COUNCIL OF ENGINEERS
FOR THE ENERGY TRANSITION

An independent advisory council to the
United Nations Secretary-General

# Energy Rating Labels and Potential for Energy Savings Across the Global South

## Key Messages

1. Implementing high energy performance standards and energy rating labels for appliances such as lights, air conditioners, refrigerators, and industrial motors could save emerging and developing economies up to 3,442 TWh of electricity annually (10%) by 2050, equivalent to the current electricity consumption of all of Africa, Oceania, Central Asia, Latin America, and the Caribbean combined.
2. Expanding these high energy performance standards and labels to other equipment types across the household, industrial, and commercial sectors could double savings to 6,800 TWh (20%). Further, adopting Best Available Technology (BAT) could increase savings to 40%. The transport sector could achieve up to a 50% reduction in energy use with aggressive fuel consumption standards.
3. Minimum Energy Performance Standards (MEPS) and Energy Rating Label (ERL) programs significantly decreased energy use. In 2018, EU countries saved an estimated 15% of electricity demand due to these programs. They also achieved 15% savings in oil and gas consumption by 2020. Globally, the average specific energy consumption of new vehicles decreased over 27%, from 9.5 L/100km in 2005 to 6.9 L/100km in 2022, due to fleetwide fuel consumption standards.
4. Over 1.6 billion people (about 20% of the global population) live in 57 countries that have MEPS or ERL schemes but do not fully use their potential, while 24 countries lack any groundwork or implementation of these energy efficiency ratings. Energy efficiency labelling is also a social justice policy that improves energy access and quality of life while reducing national energy expenditures.
5. MEPS and ERL programs can accelerate technological and efficiency improvements by two to three times. For instance, Japan's Top Runner Programme reduced computer energy use by 90% in six years, and new TV energy use declined by 60%.
6. A consumer using standard bulbs and fans requires about 250W to power their home. Switching to energy-efficient equipment, like 30W Brushless DC (BLDC) motor fans and LED bulbs, can reduce this to just 75W, highlighting energy efficiency's potential in helping accelerate energy access for all, by reducing energy needs of current and future energy users.

# 1. INTRODUCTION TO MINIMUM ENERGY PERFORMANCE STANDARDS AND ENERGY RATING LABELS

## 1.1. Energy Rating Labels

An Energy Rating Label (ERL) is a standardized label that provides consumers with information about the energy efficiency of various products, typically household appliances, electronics, oil and gas heaters, and cars. These labels are designed to help consumers make informed purchasing choices by indicating how much energy a product consumes to provide a particular service, such as lighting, cooling, heating, cleaning, cooking, and mobility. The labels provide comparisons with similar products, enabling consumers to choose those that offer better energy performance and lower lifecycle costs for providing an equivalent amount of service. This not only helps consumers save money on energy bills over the appliance's lifetime, but it also encourages manufacturers to innovate and produce more energy-efficient products to remain competitive in the market. These labels are often mandated by governments or regulatory bodies as part of energy efficiency regulations to encourage the purchase of more energy-efficient products.

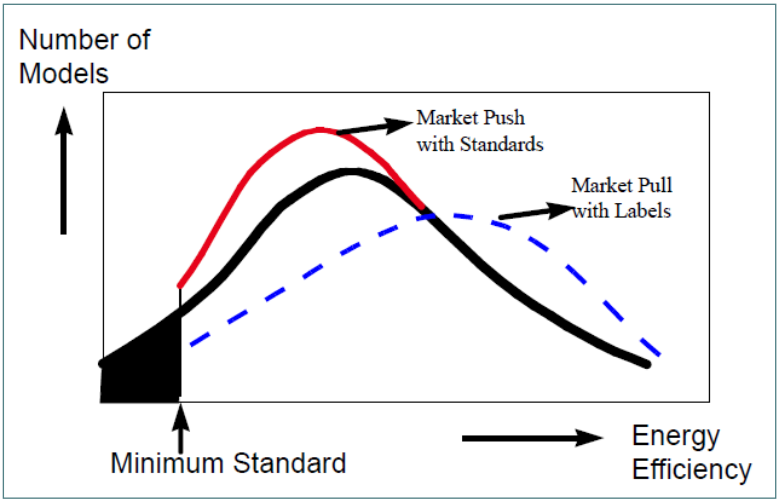
## 1.2. Comparative Labels vs Endorsement Labels

Energy labels are classified into two types:  comparative labels and endorsement labels. Comparative labels are essential tools for consumers to evaluate the energy efficiency and relative ranking of products. The most widely used forms of comparative labels come in the shape of stars, bars, and dials, offering intuitive visual representations that consumers can quickly understand and compare.[1] These labels often coexist with endorsement labels, which indicate that products belong to the highest energy efficiency class or meet predetermined standards or eligibility criteria, such as the North American 'Energy Star' and Japanese 'Top Runner' labels.[2] Typically displayed as a logo or mark, these labels show that the product has met specific standards or criteria without providing detailed comparative energy efficiency information. Endorsement labels, owing to their characteristics, are usually voluntary, while comparative labels are often mandatory.

## 1.3. Minimum Energy Performance Standards (MEPS)

Minimum Energy Performance Standards (MEPS) are crucial regulatory tools implemented by governments to establish the minimum level of energy efficiency that products must meet before they can be sold or imported into a market.[3] MEPS are reinforced by test procedures, often referred to as test standards, which ascertain appliance performance, energy consumption, and consequently, energy efficiency. Designated laboratories test appliances provided by manufacturers and importers, issuing certificates of approval to ensure compliance with standards and transparency for consumers. MEPS and ERLs work in a complementary way to transform the marketplace, as shown in Figure 1. A metric is defined for each energy-consuming product to measure its energy efficiency (e.g., kilowatt-hours per year for refrigerators and liters per 100 km for cars). The black line in Figure 1 represents the market for products in the absence of standards and labels. As the red line shows, MEPS "push" the market by removing the least efficient models of t product type. At the same time, as represented by the blue line, ERLs "pull" the market by giving consumers the information they need to make informed decisions and purchase the most efficient models, thereby reducing their energy costs. This encourages manufacturers to design more efficient products to stay competitive. Together, MEPS and ERLs increase the efficiency of products offered in the market.[4]

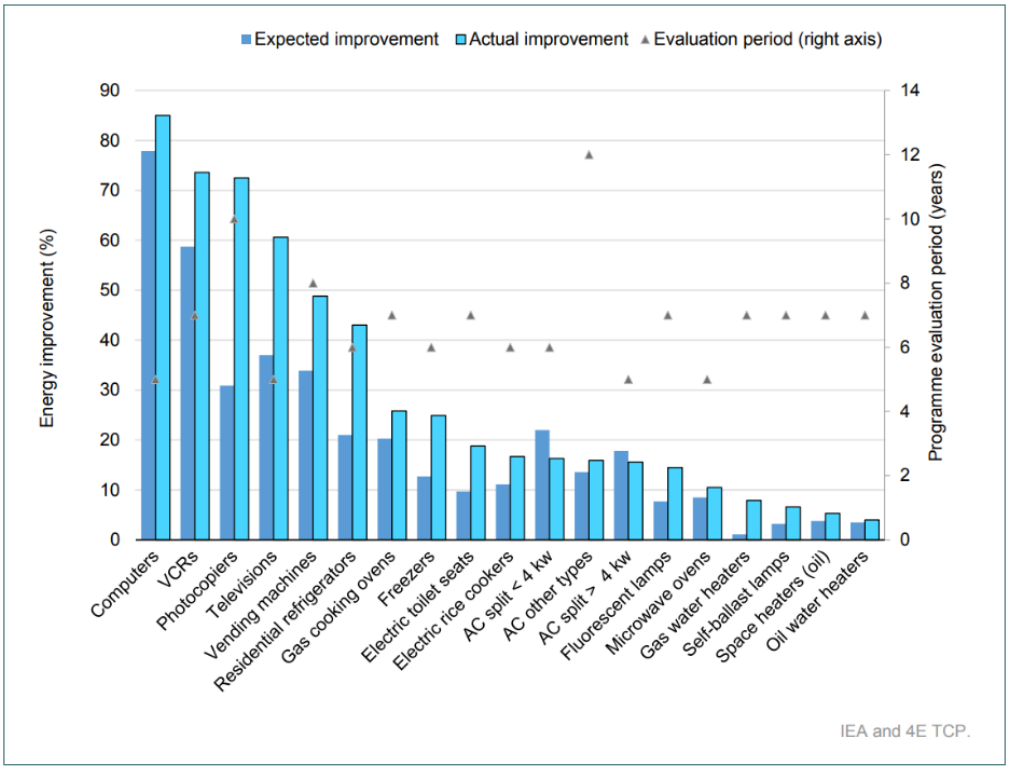
**Figure 1**. Standards and Labels Work Together to Transform Markets. Source: North American Energy Working Group, "North American Energy Efficiency Standards and Labeling," (NAEWG, 2002).




The International Energy Agency (IEA) estimates that the rate of technological and efficiency improvement increases two to threefold with the introduction of MEPS and ERL programs.[5] For example, the Japanese Top Runner Program uses the top 5% of products with the highest efficiencies in each category to set efficiency goals for the next five years. This approach has resulted in the significant savings seen in Figure 2.

New computers saw an 85% reduction in energy consumption in just five years, an improvement of 17% per year. New TVs saw a 60% reduction in the same time, while refrigerators saw a 44% reduction over six years, and photocopiers a 72% reduction over ten years. In the vast majority of the product categories, actual improvement was much higher than expected improvement.

**Figure 2**. Expected versus delivered improvements of the Japanese Top Runner Program. Source: International Energy Agency, "Achievements of Energy Efficiency Appliance and Equipment Standards and Labelling Programmes" (IEA, 2021).



Among the range of available energy efficiency tools, MEPS and ERL programs offer several advantages:

a. They can produce substantial energy savings in a cost-effective way by increasing economic efficiency.
b. They control the behavior of a smaller number of manufacturers and importers, rather than the total energy consuming public, while treating all manufacturers, distributors, and retailers equally.
c. The energy savings are quite assured, are relatively simple to quantify, and can be easily verified.

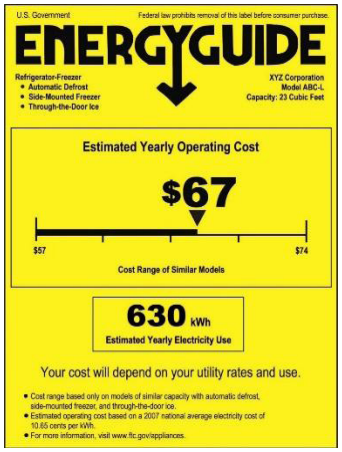
By ensuring that the superiority of new models is relayed to prospective buyers, MEPS and ERL programs encourage the research and development (R&D) necessary for innovation and efficiency. These programs require continuous review and adjustment of criteria, as well as the regular raising of standards and efficiency bands and tiers, to ensure progress toward energy saving goals.[6]

## 2. COMPARISON OF MEPS AND ERL PROGRAMS ACROSS THE GLOBE

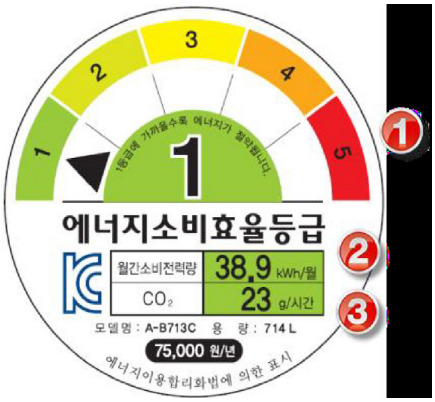
According to the IEA, as of 2021, 120 countries employ energy standards and labelling programs across 100 different types of appliances and equipment in the domestic, commercial, transport and industrial sectors.[7] This is an encouraging increase from 81 countries with such programs, across 55 product types in 2013.[8] These MEPS and ERLs vary widely across different regions and countries, reflecting diverse methodologies, labelling systems, and update schedules, as reflected in Table 1 and Figure 3. The examples shared cover the developed world and emerging and developing economies, as well as long-established ones compared to newer ones. The methodologies for MEPS assessment vary significantly between countries and regions. For air conditioners, the primary metrics may include annual energy consumption (in kWh, for a set number of annual cooling hours by climate zone), Energy Efficiency Ratio (EER), and Seasonal Energy Efficiency Ratio (SEER). In some cases, the metric is presented as annual operating costs or cost-benefit estimates (e.g., in Nigeria).[9]

The ERL also varies across different countries, depending on the country's regulatory requirements. It may be shown in either a qualitative or quantitative manner, or both. In the Asia-Pacific region, countries like Australia, Bangladesh, China, India, Japan, Singapore, and the Republic of Korea, have implemented various MEPS and ERLs, typically using star ratings, ticks or bar labels to denote efficiency, with updates ranging from regular intervals to every few years. In Africa, South Africa has mandatory ratings for many appliances, with labels ranging from A+++ to G, which are updated every three years. Nigeria and Morocco have also established MEPS and ERLs, while Egypt has a combination of mandatory and voluntary standards. The European Union (EU) and some European countries, including the United Kingdom (UK), Turkey, and Russia, use A to G labels, with updates every few years. In North America, the United States of America (USA) and Canada employ a slider bar system, with annual operating cost displayed on a sliding range. The most efficient appliances can earn an Energy Star rating. Latin American and Caribbean nations such as Argentina, Brazil, Colombia, Costa Rica, Jamaica, and Mexico have mandatory labels for many household and industrial appliances, often using A to G labels with regular updates.

