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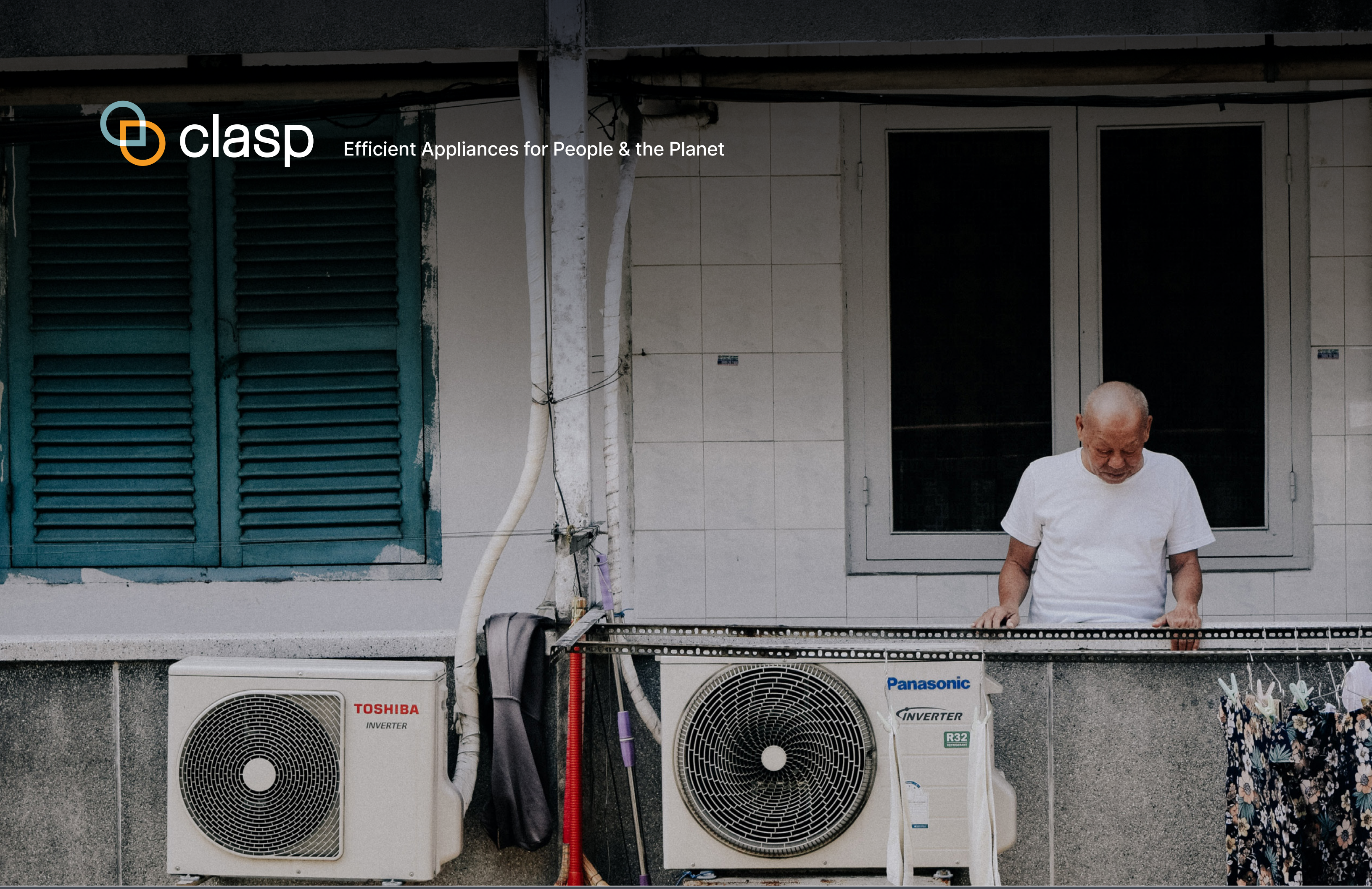

Pennies Per Pound

The Return on Investment from Appliance Policy Technical Assistance

SEPTEMBER 2021

ABOUT

This report aims to quantify the ‘return on investment’ or ‘value for money’ that can be achieved by investing in appliance policy technical assistance as a climate change mitigation strategy. We conducted a high-level review of 12 policy interventions across a total of eight countries and regions, comparing administrative program costs per ton of CO_2 or CO_2e avoided, to demonstrate the cost-effectiveness of appliance energy efficiency programs and related technical assistance efforts. This report is intended to serve as a reference for program administrators, development agencies, philanthropists, and others who seek to achieve climate benefits through appliance energy efficiency programs and policies.

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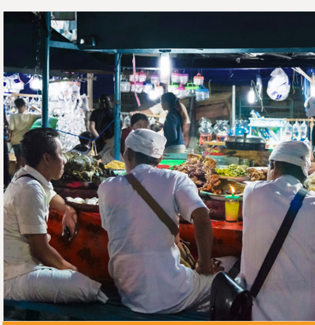
DISCLAIMER



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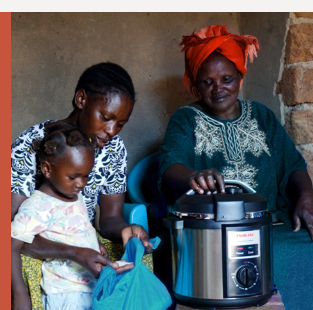

IMPACT

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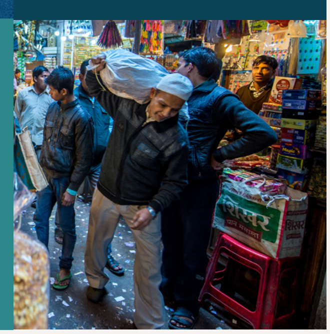

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Introduction & Methodology

Introduction

Rising global temperatures and extreme weather events underscore the need for aggressive action on the climate crisis. Between 1990 and 2016, rising incomes led to a dramatic increase in major appliance energy demand globally. This trend is likely to accelerate in the next decade as more than 2 billion people around the world gain access to electricity via the grid and/or distributed energy.[1] Given appliance lifetimes of five to 15 years, meeting this demand with inefficient appliances would lock-in higher than necessary carbon dioxide (CO_2) emissions for the planet and higher energy bills for consumers everywhere.

The Intergovernmental Panel on Climate Change estimates global warming has increased 1°C above pre-industrial levels, with warming likely to reach 1.5°C between 2030 and 2052 if temperatures rise at their current rate. This warming will persist for centuries and "will continue to cause further long-term change in the climate system, such as sea level rise, with associated impacts."[2] In short, there is an urgent need to raise collective ambition and spur meaningful action on appliance energy efficiency policy worldwide, particularly in major and growing economies.

