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Efficient Appliances for People & the Planet

Integrating Appliance Efficiency into Nationally Determined Contributions

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The Opportunity

There is a substantial gap between the pledges outlined in updated nationally determined contributions (NDCs) to the Paris Agreement and what is needed to prevent the worst impacts of climate change. Even with existing NDC commitments, the planet is on track to warm 2.7°C by the end of the century, well beyond the Paris Agreement's 1.5°C goal. [1]

Recognizing the urgent need for more ambitious action, all parties to the Paris Agreement are encouraged to strengthen their NDCs by COP27 in November 2022.[2] With just eight months before governments reconvene in Cairo, countries urgently need to put forth stronger climate pledges that will mitigate emissions in high-impact sectors.

One obvious area for greater ambition is appliance energy efficiency, representing a large and often underutilized mitigation pathway in NDCs. Buildings account for 28% of all energy-related CO2 emissions globally, and this share has been rising in recent years, largely due to the growing demand for heating, cooling, and appliances.[3] Final energy demand from appliances is projected to increase by 10% between 2020 and 2030 under a business as usual scenario due to rising demand in developing economies.[4]

Appliance efficiency policies are among the most commonly used and cost-effective mitigation tools available to governments. For decades, they have helped shift markets towards more efficient products. The IEA estimates that long-running efficiency policies save as much as 15% of national electricity consumption.[5] Research by CLASP on the administrative costs of running such programs demonstrates that appliance efficiency can deliver large emissions reductions for well below one US dollar per ton of CO2 (see Box 1 on page 8).[6]

The lion's share of energy savings from appliances and equipment can be achieved by targeting just four products: air conditioners (ACs), lighting, motors, and refrigerators. Doubling the efficiency of these products globally could prevent the release of 2.2 Gt of CO2 and close the emissions gap by 8% in 2030, reduce peak electricity demand, and lower strain on the electric grid (Figure 1, page 5).

1. United Nations Environment Programme, "Emissions Gap Report 2021: The Heat Is On – A World of Climate Promises Not Yet Delivered" (Nairobi, Kenya: United Nations Environment Programme and UNEP DTU Partnership, 2021), http://www.unep.org/resources/emissions-gap-report-2021.

2.UNFCCC, "Glasgow Climate Pact," 2021, https://unfccc.int/documents/310475.

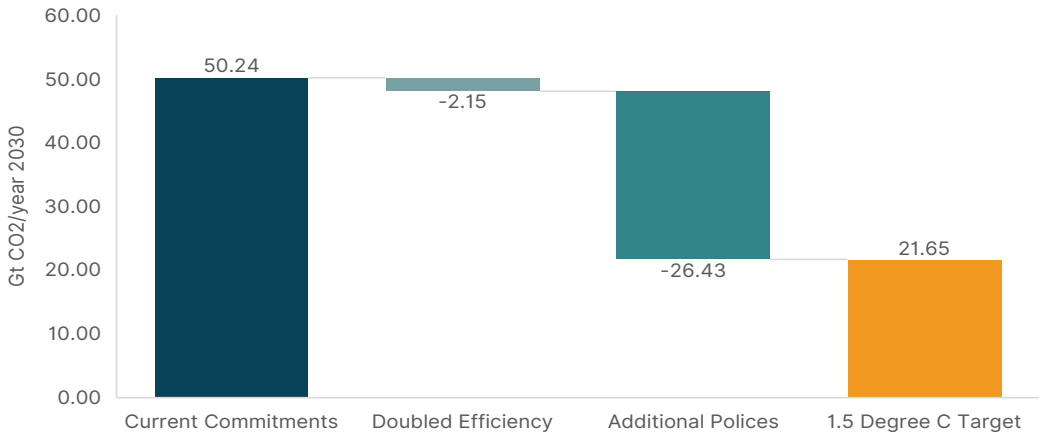
3. Thibaut Abergel and Chiara Delmastro, "Tracking Buildings 2020," Tracking Report (Paris, France: IEA, 2020), https://www.iea.org/reports/tracking-buildings-2020.

4. Appliances include: space heating equipment; air conditioners; residential refrigerator-freezers; ceiling and portable fans, televisions, and lighting.

5. IEA, "Appliances and Equipment," IEA, accessed August 27, 2021, https://www.iea.org/reports/appliances-and-equipment.

6. CLASP, "Pennies per Pound: The Return on Investment from Appliance Efficiency Technical Assistance" (Washington, DC: CLASP, 2021), https://www.clasp.ngo/research/all/pennies-per-pound-the-return-on-investment-from-appliance-efficiency-technical-assistance/.

