 8. Financial assistance is available for conversion of manufacturing facilities—see section 5.1.

Note that all economies require a suitable transitional period in order to: source adequate quantities of replacement compounds, redesign refrigerators and freezers for the local market and for the conversion of manufacturing plant. This may take longer in developing countries than the timescales adopted by countries already on this road.

Table 9. Example refrigerant options for household refrigerators at 2016

REFRIGERANT	HFC 134A	HC 600A (HC)
ODP	0	0
GWP	1,300[26]	3[27]
EFFICIENCY IMPLICATIONS (compared with R134a)	-	Typically 3 per cent better[28], but anyway no loss of energy efficiency in any case. Generally more efficient than HFC 134a in high ambient temperatures.
SAFETY	No specific issues	Flammable so precautions necessary for appliance design, manufacture, servicing and disposal.
APPLIANCE DESIGN ISSUES	No specific issues	Design must reduce leakage and ensure no sparks can ignite any that does escape.
COST IMPLICATIONS (compared with R134a)	-	Around 2 per cent more expensive per unit.[29]
SERVICING AND MAINTENANCE ISSUES	No specific issues	Training necessary for technicians and some special equipment if gas is to be removed or added.
END OF APPLIANCE LIFE IMPLICATIONS	Must be recovered and destroyed or recycled	None, other than safe venting or recovery.
PROSPECTS FOR ONGOING FUTURE USE AND AVAILABILITY	Phase out already in place for EU; Amendment to the Montreal Protocol agreed in Kigali in October 2016 now regulates global phase-down of HFCs.	No policy intentions to restrict usage other than for safety reasons in some economies.

7.4 FOAM BLOWING AGENT OPTIONS AND IMPACT ON EFFICIENCY

Insulation foam for refrigerators is usually made from PU resin. It is expanded using a blowing-agent gas. From the 1970s onward, the blowing agents were often F-gases that were later found to damage the ozone layer (such as CFC and HCFC gases) and also had high GWP. Most major refrigerator manufacturing (developed) economies have already switched to use of cyclopentane, a cost-efficient HC with good thermal properties, zero ODP and GWP 11; whereas the majority of the US refrigerator market still uses HFC blown foams. Several alternatives exist and others are under development.

Foams containing ozone-depleting gases will present a significant challenge for waste management of old appliances in developing countries until well beyond 2050.[30] The costs of managing foam-blowing-agent waste are much higher than the costs of managing refrigerant waste due to higher handling costs and extreme difficulty of recovering the gas safely. Therefore, this cost impact provides a strong incentive to regulate for foam-blowing agents with very low GWP.

Developing countries are strongly encouraged to leapfrog over HCFC and HFC blowing agents and move straight to very low GWP solutions.

7.5 SAFE REMOVAL OF OLD APPLIANCES FROM THE MARKET

Old refrigerators are a major policy challenge on several levels. It becomes important to get them out of use because of their very poor energy efficiency (although because they can keep working for decades they tend to enter second (or third) lives rather than the waste stream). Old refrigerators also often contain environmentally damaging F-gases as their refrigerant or foam-blowing agent. Recovered F-gases can be safely recycled, reclaimed or destroyed at sufficiently high temperatures with appropriate incineration technology.

Other components classified as hazardous waste (e.g. mercury containing switches, PCB-containing capacitors, circuit boards) should also be recovered for safe disposal. On the positive side, the metal of refrigerators generally has good recycled value, and their plastics can be recycled or are at least environmentally benign for landfill.

Appliances with ODP refrigerants such as CFC-12 may still be found in some used appliance markets and within the bank of old appliances in homes and awaiting destruction (see section 7.5). The HFC refrigerant R134a, with zero ODP but GWP 1300 times as potent as CO_2, currently accounts for around 60 per cent of refrigerators in use worldwide, although this can vary significantly by economy. As noted above, HCs are now used in half of the world's newly produced refrigerators and in the EU isobutane accounted for at least 95 per cent of refrigerator sales in 2014.