Increasing appliance and equipment efficiency is one of the most immediate, reliable, and cost-effective ways to cut carbon emissions. A recent retrospective study from the UK found that over a 30-year period, energy efficiency was the biggest single contributor to economy-wide emission reductions and was one of only two strategies (along with renewables) that delivered beyond expectations, in contrast to other mitigation strategies which fell well short of their targets.[3] A global transition to efficient appliances and equipment would cut more than 1 gigaton (Gt) of carbon emissions per year and save more than USD 200 billion annually on electricity bills. If best available technologies were adopted, CO_2 emissions could be reduced by another 1.9 Gt, getting us halfway to the Nationally Determined Contribution goals under the Paris Agreement.[4]

Much of the existing research on the impact of appliance efficiency policies and programs focuses on consumer energy bill savings and CO_2 emissions reductions, rather than the costs to governments to run the programs. In the United States (US), the Appliance Standards Awareness Project (ASAP) and the American Council for an Energy Efficient Economy (ACEEE) evaluated the impacts of the US Department of Energy's appliance standards program in 2015 and found residential and commercial customers saved USD 80 billion on their utility bills.[5] Standards the Department of Energy instituted in 2016 will ultimately save both residential and consumer customers combined USD 2 trillion in utility bills by 2030.[6]

While the benefits of energy efficiency are widely proven and accepted, there is little research that looks at the investment needed to design, implement, and enforce appliance efficiency

1. Energy Sector Management Assistance Program 2018.
2. IPCC 2018.
3. Lees 2021.
4. International Energy Agency 2017.
5. Appliance Standards Awareness Project 2020.
6. Alliance to Save Energy 2018.

standards and labelling programs at the national level. In this report we analyze the climate impacts that are achieved through appliance energy efficiency, evaluate the costs of running national and regional appliance energy efficiency programs and delivering technical assistance (TA) to support governments, and discuss the return on investment for these efforts on a CO_2 emission reductions per dollar basis.

We view our cost-effectiveness calculation from the perspective of a government administrator. Program implementation and administrative costs, in addition to TA delivery costs, are considered at the national and regional level. We find that across many unique cases, from multi-year national or regional appliance efficiency programs to small, targeted technical assistance efforts, CO_2 mitigation impacts are achieved for much less than the US social cost of carbon of USD 51 per ton.[7] This finding supports the conclusion that appliance energy efficiency programs and policies are highly cost-effective tools for climate change mitigation.

TECHNICAL ASSISTANCE & CLASP'S EXPERIENCE

Energy efficiency policy is facilitated by a diverse network of organizations, many of which provide TA to the national and regional government agencies responsible for developing and implementing appliance efficiency programs. The definition of TA is broad. It may include activities such as data collection and impacts analysis, stakeholder facilitation, education and training, and consultations with technical experts. All of these activities are performed in collaboration with the government agency responsible for policy implementation.[8] In the appliance sector, these activities increase policy impacts by improving the speed of implementation, the breadth of product coverage, the stringency of standards, and the awareness of manufacturers, retailers, and consumers, among other factors.

CLASP supports ambitious efforts to mitigate climate change through appliance and equipment energy efficiency. Our team provides technical and policy advisory services directly to governments to develop and implement the most ambitious and cost-effective appliance efficiency policies all over the world. We work in partnership with policymakers and other key stakeholders in dozens of countries—from Brazil to Indonesia, the European Union (EU) to China—with support from a diverse group of funders. Since our founding in 1999, CLASP has delivered technical assistance to support appliance energy efficiency practitioners in more than 100 countries.

7. U.S. Interagency Working Group on Social Cost of Greenhouse Gases 2021.

8. U.S. Department of Energy 2020.

Methodology

As with any climate change mitigation strategy, assessing the effectiveness of an appliance energy efficiency policy requires an analysis of the economic impacts on consumers, manufacturers, and society. In this report, we seek to understand the return on investment (ROI) from appliance efficiency policies, in terms of reductions in climate emissions. We define ROI as the value for money of a specific intervention, expressed as the sum of administrative costs invested (in US dollars) per ton of CO_2 equivalent (CO_2e) mitigated.

DATA SOURCES

To calculate ROI, we aimed to determine two factors: first, the costs of developing, revising, implementing, and enforcing an appliance minimum energy performance standard (MEPS); and second, the net environmental benefits achieved by the MEPS. To obtain this data, we used existing research, interviews, and internal CLASP expenditure data and savings projections.

Existing Literature: We conducted a literature review to identify examples of ROI across a wide range of climate policies to form a baseline for comparison but identified few resources on the topic. There are many research papers that calculate consumer and societal costs of various climate change mitigation policies – see for example Gillingham and Stock's Cost of Reducing Greenhouse Gas Emissions – but the authors typically did not attempt to estimate the administrative costs of policy implementation.

In these cases we examined the infrastructure and implementation costs of policy measures. Gillingham and Stock compare the static costs (measured in US dollars (USD) per ton of CO2) for a wide range of environmental policies from different economic studies (see Appendix A for a complete list). The cost estimates range from USD 10 to USD 1,000 per ton of CO2 avoided.[9] Policies like behavioral energy efficiency are estimated at USD -190 per ton and renewable portfolio standards between zero and USD 190 per ton.

Several resources cited government spend and energy savings projections from national appliance programs in the US and the EU. We used these reports as our primary data sources for calculating the ROI of national appliance programs.

Interviews: We conducted interviews with experts in the appliance sector from Pacific Northwest National Laboratory (PNNL) and ASAP in the US, as well as experts in the EU and with United Nations Environment. These discussions further confirmed the lack of existing research on the report topic but pointed us to supplemental resources. In addition, everyone we interviewed hypothesized that modest investment in appliance policy would deliver large returns.

CLASP Data: To generate ROI estimates for CLASP technical assistance projects, we relied upon historical expenditures (e.g., salaries, contractors, travel, and workshops) and emissions reduction projections from the past several years.

9. Gillingham and Stock 2018.

CALCULATING COSTS & BENEFITS

Costs Included: The primary costs considered in this analysis are derived from CLASP's records of technical assistance expenditures. Depending on the policy under development, these include a combination of CLASP labor, overheads, and other direct costs (e.g., travel, expert consultant support) to support a government with the following types of activities:

- Baseline market data collection and analysis.
- Test procedure development.
- Product purchase and laboratory testing fees.
- Analysis of expected impacts.
- Development and promulgation of regulations, including technical publications, facilitation of public meetings and other stakeholder consultations, and review and responses to stakeholder comments.
- Support for certification and enforcement, including developing and maintaining certification tools.

It should be noted that within these categories there is often a high degree of variability from project to project, based upon factors such as the complexity of the product policy under consideration, the presence of widely-accepted international test standards, the existence of similar policies in neighboring countries, etc. For example, for some product types a completely bespoke and intensive data collection and analysis process is required to develop policy recommendations, while for others it is possible to perform a simple statistical analysis from an existing database with a much lower level of effort. It is much faster and less costly to analyze a market and propose MEPS for a commodity product for which data and policy examples are readily available (e.g., televisions) than for a complex product with unique local features and functions that is not heavily regulated elsewhere (e.g., set-top boxes).