FIGURE 1: POTENTIAL FOR DOUBLED APPLIANCE EFFICIENCY TO HELP CLOSE GLOBAL EMISSIONS GAP



Note: This graph shows the emissions gap under current NDCs. The bar on the far right ('1.5 Degree C target') shows estimated global annual emissions needed to stay on track with the Paris Agreement's 1.5° C target in 2030, while the bar on the far left ('Current Commitments') shows estimated annual emissions with current NDCs. The 'Doubled Efficiency' bar shows the emissions that could be mitigated by doubling the efficiency of four products (air conditioners, lighting, motors, and refrigerators). Finally, the 'Additional Policies' bar shows the remaining emissions that must be mitigated through new commitments. Please note the 'Doubled Efficiency' bar does not account for appliance policies already included in NDCs.

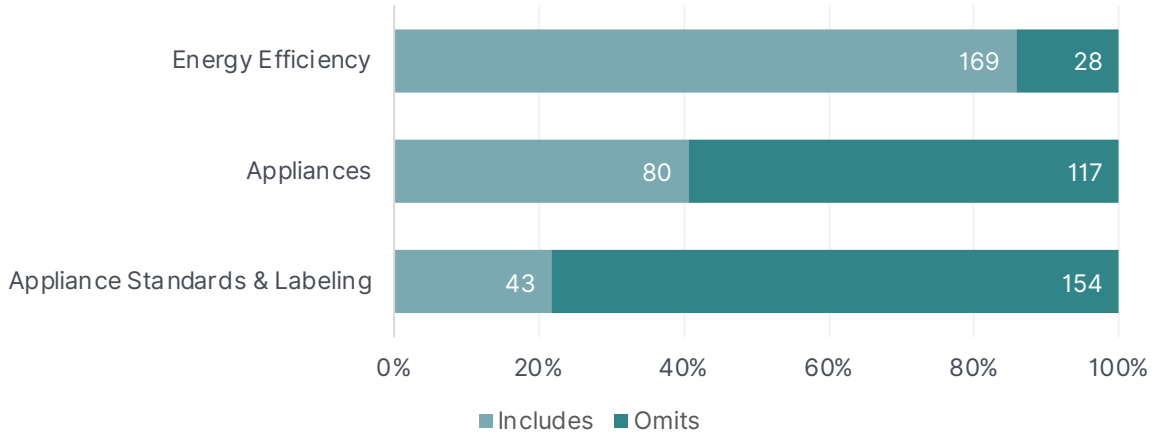
Appliances & Equipment in NDCs

NDCs provide an opportunity for countries to define their high-level climate agenda based on specific mitigation actions or emissions targets. They are critically important to achieving the goals of the Paris Agreement and often serve as an important catalyst for national climate policy.

Key Finding 1: Appliance efficiency policies are largely absent from NDCs. While 86% of governments cite energy efficiency in their NDC, only 61% mention appliance energy efficiency policies as a mitigation action (Figure 2).[7] Even fewer governments (22%) specifically mention minimum energy performance standards or energy labeling, the primary policy methods for improving product efficiency.

The omission of appliance energy efficiency references reflects a general lack of specificity among NDCs. For example, 80% of NDCs reference the transportation sector, but only 65% mention road transportation specifically, and even fewer call out specific mitigation actions like a shift to low- or zero-carbon fuels (30%).[8] Likewise, 75% of NDCs reference land-use change and forestry, but only 29% call out sustainable forest management as a mitigation tool.[9]

FIGURE 2: SHARE OF NDCS REFERRING TO ENERGY EFFICIENCY AND APPLIANCES



7. Source: Author's analysis. All NDCs were sourced from the World Resources Institute's Climate Watch tool. A keyword search was used to count the number of NDCs in each category as followed: energy efficiency (energy efficiency), appliances (air conditioner, appliance, dishwasher, electrical equipment, fan, freezer, heat pump, heating, label, labelling, LED, lightbulb, lighting, MEPS, minimum energy performance standard, motor, refrigerator, space heating, washing machine), appliance standards and labeling (label, labeling, MEPS, minimum energy performance standards, standards).

8. UNFCCC, "Nationally Determined Contributions under the Paris Agreement: Synthesis Report by the Secretariat," synthesis report (United Nations Framework Convention on Climate Change, 2021), 37–38, https://unfccc.int/documents/306848.

9. UNFCCC, 37–38.

Key Finding 2: 50% of governments with high mitigation potential within the buildings sector do not mention appliances in their NDCs. Closer analysis reveals new opportunities for future revisions. CLASP identified 20 economies where appliance standards and labeling policies can deliver large energy savings and climate impacts.[10] Of these countries, just over half (55%) directly mention appliances or appliance energy efficiency in their NDCs.

Similar trends emerge when analyzing the NDCs of governments already committed to improving appliance efficiency. The Super-Efficient Equipment and Appliances Deployment (SEAD) Initiative is a voluntary collaboration of governments working to promote the manufacture, purchase and use of energy-efficient lighting, appliances, and equipment worldwide.[11] Only 50% of SEAD members directly reference appliances or appliance energy efficiency policies in their NDCs.

