

04

Taking Proven Solutions to Scale



Building with ACs stretching up toward sky. Credit: Shutterstock

The solutions needed to accelerate the adoption of efficient appliances critical to reducing emissions, expanding access, and enhancing adaptive capacity are proven, scalable, cost-effective, and widely used.

Energy efficiency policies can halve the energy consumption of major appliances, including refrigerators, televisions, and washing machines,¹³³ and decrease appliance prices over time.¹³⁴ Complementary efforts

in research and development (R&D) funding, financing and financial incentives, bulk procurement requirements, awards, and informational tools have been critical to driving market uptake of efficient appliances. These solutions target the market at different stages of development and work collectively to transition it into a new paradigm centered around net zero-ready appliances (Table 8).

TABLE 8. SUMMARY OF APPLIANCE EFFICIENCY POLICIES & MARKET DEVELOPMENT PROGRAMS

TYPE OF POLICY OR PROGRAM	EXAMPLES
Market Clearing	MEPS limit the maximum amount of energy an appliance can consume, clearing out the most inefficient products in a specific market.
Market Growth	Appliance labeling programs, incentives, bulk procurement requirements, and awareness raising efforts work to lower economic, market, and information barriers to drive the sale of efficient appliances, which in turn help create economies of scale to improve overall appliance efficiency.
Market Innovation	R&D funding, awards and competitions, and endorsement labels help drive innovation and increase the availability of high-efficiency appliances on the market.

Appliance efficiency policies like standards and labeling are proven, scalable, and cost-effective with benefits outweighing costs at a ratio of four to one.

Appliance efficiency policies like standards and labeling are proven, scalable, and cost-effective with benefits outweighing costs at a ratio of four to one.

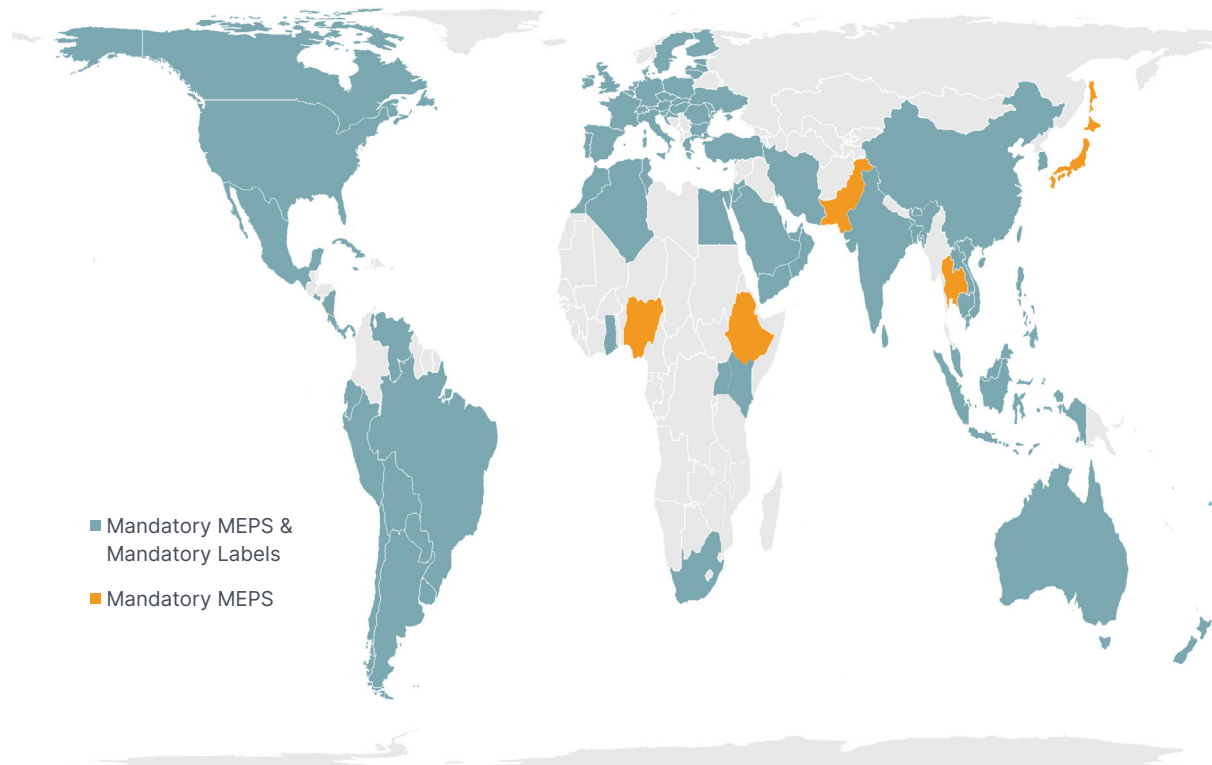
In this section, we introduce the major types of policies and programs that have been used to improve the energy efficiency and quality of appliances throughout the world. We also provide examples and case studies of those solutions and highlight valuable takeaways that governments, development institutions, donors, and others can use to replicate the interventions in other contexts.