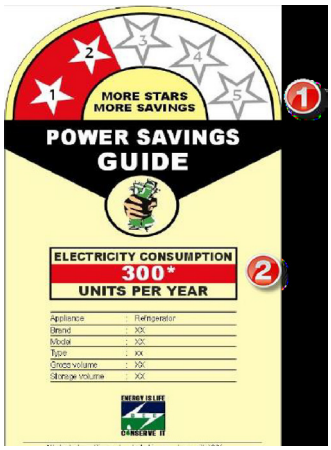
**Figure 3**. Various ERLs used in different countries




United States[10]

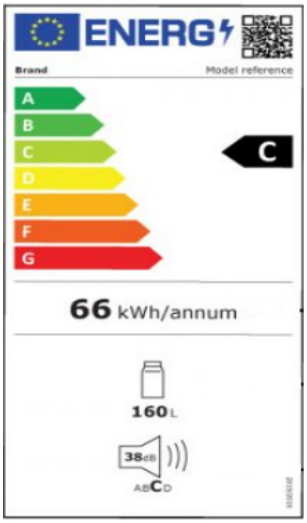



Republic of Korea[11]

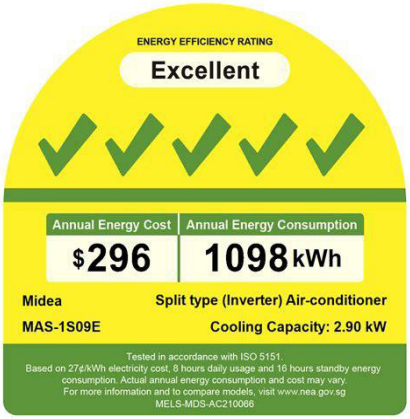



India[12]


Indonesia[13]



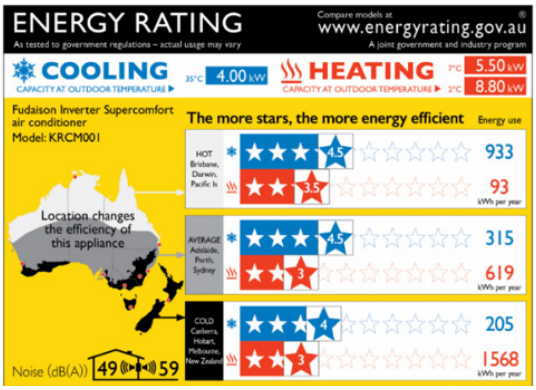

European Union[14]



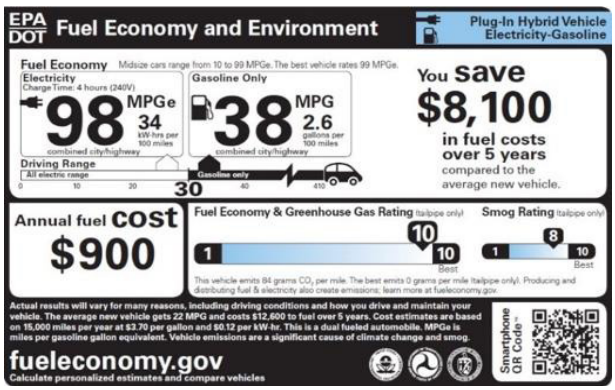

Singapore[15]

Several countries, including Australia, China, and Nigeria, have introduced climate—or zonal-based ratings for heating and cooling appliances, allowing consumers to make the best purchasing decisions based on their region, as shown in Figure 4. In the US, fuel economy labels for passenger vehicles now include savings over five years, as well as annual fuel cost and miles per gallon (mpg). Regardless of the efficiency metric used, however, consumers' willingness –to pay for an energy efficient appliance is highest when annual operating costs or energy bills are included, rather than just relying on an energy-based metric.[16]

**Figure 4**. Zonal based ERL in Australia; US EPA Fuel Economy Label




Australia[17]




United States[18]

**Table 1**. The availability of MEPS and ERLs in selected countries.

| Region | Country | Appliances Covered (Mandatory ir Voluntary as of 2023 | Labels | Key Metrics Used (e.g. For Air Conditioners) | Scheduled Update |
|---|---|---|---|---|---|
| Africa | South Africa[19] | Mandatory: Refrigerators, air-conditioners, washing machines, dishwashers, electric ovens, dryers, LED lights (May 2023), motors (2024), electric motors (sized between 0.75 and 375 kW, expected in 2023), televisions and electric monitors (expected 2023). | Rated from an A+++, (indicating the best) to D, E, F or G (worst) | Energy rating in kWh/year and cost-benefit analysis | 3 years |
| | Nigeria[20,21] | MEPs were introduced in the country for refrigerators and air-conditioners in January 2018.<br><br>Mandatory: Solar energy kits (implemented in 2020).<br><br>Voluntary: Lighting, lamps, non-directional lamps (under development). | Clock-shaped gauge having 5 stars | Seasonal Energy Efficiency Ratio (SEER), Energy Efficiency Ratio (EER) | 5 years |
| | Egypt[22,23,24] | Mandatory: refrigerators/freezer (Revised 2018), space heating and space cooling, air conditioning, room ACs - stationary ACs (Revised 2018), storage water heaters (Adopted 2019), non-directional lamp (Revised 2020), and kitchen ovens (Adopted 2017).<br><br>Voluntary: Water pumps (Adopted in 2021). | A to G (A the best) | Insufficient data | Insufficient data |

| Region | Country | Appliances Covered (Mandatory ir Voluntary as of 2023 | Labels | Key Metrics Used (e.g. For Air Conditioners) | Scheduled Update |
|---|---|---|---|---|---|
| Asia-Pacific | China[25] | Mandatory: Refrigerators and room air conditioners.<br><br>Voluntary: Monitors, LCD TVs, plasma TVs, rice cookers, induction cookers, household washing machines, refrigerators, water storage electric water heaters, energy-saving lamps, printers, copiers, electric fans, fax machines, computers, and irons. | 1-5 bars (1 being the most efficient) | kWh/year and EER/ SEER | Insufficient data |
| | India[26,27] | Mandatory: Refrigerator (frost-free and direct-cool), electric water heater, TV, room air conditioner (cassette, floor standing tower, ceiling, corner AC, updated: 2020), Tubular Fluorescent Lamps (TFL), LED lamps (updated:2018), distribution transformer, and ceiling fan.<br><br>Voluntary: Computer, domestic gas stove, industrial motor, submersible pump set, washing machine (updated: 2024), ballast, solid state inverter, office automation products, diesel engine driven mono-set pumps for agricultural purposes, diesel generator set, chillers, microwave ovens, solar water heaters, deep freezers, ultra-high-definition TV, air compressors, tyres, high energy Li-battery. | 1-5 stars (more colour stars mean more efficiency) | Star Rating and kWh/year | 2-3 years |
| | Japan[28] | Mandatory: 21 products, including refrigerators, freezers, RACs, fluorescent lights, TVs, DVD recorders, electric rice cookers, electric toilet seats, passenger cars, etc.<br><br>Voluntary (Energy Star): Computers, copiers, hard-disk drives, monitors, MFDs, and scanners. | Top-Runner (5 Star Rating) | Star Rating and kWh/year | Regular |
| | Malaysia[29] | Mandatory: Refrigerator, lighting equipment, industrial electric motors and other industrial equipment, TV, air-Conditioner, washing machine, microwave oven, electric rice cooker, freezer, and electric Oven. | 2-5 Stars | Star Rating and kWh/year | Insufficient data |
| | Singapore | Mandatory: Air-Conditioners, Portable Air-Conditioners (PAC), refrigerators, clothes dryers, televisions, general lighting, water heater, three-phase VRF air-conditioners, three-phase induction motors, and commercial storage refrigerators. | 1-4 Ticks | kWh/year, annual cost and qualitative rating (e.g. Good) | Insufficient data |

| Region | Country | Appliances Covered (Mandatory ir Voluntary as of 2023 | Labels | Key Metrics Used (e.g. For Air Conditioners) | Scheduled Update |
|---|---|---|---|---|---|
| Asia-Pacific Cont. | Republic of Korea | Mandatory: (ERL): 21 products, including refrigerator-freezers, kim-chi refrigerators, room ACs, washing Machines, Fluorescent, Lamps, Rice Cookers, Passenger cars, etc.<br><br>Voluntary: (High-efficiency label): 34 products, including ballasts, boilers (Gas), CFLs, pumps, etc. | 1-5 Dial (1 the most efficient) | kWh/year | Insufficient data |
| | Australia[30] | Mandatory: Air conditioners, cloth washers and dryers, computer monitors, computers, dishwashers, distribution transformers, electric water heaters, external power supplies, electric motors, gas water heaters, refrigerators and freezers, lighting, pool pumps, refrigerated cabinets, set-top boxes, and TVs. | 1-6 Stars (up to 10 stars for super-efficient) | Star Rating, kWh/year, SEER | Regular |
| Europe (Eastern, Western, and others) | EU Countries[31] | Mandatory: refrigerators, dishwashers, washing machines, televisions, vacuum cleaners, tumble dryers (2021), light bulbs and lamps (2021), and Tablets and mobile phones (implemented by 2025). | A to G Label (A best) with colour | kWh/year | 4 years |
| | Turkey[32] | Mandatory: washers and dryers, refrigerators, LEDs (2021), heaters (2018), and domestic ovens (2015) | A to G Label (A best) | kWh/year | Regular |
| | Russia[33] | Mandatory: Refrigerating appliances, washing machines, dishwashers, washer-dryers, air conditioners, electric lamps, televisions, electric ovens, and incandescent bulbs (Feb 2019).<br><br>Voluntary: Electric motors, household refrigerators and freezers, and windows and glazing (2013). | A to G Label (A best) | kWh/year | Insufficient data |
| | United States[34] | Mandatory: Office equipment, household appliances, electronics, refrigerators, air conditioners, fans, furnaces, boilers, residential lighting products, windows, and roof products. | 6 & 10 stars | kWh/year and annual cost | Regular |
| | Canada[35] | Mandatory: Washers and dryers, dishwashers, freezers, electric ranges and ovens, refrigerators and refrigerator-freezers, and room air conditioners.<br><br>Voluntary: central air conditioners, furnaces (oil-, gas- or propane-fired), heat pumps (air source), gas fireplaces, and water heaters. | 6 & 10 stars | kWh/year | Regular |

| Region | Country | Appliances Covered (Mandatory ir Voluntary as of 2023 | Labels | Key Metrics Used (e.g. For Air Conditioners) | Scheduled Update |
|---|---|---|---|---|---|
| Latin America and Caribbean | Brazil[36] | Mandatory: Refrigerators, freezers (updated 2021), air-conditioners (updated 2018), lighting, heating appliances, cooking ovens, washers and dryers, transformers (2018), ceiling fans and electric motors (2017). | A to G (A best) | kWh/year | Insufficient data |
| | Mexico[37] | Mandatory: Cooktop/hob oven, central air conditioner, room air conditioner (2011), clothes washer, Industrial machinery and electronic products pump system, heating water heater, freezer, refrigerated cabinet, refrigerator-freezer (2012), and packaged terminal. | Report card kind containing information | kWh/year | 2-3 years |
| | Colombia[38] | Mandatory: Refrigerators, air-conditioners, TV, three-phase motors, lighting and freezers (implemented in 2016 but the last revision for air-conditioners, lighting and freezers was made in 2019). | A to G (A best) | kWh/year | 1-3 years |
| | Argentina[39] | Mandatory: Lamps (last revised: 2018), air conditioners (2014), refrigerators and freezers (2013), Washing machines (2013), ballast TV sets and monitors, gas cooking appliances (2019) induction motors, electric water heaters, and microwave ovens. | A to G (A best) | Insufficient data | 2-3 years |
| | Jamaica[40] | Mandatory: Refrigerators and freezers (Last updated: 24 Jan 2023), and HVAC systems (meet standards of 2019). | 6 stars for cooling | kWh/year and annual cost | Insufficient data |
| | Costa Rica[41] | Mandatory: Refrigerators and freezers (Last updated: 10 Dec 2022), air-conditioners, lighting bulbs, washing machines, and fans. | A to G (A best) | Insufficient data | 2-3 years |