The lack of inclusion of appliances in NDCs may reflect an oversight rather than a gap in mitigation efforts. For example, Australia and China, both SEAD members, do not reference appliance efficiency in their NDC despite having established energy efficiency programs that deliver savings proportionate to 5% of total electricity consumption annually.[12] Efforts like the SEAD Initiative's Product Efficiency Call to Action are working with SEAD member governments to deliver more ambitious commitments on appliance energy efficiency and develop policy roadmaps to ensure effective implementation (see Box 1, page 8).

Key Finding 3: 36% of governments have established appliance efficiency policies but fail to list appliance energy efficiency as a key mitigation action.[13] For example, the European Union (EU) does not mention appliance energy efficiency as a mitigation action despite its long-running and highly effective appliance efficiency policies, which are responsible for delivering savings close to 15% of total electricity consumption.[14] Likewise, Brazil and South Africa also have growing appliance efficiency programs but do not include appliance standards or labeling mitigation actions in their respective NDCs. Including targets or specific policies for appliances could drive more ambitious action, promote existing policies, and set an example for other governments.

10. Countries include: Australia, Brazil, Canada, Chile, China, the European Union, India, Indonesia, Japan, Mexico, Pakistan, the Philippines, Russia, South Africa, South Korea, Thailand, Turkey, the United Kingdom, the United States, and Vietnam.

11. As of August 2021, SEAD's member governments include: Argentina, Australia, Brazil, Canda, Chile, China, Colombia, Denmark, the European Commission, Germany, Ghana, India, Indonesia, Japan, Korea, Mexico, Nigeria, Russia, Saudi Arabia, South Africa, Sweden, and the United Kingdom.

12. IEA, "Achievements of Energy Efficiency Appliance and Equipment Standards and Labelling Programmes" (Paris, France: International Energy Agency, 2021), 5, https://www.iea.org/reports/achievements-of-energy-efficiency-appliance-and-equipment-standards-and-labelling-programmes.

13. Based on policy data in the CLASP Policy Resource Center (CPRC). For more: cprc-clasp.ngo.

14. IEA, "Achievements of Energy Efficiency Appliance and Equipment Standards and Labelling Programmes," 13.

Box 1: About the SEAD Product Efficiency Call to Action

Appliance and equipment energy efficiency offer great potential to abate carbon emissions and save consumers money on energy bills. Recognizing this potential, the SEAD Initiative, International Energy Agency (IEA), CLASP, and the United Kingdom Department for Business, Energy and Industrial Strategy (UK BEIS) launched the Product Efficiency Call to Action (Call to Action) at COP 26 in November 2021. The Call to Action urges governments to commit to fast, ambitious action on appliance and equipment energy efficiency. It has two aims:

1. Drive international action to double the efficiency of the four highest energy-consuming products sold globally by 2030; and

2. Strengthen the SEAD initiative to support countries in achieving raised ambition quickly, easily, and at a lower cost.

To date, 14 countries[15] have signed the Call to Action with the potential to avoid 4.2 Gt of CO2 emissions over ten years, equivalent to the emissions produced by 465 medium coal-fired power plants.[16] Global support of the Call to Action could reduce energy consumption by 6,700 TWh per year, equivalent to the generation of more than 3,000 medium-sized coal-fired power plants, and avoid 2.9 Gt of CO2 emissions per year.

Beginning in 2022, Call to Action signatories will develop national roadmaps for how they plan to deliver the Call to Action, including concrete steps and targets for doubling product efficiency. Policy roadmaps will, where appropriate, leverage existing international test methods and standards, and use existing performance tiers based on international standards. They may also aim to align with other priorities such as National Cooling Action Plans.

Learn more about the SEAD Product Efficiency Call to Action.

15. Signatories include: Australia, Brazil, Chile, Colombia, Denmark, Germany, Ghana, India, Indonesia, Japan, Korea, Nigeria, Sweden and the United Kingdom.

16. CLASP, "Press Release: Product Efficiency Call to Action Becomes Largest Global Commitment to Appliance & Equipment Energy Efficiency Ever" (CLASP, 2021), https://www.clasp.ngo/updates/press-release-product-efficiency-call-to-action-becomes-largest-global-commitment-to-appliance-equipment-energy-efficiency-ever/.

Closing the Emissions Gap: Recommendations for Governments

Appliance efficiency can play a critical role in delivering the goals of the Paris Agreement if governments take the following steps:

1. Update their NDC with ambitious and specific targets for appliance energy efficiency, and

2. Establish or expand national appliance efficiency programs to implement and enforce policies and achieve the targets outlined in their NDC and national policies

RECOMMENDATION 1: UPDATE NDCS WITH AMBITIOUS TARGETS APPLIANCE ENERGY EFFICIENCY

Governments should include specific emissions targets for appliances that cover the indirect reductions that stem from reducing product energy demand. Setting concrete targets for the emissions reductions that can be achieved through appliance efficiency programs not only clarifies how governments plan to achieve high-level climate goals, but also signals to other national priorities.