Several policy options are relevant to assist the safe removal of old appliances:

- **Subsidised "new for old" or "take-back" schemes** are often used to ensure the safe and permanent removal of old appliances from the market. Such schemes must address the challenge of safe management of the waste stream, which will continue for decades to come.
- **Venting of refrigerant gases should be prohibited**, unless of very low GWP and zero ODP.[31] Recovery of the refrigerant is technically straightforward at source but requires close management of the waste gases to ensure they are recycled or securely destroyed.
- **Several economies have implemented extended producer responsibility schemes (EPR)** under which the manufacturer (or supplier in the case of imports) has a legal duty to responsibly dispose an allocated proportion of old appliances. EPR also places responsibilities on consumers, retailers and waste management companies. EPR shifts the financial responsibility to deal with such waste to producers and the supply chain so it can encourage more environmentally sound products.

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, distribution 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.

The Fundamental Policy Guide is cross-cutting for all United for Efficiency priority products including lighting, residential refrigerators, air conditioners, distribution transformers and electric motors.

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.

9. RESOURCES

To support countries and regions in the development of efficient appliance activities and strategies, many organisations have published support materials. These include:

International Information Sources Regarding Refrigerators and Related Policy:

- **The Green Cooling Initiative (GCI)** is funded by the International Climate Initiative by the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) and implemented by GIZ Proklima. The GCI promotes the application of climate-friendly and energy-efficient cooling technologies in developing countries, and advises accordingly under the UN technology mechanism. The GCI supports the exchange between technology suppliers and users, as well as between the industry, public institutions and civil society. Within technology partnerships, the GCI supports the development of technology roadmaps for the cooling sector and demonstrates climate friendly refrigeration and air conditioning in developing countries. Through its Green Cooling Network it provides useful information, gives access to knowledge and brings people together working on the same goal: Promoting green cooling worldwide. The Green Cooling Initiative (GIZ Proklima) country data map provides an overview of GHG emission estimates resulting from domestic refrigeration for many countries;

- **Super-Efficient Equipment and Appliance Deployment (SEAD)** initiative is an initiative of the Clean Energy Ministerial. SEAD engages governments and the private sector to transform the global market for energy-efficient equipment and appliances. SEAD's member governments include Australia, Brazil, Canada, the European Commission, France, Germany, India, Japan, Korea, Mexico, Russia, South Africa, Sweden, the United Arab Emirates, the United Kingdom (UK), and the US; China maintains an observer status. See, in particular:

  - SEAD product focus on refrigerators at www.superefficient.org/Products/Residential-Refrigerators
  - SEAD Publications library
  - SEAD Policy Exchange Forum at superefficient.org/About-Us/Policy-Exchange-Forum
  - Links to many appliance certification databases, several of which include household refrigerators at www.superefficient.org/en/Tools/Product-Certification-Databases.aspx.
- **BigEE** is an international web-based knowledge platform for energy efficiency in buildings, building-related technologies, and appliances in the world's main climatic zones. It provides information about energy efficiency options and savings potentials, net benefits and how policy can support achieving those savings. BigEE has a policy guide for refrigerators at www.bigee.net/en/appliances/guide/residential/group/1/.
- **The Topten websites** provide lists of best available technology products, bringing market evidence and policy recommendations to support policy makers in developing regulations and includes household refrigerators.
- **CLASP** standards and labelling database at http://clasp.ngo/Tools/Tools/SL_Search.