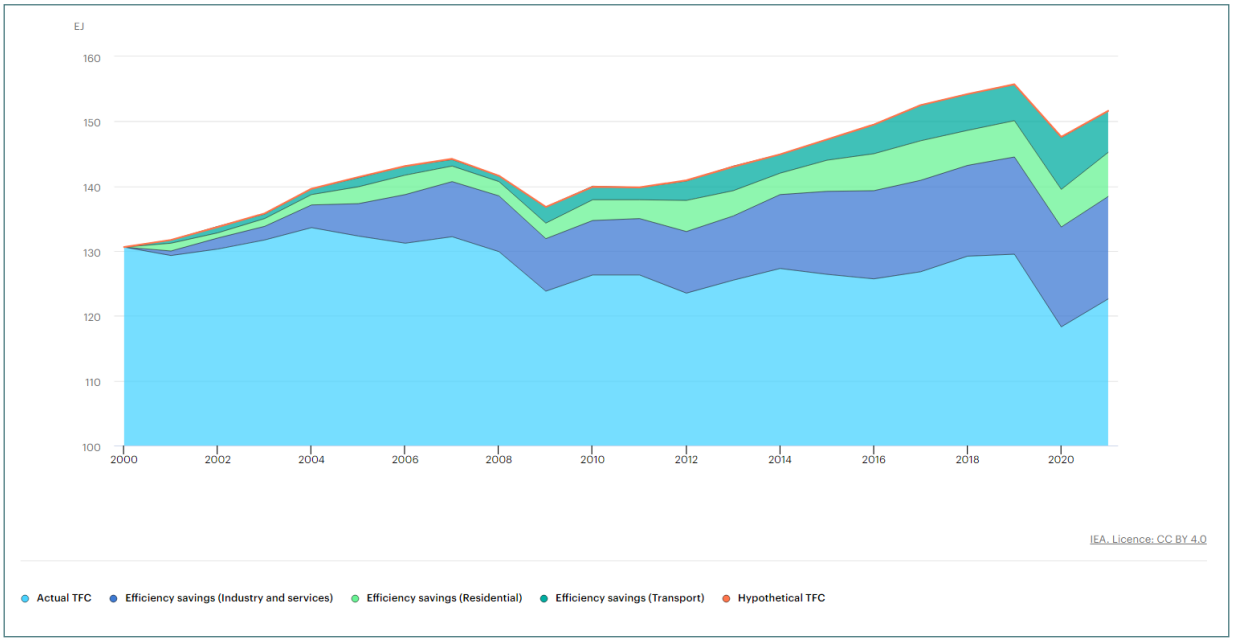
The institutional framework for implementing MEPS and ERLs varies across countries. Within the European Union, the European Commission is tasked with developing both MEPS and ERLs in consultation with stakeholders and member state experts. The Commission then promulgates the relevant MEPS or ERLs as legally binding standards across all member states. However, although the standard-setting takes place at the EU-level, enforcement across the European single market is decentralized. Each member state has its own national market surveillance authorities that are responsible for ensuring compliance with European energy label regulations.[42] In the United States, a multitude of organizations participate in the assessment of products for inclusion in the energy labelling scheme, resulting in a notably lengthy procedure. The Department of Energy (DoE) holds the ultimate authority, thus products targeted for evaluation undergo initial scrutiny by the DoE.

Manufacturer trade associations play a pivotal role by gathering fundamental data from their member companies, which is utilized in the development of standards. Concurrently, research institutions conduct thorough analyses to ascertain both the technical feasibility and economic viability of these standards, drawing from the amassed data.[43] In China, the formulation of MEPS is overseen by the China National Institute of Standardization, although the final decisions involve several government organizations. Numerous expert teams are engaged in the development of standards, including academic experts, industry representatives, certification authorities, consultants, and end-user organizations.

## 3. ESTIMATED SAVINGS ACHIEVED BY EXISTING MEPS AND ERL PROGRAMS

The total energy use in IEA countries in 2021 is estimated to be 20% lower than the Business as Usual (BAU) scenario, due to energy efficiency gains since 2000, resulting in final energy savings of approximately 30 exajoules (EJ), as shown in Figure 5. The EU estimates that at least half of its energy efficiency gains come from Energy Efficiency Standards and Labelling (EES&L) schemes.[44]

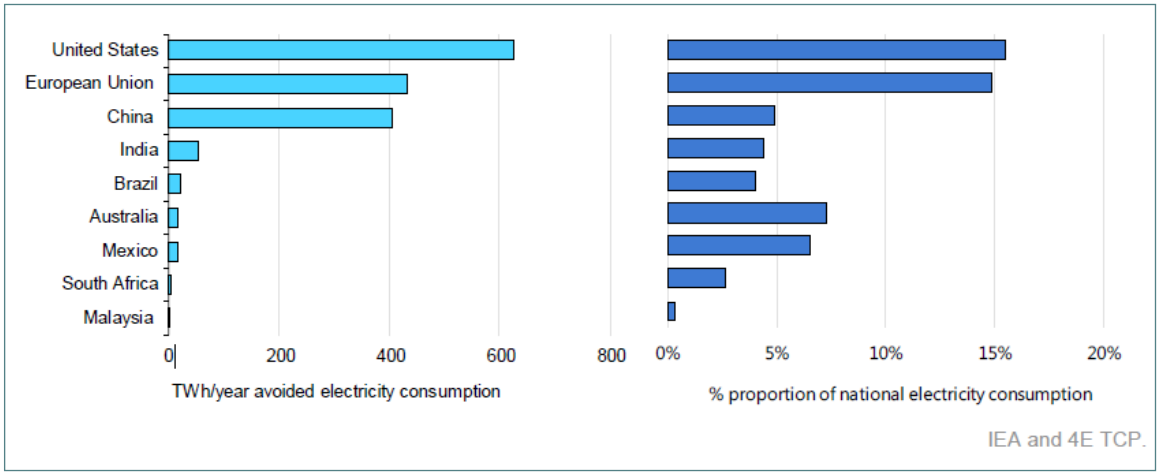
**Figure 5**. Estimated savings of final energy use in IEA countries 2000-2021. Source: International Energy Agency, "Achievements of Energy Efficiency Appliance and Equipment Standards and Labelling Programmes" (IEA, 2021).




The EU and US saved an estimated 15% and 16% of their electricity demand, respectively, in 2018 due to MEPS and ERL programs compared to BAU, as shown in Figure 6.[45] China and India saw savings of 5% and 4% , respectively. The BAU scenario assumes a certain level of technological innovation each year, even without MEPS and ERL programs. The savings are highest in regions with the longest-running MEPS and ERL programs, such as the EU and US, due to the compounded savings impact with each additional year. However, countries like Brazil, China, and India may see a faster increase in their energy savings by leveraging the technological advances from regions that introduced these schemes earlier.

In addition, with an emerging middle class, much of the savings will come from dampening the energy increase needed to raise the quality of life and comfort of families entering the middle class. For instance, in the case of light, incandescent bulbs provided just 10 lumens of light per watt (W) of input power, but 20 years later, new LED bulbs give up to 200 lumens per watt, reducing the average electricity needs of a bulb from 60 – 100 W down to only 5 - 12W. However, even with these improvements, LEDs are just 14% - 29% efficient compared to the theoretical limit for light.

**Figure 6**. MEPS and ERL-related annual electricity savings, 2028. Source: International Energy Agency, "Achievements of Energy Efficiency Appliance and Equipment Standards and Labelling Programmes" (2021).

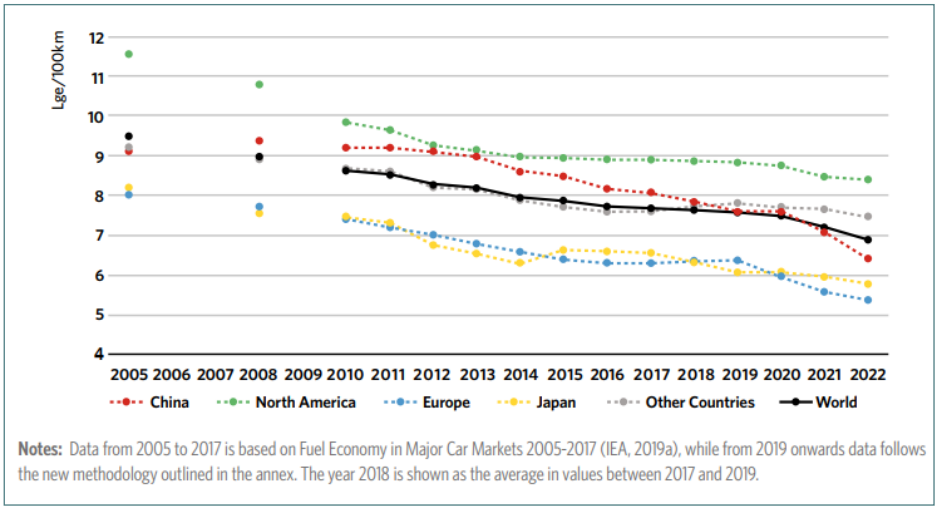



By applying the savings rates from Figure 6 to 2022 electricity generation data for the countries listed in Figure 6, as well as Canada, Japan, and the Republic of Korea (which have long-running EES&L programs), MEPS and ERLs resulted in over **2,100 terawatt-hours (TWh)** of savings, or 7.2% of the world's total electricity generation.[46] These savings come from the wide variety of appliances and equipment for which each country imposes MEPS and ERLs for, as seen in Table 1. This calculation does not include savings from other countries, both with and without such programs.

Assuming a conservative average savings of 20% across all these countries in 2050 from EES&L schemes, would result in **7,576 TWh** of savings, or 14% of the global electricity generation in 2050 (compared to the Stated Policies Scenario in the IEA's World Energy Outlook 2023). However, compounded savings could have reached 30% or higher for these countries by then.

Adding oil and gas savings from space and water heating, the EU saw **15.3%** savings in primary energy consumption in 2020 from using EES&L schemes.[47] The global average specific energy consumption of new vehicles has reduced by over 27%, from 9.5 L/100km in 2005 to 6.9 L/100km in 2022, as shown in Figure 7, due to the strict vehicle efficiency and fuel economy standards, as well as fuel consumption labels, that many economies have made mandatory across the world.[48] The US estimates that vehicle standards have increased their average fuel economy from 13 mpg in the 1970s to 40 mpg in 2020.[49]

**Figure 7.** Trends in the specific energy consumption of new vehicles in major car markets. Source: Global Fuel Economy Initiative (2023).



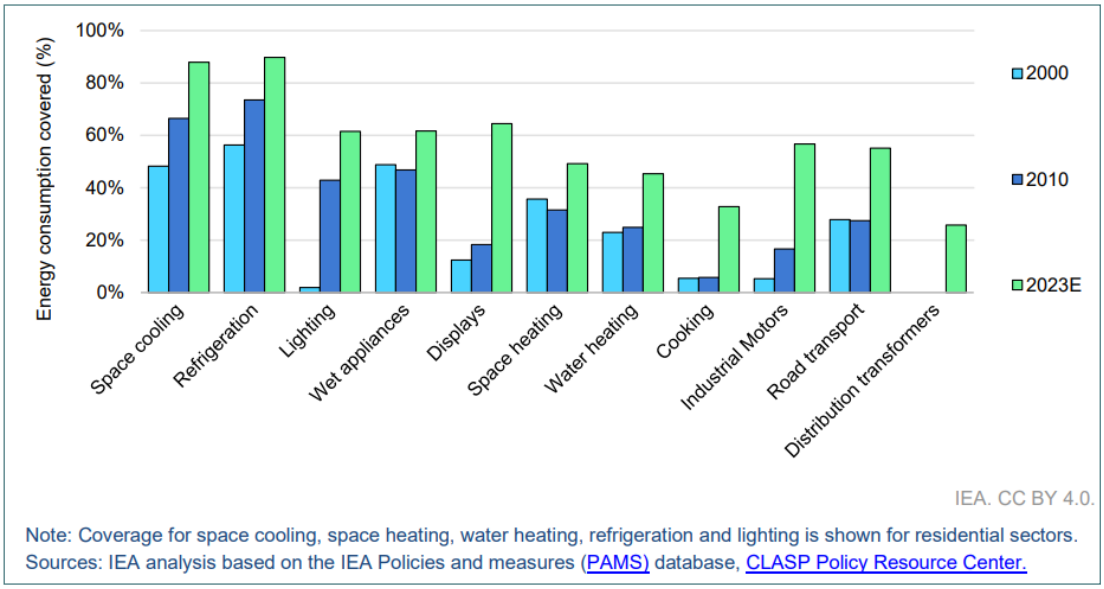

**Notes:** Data from 2005 to 2017 is based on Fuel Economy in Major Car Markets 2005-2017 (IEA, 2019a), while from 2019 onwards data follows the new methodology outlined in the annex. The year 2018 is shown as the average in values between 2017 and 2019.

Globally, many governments impose average fuel economy standards and vehicle emissions standards on a fleetwide basis on each car manufacturing company, alongside a minimum standard for each vehicle.[50] This approach differs from the MEPS used for appliances, which focus on a minimum standard for each appliance, without an additional standard for the average energy efficiency for the entire range of models a manufacturer may produce for an appliance category, e.g. air conditioner. Due to this significant difference, it can be argued that the average fuel economy seen for cars sold each year is a reflection of the average fleetwide standards imposed by governments for that year. And hence, the majority of the energy savings seen are due to the implemented standards. The US has implemented aggressive new standards for the years 2024 - 2026, intending to raise average fuel economy up from 40 mpg in 2020 to 49 mpg in 2026, aligning more closely with global benchmarks.

