

How to Modernize Canada's Energy Efficiency Act

Sarah Riddell, Matt Malinowski, and Vivian Cox



How to Modernize Canada's Energy Efficiency Act

International Lessons for Updating Canada's Appliance and Equipment Efficiency Legislation for This Century

Sarah Riddell, Matt Malinowski, Vivian Cox

Suggested citation

Riddell, S., Malinowski, M., Cox, V. 2024. How to Modernize Canada's Energy Efficiency Act. Efficiency Canada, CLASP, Carleton University, Ottawa, ON.

© Efficiency Canada
c/o Carleton University
1125 Colonel By Drive
Ottawa, ON K1S 5B6
<https://www.energycanada.org>

Facebook: <https://facebook.com/EfficiencyCanada>

LinkedIn: <https://linkedin.com/company/efficiency-canada>

Instagram: <https://instagram.com/efficiencycanada>

Table of contents

Acknowledgements	3
About the authors	4
About Efficiency Canada	5
About CLASP	5
Summary	6
Introduction	9
Ensuring meaningful progress	13
1. Mandatory review cycles	13
2. Codifying no backsliding on standards	17
Rethinking product categories to promote efficiency	19
3. Enabling broader definitions	19
4. Leveling the playing field between fuel sources	21
Broadening the scope	25
5. Setting standards for greenhouse gas emissions and other pollutants	25
6. Considering system efficiency	27
7. Requiring demand flexibility	30
Updating mandatory EnerGuide labelling	34
8. Improved label design	34
9. Digital labelling	41
10. Expanded product categories	43
Conclusion	45
Bibliography	46
Appendix	57

Acknowledgements

Thank you to The Atmospheric Fund for supporting this research.



Thank you to Brendan Haley, Senior Director of Policy Strategy, and James Gaede, Director of Research, at Efficiency Canada, for reviewing, brainstorming, and writing assistance.

Thank you to the following external reviewers for your valuable insights:

Duncan Gibb, Regulatory Assistance Project

Joanna Mauer, Appliance Standards Awareness Project

Ekaterina Tzekova, The Atmospheric Fund

Joseph Vukovich, J.D., MPP

About the authors

Sarah Riddell is the Policy Research Associate, Clean Heat at Efficiency Canada. Prior to joining Efficiency Canada, she worked in commercial energy management, working to decarbonize federal buildings in British Columbia and the Yukon. Sarah has a BSc. in Agricultural and Environmental Economics from McGill University, with a focus on the economics of climate change.

Matt Malinowski is the Buildings Director at the American Council for an Energy- Efficient Economy (ACEEE), overseeing the Program and implementing ACEEE's strategic vision for buildings research and policy activities to create a low-carbon, equitable, and affordable buildings sector in the United States. He joined ACEEE in 2024. Prior to joining ACEEE, Matt worked at CLASP where he was the Director of Climate Research, responsible for modeling climate impacts of appliances and equipment and identifying new opportunities for mitigation. Before that, he supported U.S., Canadian, and international government appliance efficiency programs at CLASP, ICF, and Guidehouse (formerly Navigant Consulting). Matt earned a master's of engineering in electrical engineering and computer science and a bachelor's of science in electrical science and engineering from the Massachusetts Institute of Technology (MIT).

Vivian Cox currently serves as a Senior Climate Policy Analyst for CLASP and works from her home office in Upstate New York. She has a background in working on HVAC/R appliance standards, particularly related to refrigeration equipment and the refrigerant phasedown. Vivian has a bachelor's degree in environmental biology and international development and is completing her master's in environmental policy at the University of Denver.

Copyediting: Aidan Belanger, Communications Specialist

Web: Aidan Djabarov, Communication Specialist

Cover: Hailey David, Communications Intern

Design: Hailey David, Communications Intern

About Efficiency Canada

Efficiency Canada is the national voice for an energy-efficient economy. Our mission is to create a sustainable environment and better life for all Canadians by making our country a global leader in energy efficiency policy, technology, and jobs. Efficiency Canada is housed at Carleton University's Sustainable Energy Research Centre, which is located on the traditional unceded territories of the Algonquin nation.

About CLASP

CLASP is the leading global authority on efficient appliances' role in fighting climate change and improving people's lives. With 25 years of expertise and offices on four continents, CLASP collaborates with policymakers, industry leaders, and other experts to deliver clear pathways to a more sustainable world for people and the planet.

The views expressed, as well as any errors or omissions, are the sole responsibility of the authors.

Summary

Canada's Energy Efficiency Act was passed in 1992, enabling the making of Energy Efficiency Regulations, which set minimum energy performance standards and labelling requirements for more than sixty categories of appliances and equipment in Canada.

The Energy Efficiency Act was amended twice in 2009 and 2017 to regulate standby power and to facilitate harmonization with the U.S., respectively, but has otherwise remained unchanged. Drawing on what energy efficiency legislation looks like in other jurisdictions, this report suggests ten ways that Canada's Energy Efficiency Act could be modernized for the 21st century.

Ensuring Meaningful Progress

- | | |
|--|---|
| 1. Mandatory review cycles | <ul style="list-style-type: none">• A six-year mandatory review cycle for efficiency standards would ensure regular progress if a technologically feasible and economically justifiable improvement exists. |
| 2. Codifying no backsliding on standards | <ul style="list-style-type: none">• Adding an anti-backsliding provision to the Energy Efficiency Act would ensure efficiency standards are only strengthened over time, never weakened.• While Canada is increasingly harmonizing with the U.S., important to maintain standards in categories that Canada leads in (residential gas furnaces, electric coil cooktops). |

Rethinking Product Categories to Promote Efficiency

- | | |
|--|--|
| 3. Enabling broader definitions | <ul style="list-style-type: none">• Heat pumps – one of the best technologies for reducing energy use and emissions from space heating – should be required instead of new or replacement residential central air conditioners (CACs).• Folding CACs and heat pumps under one definition would enable households to enjoy the same cooling provided by CACs as well as highly efficient heating. |
| 4. Leveling the playing field between fuel sources | <ul style="list-style-type: none">• Avoid siloed categorization that unfairly advantages oil and gas appliances, which are unable to achieve the efficiency levels that electric appliances can.• Appliance and equipment categories grouped by function and design rather than fuel source (common regulations for space heating rather than separate rules for air-source heat pumps and gas furnaces, for example) |

Broadening the Scope

- | | |
|---|---|
| 5. Setting standards for greenhouse gas emissions (GHGs) and other pollutants | <ul style="list-style-type: none">• GHGs and other pollutants should be explicitly regulated, rather than just a co-benefit.• Instantaneous gas water heaters and gas stoves release potent GHGs and indoor air pollutants (unburnt methane and NOx) that cannot be corrected with energy efficiency standards alone. |
| 6. Considering System Efficiency | <ul style="list-style-type: none">• Expanding the Energy Efficiency Act to be able to regulate the efficiency of systems (hybrid heating systems, motors + variable frequency drives (VFDs), clothes washers + dryers, etc.), rather than just the individual appliances and equipment, can achieve far greater energy savings.• A U.S. study estimated that universal VFD integration would reduce the motor energy consumption of motor systems by 11 per cent nationally. |
| 7. Requiring demand flexibility | <ul style="list-style-type: none">• Every electric storage water heater (ESWH) sold should have the controls and connectivity necessary to participate in automatic demand response (ADR) programs• ESWHs, which almost half of Canadians already have in their homes, can act as thermal batteries, allowing households to be paid to participate in ADR, lowering peak demand on the grid, without interrupting hot water supply. |

Updating Mandatory EnerGuide Labelling

- | | |
|---------------------------------|---|
| 8. Improved label design | <ul style="list-style-type: none">• Categorical labels (e.g. 1-5 stars or letters A-G) are easier for consumers to understand compared to the current continuous label.• Wider categories (e.g. all fridge-freezers vs. narrow model categories) give consumers a better idea of the comparative efficiency of products. |
| 9. Digital labelling | <ul style="list-style-type: none">• As a growing percentage of appliance sales are happening online, online retailers should be required to display the EnerGuide label on the product webpage. |
| 10. Expanded product categories | <ul style="list-style-type: none">• Mandatory EnerGuide labelling should be expanded to more product categories, including space and water heating, televisions, gas cooking appliances, lighting products, microwave ovens, and dehumidifiers, among others. |
-

Introduction

Canada's *Energy Efficiency Act* was passed in 1992, enabling the making and enforcement of energy efficiency standards for energy-using appliances and equipment, the EnerGuide labels associated with those products, and for the collection of associated energy-use data, by Natural Resources Canada (NRCan).¹ The *Energy Efficiency Regulations* enabled by the Act, which came into force in 1995, apply to regulated products imported into Canada or shipped between provinces for sale or lease.²