Costs Excluded: This analysis does not include costs beyond those incurred by program administrators, such as:

- Costs to develop framework legislation.
- Costs to operate supplemental market transformation programs, e.g. utility rebates for efficient products, public procurement, communications, and public awareness campaigns. These are important programs to help increase adoption of energy efficient appliances, but beyond the scope of this report.[10]
- Consumer costs for purchasing efficient appliances.
- Manufacturer costs for developing and distributing efficient appliances.
- Broader economic costs of climate change.

Benefits Included: In this analysis we consider projected energy savings from individual policies and convert these to CO_2e to enable comparisons. CO_2e benefits are derived from the International Finance Institution's Harmonized Grid Emission Factor dataset and EIA's Data for Electricity Consumption and Distribution Losses. We used the following equation to convert national energy reductions (NER) to CO_2 reductions:

$$National\ Emission\ Reduction = NER \times \frac{Grid\ Emission\ Factor}{(1 - T\&D\ Loss\ \%)}$$

When estimating the national energy reductions from energy efficiency policy, CLASP implements the process on the following page to ensure that the estimates reflect market data and do not overstate the potential savings.

10. U.S. EPA 2015.

1. Estimate the average energy consumption of a typical appliance, referred to as unit energy consumption (UEC), before and after the policy.

2. Calculate the total point-of-use energy consumption by multiplying UEC by the number of units in use (the "stock").

3. Multiply the total point-of-use energy consumption by factors that reflect upstream losses in the transmission and distribution system, the fuel mix of the electricity grid or other emissions factors of other pollutants, and the marginal consumer energy prices.

4. Finally, compare the discounted decrease in operating costs against any increase in the up-front purchase and installation cost of the product, either at the national or consumer/end-user level.

Net benefits are then calculated as the difference between the National Energy Consumption (NEC) under the business-as-usual (BAU) case and the policy case:

$$National\ Energy\ Reduction = NEC_{BAU} - NEC_{Policy}$$

BAU represents the absence of policy and may also be sometimes called "base case". It is typically based on the current situation but may also include forecasts of some intrinsic energy reductions due to technology improvements, which tend to reduce the energy reductions that can be attributed to the policy.

Benefits Excluded: There are several benefits from appliance energy efficiency policy beyond CO_2e reductions that are beyond the scope of this analysis, unless otherwise noted.[11] These include consumer savings on energy bills; productivity gains (e.g., due to better working conditions from air conditioning); energy security; technology innovation; job creation; industrial competitiveness; improved public health, education, and other social services.

SOCIAL COST OF CARBON

When looking at the cost of mitigating CO_2 emissions, it is important to consider the larger context. The social cost of carbon aggregates the economic costs of climate change to provide a cost per ton of CO_2 that is emitted. When comparing the cost of policies or market mechanisms to reduce CO_2 emissions, it can be helpful to compare to the social cost of carbon for a quick indication of where the cost lies. If the cost of the policy is less than the social cost of carbon, it may be considered cost effective. If the cost of the policy is greater than the social cost of carbon, it may not be cost effective. However, when assessing a policy it is important to consider other factors as well (e.g., if a policy brings significant productivity or economic gains to communities).

The US Interagency Working Group on Social Cost of Greenhouse Gases set the interim social cost of carbon at USD 51 per ton CO_2 in February 2021.[12]

CASE STUDIES

In the following section, we first present an assessment of the ROI from large-scale national and regional appliance standards and labeling programs in the US and EU. After that, we present a series of technical assistance case studies. Large-scale programs and targeted technical assistance often work in tandem, so analyzing the ROI from both provides a holistic view of the potential impact from investments in the sector. For countries with new programs and/or fewer resources, technical assistance is often used to support individual product policies. It is often a critical first step to build national capacity, foster institutional learning, and set the stage for program expansion.

To ensure that results are comparable, we take cumulative CO_2 reductions over 10 years, so typically 2020-2030 or in the case of standards opportunities being considered today, 2025-2030. For the program budget, we have converted all costs to USD and inflated them to 2020 dollars. Where possible we have accumulated program budgets over the years preceding standards adoption when they were being developed.

11. U.S. Department of Energy 2017

12. U.S. Interagency Working Group on Social Cost of Greenhouse Gases 2021

Case Studies: Large-Scale Standards Programs

United States

APPLIANCE EFFICIENCY PROGRAMS

The US has a comprehensive appliance standards program, administered by the Department of Energy (DOE),[13] a mandatory labelling program – EnergyGuide[14] – administered by the Federal Trade Commission, and a widely known voluntary labelling program – ENERGY STAR – administered jointly by the Environmental Protection Agency (EPA) and DOE.[15]

APPLIANCE & EQUIPMENT STANDARDS PROGRAM

Energy efficiency policy action in the US is dependent on the political landscape and its pace changed dramatically over the last several years. Under the Obama Administration (2009-2016), 40 efficiency standards on new appliances were finalized, more than the previous two administrations combined.[16] By contrast, the Trump Administration (2017-2020) delayed numerous efficiency standards and was forced to implement others only due to a federal court ruling.[17] Under the current Biden Administration (2021-present) we anticipate a renewed interest in advancing the speed and ambition of US appliance standards.

In this report we provide several ROI estimates for the DOE standards program based on estimates by the Appliance Standards Awareness Project (ASAP), an advocacy organization. ASAP estimated the impact of Obama-era standards and two future scenarios for the potential impact from increased ambition under the Biden administration.

For the Obama-era standards, DOE itself projected they would reduce CO2 emissions by 3,000 MtCO2 cumulatively through 2030;[18] however, ASAP estimates CO2 reductions of 1,215 MtCO2 through 2030.[19] CLASP used this more conservative ASAP estimate. Looking at just the 10 years between 2017 and 2026 results in 703 MtCO2. These reductions were supported by a budget of $414 million.[20]

SUMMARY	
2008-2016 Budgets (USD)	$414 million
CO_2 Emission Reductions 2017-2026	703 Mt
Return on Investment (USD/ ton CO_2)	$0.59

For the future impact of Biden-era standards, CLASP referenced ASAP's 2020 report, "A Powerful Priority: How Appliance Standards Can Help Meet U.S. Climate Goals and Save Consumers Money",[21] which includes projected CO2 savings from potential standards under two grid emissions scenarios: a low-carbon grid and the 2020 Annual Energy Outlook reference case. The two estimates are 57 and 105 MtCO2 annually in 2035, which

13. U.S. Department of Energy 2017.

14. Federal Trade Commission 2020.

15. U.S. EPA. 2020.

16. Marshall 2016.

17. NRDC 2019.

18. U.S. Department of Energy 2016. While the document does not specify whether estimate is for carbon or CO2 ("carbon pollution by at least 3 billion metric tons cumulatively by 2030"), it qualifies it as equivalent to half of economy-wide annual emissions, which were approximately 6,000 MtCO2 in 2016. (See U.S. EPA 2021).