## 4. COUNTRIES THAT HAVE LOW TO NO IMPLEMENTATION OF MEPS OR ERLS

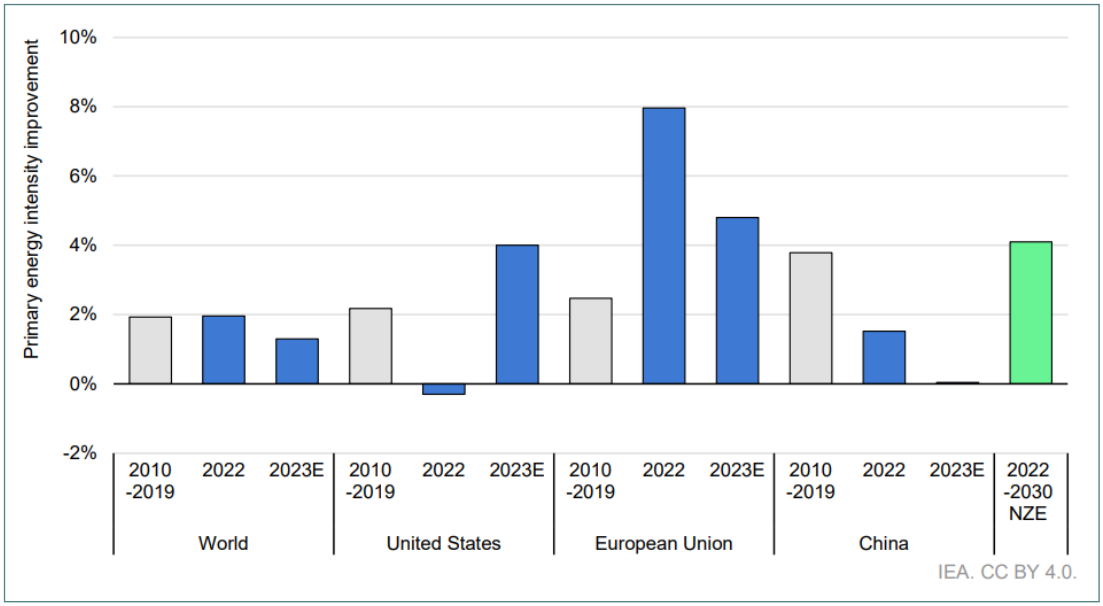
The IEA estimates how much of global energy use is covered by MEPS, focusing specifically on major end uses, as shown in Figure 8.43 Significant progress has been made in space cooling (air conditioners, fans, chillers, etc.) and refrigeration. However, there is still much to be done in the other end uses (also known as services), especially in space and water heating, cooking, and road transport across much of the world. As expected, ERLs have less coverage across these end uses, as ERLs are usually implemented after MEPS.

**Figure 8**. Global energy use coverage of minimum performance standards for major end uses, 2000-2023. Source: International Energy Agency, "Energy Efficiency 2023" (2023).




Global energy efficiency gains are much lower than the targets needed for Net Zero Emissions Scenario (NZE) by 2050 (Figure 9).[51] MEPS and ERLs are extremely important in accelerating energy efficiency gains, if the world is to meet its target of improving energy efficiency or energy intensity by 4% every year from now to 2050, in order to reach Net Zero Emissions (commitment made by 132 countries at COP28).

**Figure 9**. Annual primary energy intensity improvement, 2010-2019, 2022, 2023 compared to NZE Scenario. Source: International Energy Agency, "Energy Efficiency 2023" (2023).




This section focuses on countries across the globe where either MEPS, ERLs, or both, are missing or are in an inception or abandoned stage. Further, countries exist where groundwork for the schemes has been paved (regulatory- and/or administrative-wise), however, their real implementation has not been launched to reach end-users and make an impact on their purchasing decisions.

A total of 57 UN member countries, along with non-member states and non-self-governing territories, have been identified with little to no implementation or insufficient implementation of either MEPS or ERL schemes, as shown in Table 2.[52,53,54] Making use of the overall indicator for energy efficiency proposed in the RISE database, the sub-indicators for MEPS and ERL are combined to create a MEPS + ERL criterion for the proposed three categories:[55]

1. zero implementation: 24 countries, population of 480 million (5.97% of global population),
2. score of up to 25 (out of 100): 21 countries, 735 million (9.16% of global population), and
3. score between 25 and 35: 12 countries, population of 405 million (5.97% of global population).

**Table 2**: Countries with no to low implementation of either Minimum Energy Performance Standards (MEPS) and/or Energy Rating Labels (ERLs) schemes (Data source: Worldometer1 and RISE2)

| Region | Country | Population (2023)[56] | (MEPS+ERL)/2[57] |
|---|---|---|---|
| Asia | Azerbaijan | 10,412,651 | 0 |
| Asia | Laos | 7,633,779 | 0 |
| Asia | Maldives | 521,021 | 0 |
| Asia | Mongolia | 3,447,157 | 0 |
| Asia | Turkmenistan | 6,516,100 | 0 |
| Latin America & the Caribbean | Guatemala | 18,092,026 | 0 |
| Asia | Cambodia | 16,944,826 | 0 |
| Asia | Yemen | 34,449,825 | 0 |
| Africa | Cameroon | 28,647,293 | 0 |
| Africa | Sudan | 48,109,006 | 0 |

| Region | Country | Population (2023)[56] | (MEPS+ERL)/2[57] |
|---|---|---|---|
| Africa | Eritrea | 3,748,901 | 0 |
| Africa | Mali | 23,293,698 | 0 |
| Africa | Congo | 6,106,869 | 0 |
| Africa | Mauritania | 4,862,989 | 0 |
| Africa | Somalia | 18,143,378 | 0 |
| Africa | Angola | 36,684,202 | 0 |
| Africa | Madagascar | 30,325,732 | 0 |
| Africa | Mozambique | 33,897,354 | 0 |
| Africa | Liberia | 5,418,377 | 0 |
| Africa | DR Congo | 102,262,808 | 0 |
| Oceania | Papua New Guinea | 10,329,931 | 0 |
| Africa | Central African Republic | 5,742,315 | 0 |
| Africa | Burundi | 13,238,559 | 0 |
| Africa | South Sudan | 11,088,796 | 0 |
| Asia | Afghanistan | 42,239,854 | 1 |
| Latin America & the Caribbean | Haiti | 11,724,763 | 1 |
| Africa | Malawi | 20,931,751 | 3 |
| Africa | Tanzania | 67,438,106 | 4 |
| Asia | Georgia | 3,728,282 | 6 |
| Africa | Lebanon | 5,353,930 | 6 |
| Africa | Ethiopia | 126,527,060 | 9 |
| Latin America & the Caribbean | Honduras | 10,593,798 | 13 |
| Asia | Myanmar (Burma) | 54,577,997 | 13 |
| Asia | West Bank and Gaza (State of Palestine) | 5,371,230 | 15 |
| Africa | Sierra Leone | 8,791,092 | 17 |
| Africa | Zimbabwe | 16,665,409 | 19 |
| Asia | Oman | 4,644,384 | 20 |
| Asia | Armenia | 2,777,970 | 21 |
| Asia | Tajikistan | 10,143,543 | 22 |
| Asia | Kazakhstan | 19,606,633 | 22 |
| Asia | Pakistan | 240,485,658 | 22 |
| Asia | Bahrain | 1,485,509 | 23 |
| Africa | Uganda | 48,582,334 | 24 |
| Asia | Kuwait | 4,310,108 | 25 |
| Asia | Nepal | 30,896,590 | 25 |
| Latin America & the Caribbean | Dominizan Republic | 11,332,972 | 26 |
| Africa | Zambia | 20,569,737 | 26 |
| Latin America & the Caribbean | Venezuela | 28,838,499 | 28 |

| Region | Country | Population (2023)[56] | (MEPS+ERL)/2[57] |
|---|---|---|---|
| Oceania | Vanuatu | 334,506 | 28 |
| Africa | Benin | 13,712,828 | 28 |
| Latin America & the Caribbean | Paraguay | 6,861,524 | 30 |
| Asia | Kyrgyzstan | 6,861,524 | 30 |
| Latin America & the Caribbean | Bolivia | 12,388,571 | 31 |
| Oceania | Solomon Islands | 740,424 | 31 |
| Asia | Indonesia | 277,534,122 | 35 |
| Latin America & the Caribbean | Jamaica | 2,825,544 | 35 |
| Africa | Burkina Faso | 23,251,485 | 35 |

Color legend and population shares per listed categories.

| Countries with combined MEPS+ERL indicator | Population (2023) | Percentage from total world population |
|---|---|---|
| (MEPS+ERL=0) | 479,918,880 | 5.97% |
| (0<MEPS+ERL<=25) | 736,876,001 | 9.16% |
| (25<MEPS+ERL<=35) | 405,125,559 | 5.04% |
| (MEPS+ERL<=35) | 1,621,920,440 | 20.16% |
| MEPS+ERL<=35) | 8,045,311,447 | |

The aggregated energy efficiency indicator in the RISE database includes 11 sub-indicators, two of which assess the implementation level of either MEPS or ERLs by country. The assessment is performed qualitatively, i.e. via a set of questions probing the existence or nonexistence of MEPS and ERLs, without quantifying the level of its real implementation among end users. Cross-referencing with relevant and quantifiable enablers or hinderers, decisive for maximizing energy savings resulting from real exploitation of MEPS and ERLs, is missing. Among them, we have identified several quantifiable aspects that need to be regarded concurrently, as a metric to assess what type of measures, policies, actions, technologies can be recommended as most suitable for a country to positively exploit and exhaust the benefits that derive from implementing either MEPS or ERLs. A suggested list of those aspects is provided in Section 10.

More than 1.6 billion people worldwide, representing about 20% of the world population, live in 57 countries that still do not use the potential of MEPS or ERL schemes for various reasons. A full list of such countries is provided in Annex A, including additional information (electricity access, GDP, PPP), whereas the largest countries by population, either without MEPS or ERL schemes, or with a large untapped potential for energy saving due to poorly implemented schemes are:

1. Indonesia (Asia): 277 million (about 3.5% of world population), with a score of 35;
2. Pakistan (Asia): 240 million (about 3% of world population), with a score of 22; and
3. Ethiopia (Africa): 126 million (about 1.6% of world population), with a score of 9.

## 4.1. Countries with no implementation of either MEPS or ERLs

There are 24 countries where no groundwork or implementation for either MEPS or ERL schemes has occurred. With a population of almost 480 million inhabitants, these countries hold a significant potential to contribute to both national and global energy savings, as well as corresponding CO2 emissions reductions. Among them, the country with the

largest population without implementing either MEPS, ERLs, or both is the Democratic Republic of Congo (Africa) with a population of 102 million (about 1.3% of the world population).

## 4.2. Countries with low or insufficient implementation of MEPS, ERL schemes, or both.

As per the information listed in Table 2, there are a total of 33 countries that deploy MEPS, ERLs, or both (score 0 < MEPS + ERL <=35), but without the necessary dedication, or a sufficiently wide extent. These countries fall into three categories:

1. Some have laid the groundwork for MEPS, ERLs, or both, but their real implementation has not been launched across the country to reach customers and make an impact on their purchasing decisions. This could be due to a temporary or permanent suspension of activities.
2. Some only implement MEPS, but do not use any ERLs. This allows the push impact of an EES&L scheme, but not the pull impact.
3. Some implement both MEPS and ERLs, however they use it for only a handful of equipment types, for instance just lights and fans. Hence, they have barely touched the surface of the energy savings benefits they can receive from such schemes.

Within these 57 countries, there is a population of 1.1 billion inhabitants with the potential to gain tremendously from energy efficiency via expanding MEPS and ERLs implementation, allowing them to achieve sustainable growth of their economy and quality of life, while reducing nationally determined contributions of CO2 emissions.

It should be noted that apart from the 57 countries identified here, all other countries stand to benefit from expanding their MEPS and ERL programs to their maximum potential. Some have implemented such MEPS and ERLs across most major appliance types in the residential sector, however, have not expanded the programs to include commercial, industrial or transport equipment, e.g. cars, trucks, buses, wheels, commercial sized printers, commercial refrigerators, cooking ranges, large sized motors, boilers, spinning machines, cutting machines, etc. Hence, all countries will benefit from regular review of their programs to not only update their MEPS and ERLs criteria and tiers, but also to expand the categories and sectors of equipment types covered.

# 5. ESTIMATED POTENTIAL FOR SAVINGS IF IMPLEMENTED IN THESE COUNTRIES

The United Nations Environment Programme (UNEP), through its United for Efficiency (U4E) initiative, is collecting data on the status of MEPS and ERL programs from 154 emerging and developing economies. They have also made tremendous efforts to devise global Model Regulation Guidelines that establish global harmonized MEPS for lights, ceiling fans, air conditioners, refrigerators (residential and commercial), industrial motors and distribution transformers, which together make up about 50% of any country's electricity consumption.

Using U4E projections for energy savings and extrapolating from 2040 to 2050, as shown in Table 3, we see that implementing MEPS using the Model Regulation Guidelines (the minimum ambition scenario) on just these appliances and equipment (excluding fans) can save over **4%** or **1,297 TWh** of the total BAU electricity use of the Global South in 2050 (estimated at 32,000 TWh according to IEA WEO 2023). In addition, adding MEPS for ceiling fans can add an additional 1%, or about 320 TWh of savings per year.

If ERLs are also implemented for these specific appliances and equipment, promoting significant adoption of high efficiency appliances (the high ambition scenario), the savings increase to **8.76%** of electricity, **2,802 TWh**, per year in 2050. Adding ceiling fans labels increases this to **10.76%** savings, or **3,442 TWh** per year in 2050.

**Table 3**. Overall saving considering minimum and maximum ambitions (U4E cumulative). Source: Adapted from United for Efficiency, "U4E Country Savings Assessments Factsheet." (2024).