Appliance and equipment energy efficiency standards have had a substantial positive economic and environmental impact in Canada since their introduction. Between 1995 and 2022, the efficiency standards implemented by the Energy Efficiency Regulations saved over 340 petajoules (PJ) of energy and reduced greenhouse gas (GHG) emissions by more than 44 megatonnes (Mt) of carbon dioxide-equivalent (CO_{2e}).³ The Energy Efficiency Regulations continue to have a sizable impact in terms of energy and cost savings and GHG emission reductions. Amendment 17 to the Energy Efficiency Regulations, which came into force in 2023, is expected to generate almost \$1.7 billion in cumulative net benefits and 3.2 Mt CO_{2e} emissions reductions by 2050.⁴ Amendment 18, currently in pre-publication, would have an estimated present value of the net benefits around \$51 billion by 2050, and cumulatively reduce energy consumption and GHG emissions by 1,152 PJ and 65 Mt CO_{2e} by 2050, respectively, if it goes into force as currently proposed.⁵

Several provinces also have their own provincial Energy Efficiency Acts and Regulations that set (often higher) standards for federally regulated appliances and equipment sold in their

¹ Minister of Justice, "Energy Efficiency Act (S.C. 1992, c. 36)"; Natural Resources Canada, "Canada's Energy Efficiency Regulations."

² Natural Resources Canada, "Guide to Canada's Energy Efficiency Regulations."

³ Natural Resources Canada. "Energy Efficiency: An Essential Part of Canada's Net-Zero Future - Report to Parliament under the Energy Efficiency Act 2021-2022."

⁴ Natural Resources Canada. "Canada Gazette, Part 2, Volume 156, Number 26: Regulations Amending the Energy Efficiency Regulations, 2016 (Amendment 17)."

⁵ Natural Resources Canada, "Canada Gazette, Part 1, Volume 158, Number 25: Regulations Amending the Energy Efficiency Regulations, 2016 (Amendment 18)"

province and/or that regulate appliances and equipment not covered by federal efficiency standards.⁶

How energy is used and conserved and the technologies that are available have changed dramatically since Canada's Energy Efficiency Act was passed. When the Act was originally passed, the Internet was in its infancy and CDs had just surpassed cassette tape sales.⁷ Appliances can now be controlled remotely with smartphones, allowing households to schedule when their dishwasher or clothes dryer runs and even see what is in their fridge while at the grocery store. Appliance faults can be diagnosed remotely, allowing technicians to ensure they bring the correct part for repairs. For commercial and industrial use, smart sensors can now optimize electric motor efficiency with real-time monitoring of the temperature and vibrations inside the motor.⁸

Given that Canada has the most energy-intensive economy of IEA member countries,⁹ is already experiencing catastrophic climate change,¹⁰ and the critical role of energy efficiency in addressing affordability,¹¹ it is essential to update the laws governing appliances and their efficiency to reflect these concerns. The federal *Energy Efficiency Act* has only been amended twice since 1992 – once, in 2009, to regulate standby power,¹² and again in 2017, to facilitate maintaining harmonization with other jurisdictions (mainly the U.S.).¹³ As a result, ministerial regulations were enabled for 60 product categories in Amendment 17 to the Energy Efficiency Regulations, wherein NRCan has the authority to update standards to maintain alignment with those of the U.S. Department of Energy (DOE) without requiring the typical two-year amendment process (see Appendix for illustration of typical process).

The Paris Agreement – which Canada ratified in 2016 – calls to limit global temperatures to 1.5 °C above pre-industrial levels.¹⁴ According to the Intergovernmental Panel on Climate

⁶ Natural Resources Canada, "Energy Efficiency Regulations by Province."

⁷ Lynskey, "How the Compact Disc Lost Its Shine."

⁸ "Smart Electric Motor"; "Smart Motor Sensors | SICK."

⁹ IEA, *Canada 2022 Energy Policy Review*.

¹⁰ Environment and Climate Change Canada. "Temperature Change in Canada."

¹¹ Abhilash Kantamneni, "Energy Poverty in Canada."

¹² Natural Resources Canada, "Amendments to the Energy Efficiency Act Pass in the House of Commons."

¹³ Natural Resources Canada, "Canada's Energy Efficiency Regulations."

¹⁴ United Nations Climate Action. "For a Livable Climate: Net-Zero Commitments Must Be Backed by Credible Action."; Legislative Services Branch. "Canadian Net-Zero Emissions Accountability Act (S.C. 2021, c. 22)."

Change (IPCC), GHG emissions must be reduced by 45 per cent by 2030 and reach net-zero by 2050 in order to do so. The Canadian Net-Zero Emissions Accountability Act was passed in 2021, requiring the setting of national GHG reduction targets and “to promote transparency, accountability and immediate and ambitious action in relation to achieving those targets”.

Although overall national emissions in 2022 (the latest year with available data) were 7.1 per cent below 2005 levels, direct emissions from buildings have increased by 4.5 per cent.¹⁵ Appliance and equipment efficiency standards will be critical in achieving Canada’s emissions reduction targets, as the Energy Efficiency Regulations impact almost all of the energy end-uses that are responsible for GHG emissions in residential and commercial/institutional buildings.¹⁶ These include, but are not limited to, space heating and cooling, water heating, appliances, lighting, and motors. The Canadian Institute for Climate Choices’ (now the Canadian Climate Institute) *Canada’s Net Zero Future* report lists energy-efficient equipment as one of the most significant commercial and scalable solutions across modelled pathways to net zero.¹⁷

Compared to analogous laws in other countries, however, Canada’s Energy Efficiency Act is limited in its scope and power in many ways and needs to be modernized to facilitate those vital energy efficiency gains. The need to modernize its Energy Efficiency Act is not unrecognized – it is listed as a priority in the IEA’s *Canada 2022 Energy Policy Review* and as being “under review” in NRCan’s 2021-2022 report to Parliament under the Energy Efficiency Act (with the stated aim of “enhancing competitiveness and promoting innovation”).¹⁸ In June 2024, the Canadian Electricity Advisory Council, an independent expert advisory body to the Minister of Energy and Natural Resources, published their report *Powering Canada: A blueprint for success*, which included modernizing the Energy Efficiency Act as one of its recommendations.¹⁹

¹⁵ Environment and Climate Change Canada, “Greenhouse Gas Sources and Sinks in Canada.”

¹⁶ Natural Resources Canada, “Canada’s GHG Emissions by Sector, End Use and Subsector – Including Electricity-Related Emissions.”

¹⁷ Jason Dion et al., “Canada’s Net Zero Future: Finding Our Way in the Global Transition.”

¹⁸ International Energy Agency, “Canada 2022 Energy Policy Review”; Natural Resources Canada, “Energy Efficiency: An Essential Part of Canada’s Net-Zero Future - Report to Parliament under the Energy Efficiency Act 2021-2022.”

¹⁹ Canadian Electricity Advisory Council, “Powering Canada.”

In July 2024, NRCan released the *Canada Green Buildings Strategy*, which announced that the Energy Efficiency Act will be modernized “to update the suite of legislative tools needed to account for the realities of today’s online retail environment for energy-using products and equipment.”²⁰

In the sections below, we describe what the *Energy Efficiency Act*, modernized for the 21st century, could look like in Canada. This discussion is organized under four broad themes, each with multiple suggestions for improvement and discussion of the potential impacts:

- 1) Ensuring Meaningful Progress;
- 2) Rethinking Product Categories to Promote Efficiency;
- 3) Broadening the Scope of the Energy Efficiency Act; and
- 4) Updating the Mandatory EnerGuide Labelling.

While each recommendation is presented separately, they should be understood as complementary changes the federal government could make to enhance the scope and contribution of Canada’s Energy Efficiency Act to address climate change, improve affordability, and deliver health benefits. For each recommendation, we describe what the Act cannot currently do, what we can learn from other jurisdictions’ energy efficiency legislation and, lastly, how the act could be modernized to address that concern.

²⁰ Natural Resources Canada, “The Canada Green Buildings Strategy.”

Ensuring meaningful progress

1. Mandatory review cycles

What the act can't do now

NRCan regularly amends Canada's Energy Efficiency Regulations to strengthen minimum energy performance standards (MEPS) for existing product categories or to expand regulation to new energy-using products.²¹ For example, Amendment 17 came into force in 2023, and Amendment 18's pre-publication in the *Canada Gazette, Part I*, was June 22, 2024.²² However, the regularity with which each category of appliance or equipment is updated varies greatly, as the frequency of updates is not mandated in the Energy Efficiency Act.²³ As a result, efficiency standards for certain appliances and equipment have not kept pace with the speed of progress in the market. For instance, efficiency standards have stalled for major home appliances such as dishwashers, refrigerator-freezers, clothes washers, and clothes dryers.