19. Internal ASAP estimate assuming a grid emission factor declining from 0.56 in 2012 to 0.39 in 2030. Even when using the 2012 grid emission factor, ASAP's CO2 reduction estimate is half of DOE's (U.S. Department of Energy 2016).

20. Annual budgets for "Equipment Standards and Analysis" or "Equipment and Building Standards" prorated over the months that Obama was in power and inflated to 2020 dollars. For years when a Continuing Resolution provided funding and less specific budget data is available, CLASP estimated the Equipment Standards budget from the prior year by looking at the change in the budget for the entire Building Technologies Office, of which the Appliance Standards program is a part. CLASP further reduced the resulting total of $517 million by 20% to reflect that appliance standards constitute roughly 4/5 of the DOE program.

21. Mauer and deLaski 2020, p. 9.

CLASP turned into a cumulative figure for 2026-2035 assuming linear growth each year as products age and are replaced with ones that meet the new standards.

Meanwhile, the 2020 Enacted Budget for the DOE Codes and Standards program was $55 million;[22] or $44 million for just appliance standards. Extending that level of funding over the four years of the Biden administration would result in a total budget of $176 million.

SUMMARY	
2021-2024 Budget Estimate (USD)	$176 million
CO_2 Emission Reductions (2026-2035)	285–525 Mt
Return on Investment (USD/ ton CO_2)	$0.34–0.62

ENERGY STAR LABELING PROGRAM

The ENERGY STAR program, a voluntary endorsement labelling scheme launched in 1992, is used to identify energy efficient products, buildings, residential homes and industrial plants. Products that earn the ENERGY STAR label are certified to meet specified standards for energy efficiency. Approximately 90% of American households report that they recognize the ENERGY STAR label, and the program contributes to substantial consumer energy bill savings.[23] Energy savings and government cost information are not consistently reported in budget filings, but annual budgets (e.g., when the program is discussed publicly) indicate modest administrative costs.[24] Please note the budget and estimated emissions reductions used to calculate policy ROI are annual savings, rather than cumulative savings over a 10-year period.

SUMMARY	
Annual Proposed 2019 Budget (USD)	$16 million[25]
Annual CO_2 Emission Reductions 2019	390 Mt[26]
Return on Investment (USD/ ton CO_2)	$0.041

22. U.S. Department of Energy 2020, p 188.

23. U.S. EPA 2015.

24. Cama 2018.

25. Cama 2018. $31 million budget reduced by an assumed 50% to reflect that ENERGY STAR also includes homes, commercial buildings, and industry, in addition to product labeling.

26. U.S. EPA n.d

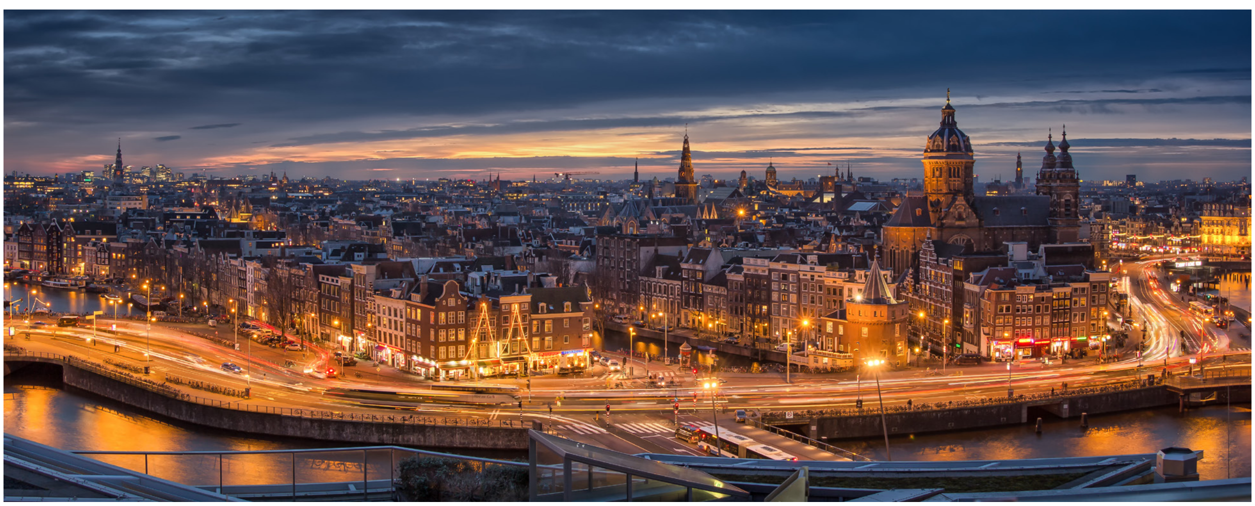
European Union

APPLIANCE EFFICIENCY PROGRAMS

ECODESIGN AND ENERGY LABELING PROGRAM

The European Commission regulates the energy efficiency of appliances through its Ecodesign Directive and Energy Labeling Regulation, which together encompass a directive for minimum energy performance standards, adopted in 2005, and energy labelling, last revised in 2010. Every three years a set of products are identified to be studied in detail. As of 2020, 28 Ecodesign and 16 labelling regulations had been adopted, some have been subsequently updated, and three voluntary agreements have been established.[27] The annual budget for the Commission's work on standards and labelling includes administrative costs of about USD 3.5 million per year.[28] This budget covers approximately 15 full-time employees dedicated to the program, as well as external consultants, committee/expert meetings, and individual member state costs when participating in decision-making and market surveillance. Please note the budget and estimated emissions reductions used to calculate policy ROI are annual savings, rather than cumulative savings over a 10-year period.

SUMMARY	
Annual Budget 2015 (USD)	$3.5 million[29]
Annual CO_2e Mitigated	130 Mt[30]
Return on Investment (USD/ ton CO_2e)	$0.046



27. European Commission 2020.

28. European Commission 2015.

29. Ibid.

30. Ibid.

Case Studies: CLASP Technical Assistance

India

MULTIPLE APPLIANCES

The Government of India introduced the Energy Conservation Act (EC Act) 2001 and established the Bureau of Energy Efficiency (BEE) in 2002. The EC Act identifies standards and labeling (S&L) as a major thrust for improving appliance energy efficiency. Launched in 2006, India's S&L program enables consumers to make informed choices about the energy and cost saving potential of products. It includes both comparative and endorsement labels. Labeling begins on a voluntary basis and then transitions to a mandatory approach as market receptivity increases.

CLASP has supported BEE's S&L program since 2000. In 2015, BEE and CLASP signed a 10-year Memorandum of Understanding (MOU) to formalize their partnership. Over the years, technical assistance has evolved to support increasingly complex products, including room air conditioners, refrigerators, ceiling fans, solar water heaters, microwaves, lighting, and televisions. Key activities include data collection and analysis, development of standards levels, and estimation of energy savings potentials, which are shared with technical committees.

CLASP's support also includes institutional capacity building, compliance, and consumer awareness. Activities involved the development of a tool for policy prioritization, a Standards and Labeling Operations Manual, and a mobile app and consumer-facing videos to improve awareness of the benefits of efficient products.