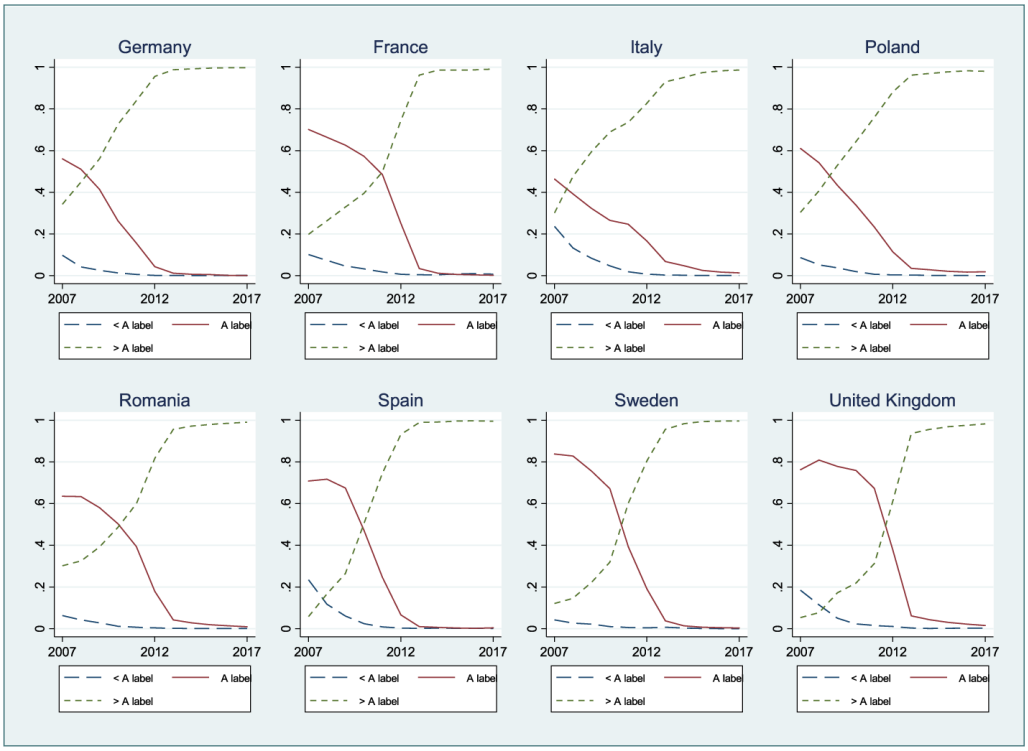
| OVERALL SAVINGS: | Annual | Annual |
|---|---|---|
| **2030 results** | **Minimum Ambition** | **High Ambition** |
| Electricity savings (TWh) | 527.3 | 998 |
| CO2 savings (Million tonnes) | 467.3 | 899.6 |
| Financial savings (Billion US$) | 74.3 | 141.1 |
| Power stations [500MW] | 240.8 | 455.7 |
| % of Global South BAU Electricity Use | 2.64% | 4.99% |
| **2040 results** | **Minimum Ambition** | **High Ambition** |
| Electricity savings (TWh) | 912.6 | 1900 |
| CO2 savings (Million tonnes) | 817.2 | 1700 |
| Financial savings (Billion US$) | 131.3 | 267.6 |
| Power stations [500MW] | 416.7 | 849.2 |
| % of Global South BAU Electricity Use | 3.51% | 7.31% |
| **2050 results** | **Minimum Ambition** | **High Ambition** |
| Electricity savings (TWh) | 1297.9 | 2802 |
| CO2 savings (Million tonnes) | 1167.1 | 2500.4 |
| Financial savings (Billion US$) | 188.3 | 394.1 |
| Power stations [500MW] | 592.6 | 1242.7 |
| % of Global South BAU Electricity Use | 4.06% | 8.76% |

However, it must be noted that these estimates include the impact for countries like Brazil, China, India, and South Africa, which implemented MEPS and ERL programs several years ago, covering a large portion of their appliances. According to the IEA, as shown in Figure 6, China was already experiencing 5% annual savings from these programs in 2018, while India and Brazil experienced 4% savings, and South Africa about 2.5% savings. By 2050, they would be saving at least 15% of their electricity, similar to what the EU and the US are achieving today. The savings estimated by UNEP in the high-ambition scenario do not take these savings into account, as they are considered part of the BAU or current stated policies scenario. If these savings are also considered, the actual electricity savings in 2050 under the high ambition scenario could reach or even exceed **15% (4,800 TWh)** for the entire Global South.

This possibility is illustrated with the adoption rates seen for high efficiency appliances in the EU from 2007 to 2017 in Figure 10.[58] In the case of Spain and the UK, the market share of most efficient refrigeration appliances increased from 0% to over 90% in just five years due to MEPS and ERL programs. However, it could take 5 to 10 years for older, already installed appliances to be retired.

Considering that UNEP projections do not include appliances like washing machines, TVs, cooking stoves, ovens, water pumps, space heaters, dishwashers, computers, printers, photo copiers, data servers, and other residential, commercial and industrial equipment, the total electricity saving in 2050 for the Global South could exceed 20% with the use of MEPS and ERLs. After all, the Japanese Top Runner Program delivered significant energy reductions (up to 85%) across a variety of appliances in just 5 to 10 years.

**Figure 10**. Adoption rate of high efficiency appliances in selected EU countries. Source: Schleich et al., "How Effective Are EU Minimum Energy Performance Standards and Energy Labels for Cold Appliances" (2021).




Best Available Technologies (BAT) currently offer additional energy savings of 19% for fans, 28% for air conditioners, and 33% for lighting, compared to high-efficiency appliances generally found in the highest slab of an ERL program, as shown in Table 4.

**Table 4**. Energy savings from the best available technologies

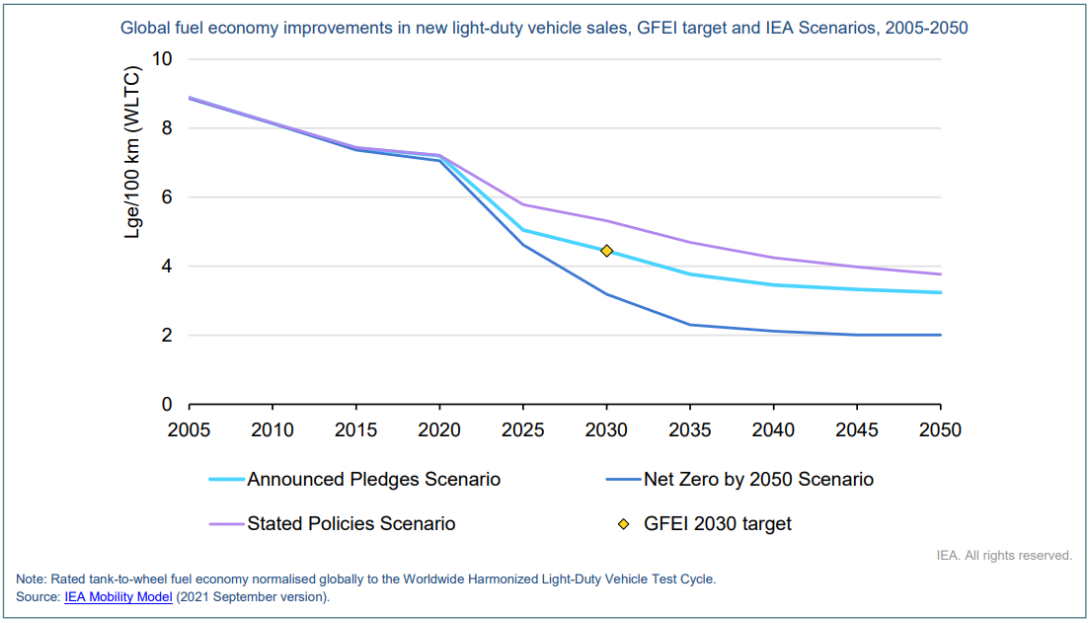
| | Efficiency Indicator | UNEP NRG | UNEP High Efficiency | BAT | BAT Savings |
|---|---|---|---|---|---|
| Light | lm/W | 80 | 140 | 210 | 33% |
| AC (cooling) | SEER (Wh/Wh) | 6.1 | 8 | 11.1 | 28% |
| Ceiling fan (56") | m3/min/W | 4.1 | 11 | 13.66 | 19% |

In fact, the IEA estimates that the BAT air conditioner is three times as efficient as the average air conditioner in use globally, implying that the average AC has a SEER of 3.5 to 4 instead of the Model Regulation Guidelines of 6.1, the higher efficiency SEER 8 or the BAT SEER of 11. This means that if everyone in the world switched to a BAT air conditioner, we could cool three times as much space (and people) using the same amount of electricity. Conversely, the current space cooling could be achieved using 60-70% less electricity.

Taking the same trend to other appliances, a BAT scenario could lead to at least 40-50% electricity savings (12,800 TWh) compared to a BAU scenario, or about 20-30% compared to the High Ambition Scenario. A BAT scenario could look like a more aggressive escalation of MEPS and a significantly higher criteria for the highest efficiency tier, to allow only BAT appliances, or those near BAT in efficiency, to qualify. For instance, in a country using a 5-star system, only BAT appliances and those consuming up to 5% more energy than BAT appliances, would qualify for a 5-star rating, while high efficiency appliances using 5-20% more energy than BAT would fall in the 4-star tier, and so on. Thus, only a handful of appliance models, and maybe only one, would earn a 5-star rating, increasing pressure on others to improve their energy efficiency to earn the right to advertise their 5-star energy savings and performance.

The IEA and the Global Fuel Economy Initiative (GFEI) calculate that fuel economy of cars needs to improve from the current 6.9 L/100km to 2 L/100km by 2040 to reach the IEA's Net Zero Emissions scenario by 2050, as illustrated in Figure 11.[59] For such an ambitious target, EES&L schemes, i.e. vehicle standards and fuel consumption labels, are needed in every country of the world, not in just the existing countries that implement them, to push the innovation necessary to achieve this target. That may be the deciding factor to switch from the Announced Pledges Scenario to the Net Zero Scenario given in the figure below. The difference between the Stated Policies Scenario (94 EJ) and the Net Zero Scenario (47EJ) is 47EJ for road transport energy consumption in 2050 according to World Energy Outlook 2023.

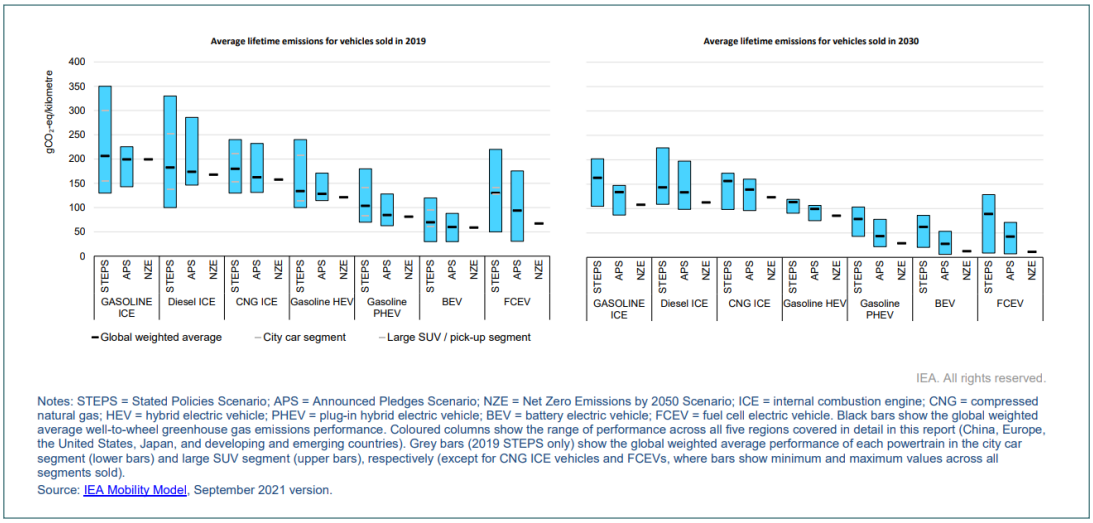
**Figure 11**. Full implementation of the IEA announced Pledge Scenario meets the GFEI 2030 targets for fuel economy of new light-duty vehicles sales. Source: Global Fuel Economy Initiative, "Working Paper 22 - Vehicle Fuel Economy in Major Markets 2005-2019" (2021).




Half of the savings will come from increased electrification of vehicles, as electric vehicles (EVs) are, on average, 75% efficient compared to the 22% efficiency of internal combustion engines (ICEs). As a result, EVs have lower tank-to-wheel energy consumption than ICEs, as shown in Figure 12.  Global Fuel Initiative 2021. The other half of the savings in the NZE scenario can be considered efficiency gains of every vehicle type, whether electric or ICE.

Hence, over 23 EJ of fossil fuel savings for road transport can be attributed to EES&L, or a reduction of 25% from the Stated Policies or BAU scenario. In reality, the contribution of MEPS and ERLs will likely be higher, as many countries use them also to drive the increased electrification of their fleet by using both fuel economy and carbon emissions as metrics.

**Figure 12**. Well-to-wheel greenhouse gas emissions ranges across regions and countries in the States Scenarios and Announces Pledges Scenarios. Source: Global Fuel Economy Initiative, “Working Paper 22 - Vehicle Fuel Economy in Major Markets 2005-2019” (2021).




Notes: STEPS = Stated Policies Scenario; APS = Announced Pledges Scenario; NZE = Net Zero Emissions by 2050 Scenario; ICE = internal combustion engine; CNG = compressed natural gas; HEV = hybrid electric vehicle; PHEV = plug-in hybrid electric vehicle; BEV = battery electric vehicle; FCEV = fuel cell electric vehicle. Black bars show the global weighted average well-to-wheel greenhouse gas emissions performance. Coloured columns show the range of performance across all five regions covered in detail in this report (China, Europe, the United States, Japan, and developing and emerging countries). Grey bars (2019 STEPS only) show the global weighted average performance of each powertrain in the city car segment (lower bars) and large SUV segment (upper bars), respectively (except for CNG ICE vehicles and FCEVs, where bars show minimum and maximum values across all segments sold).