NRCan proposed new MEPS for those categories equivalent to 2019 ENERGY STAR® performance levels, as part of Amendment 17 for 2023 enforcement. However, they were removed from the amendment after industry push-back.²⁴ They were then included in the pre-consultation for Amendment 18 for 2024 enforcement.²⁵ However, due to NRCan aligning with the U.S. DOE for these categories, compliance dates for the updated efficiency standards vary from 2027 to 2030 (when the latest U.S. appliance standards take effect), depending on the appliance.²⁶

²¹ Natural Resources Canada, "Amendments to the Energy Efficiency Regulations, 2016."

²² Natural Resources Canada, "Canada Gazette, Part 2, Volume 156, Number 26," 17; Government of Canada, "Canada Gazette, Part 1, Volume 158, Number 25," 18.

²³ For example, the efficiency standard for gas ranges has remained unchanged since 1995: Natural Resources Canada, "Gas Ranges - Energy Efficiency Regulations."

²⁴ Natural Resources Canada, "Proposed Approach to Regulating Home Appliances to ENERGY STAR Performance Levels - Pre-Consultations, Webinar #1"; "Higher Energy Efficiency Rules for Appliances Could Raise Costs, Industry Group Says."

²⁵ Public Works and Government Services Canada, "Canada Gazette, Part 1, Volume 157, Number 33."

²⁶ U.S. Department of Energy, "2024-04-24 Energy Conservation Program: Energy Conservation Standards for Dishwashers; Direct Final Rule"; U.S. Department of Energy, "Energy Conservation Program: Energy Conservation Standards for Refrigerators, Refrigerator-Freezers, and Freezers; Direct Final Rule."

For many refrigerator-freezer models, this would mean 15 years without strengthened standards. According to the IEA’s 2021 *Product Energy Efficiency Trends (PEET) Analysis*, Canadian refrigerator-freezer efficiency is lagging in every size category (see Figure 1).²⁷ Australia and Korea, evaluated alongside Canada in the PEET study, have also since strengthened their standards, leaving Canada even further behind.²⁸

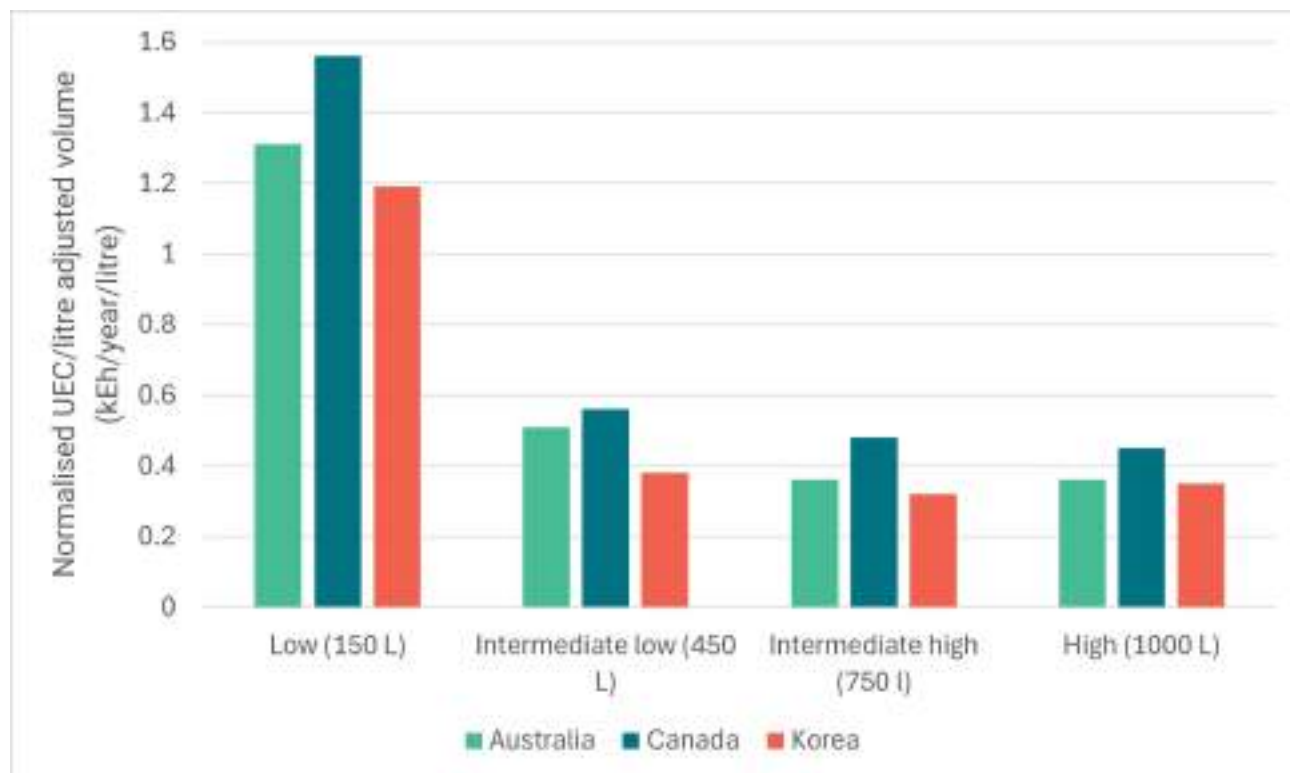


Figure 1: Average normalized annual energy consumption for refrigerator-freezers for each market in 2019, by capacity.²⁹

How it is done in other jurisdictions

China: In 2022, China upgraded its policies regulating energy efficiency standards to include mandatory review cycles for standards and labelling (S&L).³⁰ The policy requires the State

²⁷ IEA Technology Collaboration Programme, “PEET Efficiency Trends Analysis.”

²⁸ Australian Department of Climate Change, Energy, the Environment and Water, “Greenhouse and Energy Minimum Standards (Household Refrigerating Appliances) Determination 2019”; Aoki, “Korea Enhances Energy Efficiency Standard for Home Appliances.”

²⁹ IEA Technology Collaboration Programme, “PEET Efficiency Trends Analysis.”

³⁰ CLASP. “Summary of Recent Policies on China’s Energy Efficiency Standard Rescaling and Upgrading,” March 22, 2023.

Administration for Market Regulation (SAMR) to regularly review and evaluate existing MEPS and labelling programs every five years. SAMR must then issue the finalized revisions to national S&L within 18 months.

United States: The Energy Policy and Conservation Act (EPCA) – the law that governs the U.S. standards program – has a six-year mandatory review cycle for efficiency standards.³¹ Thus, the U.S. DOE must propose an updated standard if a technologically feasible and economically justifiable improvement exists six years after an efficiency standard comes into force for a product category. The requirement specifies that “any new or amended energy conservation standard prescribed [...] for any type (or class) of covered product shall be designed to achieve the maximum improvement in energy efficiency, or [...] water efficiency, which [...] is technologically feasible and economically justified”.³² The U.S. DOE then has two years to finalize the standard.

What the act could do

As Canada increasingly harmonizes with the U.S. on efficiency standards, another logical alignment would be the length of mandatory review cycles. As discussed above, a six-year mandatory review cycle, where NRCan must adopt the highest efficiency levels that are technologically feasible and economically justified, would address the issue of outdated and underperforming product energy efficiency regulations. Six years is enough time for new technological advancements or the cost of more efficient products to decline. For example, the efficiency of light-emitting diode (LED) lighting technology has improved significantly, by approximately four lumens per watt (lm/W) year-over-year since 2010, when commercial LEDs first became widely available.³³ The cost of LEDs has also decreased by more than 20 times over the past two decades.³⁴ Typical LEDs in the residential market now have an efficiency of over 100 lm/W,³⁵ four to nine times more efficient than the current Canadian standard for

³¹ Energy conservation standards, para. (m).

³² Energy conservation standards, para. (o).

³³ Kevin Lane, “Lighting.”

³⁴ “The Lightbulb Moment.”

³⁵ Kevin Lane, “Lighting.”

general service lamps since 2014.³⁶ Further, this is more than twice as efficient as NRCan's proposed standard of 45 lm/W in the pre-consultation to Amendment 18 (expected enforcement starting in 2025).³⁷ According to the IEA, 140 lm/W by 2030 will be necessary to align with net zero,³⁸ therefore, regular updates to lighting efficiency standards are essential.