Governments should include specific targets for direct GHG emissions for select appliances. This may include targets for f-gases (refrigerators and air conditioners, see Box 2, page 10) and black carbon (cookstoves). WRI's Working Paper, Strengthening Nationally Determined Contributions to Catalyze Actions That Reduce Short-Lived Climate Pollutants, offers recommendations for ensuring targets for these pollutants are considered and appropriately reflected in NDCs.

Finally, governments should address how they will ensure compliance with policies to safeguard the energy and climate benefits of appliance efficiency programs. Appliance energy efficiency programs can lose up to 25% of expected energy savings when products do not perform as claimed.[17] Therefore, strategic compliance programs are critical to ensuring the energy and emissions targets outlined in NDCs are met.

When deciding which appliances to prioritize, governments should target the products with the highest potential impact first. Air conditioners, lighting, industrial motors and refrigerators are responsible for 40% of global electricity consumption and produce 5 Gt of global CO2 emissions each year—roughly equivalent to the total emissions produced by the United States in 2020.[18] Endorsing existing initiatives like SEAD Product Efficiency Call to Action—which aims to double the efficiency of residential air conditioners, residential lighting, industrial motors, and residential refrigerators (see Box 1 on page 8)—is a

17. A 2010 study estimated the rate of non-compliance in the United Kingdom to be around 10 to 15% at manufacturing level (failure to meet the claim on the label) and 20% at retail level (absent or incorrect labelling). See Defra Market Transformation Programme Compliance Strategy, available at http://efficient-products.defra.gov.uk/compliance. Australian compliance rates are estimated at around 85%. See IEA Policy Pathways: Monitoring, Verification and Enforcement 2010, available at: https://www.iea.org/publications/freepublications/publication/monitoring.pdf. In new or developing programs with no compliance framework, non-compliance are assumed to be significantly higher.

18. EIA, "In 2020, the United States Produced the Least CO2 Emissions from Energy in Nearly 40 Years," US Energy Information Agency, 2021, https://www.eia.gov/todayinenergy/detail.php?id=48856.

Box 2: Addressing Cooling Appliances in NDCs

Human-caused climate change is increasing the frequency and intensity of extreme heatwaves. By 2050, 70% of the world's population could experience severe heat waves.[19] Energy demand for space cooling is expected to more than triple by 2050 when more than 1 billion air conditioners will be in use globally.[20]

The cooling sector is a ticking climate bomb. A rise in demand will increase both direct greenhouse gas emissions from short-lived climate pollutants (f-gases) and indirect emissions from electricity use (CO2).

NDCs must address both f-gases and indirect CO2 emissions for all cooling appliances. More than 120 countries have already agreed through the Kigali Amendment to the Montreal Protocol to phase down HFCs (one of the most potent f-gases), and some have put forth national cooling action plans (NCAPs) to promote sustainable cooling and improve cooling efficiency.

Including NCAPs and specific targets for direct and indirect emissions in NDCs will align national efforts across two major international treaties and ensure better outcomes for cooling efficiency. The Clean Cooling Collaborative's report, How Countries Can Enhance Nationally Determined Contributions in 2021 with Climate-Friendly Cooling, contains real-world examples and actionable steps for governments.

19. Chatham House, "Climate Change Risk Assessment 2021" (London, 2021), https://www.chathamhouse.org/2021/09/climate-change-risk-assessment-2021/03-direct-climate-impacts.

20. IEA, "The Future of Cooling" (Paris, France, 2018), https://www.iea.org/reports/the-future-of-cooling.

promising starting point. By endorsing the SEAD Product Efficiency Call to Action and/or incorporating the target of doubled efficiency into NDCs, governments can work toward a common goal and coordinate efforts to improve appliance efficiency.

Governments may wish to complement conventional policy targets with forward-facing goals that drive innovation and push products toward higher power performance. Technologies like wide bandgap (WBG) semiconductors[21] have the potential to save 100 Terawatt hours (TWh) per year, equivalent to the annual energy consumption of the Netherlands.[22] The IEA Technology Collaboration Programme on Energy Efficient End-Use Equipment's (4E) Power Electronic Conversion Technology Annex (PECTA) is coordinating a range of tasks to promote WBG semiconductors, including the development of a roadmap and range of policy measures for governments. Electing to engage with PECTA or eventually adopt policy measures for emerging technologies can enrich an ambitious policy commitment beyond conventional approaches.

RECOMMENDATION 2: ESTABLISH OR EXPAND APPLIANCE EFFICIENCY POLICIES

National climate roadmaps and policies must support and reinforce the mitigation pathways and targets outlined in NDCs. Governments can develop national roadmaps with concrete steps and milestones for improving appliance efficiency. Standards and labeling programs are the primary vehicles for delivering large reductions in energy consumption and emissions. Where appropriate, roadmaps should leverage existing international test methods and standards, use existing performance tiers based on international standards, and align with other roadmaps, such as National Cooling Action Plans.