Source: IEA Mobility Model, September 2021 version.

## 6. OPPORTUNITIES AND BENEFITS

In recent years, electricity access in developing countries has seen notable progress. These efforts can see significant acceleration if an approach of energy efficiency is adopted. Energy efficiency allows new consumers to use less energy to gain a higher quality of life, creating a more sustainable energy consumption pattern.

Energy efficiency is delivering the same useful service (light, heat, cooling, transport, etc.) while using the least amount of energy. It can also be defined as the highest amount of useful service one can achieve for a unit of input energy or power. Compact Fluorescent (CFL) bulbs provide 50-70 lumens per watt, while LEDs offer 100-200 lumens per watt. The Philips Dubai LED bulb produces 600 lumens of light using just 3 watts of power, compared to 60 watts of the incandescent and 10 watts for a CFL bulb.

**Table 5**. Standard vs energy efficient energy access solution (demand side)

| | | |
|---|---|---|
| Option 1 | 5 x 10W CFL bulbs, 2 standard 100W 56” ceiling fans | Power need = 250W |
| Option 2 | 5X 3W LED bulbs, 2 BLDC 30W 56” ceiling fans | Power need = 75W |

For a two-room home in a village, you may typically need 3,000 lumens of light and 2 fans providing 350 m3/min of circulation in each room. If the consumer uses standard bulbs and fans, they would need 250 watts of power for their home. However, by using energy-efficient equipment, including new 30-watt Brushless DC (BLDC) motor fans, the power requirement could be reduced to just 75 watts.

In a similar vein, just 10 years ago refrigerators in South Asia consumed 4-10 kWh of electricity per day, while new inverter refrigerators now consume only 1 kWh/day. Twenty years ago, 60” plasma TVs in the US used 1kW of power, while 60” 4K LED TVs now use just 100 watts (or even less in energy-saving mode).

This demonstrates the potential of energy efficiency in accelerating energy access for all by reducing the energy needs of current and future energy users. Hence, it dramatically reduces the need for new power plants and grid upgrades and expansions, as well as the financing required to fund them. It also solves to a large extent the conflicting priorities of reaching Net Zero by 2050 while also increasing energy access and quality of life of the masses.

As illustrated by previous sections in this paper, MEPS and ERLs are extremely important tools in achieving and maximizing energy efficiency gains, and hence to facilitate energy access for all. In addition, MEPS and ERL programs (and the resultant energy efficiency gains) yield a spectrum of co-benefits on the individual, national and international level, as illustrated in Figure 13. On an individual level, they significantly improve health and well-being by reducing indoor and outdoor air pollution through lower energy consumption. They help alleviate poverty by making energy more affordable and accessible, particularly for low-income families, while also empowering consumers to make informed choices. They boost disposable income by cutting energy bills and operational costs for households and businesses, thereby freeing up funds for other essential needs and investments. Overall, these initiatives drive positive socio-economic outcomes, fostering healthier, more equitable, and sustainable communities.[60]

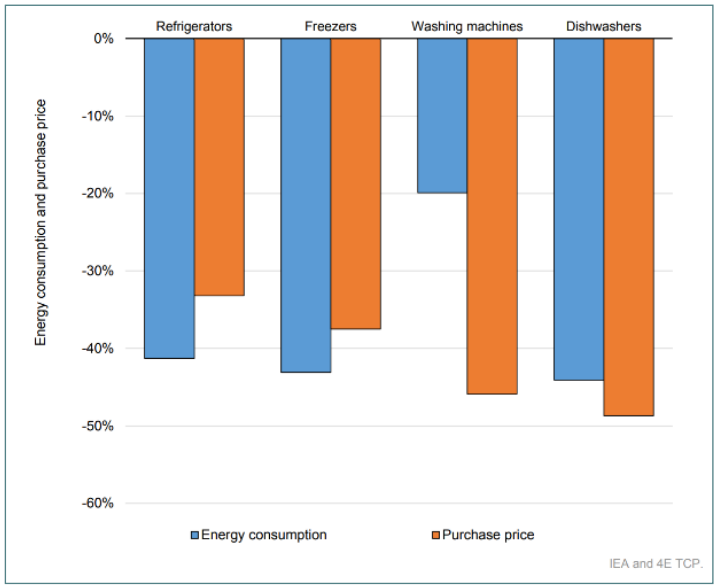
**Figure 13**: Array of Co-benefits Linked to Energy Efficiency and Labeling Programs. Source: Ryan et al. "Spreading the Net: The Multiple Benefits of Energy Efficiency Improvements" (2012).


At the national level, MEPS and ERLs reduce energy-related public expenditures by curbing energy demand and mitigating the need for costly infrastructure investments. They enhance energy security by reducing dependence on imports, thereby safeguarding against supply disruptions. Moreover, the macroeconomic effects are notable, with increased investments in energy efficiency stimulating economic growth, job creation, and competitiveness. On an international scale, such programs moderate energy prices by decreasing global demand and foster stability in energy markets. They promote sustainable natural resource management by reducing resource extraction and environmental degradation.

In addition to the above benefits, the R&D and innovation necessary to increase energy efficiency of appliances, vehicles and machinery has also reduced resource consumption. For instance, water use in washing machines and dishwashers has dramatically declined. Moreover, this innovation has driven appliance prices lower over the years, even though energy efficiency has increased, as shown in Figure 14.[61]

For example, high efficiency air conditioners are available in almost all global markets and do not necessarily represent higher upfront costs. In Thailand, consumers with a budget of USD 350 can choose between a low-efficiency unit of EER 3 and one of double efficiency (EER 6) for the same price. Purchasing the more efficient unit would halve the electricity bill, resulting in savings of up to USD 2,000 over the unit's lifetime. This pattern is evident in market data for most places around the world.[62]

**Figure 14**. Changes in residential appliances process and energy performance in Australia, 1993-2014. Source: International Energy Agency, "Achievements of Energy Efficiency Appliance and Equipment Standards and Labelling Programmes" (2021).




Therefore, the implementation of MEPS and ERL programs also helps prevent the Global South from becoming a market where developed countries offload the appliances, vehicles, and machinery not meeting their own standards. While the perceived higher costs of energy-efficient appliances are sometimes cited by governments as a reason for not implementing MEPS, and by local manufacturers and importers as a basis for opposing MEPS, this argument does not hold true.

## 7. COUNTRY OR REGION-SPECIFIC CHALLENGES, BARRIERS, AND THREATS

Implementing MEPS and ERLs schemes in the Global South could face several challenges:[63]

- Lack of data availability

  The lack of comprehensive data in individual countries, whether developed or underdeveloped, poses a significant obstacle to the implementation of MEPS and ERL programs. Without accurate and up-to-date information about factors such as consumer preferences, purchasing power, existing appliance stock and its energy-efficiency profile, and market dynamics, it becomes challenging to estimate the potential economic and environmental impacts of such programs. To effectively design and implement MEPS and ERL programs, policymakers and stakeholders require data-driven insights to understand the specific needs, challenges, and opportunities within each market. This includes information on the availability and affordability of energy-efficient products, and the level of consumer awareness and education regarding energy efficiency and the regulatory environment.

- Insufficient legal framework and institutional structures

  In many cases, the responsibility for MEPS and ERL programs may be fragmented across different government departments or agencies, each with its own jurisdiction and mandate. While responsible authorities may be defined, effective coordination and strong communication among agencies is essential. Clear legal frameworks and inter-agency cooperation are needed to assign roles, enforce regulations, and strengthen the compliance regime to ensure program success.

- Lack of proper implementation

  Reaching the full potential of MEPS and ERL programs can be constrained without proper implementation. Setting up the regulation and creating the institutional framework, however, not implementing those decisions, or following up on adoption in marketplace, has also stalled progress in many countries. For instance, in Pakistan, MEPS were developed for motors and air conditioners in 2014 and 2015, as well as for ceiling fans, however, the MEPS were never rolled out or enforced. Ceiling fan ERLs were introduced, but the tiers have barely been updated, even after a decade. Meanwhile new ceiling fans use significantly less electricity due to the adoption of BLDC motor technology. Hence, most of the public is unaware of MEPS and ERLs inside the country.

- Absence of energy efficiency standards harmonization at regional levels

  The absence of harmonized energy efficiency standards at the regional levels hampers trade and creates market fragmentation. Inconsistent standards increase compliance costs for manufacturers and confuse consumers. Harmonization streamlines trade, promotes adoption of energy-efficient technologies, and fosters regional cooperation on environmental goals. Achieving this requires collaboration among governments, regulatory bodies, industry stakeholders, and international organizations to align standards and certification processes.

- Low/subsidized energy tariffs

  Low or subsidized energy tariffs undermine the cost-effectiveness of energy efficiency programs. When energy prices are artificially low, there is less incentive for consumers to invest in energy-efficient technologies or behaviors because the potential savings are lower. Energy prices must align with their true costs by phasing out subsidies and implementing progressive pricing structures (such as consumers using up to 200 kWh could pay 10 c/kWh, but those using 201-300 kWh pay 12 c/kWh, and 15 c/kWh for using 301-400 kWh per month) to provide cross-subsidization (richer or energy wasteful consumers end up subsidizing poorer or energy conscious consumers), and promoting energy conservation through public awareness campaigns and incentives for efficiency upgrades.

- Low literacy rates

  Many developing countries grapple with low literacy rates. Designing MEPS and ERL programs that allow their less literate citizens to also make energy-efficient purchases could be a challenge. The use of color to denote efficiency, such as the dark green to red scale seen in the EU's A to G labels, as well as the use of symbols like stars, ticks and sliding scale could prove useful. In parallel, all countries, but especially the ones with low literacy rates, would significantly benefit from nationwide campaigns using television and social media advertisements to raise awareness of its citizens about the introduction of ERLs and MEPS, and what stickers to look for on the appliances at the time of purchase, as well as how to interpret the labels they see. At the same time, authorities should ensure that the labels are prominently displayed on the front of the appliances in retail stores, as well as on the cartons and packaging of the appliances.

- Absence of testing infrastructure at national and regional levels

  The absence of testing infrastructure at national and regional levels hinders the implementation of energy efficiency standards. Without adequate facilities, verifying appliance energy performance and ensuring compliance becomes challenging. To address this, investment in testing laboratories and certification bodies is essential, alongside capacity-building initiatives. Resources can also be pooled across neighboring countries or on a regional level to reduce investment required, or testing facilities from neighboring regions could be used.

- Absence of a revision schedule

  Some MEPS and ERL programs fail to incorporate evaluation planning into program design. Hence, evaluations may not be conducted regularly to identify when standards or ERL tiers become outdated. This lack of timely assessment hampers the effectiveness of energy efficiency initiatives, highlighting the need for integrating evaluation frameworks from the early stages of program development and implementing periodic assessments to ensure MEPS and ERLs remain relevant and impactful. A revision schedule is also essential to ensure more appliance and equipment types get included over time.

- Limited market monitoring and sampling due to personnel and funding constraints

  Without adequate human and financial resources, regulatory agencies struggle to conduct regular monitoring and sampling of the market to ensure compliance with MEPS. This lack of oversight can lead to the proliferation of non-compliant products, undermining the effectiveness of energy efficiency initiatives and consumer confidence. Hence, adequate investment is needed in manpower and funding to strengthen market surveillance efforts and uphold the integrity of energy efficiency regulations.

- Impact of corruption on energy efficiency implementation in developing countries

  In developing countries, particularly in the African and Asian regions, high levels of corruption pose significant challenges to the effective implementation of MEPS and ERL programs. Corruption compromises environmental and energy regulations and policies, making it difficult to enforce standards strictly. In certain African countries, despite the existence of MEPS and ERLs, the market continues to be flooded with sub-standard appliances because of corruption.[64] Consequently, consumers are exposed to appliances that fail quality and safety standards, posing risks to their well-being and the environment. Tackling corruption is crucial for ensuring compliance with regulations, safeguarding consumer interests, and promoting a marketplace that prioritizes high-quality, energy-efficient appliances.

# 8. WAY FORWARD FOR IMPLEMENTATION

Developing and emerging economies that have not yet set up MEPS and ERL programs now have a wealth of resources and collaborations to draw upon.

## 8.1. United Nations Environment Programme's United for Efficiency Initiative

The United Nations Environment Programme's United for Efficiency (UNEP-U4E) is a global initiative aiding developing and emerging economies in transitioning their markets to energy-efficient appliances and equipment through a holistic and integrated policy approach. U4E's role as a neutral convener and its extensive experience in developing and supporting implementation of regional MEPS harmonization programs and national market transformation projects in over 40 countries make it uniquely positioned to drive the adoption of climate-friendly, sustainable and energy efficient products.

U4E offers a comprehensive suite of tools and resources, developed and endorsed by leading technical international organizations and manufacturers, to assist policymakers in quantifying economic opportunities and guiding market transformation towards climate-friendly, higher-performance energy-efficient appliances and equipment. These resources include Global Model Regulations Guidelines along with complementary market assessments and guides on labelling, compliance and performing market assessments, which specify and streamline the MEPS implementation and enforcement for room air conditioners, residential refrigeration (on and off-grid), commercial refrigeration, ceiling fans, lighting products, industrial motors and distribution transformers. These Model Regulation Guidelines will soon also include heat pumps, data centers, and other equipment in due course. These are also complemented with Model Public Procurement Specifications and Financing Guidelines.