With the long lifetime of many appliances and equipment (upwards of 20+ years for heating systems and nine to 15 years for major home appliances), regular updates to the Regulations also ensure consumers aren't locked into higher utility bills from inefficient appliances.³⁹

Mandatory review cycles in the U.S. come with a lockout period, where the DOE is prohibited from updating standards more frequently than every six years. Because efficiency and technological improvements progress at varying rates in different appliance and equipment categories, Canada should have the mandatory review cycle as a backstop and avoid adopting a lockout period. This will allow NRCan flexibility to update standards more frequently than stipulated by the mandatory review cycle if justified by techno-economic improvements.

³⁶ There are different lighting wattage requirements for different bins (ranges) of lumens. Across the lumen ranges, the minimum efficiencies for a general service lamp (GSL) range from 10.7 to 25.8 lm/W: Natural Resources Canada, "General Service Lamps and Modified Spectrum Incandescent Lamps - Energy Efficiency Regulations."

³⁷ Natural Resources Canada, "General Service Lamps - Technical Bulletin on Developing the Standards."

³⁸ Kevin Lane, "Lighting."

³⁹ National Association of Home Builders and Bank of America Home Equity, "Study of Life Expectancy of Home Components."

2. Codifying no backsliding on standards

What the act can't do now

There is currently no provision in the Energy Efficiency Act mandating that MEPS can only be strengthened over time and never weakened. While standards have never been weakened (i.e., undergone “backsliding”) in Canada, the current Act does not explicitly prevent efficiency standards from being weakened in the future. There are reasons to believe backsliding could happen without this clarification, such as political lobbying by vested interests, harmonization with lower international standards, or leniency for smart appliances or appliances with additional energy-consuming features.

How it is done in other jurisdictions

United States: The U.S. EPCA includes an “anti-backsliding” provision, which prohibits the U.S. DOE from amending energy conservation standards in a way that “increases the maximum allowable energy use, ... or decreases the minimum required energy efficiency, of a covered product”.⁴⁰ This provision ensures that once a minimum energy efficiency standard is established for a product, it cannot be weakened.

What the act could do

As Canada increasingly harmonizes with U.S. energy efficiency regulations, it must be codified that efficiency standards can only be strengthened. While most U.S. appliance and equipment efficiency standards are equivalent to or stronger than Canada’s, and Canadian standards would benefit from harmonization, there are exceptions. Currently, Canada’s electric cooktop efficiency standard allows a maximum electricity consumption of 258 kWh/year.⁴¹ In February 2024, the U.S. DOE released a final directive for cooking products with no minimum efficiency standard for electric coil cooktops.⁴² NRCan has listed ranges (combined cooktops and ovens)

⁴⁰ U.S. Department of Energy, “Energy conservation standards.”

⁴¹ Natural Resources Canada, “Electric Ranges - Energy Efficiency Regulations.”

⁴² U.S. Department of Energy, “Energy Conservation Program: Energy Conservation Standards for Consumer Conventional Cooking Products; Direct Final Rule.”

as one of the proposed categories to be updated in Amendment 19.⁴³ While the proposed Canadian standards won't be public until Autumn 2024,⁴⁴ a choice to align with the U.S. DOE's proposed standards could lead to removing existing standards for electric coil cooktops in Canada. Electric coil cooktops are popular, especially in rental housing, as they have the lowest purchase price among cooktop styles. Thus, efficiency standards prevent worsening energy burdens for low- and medium-income households. This is one example of why codifying anti-backsliding requirements is essential.

A modernized Energy Efficiency Act should also prevent the weakening of standards in response to pressure from manufacturers to allow new product features that consume more energy than the current standards allow. Examples of energy-using features abound, from Wi-Fi on common household appliances to ultra-high-definition televisions. Preventing standards from being loosened for new technologies requires manufacturers to improve the technology rather than finding loopholes that will saddle consumers with higher energy bills.

⁴³ Natural Resources Canada, "Amendments to the Energy Efficiency Regulations, 2016."

⁴⁴ Natural Resources Canada, "Pre-Consultations for Next Amendments - Energy Efficiency Regulations."

Rethinking product categories to promote efficiency

3. Enabling broader definitions

What the act can't do now

Heat pumps are among the best technologies for reducing energy use and GHG emissions from space and water heating. A policy that could significantly increase heat pump adoption in Canada would be requiring heat pumps instead of new or replacement central air conditioners, as detailed in *The Cool Way to Heat Homes* report.⁴⁵ The two appliances are fundamentally the same in that they transfer heat between indoor and outdoor spaces. With a couple of additional components, the heat pump can transfer heat in both directions, providing heating and cooling (see Figure 2).



Figure 2: Central air conditioner outdoor unit (left) and heat pump outdoor unit (right). The reversing valve is shown in cyan, and the defrost board is shown in white.⁴⁶

The Cool Way to Heat Homes report estimates that installing heat pumps instead of residential central air conditioners in Canada starting in 2025 would produce \$12.6 billion of net benefits by the end of 2035.

⁴⁵ Gard-Murray et al., "The Cool Way to Heat Homes: Installing Heat Pumps Instead of Central Air Conditioners in Canada."

⁴⁶ Trane, "Trane XB Series."

One way to accelerate the adoption of heat pumps would be for the Energy Efficiency Act to enable definitional changes for existing product categories. By redefining a central air conditioner to provide heating as well as cooling (i.e. equivalent to a heat pump), consumers would have the same cooling that an air conditioner provides, with the addition of highly efficient heating. This would replace heating that would otherwise have come from less efficient fossil fuel or electric resistance heating systems, therefore reducing energy costs and GHG emissions.

How it is done in other jurisdictions

United States: The U.S. currently faces a similar challenge to Canada, with heat pumps and air conditioners defined as separate products under EPCA.⁴⁷ Updated legislation would be necessary to combine these and other legislatively-defined products.

Similarly, the EPCA defines and sets standards for general service fluorescent lamps (GSFLs) separately from the category that the majority of lightbulbs fall into, general service lamps (GSLs).⁴⁸ Current standards for those products are not technology-neutral, effectively preventing DOE from considering new technologies as the basis for improved standards.⁴⁹ Linear fluorescent lightbulbs, like T8s and T5s, are very common in commercial and institutional settings. Having a siloed GSFL category prevents linear lighting from advancing to take advantage of light-emitting diode (LED) technology, which is almost universal in screw-based lighting. Mercury-free LEDs are widely available, provide the same or better lighting service, longer product life, and much lower lifecycle product costs.⁵⁰ EPCA, however, does provide a method of setting different standards for product type (or class) within a definition based on the following differences:⁵¹

⁴⁷ Definitions, para. (21), (24).

⁴⁸ U.S Department of Energy. "Energy Conservation Program: Energy Conservation Standards for General Service Fluorescent Lamps."

⁴⁹ Andrew deLaski et al., "Next Generation Standards: How the National Energy Efficiency Standards Program Can Continue to Drive Energy, Economic, and Environmental Benefits."

⁵⁰ Office of Energy Efficiency & Renewable Energy. "LED Lighting - Energy Saver."

⁵¹ Energy conservation standards, para. (q).

- (A) consume a different kind of energy from that consumed by other covered products within such type (or class) or
- (B) have a capacity or other performance-related feature which other products within such type (or class) do not have, and such feature justifies a higher or lower standard from that which applies (or will apply) to other products within such type (or class).

In determining under this paragraph whether a performance-related feature justifies the establishment of a higher or lower standard, the [Energy] Secretary shall consider factors such as the utility to the consumer of such a feature and other factors that the Secretary deems appropriate.

While subparagraph (A) should likely not serve as an example based on the discussion of leveling the playing field between fuels, in the following section, subparagraph (B) could serve as a test for modifying the definitions and standards for appliances that provide the same utility to the user, such as heating or lighting without regard to the underlying technology.

What the act could do

The Energy Efficiency Act should explicitly permit definitional changes that allow combining product categories for appliances with similar performances or functions. Definitional revisions reflecting technological progress changes should also be permitted. NRCan should have the prerogative to evaluate the impact of potential definitional changes before implementation. A combined standard for central air conditioners and heat pumps would favour heat pumps over air conditioners, as they provide low-carbon heating and cooling.

4. Leveling the playing field between fuel sources

What the act can't do now

Currently, the Energy Efficiency Regulations have separate categories with different efficiency standards for each fuel source of an appliance or equipment category (e.g. gas and electric stoves standards are set separately), which often aren't updated at the same frequency (most

recently updated in 1995 and 2003, respectively).⁵² A common justification for this approach is maintaining technological neutrality, yet there remains the risk of inadvertently creating an unlevel playing field.