Adopting a ladder approach for efficiency policies will help governments chart a clear pathway for raising ambition over time and enable harmonization across multiple economies. Through the SEAD Product Efficiency Call to Action, the IEA developed an energy efficiency ladder to help governments determine the appropriate steps for minimum energy performance standards (MEPS), label thresholds for categorical and endorsement labels, high energy performance standards for incentives, and aspirational targets for research and development. To develop the ladder, a party must a) agree on a testing procedure to measure energy efficiency, b) define efficiency thresholds (i.e., the different rungs on the ladder), c) map existing efficiency requirements on the ladder, and d) set new targets for how products will 'climb the ladder.'

When considering a ladder approach for electric motors, for example, a country or set of countries may agree to use an internationally agreed-upon testing procedure (IEC 60034-2-1) to measure efficiency and employ an International Efficiency (IE) classification scheme (IEC 60034-30-1) to set different levels for

21. Wide bandgap semiconductors leverage materials like silicon carbide (SiC) and gallium nitride (GaN) and have a larger bandgap than conventional semi-conductors, allowing them to power devices to operate a higher voltages, temperatures and frequencies. Potential applications for wide bandgap semiconductors include: data centers, electric vehicles, laptops, mobile phones, and renewable energy generation.

22. IEA, "The Energy Efficiency Potential and Application Readiness of Wide Band Gap Technology," Policy Brief (Paris, France: International Energy Agency, 2020), 2, https://www.iea-4e.org/wp-content/uploads/publications/2020/12/4E-Policy-Brief-PECTA-1-271120.pdf

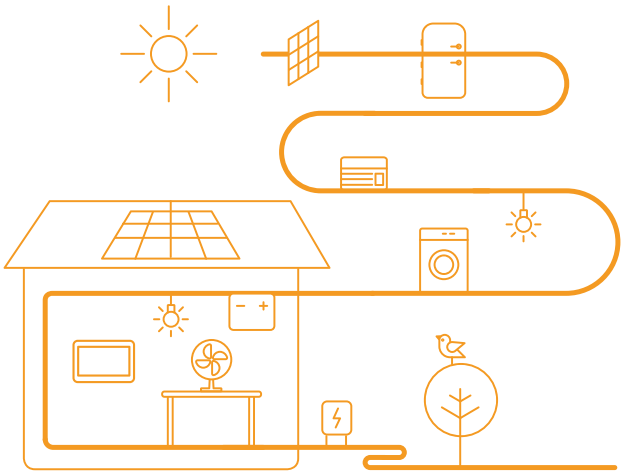
MEPS and comparative labels. Countries could then set future MEPS for moving up the ladder and implement them at different times based on market conditions. When developing a policy ladder for other products, governments should also consult international testing procedures and model regulations (see below).

RESOURCES FOR GOVERNMENTS

A number of tools exist for governments to design and assess the impact of new policies or policy ladders and promote policy compliance. When developing an efficiency program, policymakers may wish to review existing and model regulations. The CLASP Policy Resource Center is the most comprehensive hub for existing regulations. It contains over 1400 energy efficiency, water efficiency, and quality standards for appliances and equipment, spanning 14 product categories and 120 economies. Additionally, United for Efficiency's model regulation guidelines for air conditioners, distribution transformers, electric motors, lighting, and refrigerators contain voluntary guidelines in emerging economies considering a regulatory or legislative framework for appliances and equipment. They cover product scope, test methods, minimum efficiency levels and a set of minimum performance requirements, and market surveillance.

Mepsy, CLASP's climate and impact calculator, enables governments to assess the energy and climate impacts of a specific policy for seven products: air conditioners, fans, televisions, lighting, motors, refrigerators, and space heating. The tool enables users to define custom shipment, equipment, economic, energy sector, and market data to refine estimate more realistic policy scenarios.

CLASP also maintains several resources to help policymakers formulate and implement compliance strategies at all stages. Topics include conformity assessment (which protects suppliers' competitiveness by ensuring that they are all subject to the same robust market entry conditions); market surveillance (which identifies and checks potential non-compliance cases); and enforcement (which establishes a system to prove and rectify cases of non-compliance). CLASP will publish its compliance resources in a comprehensive toolkit for governments in September 2022.