The Model Regulation Guidelines allow governments to have the first draft of their regulation ready for these appliances and equipment. The guidelines cover energy efficiency and functional performance requirements for each product type, product information reporting and labelling, testing conditions and methods for checking those requirements, demonstrating compliance, as well as market surveillance and enforcement. U4E has used global best practices to define fairly competitive, yet realistic, MEPS for these appliance categories that could be implemented in any country to rid the market of the most inefficient appliances on the shelves.

Any government should ideally coordinate with UNEP and U4E for help in establishing these regulations, as they may need help in modifying these guidelines for their country conditions. According to UNEP, "Each country has unique characteristics. This guidance is intended as a starting point to inform policies and programmes rather than as a final template to adopt. Market transformation interventions should be undertaken transparently and with sufficient time to address local circumstances (e.g., availability and prices of products, income levels, utility tariffs, etc.). Such processes are typically led by an energy ministry with the support of a national standards body and conducted in consultation with many experts from the public and private sectors, and civil society."[65]

In parallel, UNEP-U4E has also developed a secure open-source prototype version of a Product Registration System (PRS) which serves as an effective monitoring, verification and enforcement tool for countries while strengthening their compliance regime. Furthermore, PRS databases can help in setting up new or revised MEPS and ERL programs based on factual data. The PRS can work on slow connections and integrates an applicant portal (manufacturers), a regulator portal, and an administrator portal.

In addition, UNEP-U4E's Country Savings Assessments provide quantified potential financial, environmental, energy, and societal benefits for 156 developing and emerging economies that are possible with a transition to energy-efficient lighting, refrigerators, room air conditioners, electric motors and distribution transformers.

## 8.2. Global Fuel Economy Initiative

The Global Fuel Economy Initiative (GFEI) is a collaboration of UNEP, the FIA Foundation, the IEA, the International Council on Clean Transportation (ICCT), the International Transport Forum (ITF) and the University of California, Davis, Institute of Transportation Studies. GFEI aims to accelerate and enable rapid transition to efficient, zero-emission vehicles through their research, global advocacy and capacity-building. It focuses on all vehicle types, including EVs, ICE, fuel-cell based, etc. GFEI has helped about 70 countries develop their fuel economy policies, and well as many others on their electrification policies for their transport sector.

GFEI also releases regular publications, following the trends of vehicle fuel economy and new associated technology breakthroughs and potential pathways to reach Net Zero Emissions by 2050.

## 8.3. World Forum for Harmonization of Vehicle Regulations

The World Forum for Harmonization of Vehicle Regulations (WP.29) is a global regulatory forum within the institutional framework of the UNECE Inland Transport Committee set up for the global harmonization of vehicle regulations. "The regulatory framework developed by the World Forum WP.29 allows the market introduction of innovative vehicle technologies, while continuously improving global vehicle safety. The framework enables decreasing environmental pollution and energy consumption, as well as the improvement of anti-theft capabilities."[66]

"WP.29 is a global forum allowing open discussions on motor vehicle regulations. Any member country of the United Nations and any regional economic integration organization, set up by country members of the United Nations, may participate fully in the activities of the World Forum and may become a contracting party to the Agreements on vehicles administered by the World Forum. Governmental and non-governmental organizations (NGOs) may also participate in a consultative capacity in WP.29 or in its subsidiary working groups."[67]

WP.29 was also responsible for introducing the Worldwide Harmonized Light-Duty Vehicle Test Cycle as a replacement for vehicle test procedures around the world. The WLTP is quickly being adopted by car manufacturers and governments around the world to be a better reflection of real-world driving conditions, allowing car manufacturers to more accurately prove fuel economy for their cars, and for consumers to have more accurate information for their purchasing decisions.

## 8.4. International Electrotechnical Commission (IEC)

The IEC (International Electrotechnical Commission) was founded in 1906, when the introduction of electricity in society was unorganized and scattered, with many different voltages, frequencies, connectors, fuses, cabling, etc. being used across the world, and even within the same city. The IEC was formed as a consortium of countries for the preparation and publication of international standards for all electrical, electronic and related technologies, as well as the conformity assessment systems to test and certify equipment and technologies for meeting those standards.

Today, the IEC brings together almost 170 countries to ensure that products work safely with each other everywhere in the world. "The IEC mission is to achieve worldwide use of IEC International Standards and Conformity Assessment Systems to ensure the safety, efficiency, reliability and interoperability of electrical, electronic and information technologies, to enhance international trade, facilitate broad electricity access and enable a more sustainable world. IEC International Standards reflect the global consensus and distilled wisdom of many thousand technical experts who are delegated by their countries to participate in the IEC."[68]

"They provide instructions, guidelines, rules or definitions that are then used to design, manufacture, install, test & certify, maintain and repair electrical and electronic devices and systems. IEC International Standards are essential for quality and risk management; they help researchers understand the value of innovation and allow manufacturers to produce products of consistent quality and performance."[69]

"IEC International standards are also often adopted by countries or regions to become national or regional standards. For example, close to 80% of European electrical and electronic standards are in fact IEC International Standards.

"Regulations are rules or directives that are made and maintained by a national or regional authority. It is quite common for technical regulations to refer to international standards because standards help avoid that the law becomes too detailed or descriptive. This approach allows laws to stay current because standards are regularly reviewed and updated."[70]

For a country establishing MEPS or ERL programs, it will be essential to also establish a National Standards Organization, if it does not already exist. This Standards organization will be in charge not only of establishing quality, performance (including energy), safety and interoperability requirements for all equipment (appliances, electronic equipment, machinery, vehicles, etc.), but also in setting up laboratories that would test and certify that performance. Its scope will be broad across all sectors, not just for energy efficiency. However, the existence of such an organization is essential in supporting the National Energy Efficiency organization to establish MEPS and ERL in their country, and to test and certify appliances, equipment and vehicles as having met those standards, or tier levels for ERLs.

By joining the IEC, the country will get immediate guidance in the best practices of setting up the National Standards Organization. The IEC full members and associate members get the right to send experts to join any existing technical committee and be part of the team that debates and develops the standards within that technical committee. The IEC currently has 228 technical committees and sub-committees, working on developing and updating standards on all possible equipment types and their included components, e.g. rotating machinery, appliances for air conditioning, internet of things, cables, sockets, fuses, solar PV cells, lighting, power transformers, etc.). Such exposure is priceless for training experts and professionals who will become instrumental in taking the National Standards Organization forward.[71]

"The IEC also runs the Affiliate Country Programme, which allows developing or newly industrializing countries to participate in IEC work without the financial burden of membership."[72]

For its energy efficiency specific work, The IEC Advisory Committee on Energy Efficiency (ACEE) has developed Guide 118 which enables technical committees to harmonize energy efficiency standardization and adopt a systems approach.

To aid implementation, there are other services like the Electrical Energy Efficiency (E3) programme by the IECEE which supports industry efforts to develop energy efficient products. The IECEE E3 programme is a third-party conformity assessment service and implies the granting of a Statement of Test Results (STR), helping provide proof of compliance and build trust in the market. It is compatible with energy rating or labelling (including MEPS), and other standby power reduction programmes because the E3 STR and associated Test Report may be used as a basis for assessing product energy efficiency.

The IEC has also putted concentrated effort in developing a rating system for electric motors, which is now the basis of most motor related MEPS across the world. IE1 are standard efficiency motors, while IE2, IE3 and IE4 are called high efficiency, premium efficiency and super premium efficiency motors, respectively. The EU is the first region to have mandated IE4 levels for the MEPS of large sized motors.[73]

## 8.5. International Energy Agency (IEA)

The IEA collects extremely detailed data from most countries across the globe on all topics related to energy, including energy efficiency. This allows them to publish annually updated global data, such as the World Energy Outlook 2023, Energy Efficiency 2023, World Energy Investment 2023, Oil Market Report, Gas Market Report, as well as more specific topic or country-specific reports.

But in addition to these energy data and trends reports, the IEA has a comprehensive energy policy repository that includes energy policies for almost every country on the planet. Emerging Markets and Developing Economies (EMDE) countries looking to bring in energy efficiency regulations, MEPS and ERL programs can use this database to identify policies that match most closely their country dynamics and conditions and use these policies as first drafts. This may also help identify countries that they would like to collaborate with in setting up their EES&L systems.

## 8.6. Further Comments

Contrary to expectations, MEPS and ERL programs are not very costly for a country's government. Manufacturers have the primary responsibility for testing and affixing the labels, and therefore, bear the majority of the financial burden, not the government. The National MEPS and ERL authority or regulator monitors the labeling process by auditing the labels affixed to appliances by the Original Equipment Manufacturers (OEMs). The National authority picks up appliances randomly from the marketplace for testing and verification of results quoted on label. The sampling rate could be set initially to 10% and reduced over time to just 1% once the program is well-established. The threat of this audit and its consequences are enough to ensure most manufacturers stay honest in their reporting and labelling.

The testing and labelling schemes, along with the associated standards, can be developed through the National Quality and Standards organization, which can also approve various private sector testing facilities to carry out the testing and labelling process. So, hence, most of the financial expenditure and earnings would be within the private sector, rather than with government authorities. This also reduces the opportunities for corruption, as government authorities would primarily fulfill a regulatory oversight role.

**Summary of key steps:**

a. Countries can leverage global resources, such as UNEP/U4E, IEC, GFEI and WP.29 to set up MEPS and testing laboratories for appliances, equipment and vehicles, as well as associated regulation, in the country. Where available, they can alternately use testing facilities in neighboring countries. Refer to the IEA policy database for further guidance on regulations.

b. After MEPS have been implemented, introduce ERL programs. UNEP-U4E has a comprehensive guide for setting up an ERL program. Collaboration with neighboring countries that have existing ERL programs can provide useful frameworks to build upon.

c. Ensure ERL labels display the annual energy bill for the appliance, equipment or vehicle. Including the annual energy costs on labels has a bigger impact on consumers' willingness to pay for higher-efficiency appliances than just displaying energy or efficiency metrics.[74]

d. Regularly update MEPS and ERLs efficiency tiers to follow global technological advancements closely and reap maximum energy savings benefits. Continue expanding the range of appliances, equipment, and vehicle types covered by MEPS and ERL programs.

e. Ensure robust testing, certifying, and monitoring systems to ensure that consumers can trust the information provided on the labels. Moreover, implement evaluation and survey systems to track and report on the impact of MEPS and ERL programs.

## 9. SUGGESTED PILOT PROJECTS, INITIATIVES, AND REGIONAL COLLABORATION

The simplest way to implement MEPS and ERL programs would be to use the nearest neighboring country with such programs. This allows access to schemes that are already similar in climate and cultural context. Often, global appliance manufacturers tend to build appliances according to certain climate and regional classes, which means the same appliances are being sold between two neighboring countries. At the same time, with similar climates and cultural context, the calculated annual energy consumption numbers for neighboring countries would also be nearly the same for the base use scenario.

Such a collaboration between two neighboring countries can be complicated in cases where diplomatic relations are tense between two neighbors. For instance, it could be practical to build upon the work of the Bureau of Energy Efficiency in India to expand and set up a central MEPS and ERL program for the South Asian Alliance for Regional Cooperation (SAARC) region, including Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka. The SAARC region covers about 21% of the global population.

UNEP-U4E, in collaboration with its technical and regional partners, supported in developing the regional policy roadmaps for harmonizing the energy performance standards for lighting and air conditioners in South-east Asia. In addition, for ACs, technical recommendations for updating the ASEAN (Association of Southeast Asian Nations) regional policy roadmap were provided which included implementing a phase-step approach in updating ASEAN Regional MEPS. Step 1 sets an aspirational target of 20% more stringent MEPS (ISO CSPF of 3.7) by 2023 from the current level of 3.08. Step 2 introduces a more stringent MEPS of ISO CSPF of 6.09 by 2025. Currently, UNEP-U4E under the ASEAN Cool Initiative aims to accelerate the implementation of the ASEAN regional policy roadmap by providing technical assistance and capacity building on MEPS and labels in the region, facilitating a swift transition to more ambitious Regional Phase II recommended levels. UNEP-U4E is also leading AC MEPS implementation efforts in Singapore and Malaysia and coordinating with similar activities in the Philippines and Vietnam. Successful implementation of regional MEPS could save 268 TWh of electricity reduce 209 Mt $CO_2$e by 2040 and yield USD 32 billion in consumer savings.

UNEP-U4E has successfully developed regionally harmonized MEPS and labels for room air conditioners and residential refrigerators for the Southern African Development Community (SADC), which comprises 16 member states. U4E closely collaborated with SADC Centre for Renewable Energy and Energy Efficiency (SACREEE) in policy development and holding bilateral consultations with all the member states. The policies passed the final voting and administrative stage in November 2023 for commencing national implementation starting from February 2024. UNEP-U4E is currently supporting Botswana, Eswatini, South Africa and Zimbabwe in implementing MEPS at national level by providing necessary capacity building, awareness raising and technical support. Key documents produced are a regional market assessment, technical notes on air conditioners and refrigerators, and the MEPS regulation.