For many types of appliances (space and water heating, clothes drying, etc.), electric appliances have the potential of achieving far greater efficiency, often by employing heat pump technology.⁵³ For example, the MEPS for residential oil furnaces in Canada is an annual fuel utilization efficiency (AFUE) of 83 (an AFUE rating of 83 means 8.3 out of 10 BTUs of energy, or 83 per cent of fuel effectively produces heat, while the other 17 per cent is lost to inefficient burners, out the flue, etc.). The most efficient oil furnaces can achieve up to approximately 96.7 AFUE,⁵⁴ compared to electric resistance heating systems, which are 100 efficient.⁵⁵ Heat pumps capable of space heating have a much higher average efficiency (up to 370 per cent).⁵⁶

Heat pump efficiency has increased substantially, due to improvements in their components, including compressors, refrigerants and heat exchangers.⁵⁷ Due to this greater degree of technological progress in electric appliances, the efficiency standards for many of these appliances have steadily increased since the introduction of the Energy Efficiency Regulations, and are consistently higher than those of oil- and gas-fueled appliances.⁵⁸

With the lower energy efficiency potential of fossil fuel appliances compared to electric appliances, separate standards can bias consumers toward oil- and gas-fueled appliances,

⁵² Natural Resources Canada, "Gas Ranges - Energy Efficiency Regulations"; Natural Resources Canada, "Electric Ranges - Energy Efficiency Regulations."

⁵³ Jake Marin. "What Makes Heat Pumps So Efficient Anyway?"

⁵⁴ ENERGY STAR, "Product Finder – ENERGY STAR Certified Furnaces."

⁵⁵ Natural Resources Canada, "Oil-Fired Furnaces - Energy Efficiency Regulations."

⁵⁶ Natural Resources Canada, "Heating and Cooling with a Heat Pump."

⁵⁷ Casey Crownhart. "Everything You Need to Know about the Wild World of Heat Pumps."

⁵⁸ In addition to the higher efficiency standards for heat pumps and electric resistance heating vs. gas and oil furnaces and boilers, there are higher efficiency standards for electric cooktops and clothes dryers. Electric cooktops and clothes dryers have MEPS of 258 kwh/year and 3.73 minimum combined efficiency factor (standard-size), respectively. The only efficiency standard for gas cooktops is that continuously burning pilot lights are forbidden and there is no MEPS for gas clothes dryers: Natural Resources Canada, "Guide to Canada's Energy Efficiency Regulations."

due to the generally lower upfront costs of less efficient appliances, as they employ older technology.

How it is done in other jurisdictions

British Columbia: British Columbia is developing the *Highest Efficiency Equipment Standards for Space and Water Heating* (HEES) regulation as part of their Clean B.C. Roadmap to 2030.⁵⁹ The proposed standards would require a 100 per cent minimum efficiency level across the board for space and water heating. With this policy, electric resistance water and space heating will still be permitted (they are 100 per cent efficient), as will electric heat pumps (which exceed 100 per cent efficiency), gas heat pumps, and hybrid systems that combine an electric heat pump with a gas furnace or boiler for backup. HEES will have a particularly significant impact, as it applies to both new construction and existing buildings.

European Union: In April 2023, the European Commission proposed a MEPS of 115 per cent for space heating (i.e. a stand-alone gas and oil boiler/furnace and standalone electric resistance phase-out) by 2029.⁶⁰ While supported by an alliance of NGOs, it was not supported by a majority of member states at the time.⁶¹

What the act could do

Categories for appliance and equipment efficiency standards should be grouped by function rather than by equipment type and fuel source. For example, appliances should be grouped as space heating appliances, space cooling appliances, cooking ranges, and so on. Each of the function-based appliance categories would have an efficiency requirement that increases incrementally over time for all equipment types, based on the technical and economic viability of doing so with any of the technologies in the category, rather than the current approach of a

⁵⁹ Clean BC, “Highest Efficiency Equipment Standards Regulatory Consultation.”

⁶⁰ Niels Ladefoged, “EU Requirements (Labelling and Ecodesign) for Heating Appliances: Current Requirements and on-Going Revisions.”

⁶¹ Marco Grippa et al., “Comments on The Regulations About Ecodesign and Energy Labelling Requirements for Space and Water Heaters”; Niels Ladefoged, “EU Requirements (Labelling and Ecodesign) for Heating Appliances: Current Requirements and on-Going Revisions.”

techno-economic analysis for each equipment type and fuel source separately. This would help avoid siloed categorization that unfairly advantages oil and gas appliances incapable of innovation/efficiency improvements comparable to electric appliances.

With the urgency of phasing out fossil fuels in buildings towards net-zero emissions by 2050, the Energy Efficiency Act should be updated to allow fair efficiency standards that apply equally across appliance categories, regardless of fuel source. Given the long lifespan of appliances, particularly heating systems (15 - 20+ years), this policy should be implemented before 2030. Combined with strong and regularly strengthened efficiency standards, leveling the playing field between fuel sources could lower energy consumption and costs technologically neutrally.

Broadening the scope

5. Setting standards for greenhouse gas emissions and other pollutants

What the act can't do now

The Regulations enabled by the Act currently only set standards for the energy efficiency of appliances and equipment. Reductions in greenhouse gas emissions (GHGs) are a co-benefit and are calculated in the cost-benefit analysis. However, no standards exist for the GHGs or other pollutants emitted. GHGs and other pollutants are regulated under the Canadian Environmental Protection Act (CEPA).⁶² However, given the urgency of mitigating climate change and the sometimes nonlinear relationship between efficiency and greenhouse gases and other pollutants, it would be beneficial to expand the Energy Efficiency Act to set standards for GHG emissions and other pollutants emitted by appliances and equipment. Making this change ensures that Canadian products are higher performing and that customers are protected, delivering pollution reduction benefits we often seek through energy efficiency. Similar discussions about the need to directly target GHG emissions are happening regarding building codes – a proposed change to the National Energy Code for Buildings is to add operational GHG emissions from 2025 and embodied GHG emissions from 2030.⁶³

How it is done in other jurisdictions

United States: In the condensing gas furnace rule, requiring residential gas furnaces to be at least 95 per cent efficient from late 2028,⁶⁴ the U.S. DOE quantified the benefits of reduced greenhouse gas and air pollution due to standards, presenting them side-by-side with the economic benefits. As can be seen in the table below, in every scenario the combined climate and health benefits are significant and even outweigh the operating cost savings.⁶⁵ For their

⁶² Environment and Climate Change Canada, “Understanding the Canadian Environmental Protection Act.”

⁶³ Kevin Lockhart, “Efficiency Canada: Public Review of Proposed Changes to the 2020 National Model Codes.”

⁶⁴ U.S. Department of Energy, “DOE Finalizes Energy Efficiency Standards for Residential Furnaces to Save Americans \$1.5 Billion In Annual Utility Bills.”

⁶⁵ U.S. Department of Energy, “Energy Conservation Program: Energy Conservation Standards for Consumer Furnaces; Final Rule,” 87638.

analysis, the U.S. DOE employed trial standard levels (TSLs) of efficiency ranging from TSL 1, the least rigorous standard, to TSL 9, the maximum technologically feasible efficiency. TSL 8 (highlighted below) is the finalized standard.

The U.S. DOE is legally required to set standards based only on economic and energy-reduction benefits. However, both DOE's and CLASP's analyses demonstrate that efficiency standards result in significant benefits for public health, and including criteria that value these society-wide benefits would maximize the impact of these policies.⁶⁶

⁶⁶ Lauren Boucher, "How National Appliance and Equipment Energy Conservation Standards Can Improve Public Health and Advance Justice40 Initiative Goals."

Category	TSL 1	TSL 2	TSL 3	TSL 4	TSL 5	TSL 6	TSL 7	TSL 8	TSL 9
Cumulative FFC National Energy Savings (quads)									
Quads.....	1.52	2.11	2.42	3.10	2.65	3.63	3.63	4.77	6.26
Cumulative FFC Emissions Reduction (total FFC emission)									
CO ₂ (million metrics tons)	86	121	142	197	158	268	215	332	472
CH ₄ (thousand tons).....	1,082	1,531	1,803	2,522	2,007	3,476	2,728	4,286	6,144
N ₂ O (thousand tons).....	0.16	0.22	0.24	0.28	0.26	0.26	0.36	0.38	0.43
NO _x (thousand tons).....	234	331	390	546	435	752	591	928	1,329
SO ₂ (thousand tons).....	(0)	(1)	(1)	(4)	(2)	(10)	(2)	(10)	(19)
Hg (tons).....	(0.00)	(0.01)	(0.01)	(0.03)	(0.02)	(0.08)	(0.02)	(0.08)	(0.15)
Present Value of Benefits and Costs (3% discount rate, billion 2022\$)									
Consumer Operating Cost Savings	6.3	9.3	10.9	13.9	12.4	18.8	17.3	24.8	32.8
Climate Benefits*.....	4.3	6.2	7.3	10.0	8.1	13.9	11.0	17.3	24.8
Health Benefits**.....	6.8	9.7	11.4	15.5	12.7	21.4	17.3	26.6	37.9
Total Benefits†	17.4	25.2	29.7	39.4	33.2	54.1	45.6	68.7	95.5
Consumer Incremental Product Costs	1.8	2.5	3.1	3.9	3.5	7.0	4.6	8.5	15.6
Consumer Net Benefits	4.5	6.7	7.8	10.0	8.9	11.8	12.7	16.3	17.2
Total Net Benefits	15.7	22.6	26.6	35.5	29.7	47.2	41.0	60.2	79.9