Refrigerants and Foam-Blowing Agents:

- **SHECCO** http://publications.shecco.com
- **UN Environment Montreal Protocol Expert panel reports.** In particular the reports of the Technology And Economic Assessment Panel, Refrigeration, Air Conditioning and Heat Pumps Technical Options Committee: ozone.unep.org/en/assessment-panels/documents
- **The Ozone Secretariat**: ozone.unep.org
- **OzonAction**: www.unep.org/ozonaction
- **Multilateral Fund for the Implementation of the Montreal Protocol**: www.multilateralfund.org/default.aspx

Relevant Publications:

MVE:

- Recently published en.lighten MVE guidebooks (overall steps adaptable to refrigerators) - www.enlighten-initiative.org/ResourcesTools/Publications.aspx
- CLASP MV&E Guidebook - The Guidebook discusses the various approaches for maintaining compliance and describes the data, facilities, and institutional and human resources needed to support MVE activities. It provides guidance on the issues to consider in the design and implementation of effective compliance frameworks, and directs the reader to references and other relevant resources
- A Survey of Monitoring, Verification and Enforcement Regimes and Activities in selected countries, Final Report. By Mark Ellis & Associates, in partnership with the Collaborative Labelling and Appliance Standards Programme (CLASP), June 2010. clasp.ngo/en/Resources/Resources/PublicationLibrary/2010/Compliance-Counts-MVE-guidebook.

Test methods and performance standards, supporting policies:

- Test procedures, measurements and standards for refrigerators and freezers, Dr. Claus Barthel, Thomas Götz, December 2012. Available from: www.bigee.net/media/filer_public/2012/12/04/bigee_doc_4_refrigerators_freezers_test_procedures_20121130.pdf
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ANNEX A: DESIGNING A COMMUNICATIONS CAMPAIGN

The success of any communication and awareness-raising campaign depends on its design, in particular in its implementation and evaluation. The design phase of a national energy-efficient refrigerator campaign should involve the following elements:

COMMUNICATION CAMPAIGN 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: stakeholder analysis as well as audience selection and prioritisation.
IDENTIFYING COMMUNICATION TOOLS	For governments, the approach should persuade officials to formulate policy that promotes and maintains best practice in energy efficiency. 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.
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 ongoing 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	Evaluating the impacts of the campaign can be key to the successful implementation of a communication campaign. Evaluations conducted by independent bodies help to ensure an unbiased view.

Table 10. Communication campaign elements

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.

Experience from the health sector showed that education campaigns are more efficient if they are maintained or repeated regularly and frequently over long periods of time. The idea being that the message should become very familiar to consumers. It is also recommended to have a consistent visual identity, through time and between products. Where several products are regulated, it is important to have one label design for all products covered so that consumers get used to it.

FOOTNOTES

1 HCs are pure natural gases with very low global warming potential (GWP) and make efficient refrigerants and fairly effective foam-blowing agents.

2 For one African country, the savings from better refrigerators should be equivalent to getting 90,000 extra homes on mains electricity by 2030, source: Country Savings Assessment for Ghana, U4E, 2015.

3 This survey of appliances in 1,000 homes was carried out in Ghana in 2006. It reflects the fact that many of the appliances were extremely old.

4 Mexico data for 1994 before MEPS – see Mexico case study in section 3.2.

5 370 kWh per year aligns with the minimum energy performance standard (MEPS) level recently set in several developed and emerging economies for this type and size of appliance.

6 Hotel minibars often use a refrigerant based on ammonia. Some absorption refrigerators can run without electricity, using instead kerosene or a flammable gas as the energy source.

7 A polyurethane foam thickness of 100 mm to 110 mm is cost effective for freezers in most economies; a thickness of 55 mm to 70 mm is generally cost effective for refrigerators. The insulation thickness does influence the available volume inside the appliance since they usually have standardised external dimensions. In practice, however, available space is not generally a limiting factor on insulation thickness

8 HC refrigerants such as HC 600a have a GWP of around 3. A practical reference point for gases with extremely low global warming impact is GWP 15, which corresponds with the GWP threshold above which 'gases must be properly extracted and properly treated' if they are present in waste equipment under the EU waste electrical and electronic equipment (WEEE) Directive 2012/19/EU.