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Appendix A: Appliances in Nationally Determined Contributions to the Paris Climate Agreement

Country	CO_2 emissions, 2020 (Mt)[23]	Share of global CO_2 emissions, 2020 (%)[24]	CO_2 emissions from appliances & equipment, 2020 (Mt)[25]	Final energy consumption from appliances & equipment, 2020 (TWh)[26]	NDC mentions energy efficiency[27]	NDC mentions appliances or appliance efficiency policies[28]	NDC mentions appliance standards and labeling[29]
Afghanistan	11.95	0.03	-	-	✓	✓	✓
Albania	5.10	0.01	0.30	5.11		✓	✓
Algeria	163.47	0.45	27.00	70.71	✓		
Andorra	0.46[30]	0.00	-	-	✓	✓	
Angola	22.51	0.06	-	-	✓	✓	
Antigua and Barbuda	0.46	0.00	-	-	✓	✓	✓
Argentina	176.51	0.49	45.05	141.32	✓	✓	
Armenia	5.82	0.02	1.89	6.78	✓		
Australia	386.44	1.07	51.20	130.80	✓		
Austria	63.69	0.18	25.44	152.87	✓		
Azerbaijan	33.89	0.09	7.93	17.10	✓	✓	
Bahamas	1.89	0.01	0.68	1.35	✓		
Bahrain	36.67	0.10	5.39	15.04	✓		
Bangladesh	108.50	0.30	30.55	53.87	✓	✓	
Barbados	1.14	0.00	0.33	0.63	✓	✓	✓
Belarus	58.97	0.16	15.26	57.82	✓		
Belgium	84.08	0.23	34.82	177.32	✓		
Belize	0.40	0.00	0.23	0.67	✓		
Benin	7.35	0.02	1.58	2.00	✓	✓	✓
Bhutan	1.46	0.00	0.1	2.3	✓	✓	
Bolivia	20.64	0.06	7.11	19.8	✓		

23. European Commission. Joint Research Centre., GHG Emissions of All World: 2021 Report. (LU: Publications Office, 2021), https://data.europa.eu/doi/10.2760/173513.

24. European Commission. Joint Research Centre.

25. CLASP, "Mepsy: The Appliance & Equipment Climate Impact Calculator" (CLASP, 2021), https://clasp.shinyapps.io/mepsy/.

26. Author's analysis. All NDCs were sourced from the World Resources Institute's Climate Watch tool. Keyword search: energy efficiency.

27. Author's analysis. All NDCs were sourced from the World Resources Institute's Climate Watch tool. Keyword search: air conditioner, appliance, dishwasher, electrical equipment, fan, freezer, heat pump, heating, label, labelling, LED, lightbulb, lighting, MEPS, minimum energy performance standard, motor, refrigerator, space heating, washing machine.

28. Author's analysis. All NDCs were sourced from the World Resources Institute's Climate Watch tool. Keyword search: label, labeling, MEPS, minimum energy performance standards, standards.

29. Hannah Ritchie and Max Roser, "CO_2 and Greenhouse Gas Emissions," Our World in Data, May 11, 2020, https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions#co2-and-greenhouse-gas-emissions-country-profiles.

Bosnia and Herzegovina	23.43	0.07	4.98	5.11	✓		
Botswana	7.05	0.02	6.48	10.94			
Brazil	451.80	1.26	97.46	401.7	✓		
Brunei	7.98	0.02	0.94	2.15	✓		
Bulgaria	38.01	0.11	11.68	28.11	✓		
Burkina Faso	3.25	0.01	1.62	2.41	✓		
Burundi	0.29	0.00	0.20	0.61	✓		
Cabo Verde	0.80	0.00	0.18	0.30	✓	✓	
Cambodia	15.82	0.04	4.84	6.91	✓	✓	✓
Cameroon	9.31	0.03	2.18	6.23	✓	✓	✓
Canada	542.79	1.51	167.87	728.44	✓	✓	
Central African Republic	0.35	0.00	0.08	0.32			
Chad	0.82	0.00	0.87	1.23		✓	
Chile	84.56	0.24	27.47	100.44	✓	✓	✓
China	11680.42	32.48	1975.41	4191.88	✓	✓	✓
Colombia	90.25	0.25	10.76	42.32	✓	✓	
Comoros	0.25	0.00	0.18	0.26	✓		
Comoros	0.25	0.00	7.42	13.76	✓		
Congo	6.18	0.02	3.66	6.41		✓	
Cook Islands	0.06	0.00	-	-			
Costa Rica	7.82	0.02	1.17	7.14	✓	✓	✓
Côte d'Ivoire	12.10	0.03	4.65	8.4	✓		
Croatia	17.70	0.05	45.49	222.01	✓		
Cuba	22.94	0.06	-	-	✓		
Cyprus	6.27	0.02	3.81	8.57	✓		
Czechia	92.08	0.26	30.11	84.04	✓		
Democratic Republic of the Congo	3.23	0.01	0.15	2.93			
Denmark	25.71	0.07	17.80	75.64	✓		
Djibouti	0.85	0.00	0.34	0.49	✓	✓	
Dominica	0.15	0.00	-	-	✓	✓	
Dominican Republic	29.09	0.08	-	-	✓	✓	✓