Table 1: Summary of results for the U.S. DOE condensing gas furnace rule for non-weatherized and mobile home gas furnaces (Recreation of table V.27)

European Union: In the EU, Ecodesign standards have the authority to regulate pollutants, including nitrogen oxides (NOx). They also consider the benefits of lower global warming potential (GWP) refrigerants for air conditioning. The NOx emissions of gas water heaters are required not to exceed 56 mg/kWh fuel input (in terms of gross calorific value (GCV)).⁶⁷

The Ecodesign approach to the GWP of refrigerants is different. Rather than setting a limit, as for NOx in water heaters, the Ecodesign regulation for split air conditioners trades off the indirect emissions from electricity use against direct emissions from high-GWP refrigerants. As seen in the table below, systems using refrigerants with GWP greater than 150 have more stringent seasonal energy efficiency ratio (SEER) and seasonal coefficient of performance (SCOP) requirements than systems using refrigerants with GWP less than or equal to 150.⁶⁸

	SEER	SCOPE (Average heating season)
If GWP of refrigerant > 150	3.60	3.40
If GWP of refrigerant ≤ 150	3.24	3.06

Table 2: Requirements for minimum energy efficiency vs. GWP of refrigerants.

⁶⁷ European Commission, “Commission Regulation (EU) No 814/2013 of 2 August 2013 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to Ecodesign requirements for water heaters and hot water storage tanks.”

⁶⁸ European Commission, “Commission Regulation (EU) No 814/2013 of 2 August 2013 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to Ecodesign requirements for water heaters and hot water storage tanks.”

What the act could do

The Energy Efficiency Act should be expanded to explicitly reduce GHG emissions and indoor air pollutants as a primary goal. As currently written, emissions reductions are considered a co-benefit to energy efficiency.

Instantaneous gas water heaters are an example of why this distinction is important - they are about 30 per cent more energy efficient than gas storage water heaters, as storage water heaters must maintain the temperature of the water they store.⁶³ However, instantaneous gas water heaters emit significant unburnt methane, a potent GHG and indoor air pollutant, as their burners turn on and off every time hot water is consumed.⁷⁰

Similarly, gas stoves and cooktops release indoor air pollutants like nitrogen oxides (NO_x) and unburnt methane.⁷¹ A meta-analysis in the U.S. found almost 13 per cent of childhood asthma cases attributable to gas stove use.⁷² Currently, the only energy efficiency standard for gas stoves under Canada's Energy Efficiency Regulations is that "it must not have a continuously burning pilot light."⁷³

Introducing standards that limit the release of GHGs and other pollutants from combustion appliances could have significant positive health and environmental impacts, ensuring energy efficiency regulations are aligned with national policy objectives.

⁶⁹ Natural Resources Canada, "Tankless Water Heaters."

⁷⁰ Pierre Delforge, "The Methane Math for Gas Tankless Water Heaters."

⁷¹ Lebel et al., "Methane and NO_x Emissions from Natural Gas Stoves, Cooktops, and Ovens in Residential Homes."

⁷² Gruenwald et al., "Population Attributable Fraction of Gas Stoves and Childhood Asthma in the United States."

⁷³ Natural Resources Canada, "Gas Ranges - Energy Efficiency Regulations."

6. Considering system efficiency

What the act can't do now

The Energy Efficiency Act and Regulations target the efficiency of individual appliances and equipment; however, sometimes, those products are combined into a system. In some instances, optimizing the performance of the individual components will be less effective than evaluating the system as a whole.

Examples abound, such as the combination of electric heat pumps and fossil-fuel backup heating in hybrid or dual-fuel space heating systems mentioned previously, increasing the energy used for spinning in clothes washers to reduce energy (and drying time) in clothes dryers, or motor systems.

How it is done in other jurisdictions

United States: The U.S. recently updated its electric motor standards to the world- leading EU levels by requiring international efficiency level 4 (IE4, also known as Super Premium efficiency) for motors with output power between 75 and 200 kW (100 to 250 horsepower).⁷⁴

This improvement, while significant (0.4 per cent reduction in total energy consumption for 150 kW motor at full load),⁷⁵ pales in comparison with energy use reductions possible by incorporating a variable frequency drive (VFD), an electronic control installed before the motor to reduce its speed to better match the needed output. The U.S. Lawrence Berkeley National Laboratory (LBNL) estimates that VFDs would reduce the motor energy

⁷⁴ U.S. Department of Energy, "Energy Conservation Program: Energy Conservation Standards for Electric Motors - Direct Final Rule."

⁷⁵ Full load efficiency at the previous IE3 requirement level is 95.4% versus 95.8% at current IE4. Commission Regulation (EU) 2019/1781 of 1 October 2019 laying down Ecodesign requirements for electric motors and variable speed drives pursuant to Directive 2009/125/EC of the European Parliament and of the Council, amending Regulation (EC) No 641/2009 with regard to Ecodesign requirements for glandless standalone circulators and glandless circulators integrated in products and repealing Commission Regulation (EC) No 640/2009, tpls. 3b, 3c.

consumption of motor systems by 11 per cent nationally,⁷⁶ with reductions as high as 29 per cent in pump applications:⁷⁷

End use application (industrial and commercial sectors)	Refrigerators (%)	Fans (%)	Pump (%)	Compressors (%)
Potential energy savings of universal VFD integration (percentage of total)	9	9	20	29
Current VFD penetration (percentage of applications)	26	25	25	20

Table 3: LBNL early estimates of total application energy consumption reduction for universal VFD application.

A field and modelling study focused on pumps in the U.S. Pacific Northwest similarly confirmed the latter finding and clarified that even constant-load systems benefit from VFDs. Constant load systems are typically oversized; VFDs allow the oversized motor to operate at the speed required by the load.⁷⁸

System type	Savings	Payback period
Constant load systems	23%	10 months
Variable load systems	43%	4 months

Table 4: Savings results summary for VFD application in constant and variable load pumps.

⁷⁶ Rao et al., “U.S. Industrial and Commercial Motor System Market Assessment Report. Volume 3,” tbl. 5.

⁷⁷ Newkirk, Rao, and Sheaffer, “U.S. Industrial and Commercial Motor System Market Assessment Report Volume 2,” tbl. 2.

⁷⁸ Cadeo Group, “Power Drive Systems: Energy Savings and Non-Energy Benefits in Constant & Variable Load Applications,” tbl. 9.

The National Electrical Manufacturers' Association recently published a new test method that allows for the equitable measurement and comparison of all kinds of motors, including ones with variable speed drives.⁷⁹ Integrating this test method into the national DOE test and basing the next standard on the results should allow VFD-driven motors to compete against fixed-speed motors, resulting in significantly lower system energy consumption.

European Union: The EU has, in the past, required motors be paired with VFDs as part of the Ecodesign regulations: "all motors with a rated output of 0.75-375 kW shall not be less efficient than the IE3 efficiency level [...] or meet the IE2 efficiency level [...] and be equipped with a variable speed drive."⁸⁰

What the act could do

The Energy Efficiency Act should allow for the consideration and inclusion of additional system components within the scope of an energy efficiency standard.

For motors specifically, to capitalize on this opportunity to reduce total systems energy consumption, NRCan would need the authority to require the use of a VFD when installing or replacing a motor. In 2022 alone, Canada's industrial electricity sector consumed 647 petajoules (PJs) of electricity.⁸¹ Globally, motors represent 74 per cent of industrial electricity consumption (479 PJ in Canada, if taking the global average).⁸² This would equal about one-fifth of national electricity consumption (586 TWh or 2108 PJ).⁸³ Given that variable load systems provide such compelling savings, requiring VFDs could free up

⁷⁹ National Electrical Manufacturers Association, "Power Index Calculation Procedure—Standard Rating Methodology for Power Drive Systems and Complete Drive Modules."

⁸⁰ Commission Regulation (EC) No 640/2009 of 22 July 2009 implementing Directive 2005/32/EC of the European Parliament and of the Council with regard to Ecodesign requirements for electric motors (Text with EEA relevance).