Just as the EU created region wide MEPS and ERLs for its member countries, the African Union (AU) could also take on the mission of introducing competitive MEPS and ERLs across the continent. It has already commissioned the African Continental Power System Masterplan with the objective of creating a single grid for the entire continent, as well the African Single Electricity Market. So, a continental wide AU MEPS and ERL program could be an achievable goal to help accelerate energy access across the continent, while significantly cutting the cost of that energy access by rationalizing the energy needs of consumers through energy efficiency.

In the Latin American region there are three interconnection systems known as Central America (made up of Costa Rica, El Salvador, Guatemala, Honduras, Nicaragua, and Panama), Andean (connecting Bolivia, Colombia, Ecuador, Peru, and Venezuela) and Southern Cone (covers countries such as Argentina, Brazil, Chile, Paraguay and Uruguay). These three groups of countries already have spaces for exchange and cooperation where they discuss regulatory and normative aspects related to the respective systems. These same spaces could be used to work on common labeling schemes and improve MEPS and their periodic review.

Many of the countries in the region have MEPS and ERLs, which were developed internally by each country. The development of these same instruments but on a regional basis could accelerate the penetration of BAT, increase trade between countries and have a larger and more robust monitoring and control infrastructure. The Latin American Energy Organization (OLADE) is an intergovernmental public body of cooperation, coordination and technical advisory, with the fundamental objective of promoting the integration, conservation, rational use, commercialization and defense of the region's energy resources. Currently, this organization is working on a roadmap for the implementation of energy intensity and efficiency indicators in order to define Regional Energy Efficiency Goals. And it is identified as a good space to promote this initiative.

The Pan American Commission on Technical Standards (COPANT) is a non-profit civil association that brings together the National Standards Organizations (NSOs) of the American continent. It currently has 32 active members and 10 adhering members (among which countries of the European Union stand out). COPANT promotes the strengthening of its members, through the transmission and exchange of experiences and knowledge in standardization and other related topics. It promotes the development of the NSOs of the region and supports the achievement of the UN Sustainable Development Goals through cooperation and collaboration in activities such as the promotion of international and regional standardization, and the use of international practices, among other activities.

To promote regional standards, in addition to technical consensus, political agreements are also needed. Therefore, regional collaboration in Latin America through the above institutions could be the key to moving towards regional energy efficiency labelling. For example, while OLADE works on political agreements and general consensus, organizations, such as COPANT, CIER (Regional Energy Integration Commission) and SIEPAC (Central American Electric Interconnection), among other technical spaces, could work on the technical development of regional energy efficiency labels.

Several Central Asian countries are also present in the list of countries identified in Section 4. Because of their historical and cultural ties to China, Russia, and Turkey, it may be pragmatic to align with the MEPS and ERL of either of those countries, whether individually or as the central Asian bloc, just as many European countries have aligned with EU labels, even though they do not belong to the EU.

## 9.1. Parting Thoughts

In Section 4, a gap was identified on how to assess what type of policies, measures, subsidies, restrictions, and other corresponding actions a government (local or national) or development/aid agency should promote in a country to fully leverage the potential of MEPS and ERLs. A potential bridge could be to cross-reference and rate relevant and quantifiable enablers or hinderers for the implementation of MEPS and ERLs, such as:

- Real access to electricity vs. level of electrification;
- Electricity prices for end-users;
- Level of economic and technological development, size of the country, population, and the availability of human resources with necessary level of technical skills vs. the potential to locally manufacture energy-efficient appliances and its cost-effectiveness or profitability;
- Liberalized market access to a variety of energy-efficient appliances from diverse manufacturers, whether produced domestically or imported;
- Literacy rates, including the share of the population with secondary and tertiary education;
- Purchasing power parity vs, the share of the population that can afford to purchase new energy-efficient appliances compared to secondhand inefficient ones;
- Perceived vs. actual levels of corruption;
- Level of implementation of endorsed energy efficiency policies nationwide;
- Risk of endorsing national or regional protectionism for the profits of oligarchs, rather than benefiting national interests;
- Other relevant aspects or attributes.

A more precise definition of such an aggregated metric, encompassing the above multifaceted framework, can be developed in a more thorough and comprehensive project-based study that shall build upon the existing approaches implemented in the RISE, UNEP, IEA, World Bank, and other similar extensive databases.

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**Annex A**: Countries with no to low implementation of either MEPS and/or ERL schemes (data source: Worldometer website, RISE, World Bank Group)

| Region | Country (or Dependency) | Population (2023)[75] | Access to Electricity % of Population (2022)[76] | Real GDP (PPP)[77] | GDP Per Capita[78] | MEPS | ERL Standards | MEPS_ERL Combined (MEPS+ERL)/2S[79] |
|---|---|---|---|---|---|---|---|---|
| Asia | Azerbaijan | 10,412,651 | 100 | $153,083,000,000 | $23,685 | 0 | 0 | 0 |
| Asia | Laos | 7,633,779 | 100 | $59,842,000,000 | $9,326 | 0 | 0 | 0 |
| Asia | Maldives | 521,021 | 100 | $11,142,000,000 | $24,808 | 0 | 0 | 0 |
| Asia | Mongolia | 3,447,157 | 100 | $41,029,000,000 | $18,108 | 0 | 0 | 0 |
| Asia | Turkmenistan | 6,516,100 | 100 | $94,790,000,000 | $17,100 | 0 | 0 | 0 |
| Latin America & the Caribbean | Guatemala | 18,092,026 | 99.1 | $159,034,000,000 | $14,066 | 0 | 0 | 0 |
| Asia | Cambodia | 16,944,826 | 92.3 | $76,023,000,000 | $5,624 | 0 | 0 | 0 |
| Asia | Yemen | 34,449,825 | 76 | $73,630,000,000 | $3,437 | 0 | 0 | 0 |
| Africa | Cameroon | 28,647,293 | 71 | $103,941,000,000 | $5,380 | 0 | 0 | 0 |
| Africa | Sudan | 48,109,006 | 63.2 | $167,369,000,000 | $3,137 | 0 | 0 | 0 |
| Africa | Eritrea | 3,748,901 | 55.4 | $9,702,000,000 | $1,628 | 0 | 0 | 0 |
| Africa | Mali | 23,293,698 | 53 | $48,184,000,000 | $2,726 | 0 | 0 | 0 |
| Africa | Congo | 6,106,869 | 50.6 | $21,913,000,000 | $6,932 | 0 | 0 | 0 |
| Africa | Mauritania | 4,862,989 | 49 | $25,245,000,000 | $6,934 | 0 | 0 | 0 |
| Africa | Somalia | 18,143,378 | 48.9 | $25,491,000,000 | $1,611 | 0 | 0 | 0 |
| Africa | Angola | 36,684,202 | 48.5 | $210,193,000,000 | $8,040 | 0 | 0 | 0 |
| Africa | Madagascar | 30,325,732 | 36.1 | $44,491,000,000 | $1,875 | 0 | 0 | 0 |
| Africa | Mozambique | 33,897,354 | 33.2 | $41,237,000,000 | $1,657 | 0 | 0 | 0 |
| Africa | Liberia | 5,418,377 | 31.8 | $7,747,000,000 | $1,819 | 0 | 0 | 0 |
| Africa | DR Congo | 102,262,808 | 21.5 | $112,144,000,000 | $1,670 | 0 | 0 | 0 |
| Oceania | Papua New Guinea | 10,329,931 | 19 | $38,065,000,000 | $4,607 | 0 | 0 | 0 |
| Africa | Central African Republic | 5,742,315 | 15.7 | $4,597,000,000 | $1,130 | 0 | 0 | 0 |
| Africa | Burundi | 13,238,559 | 10.3 | $9,128,000,000 | $950 | 0 | 0 | 0 |
| Africa | South Sudan | 11,088,796 | 8.4 | $20,010,000,000 | $1,145 | 0 | 0 | 0 |
| Asia | Afghanistan | 42,239,854 | 85.3 | $60,802,000,000 | $2,092 | 3 | 0 | 1 |
| Latin America & the Caribbean | Haiti | 11,724,763 | 49.3 | $32,428,000,000 | $3,255 | 1 | 0 | 1 |

| Region | Country (or Dependency) | Population (2023)[75] | Access to Electricity % of Population (2022)[76] | Real GDP (PPP)[77] | GDP Per Capita[78] | MEPS | ERL Standards | MEPS_ERL Combined (MEPS+ERL)/2S[79] |
|---|---|---|---|---|---|---|---|---|
| Africa | Malawi | 20,931,751 | 14 | $29,932,000,000 | $1,867 | 7 | 0 | 3 |
| Africa | Tanzania | 67,438,106 | 45.8 | $166,597,000,000 | $3,972 | 8 | 0 | 4 |
| Asia | Georgia | 3,728,282 | 100 | $63,403,000,000 | $24,681 | 13 | 0 | 6 |
| Africa | Lebanon | 5,353,930 | 100 | $72,631,000,000 | $12,852 | 13 | 0 | 6 |
| Africa | Ethiopia | 126,527,060 | 55 | $293,788,000,000 | $3,109 | 18 | 0 | 9 |
| Latin America & the Caribbean | Honduras | 10,593,798 | 94.4 | $59,562,000,000 | $7,210 | 17 | 8 | 13 |
| Asia | Myanmar (Burma) | 54,577,997 | 73.7 | $62,260,000,000 | $5,905 | 13 | 13 | 13 |
| Asia | West Bank and Gaza (State of Palestine) | 5,371,230 | 100 | $18,600,000,000 | $5,888 | 8 | 21 | 15 |
| Africa | Sierra Leone | 8,791,092 | 29.4 | $14,068,000,000 | $1,846 | 0 | 33 | 17 |
| Africa | Zimbabwe | 16,665,409 | 50 | $36,035,000,000 | $3,899 | 26 | 13 | 19 |
| Asia | Oman | 4,644,384 | 100 | $161,712,000,000 | $44,421 | 19 | 21 | 20 |
| Asia | Armenia | 2,777,970 | 100 | $44,646,000,000 | $23,054 | 0 | 42 | 21 |
| Asia | Tajikistan | 10,143,543 | 100 | $41,177,000,000 | $5,082 | 43 | 0 | 22 |
| Asia | Kazakhstan | 19,606,633 | 100 | $512,002,000,000 | $39,332 | 44 | 0 | 22 |
| Asia | Pakistan | 240,485,658 | 95 | $1,268,000,000,000 | $6,212 | 32 | 13 | 22 |
| Asia | Bahrain | 1,485,509 | 100 | $76,342,000,000 | $63,847 | 29 | 17 | 23 |
| Africa | Uganda | 48,582,334 | 47.1 | $107,733,000,000 | $3,098 | 36 | 13 | 24 |
| Asia | Kuwait | 4,310,108 | 100 | $210,884,000,000 | $56,386 | 38 | 13 | 25 |
| Asia | Nepal | 30,896,590 | 91.3 | $122,242,000,000 | $5,181 | 50 | 0 | 25 |
| Latin America & the Caribbean | Dominizan Republic | 11,332,972 | 98.1 | $217,143,000,000 | $25,610 | 26 | 25 | 26 |
| Africa | Zambia | 20,569,737 | 47.8 | $67,377,000,000 | $4,125 | 51 | 0 | 26 |
| Latin America & the Caribbean | Venezuela | 28,838,499 | 100 | $269,068,000,000 | $17,402 | 19 | 38 | 28 |
| Oceania | Vanuatu | 334,506 | 70 | $910,266,000 | $3,315 | 31 | 25 | 28 |
| Africa | Benin | 13,712,828 | 56.5 | $45,869,000,000 | $4,248 | 31 | 25 | 28 |

| Region | Country (or Dependency) | Population (2023)[75] | Access to Electricity % of Population (2022)[76] | Real GDP (PPP)[77] | GDP Per Capita[78] | MEPS | ERL Standards | MEPS_ERL Combined (MEPS+ERL)/2S[79] |
|---|---|---|---|---|---|---|---|---|
| Latin America & the Caribbean | Paraguay | 6,861,524 | 100 | $41,720,000,000 | $6,153 | 31 | 29 | 30 |
| Asia | Kyrgyzstan | 6,861,524 | 99.7 | $11,540,000,000 | $7,102 | 35 | 25 | 30 |
| Latin America & the Caribbean | Bolivia | 12,388,571 | 99.9 | $100,778,000,000 | $10,727 | 36 | 25 | 31 |
| Oceania | Solomon Islands | 740,424 | 76 | $1,628,000,000 | $3,034 | 29 | 33 | 31 |
| Asia | Indonesia | 277,534,122 | 100 | $3,419,000,000,000 | $15,612 | 32 | 38 | 35 |
| Latin America & the Caribbean | Jamaica | 2,825,544 | 100 | $28,579,000,000 | $11,475 | 28 | 42 | 35 |
| Africa | Burkina Faso | 23,251,485 | 19.5 | $48,949,000,000 | $2,726 | 44 | 25 | 35 |

Color legend and population shares per listed categories.

| Countries with combined MEPS+ERL indicator | Population (2023) | Percentage from total world population |
|---|---|---|
| (MEPS+ERL=0) | 479,918,880 | 5.97% |
| (0<MEPS+ERL<=25) | 736,876,001 | 9.16% |
| (25<MEPS+ERL<=35) | 405,125,559 | 5.04% |
| (MEPS+ERL<=35) | 1,621,920,440 | 20.16% |
| MEPS+ERL<=35) | 8,045,311,447 | |


**CEET SUBJECT MATTER EXPERT**

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