Technical assistance generated new data that contributed to a set of interactive tools to help inform policymaking. For example, CLASP conducted a national level household survey and appliance metering and developed the first National Energy End-use Monitoring dashboard.

POLICY OUTCOMES & IMPACT

CLASP's support on policies for 9 products is expected to save 240 Mt of CO_2 cumulatively by 2030. 72.6 Mt CO_2 were avoided between 2019 and 2020.[31]

SUMMARY	
Technical Assistance Budget (USD)	$7,600,000
Timeframe (years)	10 (2010-2020)
CO_2e mitigated through 2030	240 Mt
Return on Investment (USD/ton CO_2e)	$0.032

TIMELINE

- 2006: First voluntary S&L program for refrigerators and tubular florescent lamps (TFLs)
- 2009: First mandatory S&L program for frost free refrigerators, TFLs, room ACs, and direct cool refrigerators.
- 2015: Signed 10-year memorandum of understanding with BEE
- 2016: Mandatory S&L program for color TVs and electric storage water heaters. Launched Operations Manual.
- 2018-2021: Supported voluntary S&L program for six appliances

31. Bureau of Energy Efficiency 2021, 5. This estimate includes savings from domestic sector encompassing S&L and UJALA

South Africa

LIGHTING

Retailers in South Africa sell approximately 80 million general service lamps (GSLs) every year. While each individual lamp does not consume much power, the average household has 15 lamps. Collectively, GLSs consume a significant amount of electricity, driving up energy bills and contributing to evening peak power loads. South Africa initiated a process to develop efficiency standards for GSLs to help make lighting more affordable and accessible, while reducing CO_2 emissions and easing pressure on the grid. CLASP engaged in the lighting policy in South Africa in 2018 and have provided support to the government and participated in public meetings to share data, analysis and international best practice with the policy-making forum. This individual policy work has been followed by additional measures, including appliance standards for household appliances, televisions, street lighting, and electric motors.

CLASP began working with the National Regulator for Compulsory Specification (NRCS) and the Department of Mineral Resources and Energy (DMRE) in mid-2018. We have been the technical lead for drafting MEPS and helped the government, the United Nations Development Programme (UNDP), and its contractors with the market assessment, shipments model, savings projections, and life cycle cost study for the current policy.

We have assisted with the testing of LED lamps purchased in South Africa to assess their efficiency, color quality, flicker, electrical performance and other technical metrics, and participated in several workshops and public meetings.

POLICY OUTCOMES & IMPACT

The general service lighting policy is expected to be published as a national compulsory specification by the end of 2020 and will take effect one year later. When adopted, South Africa lead the continent with the most efficient lighting policy, one that is largely aligned with the recent European regulation adopted in December 2019.

SUMMARY	
Technical Assistance Budget (USD)	$100,000
Timeframe (years)	2.5 (2018-2020)
CO_2e mitigated through 2030	12.8 Mt
Return on Investment (USD/ton CO_2e)	$0.008

TIMELINE

- Jul 2018 — CLASP conducts market research and contributes to impact assessment
- Jan 2019 — CLASP becomes technical lead for lighting MEPS and prepared draft of lighting regulation
- Jul 2019 — CLASP presents recommendations on market surveillance and safety
- Nov 2019 — Manufacturer resistance to lack of enforcement in policy, rectified with workshop
- Nov 2020 — Co-sponsored Programme Manager at SANEDI to oversee continued work
- 2021 — Expected publication by South African government

Kenya

ROOM AIR CONDITIONERS AND REFRIGERATORS

Kenya's first room AC (RAC) and refrigerators MEPS went into effect in 2017, but issues with testing requirements and compliance resulted in AC imports dropping by 60% and reported higher costs for refrigerator imports.

To help refine the standards, CLASP facilitated a technical working group and conducted market assessments. CLASP continues to promote the energy label and additional revisions to the new MEPS. Our work in Kenya serves as a case study for other countries in East Africa planning to adopt similar policies. Many countries in the region have weak or non-existent energy efficiency standards for ACs and are becoming dumping grounds for substandard and inefficient room ACs, as identified in "Environmentally Harmful Dumping of Inefficient and Obsolete Air Conditioners in Africa". Kenya's example could encourage a transition to high-efficiency, low global warming potential RACs in other African countries.

POLICY OUTCOMES & IMPACT

As a result of the first MEPS passed in 2017, the regulator subsequently drafted new standards in 2018 to amend the testing procedure and improve product efficiency. The revised AC policy went into effect in 2019 and ultimately increased efficiency of room air conditioners by 11%. In addition to increasing the efficiency, the policy also eliminated from the marketplace products that contain R-22, a harmful ozone-depleting refrigerant and potent greenhouse gas. The refrigerator policy went into effect in 2020. The efficiency improvement from the previous MEPS is between 15-40%, depending on the product type. Overall, the policy removes 47% of the less-efficient models on the market.

Kenyan consumers will save USD 88 million in electricity costs over 10 years. In addition, 581 GWh of energy saved between 2020 and 2030 will free up grid capacity to power other end-uses particularly for the manufacturing sector, a major part of Kenya's agenda to elevate itself to a middle-income country by 2022.

SUMMARY	
Technical Assistance Budget (USD)	$250,000
Timeframe (years)	2 (2016-2018)
CO_2e mitigated through 2030	0.27 Mt[32]
Return on Investment (USD/ton CO_2e)	$0.929

TIMELINE

- Jul 2016 — Regulations affecting the MEPS and labelling requirements are published
- Jul 2017 — MEPS go into effect for all new imported products
- Jan 2018 — CLASP begins policy technical assistance in Kenya
- Mar 2018 — CLASP launches first Kenya AC market baseline study
- Jul 2018 — MEPS & labelling go into effect for all Kenyan retailers
- Oct 2018 — Draft revised AC MEPS published for public review & comment

32. 159,000 tons CO2 from the room AC policy and 110,000 tons CO2 from refrigerator policy.

Pakistan

ELECTRIC MOTORS

Pakistan's National Energy Efficiency and Conservation Authority (NEECA) worked with CLASP to evaluate the potential of extending its S&L program to include electric motors, and assist in the development of appropriate regulation.

CLASP conducted a market analysis, market survey and bi-lateral engagement with the motor manufacturers to establish the potential for regulation. Working with NEECA, CLASP developed initial regulatory recommendations for large motors above 5 kW based on International Electrotechnical Commission (IEC) testing protocols and performance ratings. This strategy was intended to limit negative impacts on local producers. However, industry consultations revealed that small motor manufacturers wanted to use regulation as a vehicle to improve their products and open export markets. The regulations also includeed requirements for refurbished and second-hand motors. A nominal fee will be charged to all motor registrations and sales to ensure sufficient resources for market surveillance.

CLASP's partner, Hima^Verte, conducted a market analysis and managed engagement with NEECA and motor manufacturers. Consultants and CLASP team in India and Washington, DC provided their policy expertise on compliance and best practice.