⁸¹ Statistics Canada, "Type of Energy Consumed by Manufacturing Sector, 2021 and 2022."

⁸² Rita Werle, "International Energy Agency Technology Collaboration Programme 4E Energy Efficient End-Use Equipment EMSA Electric Motor Systems Annex."

⁸³ Statistics Canada, "Electric Power, Electric Utilities and Industry, Annual Supply and Disposition."

a considerable portion of the electricity required for electrifying space and water heating in Canada.

Therefore, considering broader systems when setting appliance and equipment efficiency standards is essential to capitalize on their full potential to reduce energy consumption and lower costs for consumers and businesses.

7. Requiring demand flexibility

What the act can't do now

Tapping into the potential demand response and flexibility capabilities that certain appliances could provide is essential to reducing the need for new electrical generation, transmission and distribution infrastructure, thereby reducing the cost of electrification.⁸⁴ For example, electric storage water heaters (ESWHs), which almost half of Canadians already have in their homes,⁸⁵ can act as thermal batteries. ESWHs with the controls and connectivity necessary to participate in automatic demand response (ADR) programs could enable households to get paid to help balance the grid without interrupting the hot water supply in their homes.⁸⁶ ADR programs signal the ESWH to pre-heat water and store it when there is surplus renewable generation and/or to avoid using electricity during peak demand.

While many ESWHs come demand response-ready,⁸⁷ different manufacturers use different communication standards and protocols, some open source (like Open ADR) and some proprietary (like Google Nest). This makes large-scale adoption of residential ADR

⁸⁴ Caroline Lee, Jason Dion, and Christiana Guertin, "Bigger, Cleaner, Smarter: Pathways for Aligning Canadian Electricity Systems with Net Zero."

⁸⁵ Electric water heaters had a 48.4% market share in 2020: Natural Resources Canada, "Residential Water Heating Energy Use and Water Heater Stock Share."

⁸⁶ Lowell Ungar, "Demand Flexibility of Water Heaters."

⁸⁷ Rheem and A.O. Smith, two of the largest ESWH manufacturers include DR features "Demand Response, Time-of-Use Options Added to A. O. Smith Mobile App"; Rheem Manufacturing Company, "How Demand Response Programs Save You Energy and Money."

expensive and complicated for utilities.⁸⁸ For ESWHs that aren't manufactured demand response-ready, it is possible to have them retrofitted with a smart controller (usually by an electrician); however, with added hassle and cost compared to if it had been factory installed.⁸⁹

Requiring every new ESWH to come with the necessary controls and connectivity to participate in ADR would be considered a prescriptive requirement. By widening its scope, the Act could promote system-wide efficiency and smart demand management.

There are also public health benefits to standardized demand flexibility controls for ESWHs. Hilo, a subsidiary of Hydro-Québec, which provides smart home solutions to consumers in conjunction with ADR cash rewards, requires every participant to purchase a new ESWH directly from them to ensure they meet public health requirements against Legionella proliferation.⁹⁰ Legionella is a concern with ADR if water temperatures drop too low in the ESWH tank when shut off for a demand event.⁹¹

Prescriptive requirements for ESWHs could reference standards to ensure Legionella risk is controlled, in addition to harmonized standards and protocols for communication between the devices and utilities across Canada, rather than individual ADR programs needing to sell and install each participating ESWH to mitigate Legionella risk.

How it is done in other jurisdictions

United States: The U.S. DOE has interpreted its authority as prohibiting multiple metrics, which limits the ability to establish prescriptive requirements in addition to an efficiency performance standard. In addition, DOE does not have the authority to set requirements

⁸⁸ Jess Burgess, Geneviève Gauthier, and Pierre Gravel-Primeau, "Standards to Enable Automated Demand Response in Canada."

⁸⁹ Lowell Ungar, "Demand Flexibility of Water Heaters."

⁹⁰ "Hilo Is Offering the First-Ever Smart Solution for Electric Water Heaters That Meets Québec's Public Health Requirements."

⁹¹ Onabola, "Health and Safety Aspects of Demand Response on Electric Storage Water Heaters: A Mini Literature Review."

on appliances that would allow electric utilities to more easily control them to reduce peak demand and costs and improve reliability.⁹²

In 2022, there were unsuccessful efforts to pass a bill in the U.S. Congress to require the DOE to “determine [...] whether to require that electric storage water heaters possess demand response capabilities”,⁹³ which could have resolved the challenge.

In the absence of national regulation, however, Washington, Oregon and Colorado have set prescriptive requirements for demand-responsive water heaters.⁹⁴

What the act could do

A modernized Energy Efficiency Act should expand NRCan’s ability to require specific technologies to tackle pressing energy management issues, like the increasing need for demand-side flexibility. Setting a federal standard and protocol for the devices and equipment that enable ADR for applicable products could help fix the current patchwork of regional/provincial demand response program equipment and connectivity requirements throughout Canada,⁹⁵ while still enabling product competition and innovation.

Participation in demand response programs should remain voluntary, but the barriers for households to participate and costs to utilities would be significantly reduced with federal standards.

Similar requirements could also be evaluated for other appliances. There are currently models of thermostat, room air conditioner, refrigerator, freezer, clothes washer and dryer,

⁹² Lowell Ungar, “Demand Flexibility of Water Heaters.”

⁹³ Dingell, H.R.7962: To amend the Energy Policy and Conservation Act to modify the definition of water heater under energy conservation standards, and for other purposes; Stabenow, S.4061: A bill to amend the Energy Policy and Conservation Act to modify the definition of water heater under energy conservation standards, and for other purposes.

⁹⁴ Lowell Ungar, “Demand Flexibility of Water Heaters.”

⁹⁵ “Eligibility | Yukon Energy”; “Hilo Is Offering the First-Ever Smart Solution for Electric Water Heaters That Meets Québec’s Public Health Requirements.”; “Virtual Peaker Launches First Utility Program in Canada”; “Shift and Save - Water Heater Controllers”; NBPower, “EcoLink.”

light bulb and light fixture available on the market with connected functionality that allow usage to be scheduled.⁹⁶

⁹⁶ "Features to Consider | ENERGY STAR."

Updating mandatory EnerGuide labelling

The EnerGuide label is an essential tool for consumers and businesses when choosing which appliances and equipment to purchase, as it gives vital information that enables prospective buyers to compare efficiency between competing products and therefore estimate the annual energy costs associated with the different models available.

8. Improved label design

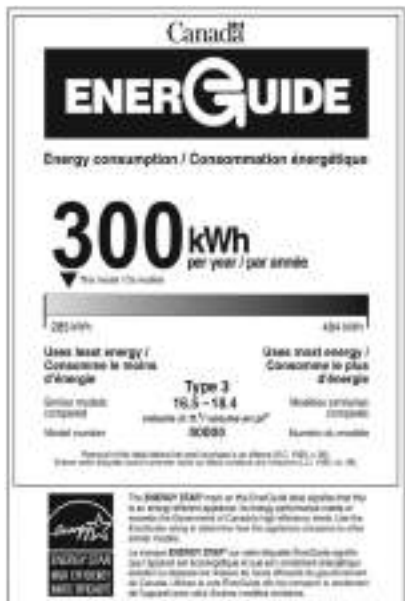
Although the current Energy Efficiency Act doesn't preclude updates to the EnerGuide label design, as energy labelling plays such a vital role in communicating product efficiency to consumers and should therefore be considered for updating in conjunction with modernizing the Energy Efficiency Act.

Limitations of the current label

The EnerGuide label is mandatory for certain appliances and voluntary for others,⁹⁷ providing basic energy performance data, with electricity consumption under standard test procedures displayed on a continuous scale compared to other models in the same class (Figure 4). However, when shopping for an appliance, the consumer may be choosing between models in different classes, making the comparison more difficult. For example, there are 32 product type categorizations of refrigerators and refrigerator-freezers,⁹⁸ many of which may be displayed side-by-side in a store.

⁹⁷ Mandatory for: clothes dryers, clothes washers (including integrated washer-dryers), dishwashers, refrigerators, freezers and refrigerator-freezers, large electric cooking appliances and room air conditioners; Voluntary for central air conditioners, furnaces (oil-, gas- or propane-fired), heat pumps—air source, gas fireplaces and water heaters: Natural Resources Canada, "The EnerGuide Label."

⁹⁸ Natural Resources Canada, "Refrigerators and Refrigerator-Freezers."