9 bigEE 'The overall worldwide saving potential from domestic refrigerators and freezers' http://www.bigee.net/media/filer_public/2012/12/04/bigee_doc_2_refrigerators_freezers_worldwide_potential_20121130.pdf

10 MEPS are usually set as energy consumption from a calculation using storage volume and some other characteristics. While energy efficiency (kWh per unit volume per day) of a larger appliance is usually better (i.e. lower) than that of a smaller appliance, the energy consumption (kWh per day) of the larger appliance is generally higher. Policies should therefore avoid steering consumers towards appliances that are larger than they need.

11 Whilst energy efficiency (kWh per unit volume per day) of a larger appliance is usually better (i.e. lower) than that of a smaller appliance, the energy consumption (kWh per day) of the larger appliance is generally higher.

12 Small is defined as less than 250 L; medium as 250 to 350 L; large as over 350 L.

13 Transition to Sustainable Buildings -- Strategies and Opportunities to 2050, 2013.

14 This is why efficiency tends to be considered as kWh per "adjusted L," where the volume is adjusted to compensate for the temperature at which each of the compartments in the appliance is operated so that appliances can be compared. However, annual energy consumption is used within this guide, being more relevant to policymakers concerned with energy demand and electricity costs to citizens.

15 Data was all normalised to be as tested to EN 62552: 2013; this has significant differences to the new global standard IEC 62552: 2015, but the data as shown is internally comparable.

16 US test method for policy purposes is US DOE 10 CFR Parts 429 and 430, Energy Conservation Program: Test Procedures for Refrigerators, Refrigerator-Freezers, and Freezers; Final Rule, April 21, 2014.

17 This equates to an equivalent (or adjusted) volume of 437 Ls according to the EU test method, which is used as the baseline for calculation (assumed 209 L net volume fresh food compartment and 80 L net volume 3 star freezer compartment; auto-defrost and sub-tropical temperature classes).

18 For example, in the EU there are 10 per cent less stringent regulations and standards (MEPS) for air conditioners with GWP of less than 150 Ecodesign of air conditioners (EC 206/2012).

19 Life-cycle costs are calculated as the sum of all one-time (purchase) and recurring (maintenance, energy costs) costs over the full life span or a the equipment.

20 Note that this is based upon a global average electricity carbon factor of 0.518 kgCO2/kWh; the actual ratio of direct to indirect equivalent emissions will vary by economy. For example for the EU this figure is 17 years, for Asia (excluding China) it is 8 years.

21 The use of existing lab capacities which are recognised according to the IEC EEE scheme ensures a defined level of quality and correctness of the measurements.

22 Note that this is based upon a global average electricity carbon factor of 0.518 kgCO_2/kWh; the actual ratio of direct to indirect equivalent emissions will vary by economy. For example for the EU this figure is 17 years, for Asia (excluding China) it is 8 years.

[23] Regarding GWP for HC 600a: The Technology and Economics Assessment Panel (TEAP) indicated in its May 2012 report that GWPs for HCs should be indirect GWPs (i.e. include climate impact of breakdown products), which would mean a GWP of around 20 but this is disputed and has not been clarified in more recent TEAP reports. Thus the common usage figure of 3 is adopted.

[24] Shecco, see: www.secop.com/fileadmin/user_data/pdfs/compressor_knowledge/shecco_natural-refrigerants-trends.pdf.

[25] HFOs are (hydrofluoroolefins which is a low GWP unsaturated HFCs). There are several HFOs and many blends/mixtures including HFCs.

[26] GWP for HFC 134a is 1300, as per Climate Change 2013, The Physical Science Basis, Working Group I Contribution to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change, Table 8.A.1. Available from: ipcc.ch/report/ar5/wg1/.

[27] See Table 8 for source of GWP for HC 600a.

[28] SKM Enviros report Phase Down of HFC Consumption in the EU – Assessment of Implications for the RAC Sector, 2012.

[29] Anecdotal evidence from manufacturers suggests around 2 per cent.

[30] See Management and destruction of existing ozone-depleting substances banks, GIZ, August 2015.

[31] The EU Waste Electrical and Electronic Equipment Directive allows safe venting of refrigerants when the GWP is 15 or less, but recently developed standards also recommend the recovery of HCs from refrigerators.

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