POLICY OUTCOMES & IMPACT

Consuming 75TWh of electricity in 2019 and costing USD 10 billion, electric motors were already a major burden to both the country and consumers. This burden was projected to grow by 60% by 2030 and cost consumers USD 16 billion. CLASP's proposed policies offer huge potential to slow this increase while supporting the achievement of the Pakistan's Nationally Determined Contributions to the Paris Agreement. Cumulative policy benefits through to 2030 are projected to be avoided emissions of 23.6 MT CO_2 and a reduction in energy consumption of 47,296 GWh.

SUMMARY	
Technical Assistance Budget (USD)	$543,000
Timeframe (years)	2 (2019-2020)
CO_2e mitigated through 2030	23.6 Mt[33]
Return on Investment (USD/ton CO_2e)	$0.023

TIMELINE

- Sep 2019 — NEECA workshop to discuss the first draft of policy revisions
- Oct 2019 — First industry forum to expand policy scope & address second-hand motors
- Nov 2019 — Second industry forums
- Dec 2019 — Discussion on further refined motor MEPS with stakeholders
- Dec 2020 — NEECA announces the first mandatory efficiency policy for electric motors

33. Assuming 100% compliance.

Sweden

LIGHTING

CLASP identified an opportunity to achieve a significant reduction in carbon emissions through a different regulatory mechanism – one designed to remove toxic substances from products. In 2019, the European Commission was considering whether to continue allowing certain fluorescent light bulbs containing toxic mercury to be sold in the EU.

Mercury is a toxic substance that can damage the nervous, digestive and immune systems, among other health effects. Since 2003, the European Commission's Restriction of Hazardous Substances (RoHS) Directive has allowed the sale of fluorescent bulbs through exemptions based on a historical lack of mercury-free alternatives.

CLASP worked closely with the Swedish Energy Agency to prepare a series of reports over a nine-month period that studied the market for mercury-free retrofit LED lamps, addressed questions from policy-makers and supported analysis by independent consultants.[34]

POLICY OUTCOMES & IMPACT

Ultimately, CLASP's analysis provided the evidence base necessary to demonstrate the feasibility of phasing-out mercury-containing fluorescent bulbs in Europe. At the time of this writing, Europe is in its final internal analysis to decide if it will phase-out fluorescent lamps in early 2022. If Europe takes this step, it will aviod 92 Mt of CO_2 emissions and 6 tons of mercury from being released into the atmosphre or placed on the market, and save consumers USD 34 billion in their lighting bills.[35,36]

SUMMARY	
Technical Assistance Budget (USD)	$80,000
Timeframe (years)	1 (2019-present)
CO_2e mitigated through 2030	101.5 Mt[37]
Return on Investment (USD/ton CO_2e)	0.00008

TIMELINE

- **Sep 2018** – Invited to co-author a study on potential phase-out of fluorescent lamps in Europe
- **Oct 2019** – Published first joint report with Sweden
- **Dec 2019** – Published revised report addressing industry criticisms
- **Feb 2020** – Report shows fluorescent lamps fail to meet exemption criteria under RoHS
- **Apr 2020** – Contributed to Oko Institute Impact Assessment and published join report with Sweden addressing industry criticism
- **Oct 2020** – Met with Germany to address technical barriers & market-based solutions

34. CLASP published three studies with the Swedish Energy Agency: "Evidence of the Availability of Mercury-Free Alternative Products to Certain Fluorescent Lamps" in December 2019; "Assessing Annex III Fluorescent Lamp Exemptions in the Light of Scientific and Technical Progress" in February 2020; and "Clarifications on Lighting Europe's Comments to the RoHS Committee" in July 2020.

35. European Council for an Energy Efficient Economy 2020.

36. Baron and Gensch 2020.

37. Cumulative, for EU-28.

European Union

TELEVISIONS

In Europe, the Ecodesign Directive and Energy Labelling Directive work together to push and pull the market for a variety of products towards more energy-efficient models.

In 2009, Europe adopted mandatory efficiency and labelling regulations on televisions (EC No. 642/2009) with a requirement that they be reviewed in 2011. The Commission started that work, however for a variety of extraneous reasons, the actual revision took many years, and only in 2019 were the updated requirements on televisions finally adopted.

CLASP supported the Commission by preparing market studies and technology assessments and developing improved test methods. Taking effect in two stages in 2021 and 2023, the new regulation is estimated to avoid cumulative emissions of 108 million tons of CO_2 between 2021 and 2030.

POLICY OUTCOMES & IMPACT

CLASP's work in televisions started in 2011 the the development of a model database based on reports of all the products offered for sale in Europe that year. This model database required updating every two years due to the fast pace of performance improvements driven by industry innovations and recognized by higher categories on the Energy Label. Consumers responded to these improvements and the market continued to progress toward higher efficiency even despite the extended review of the Ecodesign regulation.

One of the key problems facing televisions was the lack of good test standards for measuring their performance – essentially, the technology had moved faster than the standardization bodies could respond. CLASP therefore contracted a specialist video production team to develop a new

TIMELINE

- 2011: Work initiated. CLASP compiles product database
- 2013: Updated database and developed recommended leves for regulation
- 2015: Launched project to develop new TV test method
- 2016: Updated product database and revised recommended levels of regulation
- 2018: Updated product database and recommended tiers. Contributed data to Impact Assessment. Regulatory Committee adopts regulation.
- Oct 2020: Commission published regulation, to take effect in 2021 and 2023

10-minute video test clip which was designed to be more representative of typical content and improve television measurement accuracy. This video clip was released in five formats – a significant expansion on the two formats available under the old IEC test method – including an ultra-high-definition format that will accurately test the most popular TVs on the market, and two formats that address the more advanced high-dynamic-range (HDR) displays.

In addition to upgrading the video test clip of the TV test method, CLASP recognized that a technology known as Automatic Brightness Control (ABC), which reduces screen brightness to match viewers' ambient lighting conditions, had energy reduction potential that was not being fully realized by manufacturers due in part to gaps in the testing procedure. CLASP worked with expert advisors to develop a new ABC test method that is both simpler and more reliable than older ABC test methodologies and better captures energy savings. This new methodology for assessing ABC and the video test clip formed the basis of updated test standards that are now incorporated into the European regulation for televisions and electronic displays.