Ecuador	33.28	0.09	5.80	12.34	✓		
Egypt	269.55	0.75	61.38	162.76	✓	✓	✓
El Salvador	6.79	0.02	2.61	6.58	✓		
Equatorial Guinea	4.28	0.01	0.93	1.55			
Eritrea	0.73	0.00	1.63	1.91	✓	✓	
Estonia	14.37	0.04	4.51	6.23	✓		
Eswatini	1.46	0.00	0.04	1.01	✓	✓	
Ethiopia	17.01	0.05	5.86	38.66			
European Union (EU-27)	2621.85	7.29	-	-	✓		
Federated States of Micronesia	0.18[31]	0.00	-	-			
Fiji	2.38	0.01	0.24	0.52	✓		
Finland	40.70	0.11	14.49	76.41	✓		
France and Monaco	279.99	0.78	131.75	874.99	✓		
Gabon	5.95	0.02	1.19	2.19	✓		
Georgia	10.44	0.03	2.88	13.57	✓		
Germany	636.88	1.77	469.69	1524.38	✓		
Ghana	16.52	0.05	4.92	10.37	✓		
Greece	56.13	0.16	46.84	130.46	✓		
Grenada	0.18	0.00	-	-	✓		
Guatemala	19.62	0.05	4.83	10.32			
Guinea	2.77	0.01	1.1	2.1	✓		
Guinea-Bissau	0.29	0.00	0.18	0.26	✓	✓	
Guyana	1.52	0.00	0.35	0.44	✓	✓	
Haiti	3.01	0.01	8.68	4.33	✓		
Honduras	10.63	0.03	2.44	4.31	✓		
Hungary	49.41	0.14	16.22	74.52	✓		
Iceland	3.17	0.01	0.26	4.53			
India	2411.73	6.71	632.81	911.66	✓	✓	✓
Indonesia	568.27	1.58	130.09	183.43	✓	✓	

31. WRI, "Climate Watch Historical GHG Emissions," 2021, https://www.climatewatchdata.org/.

Iran	690.24	1.92	92.02	262.95	✓		
Iraq	191.30[32]	0.53	-	-			
Ireland	32.65	0.09	34.51	143.75	✓		
Israel and Palestine, State of	62.42	0.17	23.39	77.75	✓		
Italy	297.35	0.83	173.17	743.57	✓		
Jamaica	7.88	0.02	2.52	3.33	✓		
Japan	1061.77	2.95	269.28	856.17	✓	✓	✓
Jordan	26.48	0.07	7.69	18.33	✓	✓	
Kazakhstan	267.10	0.74	44.86	107.95	✓		
Kenya	16.41	0.05	6.04	14.84	✓		
Kiribati	0.06	0.00	-	-	✓		
Kuwait	89.97	0.25	13.40	33.50			
Kyrgyzstan	11.46	0.03	7.28	35.71			
Laos	41.84	0.12	3.22	6.00	✓		
Latvia	7.45	0.02	3.22	13.54	✓		
Lebanon	26.77	0.07	8.17	16.62	✓		
Lesotho	0.65	0.00	1.51	7.40	✓	✓	✓
Liberia	1.26	0.00	-	-	✓	✓	✓
Libya	52.61	0.15	-	-			
Liechtenstein	0.14[33]	0.00	-	-			
Lithuania	13.55	0.04	4.61	19.69	✓		
Luxembourg	8.00	0.02	2.39	11.91	✓		
Madagascar	4.25	0.01	0.93	2.27	✓		
Malawi	1.38	0.00	0.05	1.17		✓	
Malaysia	262.17	0.73	40.39	78.07			
Maldives	1.67	0.00	0.25	0.42	✓		
Mali	3.48	0.01	1.65	2.71	✓		
Malta	1.55	0.00	2.21	4.72	✓		
Marshall Islands	0.19	0.00	-	-	✓		
Mauritania	2.67	0.01	0.65	1.16	✓	✓	
Mauritius	3.63	0.01	1.31	2.20	✓		

32. WRI.

33. Ritchie and Roser, "CO_2 and Greenhouse Gas Emissions."

Mexico	407.70	1.13	71.79	209.36	✓		
Moldova	8.49	0.02	1.58	3.21	✓	✓	
Monaco	NA	NA	-	-	✓		
Mongolia	38.23	0.11	10.37	38.66			
Montenegro	2.52[34]	0.01	-	-	✓	✓	✓
Morocco	67.75	0.19	22.44	47.52	✓	✓	✓
Mozambique	9.94	0.03	0.52	3.34			
Myanmar/ Burma	37.71	0.10	-	-	✓	✓	✓
Namibia	4.01	0.01	1.12	6.2	✓	✓	✓
Nauru	0.07[35]	0.00	-	-	✓	✓	
Nepal	17.89	0.05	4.15	24.11	✓		
Netherlands	144.69	0.40	52.49	259.95	✓		
New Zealand	33.03	0.09	6.38	33.54	✓		
Nicaragua	5.10	0.01	1.11	2.01	✓		
Niger	2.16	0.01	1.73	1.93	✓		
Nigeria	126.92	0.35	43.96	93.36	✓		
Niue	0.11[36]	0.00	-	-	✓	✓	✓
North Korea	32.24	0.09	-	-	✓		
Norway	42.18	0.12	13.86	106.22			
Oman	87.05	0.24	5.46	12.69	✓	✓	✓
Pakistan	217.02	0.60	71.34	187.77	✓	✓	✓
Palau	1.24	0.00	-	-	✓	✓	✓
Panama	9.30	0.03	3.46	8.16	✓	✓	✓
Papua New Guinea	7.26	0.02	1.09	2.12	✓	✓	✓
Paraguay	7.84	0.02	0.74	9.91	✓		
Peru	44.48	0.12	20.16	71.01			
Philippines	139.16	0.39	35.55	65.03			
Poland	292.56	0.81	91.73	240.74	✓		
Portugal	40.43	0.11	23.19	90.93	✓		
Qatar	99.49	0.28	-	-	✓	✓	✓
Republic of North Macedonia	7.37	0.02	3.18	3.91	✓	✓	✓