4.1 Policies

Appliance energy efficiency policies are one of the most cost-effective solutions to reduce emissions and should be a cornerstone in any climate mitigation strategy. There are 86 countries with mandatory MEPS and labels for appliances (Figure 18),¹³⁵ while over 120

countries employ appliance standards and labeling programs in some capacity.¹³⁶ Data from the CLASP Policy Resource Center^{xliv} shows that there are more than 1,500 policies worldwide covering 13 broad product categories.

FIGURE 18. MANDATORY MEPS & LABELING REQUIREMENTS FOR APPLIANCES¹³⁷



xliv. The CLASP Policy Resource Center features a dynamic [Appliance & Equipment Policy Tracker](#) that shows at a glance the broad variety of product types that are addressed by appliance efficiency policies.

Longstanding appliance energy efficiency programs with the largest product coverage have cut total electricity consumption by roughly 15%, with most of the reductions in the residential sector.¹³⁸

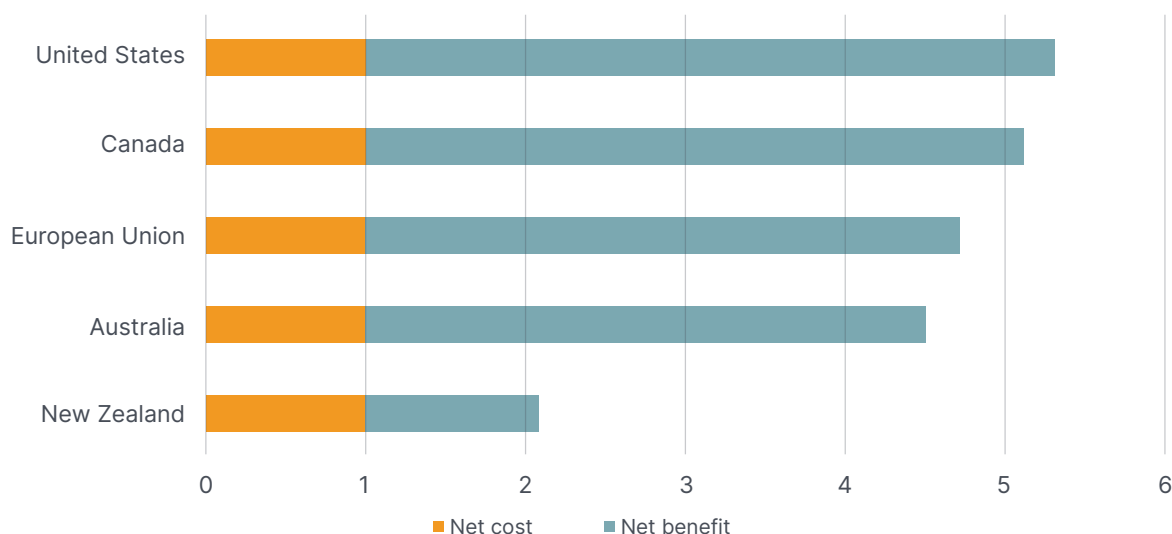
Examples include:

- **China:** China has 73 appliance efficiency policies. Between 2005 and 2020, these policies cut electricity use by more than 2,500 TWh cumulatively (170 TWh per year) and have avoided 100 Mt of CO₂ emissions per year.¹³⁹
- **European Union:** Efficiency policies in the EU cover 31 appliances.¹⁴⁰ In 2020, the EU cut energy use by 1,039 TWh—a 10% reduction from BAU—primarily resulting from EU Ecodesign and Energy Labeling measures.¹⁴¹ Additionally in 2020, the EU's Ecodesign and mandatory labeling program cut emissions by 311 Mt CO₂.¹⁴² See the case study titled [Evolving the EU Energy Label: Shaping Consumer Choices and Market Transformation](#) for more.
- **India:** India has efficiency policies for 34 appliances—14 mandatory and 20 voluntary. Standards and labeling mechanisms saved 9.95 GWh in fiscal year 2020–21¹⁴³ and avoided 7.86 Mt of CO₂.¹⁴⁴
- **United States:** In the US, efficiency policies cover 60 appliances.¹⁴⁵ Between 1987 and 2020, appliance efficiency policies in the US have saved a cumulative 20,749 TWh of energy. In 2020 alone, these policies avoided 343 Mt CO₂.^{146,147}

Beyond energy savings, appliance efficiency policies deliver large cost savings to households. In the US, the typical household saves more than \$320 USD per year on their energy bills because of standards.¹⁴⁸ In Brazil, refrigerators are often the appliance that contributes most to the electricity bills of low-income households.¹⁴⁹ Recent revisions to Brazil's labeling policies are expected to reduce consumers' electricity bills by 18.4 billion BRL [\$3.6 billion USD] and cut CO₂ emissions by 9.7 Mt in 2030. See the case study titled, [Cooling Down Costs: Updated Energy Labels Save Brazilian's Money](#) for more.

Appliance energy efficiency policies deliver cost-effective carbon mitigation wins, with benefits outpacing costs by four to one (Figure 19).¹⁵⁰ Studies analyzing marginal abatement costs for various climate interventions have shown that energy efficiency investments broadly deliver carbon savings at a negative cost.¹⁵¹ CLASP's review of the costs required to administer long standing appliance standards and labeling programs found that large quantities of CO₂ can be abated for at, or well below, \$1 USD per ton.¹⁵² To date, 43 countries directly reference appliance efficiency policies like standards and labels in their NDCs to the Paris Climate Agreement, and institutions like the World Bank have committed to intensifying support for efficiency policies in middle-income countries.^{153,154}

FIGURE 19. COST-BENEFIT RATIO FOR LONGSTANDING APPLIANCE EFFICIENCY STANDARDS & LABELING PROGRAMS¹⁵⁵



Appliance efficiency policies play an important role in building resilience to climate change while reducing stress on the grid during periods of peak energy demand. As the climate warms, people will need access to run appliances like fans and air conditioners longer and more frequently to keep cool. At the same time, this rising demand will place incredible stress on the power grid, which can lead to consequential service disruptions. In Pakistan, fans are a vital lifeline to families during the warm summer months and are known to constitute over 33% of the total load on the grid. In 2016-17, CLASP and SAMA^{Verte} collaborated with the government of Pakistan and the provincial government in Punjab to create a voluntary label for fans aimed at reducing energy consumption. This project provides valuable insights for governments looking to initiate or enhance appliance efficiency programs, underscoring that opting for a mandatory label approach significantly increases the likelihood of success. See the case study titled, [*Empowering Efficiency: Lessons from Pakistan's Energy Labeling Journey*](#) for more.

Beyond standards and labels, appliance efficiency policies focused on quality assurance can protect customers' investments and ensure that products are of high quality and will perform as advertised. Programs like VeraSol support test methods and quality standards for off-grid appliances, conduct appliance testing and build global test laboratory capacity, and certify and maintain a database of quality of solar appliances. To date, the program has certified 60 million solar appliances, benefitting 180 million people.¹⁵⁶

Strong appliance efficiency policies can have a transformative impact on markets by phasing out inefficient or harmful technologies. MEPS may be used as a tool to drive further electrification or transition away from products requiring the use of climate-polluting or environmentally hazardous materials such as high-GWP refrigerants or highly toxic mercury.



In China, appliance efficiency policies have helped to transition the market to more efficient air conditioners and push the market toward lower-GWP refrigerants like R-32. In 2020, China adopted world-leading MEPS for room air conditioners and combined two previous separate regulations into a single label based on a technology-neutral seasonal performance metric. The market share of variable-speed ACs in China increased from 53% in 2017 to 95% in 2022. Meanwhile, most fixed-speed ACs have been phased out from the domestic market. In addition, products meeting the highest energy efficiency level (grade 1) have rapidly increased their market share from 19% to 56%, and the lower-GWP refrigerant R-32 also increased its market share significantly.