SUMMARY	
Technical Assistance Budget (USD)	$502,000
Timeframe (years)	8 (2012-2020)
CO_2e mitigated through 2030	108 Mt
Return on Investment (USD/ton CO_2e)	$0.0046

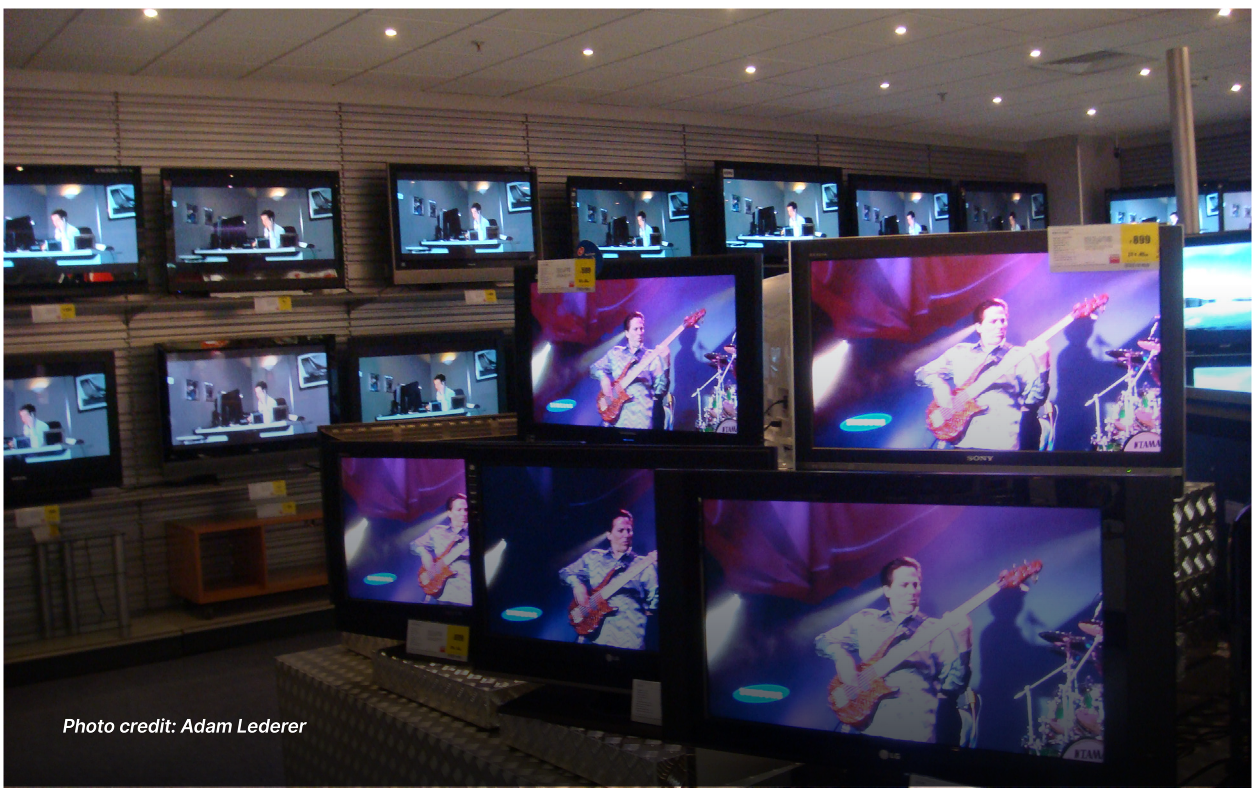


Photo credit: Adam Lederer

Brazil

ROOM AIR CONDITIONERS

The room air conditioner market in Brazil complicated, as products sold on the market are required to have a certain percentage of components sourced domestically. Domestic components, however, have not typically been very efficient and of high quality. This lack of efficient and high quality products created a scenario where it was difficult to push efficiency policy forward in Brazil. In 2017, the Institute for Climate and Society (iCS) received a grant to advance air conditioner energy efficiency. CLASP was hired in 2018 to address the domestic component quality issue and identify a way forward.

CLASP met with AC and compressor manufacturers and visited the factories to determine what could be done to alleviate the issue. In response to the lack of efficient products manufactured, CLASP interviewed both end-product and component manufacturers to uncover the root cause of the market failure. The organization found that domestic Brazilian manufacturers were capable of making efficient technology, but they were not incentivized to do so. CLASP identified the need to publish a policy timeline that gave advanced notice to manufacturers so they would have time to upgrade their production lines in time to meet the new requirements. In a subsequent report, CLASP focused on recommendations for updating the labelling scheme, which included moving to a seasonal metric for room ACs and publishing a policy roadmap to improve labelling requirements.

In addition to stakeholder interviews, CLASP attended two technical committee meetings with the AC industry to discuss the new seasonal metric, determine the new labelling levels, and set the timeline for achieving new levels. In addition, two workshops were held during the project, which focused on facilitating discussions between manufacturers, policymakers, NGOs, and academics. In total, four CLASP members contributed to the project, which included bringing best practices from both India's and the EU's seasonal metric and labelling program respectively.