34. WRI, "Climate Watch Historical GHG Emissions."

35. WRI.

36. Ritchie and Roser, "CO_2 and Greenhouse Gas Emissions."

Romania	75.80	0.21	25.79	98.51	✓		
Russia	1674.23	4.66	248.14	825.01	✓		
Rwanda	1.01	0.00	0.77	1.56	✓	✓	
Saint Kitts and Nevis	0.14	0.00	-	-			
Saint Lucia	0.29	0.00	-	-	✓	✓	
Saint Vincent and the Grenadines	0.12	0.00	-	-	✓	✓	✓
Samoa	0.36	0.00	-	-	✓	✓	
San Marino	-	-	-	-			
São Tomé and Príncipe	0.13	0.00	-	-	✓		
Saudi Arabia	588.81	1.64	98.28	189.56	✓	✓	
Senegal	10.06	0.03	2.44	3.56	✓	✓	✓
Serbia and Montenegro	77.53	0.22	-	-			
Seychelles	1.18	0.00	-	-	✓	✓	✓
Sierra Leone	1.01	0.00	0.27	0.55	✓		
Singapore	56.11	0.16	8.23	32.04	✓		
Slovakia	31.87	0.09	9.51	48.93	✓		
Slovenia	13.78	0.04	8.30	31.17	✓		
Solomon Islands	0.31	0.00	0.04	0.06	✓	✓	✓
Somalia	0.77	0.00	-	-	✓	✓	
South Africa	435.13	1.21	79.53	120.10	✓		
South Korea	621.47	1.73	138.89	518.58	✓	✓	✓
South Sudan	1.38[37]	0.00	-	-	✓	✓	
Spain and Andorra	214.85	0.60	109.55	458.16	✓		
Sri Lanka	23.73	0.07	11.11	22.74	✓	✓	✓
Sudan	20.2[38]	0.06	2.32	4.64	✓	✓	
Suriname	1.64[39]	0.00	0.36	0.63	✓	✓	✓
Sweden	42.30	0.12	7.86	91.58	✓		
Switzerland	35.30	0.10	20.2	150.26			
Syria	25.57	0.07	9.19	20.86	✓		
Tajikistan	9.00	0.03	1.21	8.30	✓	✓	

37. WRI, "Climate Watch Historical GHG Emissions."
38. WRI.
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Tanzania	11.47	0.03	5.42	9.49	✓		
Thailand	255.46	0.71	77.41	184.87	✓		
The Gambia	0.52	0.00	0.21	0.29	✓	✓	✓
Timor-Leste	1.01	0.00	-	-	✓	✓	
Togo	2.84	0.01	0.35	0.93	✓		
Tonga	0.12	0.00	-	-	✓	✓	✓
Trinidad and Tobago	30.27	0.08	1.58	3.57	✓		
Tunisia	28.59	0.08	6.36	15.36	✓		
Turkey	405.20	1.13	136.39	477.17	✓		
Turkmenistan	80.64	0.22	8.44	10.10	✓		
Tuvalu	0.01[40]	0.00	-	-	✓	✓	✓
Uganda	5.35	0.01	0.73	4.93	✓		
Ukraine	189.30	0.53	91.05	311.30	✓		
United Arab Emirates	203.14	0.56	31.19	79.06	✓	✓	✓
United Kingdom	313.73	0.87	177.57	831.77	✓	✓	✓
United States	4535.30	12.61	1029.10	4168.94	✓	✓	
Uruguay	5.88	0.02	3.27	16.46	✓	✓	✓
Uzbekistan	90.37	0.25	23.26	62.74	✓		
Vanuatu	0.17	0.00	-	-	✓		
Venezuela	88.95	0.25	26.18	50.7	✓	✓	✓
Vietnam	321.93	0.90	36.39	92.55	✓	✓	
Yemen	10.32	0.03	3.88	4.48	✓	✓	✓
Zambia	7.50	0.02	1.50	9.35	✓		
Zimbabwe	11.56	0.03	6.95	11.12	✓	✓	

40. WRI.

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