See the case study titled, [*Revolutionizing Cooling and Climate: China's Pioneering AC Efficiency Standards*](#) for more.

Despite their proven track record, cost effectiveness, and numerous benefits, rapid action is needed to accelerate the pace of policy making for appliances.

Appliance electricity consumption continues to grow and is largely driven by increasing numbers of buildings and expanding ownership and use of energy-consuming devices in emerging economies.¹⁵⁷ This report finds that even the strongest policies in place today are not sufficient to reach NZE by 2050 (see [Section 2](#)). To get on track, most of the appliances sold in 2035 and beyond must match

today's best available technology (see Table 5).¹⁵⁸ This would require significant investments in appliance efficiency and a rapid increase in the rate of policymaking in nearly all global economies. Additionally, investments in policy compliance programs are required to support effective policy implementation and lock in the benefits of adopting clean energy technologies and energy efficiency and quality standards. Resources like CLASP's [Compliance Toolkit](#) can serve as a helpful starting point for policymakers.



Two women using electric pressure cooker, trying food. Credit: CLASP

4.2 Research & Development

R&D programs are designed to directly stimulate the creation of new technology and drive continuous improvement in the efficiency of energy-consuming products. In many cases, dedicated investment in unproven technologies with high-impact potential is warranted to drive markets for more innovative, high-performing, and energy-efficient technologies.

There are many examples of successful R&D programs. In India, the Department of Science and Technology co-sponsored the Global Cooling Prize to support the development of groundbreaking high-efficiency room air conditioners.¹⁵⁹ The two winning teams showcased air conditioners with a climate impact that was five times less than conventional models and have a plan for bringing their prototype models to market by 2025.¹⁶⁰ The Jamaican and Trinidadian governments co-sponsor the Caribbean Climate Innovation Centre, which operates an incubator and an accelerator for start-up companies developing new climate-

friendly technologies, including energy-efficient technologies.¹⁶¹ To date, the center has invested more than \$800,000 USD in their clients and helped form over 100 startups.¹⁶² In the US, the Federal Government invests in R&D for energy efficiency, with the Advanced Research Projects Agency-Energy (ARPA-E) focusing on high-risk, high-reward projects, and the Department of Energy's Building Technologies Office focusing on more low-risk, low-reward projects.^{163,164}

R&D programs can be implemented by a multitude of stakeholders beyond governments. One example includes the Efficiency for Access R&D fund, which aims to accelerate innovation in off- and weak-grid appliances. Since 2018, the fund has awarded 39 companies over £5.5 million GBP in funding to support off-grid appropriate technologies ranging from solar refrigerators to egg incubators.¹⁶⁵



Female farmers interacting with crops in Tanzania. Credit: Feed The Future Mboga na Matunda

4.3 Financing & Incentives

Financing schemes and financial incentives help the private sector and consumers overcome cost barriers of efficient appliance ownership by lowering upfront costs or by spreading them out over time.

Financing can take many forms, from loans to leasing to performance contracting or third-party financing, and is often administered by governments, development banks, and other financial institutions to increase the manufacture and sale of energy-efficient appliances. Lease-to-own arrangements are typically offered by

the private sector. Utilities can also play a critical role in countries where they are regulated in a way that incentivizes them to invest in energy efficiency by offering financing programs for energy-efficient appliances to their customers. Research by CLASP and the Consultative Group to Assist the Poor (CGAP) found that utility-enabled financing can benefit both customers and providers, unlock latent demand for electricity, and improve customers' perceptions of their electric utilities.¹⁶⁶



Man loading fresh produce into cold room. Credit: New Leaf Dynamics



Ghana's ECOFRIDGES Green On-wage (GO) financing mechanism is one example of a successful appliance financing program that has supported the purchase of over 1,300 energy-efficient air conditioners and nearly 1,600 refrigerators. To lower the financial barrier to purchasing a new, efficient appliance for consumers, the program offered a credit facility with flexible repayment terms at 0% interest for 12 months to eligible customers. To ensure the supported products met minimum energy and environmental performance criteria, eligible refrigerators were required to have a five-star energy rating and use R-600a refrigerants, while eligible air conditioners needed to have at least a three-star rating and use R-32 refrigerant. Since the program's inception, the financing facility has deployed over \$1 million USD in financing, reduced energy demand by 25 MWh, and avoided over 20,000 tons of direct and indirect CO₂ emissions.