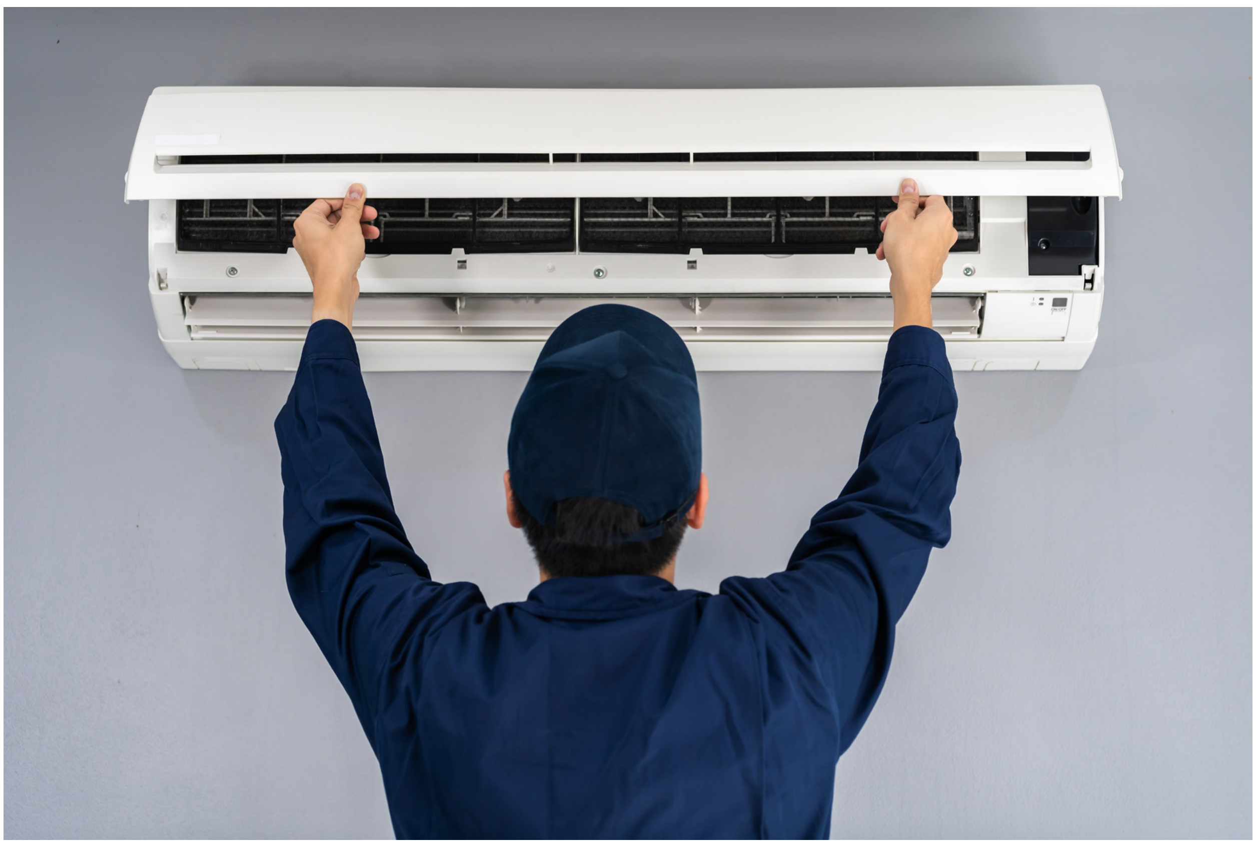
TIMELINE

- **May 2018**: Initiatied desk research
- **Aug 2018**: Toured Brazilian AC manufacturers and met with the Brazilian government
- **Oct 2018**: Delivered report, received comments, and incorporated them into final draft with key recommendations
- **Mar 2019**: Delivered and presented the labeling report. iCS led workshop on India's experience of adopting a new test metric capturing the benefits of inverter ACs
- **Sep 2019**: Attended technical committee meeting and proposed a way to adopt the new test metric based on the Indian experience. All parties accepted the proposal.
- **Jul 2020**: The new labeling policy comes into effect

POLICY OUTCOMES & IMPACT

Ultimately CLASP recommended an update to the labelling scheme that increased the minimum efficiency levels for “A class” labeled products, which are strongly preferred by Brazilian consumers. The new labelling scheme will be voluntary until 2022, after which the policy will increase the efficiency of room ACs by 52%. Again in 2025 levels will be increased to show a 108% improvement over current A-class models. These new levels are based on a new cooling seasonal performance metric that recognizes the efficiency benefits of inverter technologies, as CLASP recommended.

SUMMARY	
Technical Assistance Budget (USD)	$500,000
Timeframe (years)	3 (2017-2020)
CO_2e mitigated through 2030	21.5 Mt
Return on Investment (USD/ton CO_2e)	$0.023



Conclusion & Next Steps

Appliance energy efficiency programs and technical assistance are a cost-effective method for curbing energy demand and avoiding future emissions.

The case studies in this report all demonstrate a substantial return-on-investment from the technical assistance provided. Our case studies have costs ranging from USD 0.00008 to USD 0.929 per ton of CO_2e (Table 1). While the types of policies and markets served vary widely, the costs to deliver large-scale CO2e reductions are consistently low. Using a social cost of carbon of USD 51 per ton of CO_2e as a benchmark, it is clear that both national appliance energy efficiency programs and the technical assistance efforts supproting them are cost-effective.

Additional research is needed to capture a more thorough accounting of the ongoing administrative costs of appliance energy efficiency programs, so that governments can target the most efficient and effective approaches to policy development and enforcement. This report serves as a starting point to this endeavor but is limited in scope to largely CLASP-specific examples. We encourage other organizations to perform additional research in this area.

TABLE 1: SUMMARY OF RESULTS FROM CLASP CASE STUDIES

CASE STUDY	PRODUCTS	BUDGET (USD)	TIMEFRAME (YEARS)	SAVINGS THROUGH 2030 (MT CO_2E)	HIGH-END COSTS
India	Multiple	$7,600,000	10 (2010-2020)	240.0	$0.032
South Africa	LED Lighting	$100,000	2.5 (2018-2020)	12.8	$0.008
Kenya	Refrigerators & Room ACs	$250,000	2 (2016-2018)	0.27	$0.92
Pakistan	Electric Motors	$543,000	2 (2019-2020)	23.6	$0.0023
European Union	Televisions	$502,000	8 (2012-2020)	108.0	$0.0046
Brazil	Room ACs	$500,000	3 (2017-2020)	21.5	$0.023
Sweden	Lighting	$80,000	1 (2019)	101.5	$0.00008

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APPENDIX A

Static Cost of Policies

The static costs were taken from Gillingham and Stock's article, The Cost of Reducing Greenhouse Gas Emissions, published in Fall 2018 in the Journal of Economic Perspectives. The ROI of a variety of environmental policies are presented in the report, which can contextualize the return on investment data found in this report. However, it is important to note that the methodologies for calculating costs are different, and cannot be directly compared.

Note: The estimates presented in the table below are rounded two significant digits. The authors converted all estimates to 2017 dollars for comparability. See Appendix A-1 in the The Cost of Reducing Greenhouse Gas Emissions for sources and methods.

TABLE 2: STATIC COSTS OF POLICIES BASED ON A COMPILATION OF ECONOMIC STUDIES

POLICY	ESTIMATE ($2017/TON CO2E)
Behavioral energy efficiency	−190
Corn starch ethanol (US)	−18 to +310
Renewable Portfolio Standards	0–190
Reforestation	1–10
Wind energy subsidies	2–260
Clean Power Plan	11
Gasoline tax	18–47
Methane flaring regulation	20
Reducing federal coal leasing	33–68
CAFE Standards	48–310
Agricultural emissions policies	50–65
National Clean Energy Standard	51–110
Soil management	57
Livestock management policies	71
Concentrating solar power expansion (China & India)	100
Renewable fuel subsidies	100
Low carbon fuel standard	100–2,900
Solar photovoltaics subsidies	140–2,100
Biodiesel	150–250
Energy efficiency programs (China)	250–300
Cash for Clunkers	270–420
Weatherization assistance program	350
Dedicated battery electric vehicle subsidy	350–640

APPENDIX B

Historical US Policy Research

In a 2004 report, Respective Examination of Demand-Side Energy Efficiency Policies, Gillingham et. al. looked at low cost energy efficiency policies, including their effectiveness and costs to both the public and private sector. The report analyzes only appliance standards, financial incentives, and voluntary programs. As of publication in 2004, the report found that the programs mitigate 63 million MT of CO_2e. The report found the U.S. appliance standards program cost 3.8 cents/kWh.[39]

In a 1998 article, Projected regional impacts of appliance efficiency standards for the US residential sector, Koomey et. al. looks at the net present value of the costs and benefits of DOE's appliance standards. The team finds that over the lifetime of appliances and equipment, the present value of energy savings typically exceeds increased equipment prices by a factor of 2 or 3. Over time, these regulations have spurred innovation, and mass production has reduced manufacturer's costs for efficient designs.

The paper also analyzes the projected savings of DOE's appliance standards program between 1978 and 1996 and found that government costs have a present value of USD 201 million (1995$). This includes program costs for developing test procedures and standards and government staff salaries. In addition, for every dollar the U.S. government spends on implementing the standards, consumers save USD 165 (1995 present value.) Lastly, Koomey et. al. determined that the cost to implement the standards is less than the price of energy, so greenhouse gas reductions are achieved at a negative cost to society.

40. Gillingham, Newell, and Palmer 2004.

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