See the case study titled, [*Keeping it cool: How Ghana's ECOFRIDGES GO initiative cuts energy costs and emissions*](#) for more.

Financial incentives to accelerate the deployment of efficient appliances come in many forms, ranging from upstream incentives for manufacturers to downstream incentives for consumers. Governments have employed financial incentives for appliances since the 1970s, but other stakeholders, like utilities or international development institutions, can also issue this assistance. The most common incentives are rebates or subsidies, tax incentives, and results-based financing (RBF). Energy efficiency standards and labels can serve as a foundation for incentive programs because they provide a verified baseline for judging enhanced performance. It is possible to design an effective incentive program without underlying standards if there is a suitable test procedure to identify high-efficiency products.

For households living near or below the global poverty line of \$2.15 USD per day, an appliance represents a significant investment. **Financial incentives represent an important mechanism to make appliances more affordable for low-income customers.** SunCulture, a solar water pump provider, has partnered with the French electric company EDF and Bboxx to implement a government subsidy that will halve the cost of pumps for 5,000 smallholder farmers in Togo.¹⁶⁷ This 50% subsidy, coupled with tax exemptions, is part of a national effort to help make solar energy more

affordable and end energy poverty. The partnership between SunCulture, Bboxx, and EDF leverages each partner's strengths, allowing SunCulture's pumps to be equipped with Bboxx's platform for remote monitoring and management and pay-as-you-go financing model, while leveraging EDF's hands-on experience from sales and installation in West and Central Africa.

RBF mechanisms offer a market-driven solution that can help make effective use of resources. RBF is an umbrella term referring to any program or intervention that provides rewards to individuals or institutions after defined results are achieved and verified. While it is not a silver bullet, RBF has been employed as one solution to expand access to appliances in countries with high energy and appliance access gaps. For example, the Efficiency for Access Coalition has paired RBF with the Global Lighting and Energy Access Partnership (Global LEAP) Awards, a competition to identify high-performing and energy-efficient off-grid-appropriate appliances. Companies selected for Efficiency for Access's financing support are identified through the Global LEAP Awards, ensuring that the products incentivized are energy-efficient and of good quality. Since 2016, the program has incentivized the sale of nearly 290,000 fans, televisions, refrigerators, solar water pumps and electric pressure cookers (EPCs), benefitting over 1.2 million people.

4.4 Bulk Procurement

Bulk procurement and other procurement strategies by institutional purchasers, including governments, utilities, and international development institutions can accelerate market transformation. When making appliance and equipment purchases, these institutions can set efficiency and other related criteria to encourage manufacturers to scale up production of technologies that meet those criteria, while also decreasing the per-unit cost due to economies of scale. Harnessing the power of routine purchasing for internal uses by the government and other institutional buyers (i.e., for government offices, public schools, universities, hospitals, street lighting, water and other utilities, military/defense facilities, and other state-owned enterprises) can also be a powerful way to stimulate the market for energy-efficient products while setting an example for corporate buyers and individual consumers. These approaches highlight ways that bulk and government procurement can help make new technologies more mainstream and cost-competitive.

India's Unnat Jyoti by Affordable LEDs for All (UJALA) scheme is a successful appliance-focused energy

efficiency program with strong policy backing from the government. Launched in 2015, the program is one of the world's largest lighting replacement programs for domestic consumers which promotes the use of energy-efficient LED bulbs to replace traditional incandescent and compact fluorescent lamp (CFL) bulbs. The program is implemented by the state-owned Energy Efficiency Services Limited (EESL) and is funded through public-private partnerships. By procuring in bulk, EESL was able to make LED bulbs more affordable to consumers through a demand aggregation model. LED bulbs are distributed to households at subsidized rates, making them affordable and accessible to all. From 2012 to 2016, LED retail market prices dropped from roughly 800 Indian Rupees (INR) per LED bulb to 200 INR per LED bulb—one of the fastest LED price reductions in the world.¹⁶⁸ As of June 2023, the program had distributed over 368 million LED bulbs, mitigating 38 million tons of CO₂ per year and saving households 192 billion INR [\$2.3 billion USD] on their energy bills.¹⁶⁹ See the case study titled, [Lighting a Billion: The UJALA Program's Transformational Impact in India](#) for more.



Hanging lightbulbs. Credit: Goodcat; Shutterstock

4.5 Promotional Tools

Promotional tools like awards and informational resources offer another pathway to overcome information barriers and drive technological innovation.

Awards identify and promote top-performing products and, when widely promoted and well-recognized, awards can help improve awareness of these products among consumers and retailers. In turn, the award outcomes can influence manufacturers' product design decisions.

One example of awards competitions is the Off-Grid Cold Chain Challenge (OGCCC). The [OGCCC](#) identifies best-in-class cold chain equipment in emerging markets. The competition adopted a field-testing component to collect real-time data on energy consumption and performance of emerging cold storage equipment. Results from multiple rounds of competition demonstrate growth in the number of companies providing such cooling solutions, as

well as improvement in the design and performance. The data collected through field testing have helped identify gaps in lab and field performance and give companies the information they need to improve product design. The OGCCC has also highlighted the need to establish more robust quality and performance benchmarks for off-grid cold storage equipment. See case study titled, [Fresh Food & Reduced Emissions: The Global LEAP Off-Grid Cold Chain Challenge's Impact on Food Security & Market Growth](#) for more.

Informational tools, like qualification lists, mobile apps, and online tools, help individual consumers identify energy-efficient products, as well as guide bulk procurement. For example, online databases, like the [VeraSol Product Database](#), can help buyers and distributors of off-grid solar appliances identify high-performing products that meet international quality standards or have been tested to standardized test methods.



Aerial view of a ColdHubs storage room in Nigeria. Credit: Global LEAP Awards

4.6 Solutions in Action

Several ongoing initiatives recognize the transformative potential of appliances and provide platforms for mobilizing to realize this potential. We identified ten examples of such initiatives and wrote profiles of each to accompany this paper. The profiles, which can be accessed from Table 9, include key facts about these initiatives, including who leads and who is involved, what are their goals, and how they intend to reach those goals.

While the efforts profiled here are ambitious, they are not by themselves sufficient to achieve the change we seek. Additional investment is needed. These initiatives will have to be replicated, and some may need to be strengthened to align with the efficiency targets set forth in [Section 3.1](#). In the following section, we lay out our recommendations for action.



Woman standing near solar panel in rural India. Credit: CLASP

TABLE 9. INITIATIVES & PROGRAMS LEADING THE WAY, FULL PROFILES LOCATED IN [ANNEX B](#)

INITIATIVE OR PROGRAM	LEAD INSTITUTION(S)	TECHNOLOGIES ADDRESSED
Clean Lighting Coalition	CLASP	<ul style="list-style-type: none"> ▪ Lighting
Super-Efficient Equipment and Appliance Deployment (SEAD) Initiative	Clean Energy Ministerial, Energy Efficiency Hub	<ul style="list-style-type: none"> ▪ Residential air conditioning ▪ Lighting ▪ Residential refrigerators and freezers ▪ Industrial electric motor systems
Clean Cooling Collaborative	ClimateWorks Foundation	<ul style="list-style-type: none"> ▪ Air conditioning ▪ Fans
Ayrton Fund	United Kingdom (UK) Foreign, Commonwealth & Development Office UK Department for Business, Energy & Industrial Strategy	<ul style="list-style-type: none"> ▪ Fans ▪ Air conditioning ▪ Walk-in cold storage ▪ E-cooking
Efficiency for Access	CLASP, Energy Saving Trust	<ul style="list-style-type: none"> ▪ E-cooking ▪ Fans ▪ Lighting ▪ Refrigerators/freezers ▪ Solar water pumps ▪ Televisions ▪ Walk-in cold storage ▪ Other productive use appliances
Productive Use Appliance Financing Facility	CLASP	<ul style="list-style-type: none"> ▪ Solar water pumps ▪ Electric pressure cookers (EPCs) ▪ Refrigerator-freezers ▪ Walk-in cold storage ▪ Fans ▪ Mills
REPowerEU	European Commission	<ul style="list-style-type: none"> ▪ Heat pumps
US Inflation Reduction Act	US Department of Energy US Internal Revenue Service US Environmental Protection Agency	<ul style="list-style-type: none"> ▪ Heat pumps
United for Efficiency	UN Environment	<ul style="list-style-type: none"> ▪ Lighting ▪ Refrigeration ▪ Room air conditioners ▪ Distribution transformers ▪ Electric motors
Clean Cooking Alliance	UN Foundation	<ul style="list-style-type: none"> ▪ E-cooking