EnerGuide label for a refrigerator with an ENERGY STAR[®] certification

There are five main items displayed on the label

1. Annual energy consumption of the model in kilowatt hours (kWh)
2. Energy consumption indicator, which positions the model compared with the most efficient and least efficient models in the same class
3. Type and capacity of models that make up this class
4. The model number
5. The ENERGY STAR symbol

Figure 4: A sample EnerGuide label and its components for an ENERGY STAR-certified refrigerator.⁹⁹

Past research has shown that categorical labels (where the models are grouped using their energy consumption into several understandable categories, such as stars or the letters A through G) are much more common around the world, more accessible for consumers to understand, and a better motivator of market transformation than continuous labels (energy consumption displayed along a scale). For example, a study to redesign the similarly continuous U.S. EnergyGuide label found that consumers preferred the design below due to better organization and graphical appeal.¹⁰⁰

⁹⁹ Natural Resources Canada, “Appliances—EnerGuide.”

¹⁰⁰ Egan and Waide, “A Multi-Country Comparative Evaluation of Labelling Research.”

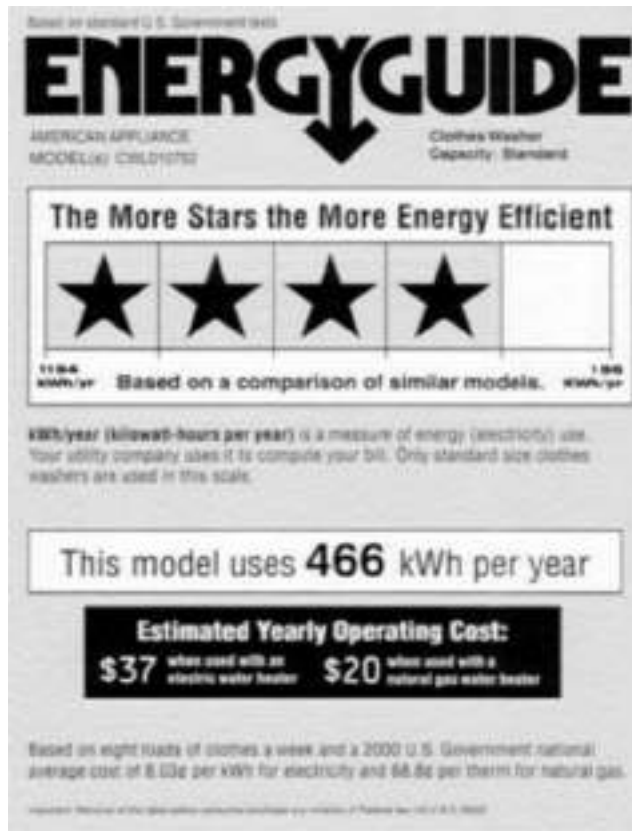


Figure 5: Preferred update to continuous U.S. EnergyGuide label.

How it is done in other jurisdictions

Mexico and Brazil: More recent studies in Mexico and Brazil similarly found that label organization and graphic appeal impact readability and consumers' choices.¹⁰¹ Figure 6 below shows the evolution of Mexico's energy label design over time. The study evaluated what styles were considered visually appealing and which were the easiest to understand. Labels with dense text were considered less helpful, as too much information was provided for consumers to reasonably understand while comparing appliances for purchase. Rating systems that included stars were generally more easily understood and appealing to consumers.

¹⁰¹ "Standards and Labeling Guidebook, Third Edition," chap. Labeling.

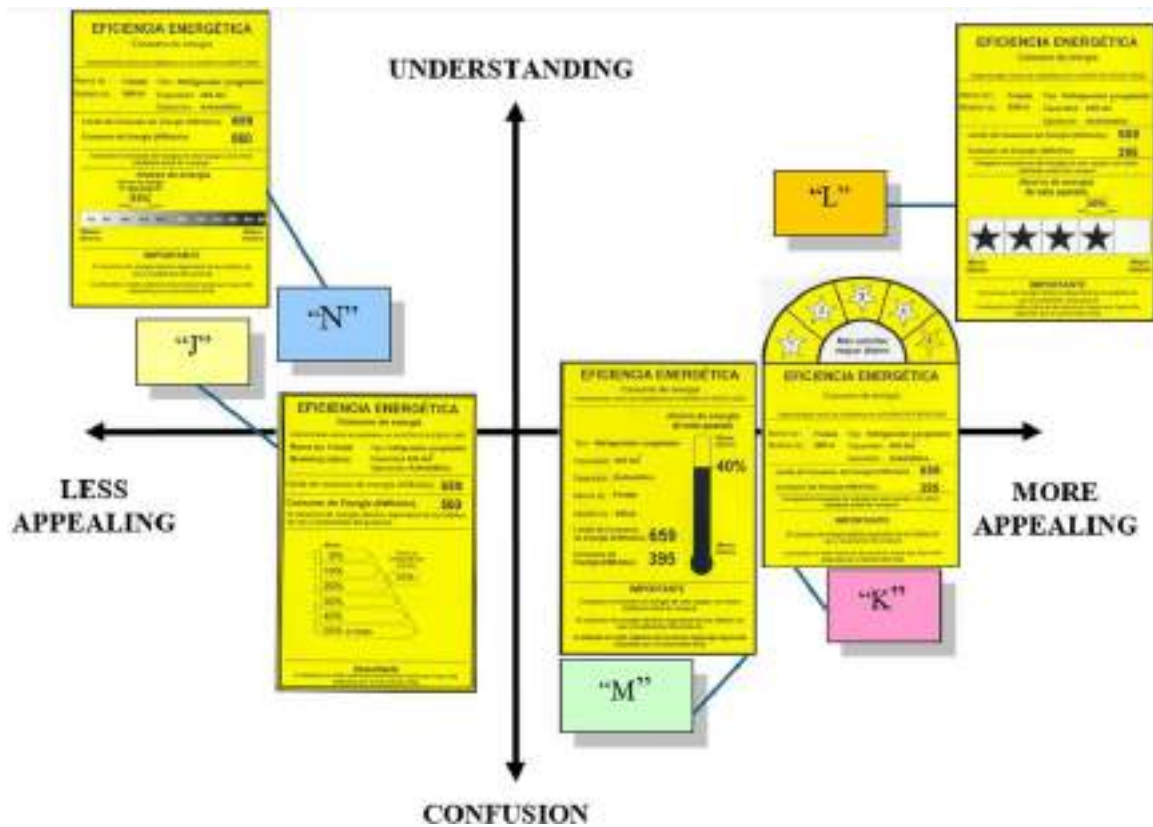


Figure 6: Evaluation of understanding and appeal of label designs in Mexico.

Figure 7 illustrates the evolution of the Brazilian energy label from the “less appealing” orange label to the 2018 version on the right. Similar to the stars in the study of label design in Mexico, the lettered (‘A’-‘E’) rating system was found to be useful to consumers in making decisions about an appliance’s performance.

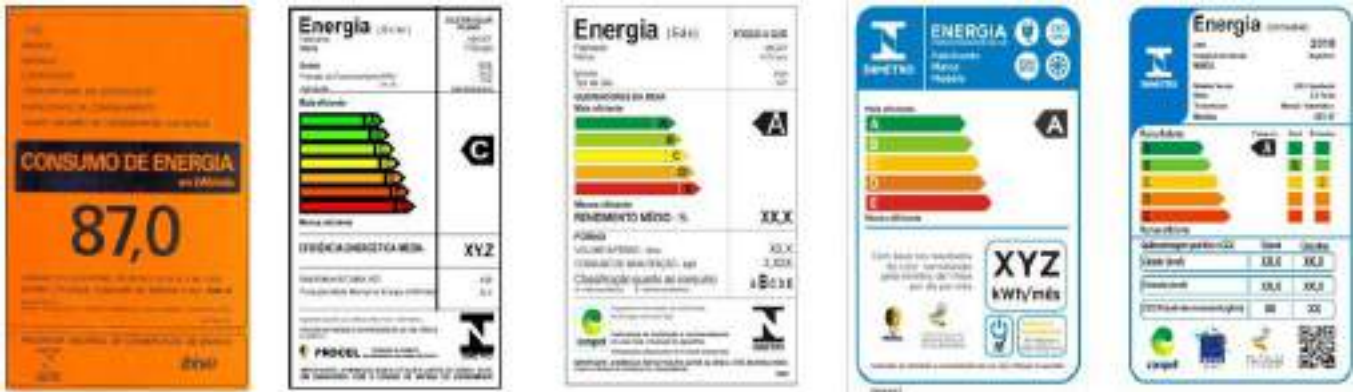


Figure 7: Evolution of label design in Brazil.

European Union: Similarly to Brazil’s energy label, the EU’s mandatory energy label (Figure 8), illustrates the product model’s efficiency on a lettered scale. However, the EU energy label scale ranges from A (most efficient) to G (least efficient), instead of the A to E of Brazil’s.¹⁰²

¹⁰² European Commission, “Understanding the Energy Label - Overview of the Energy Label.”

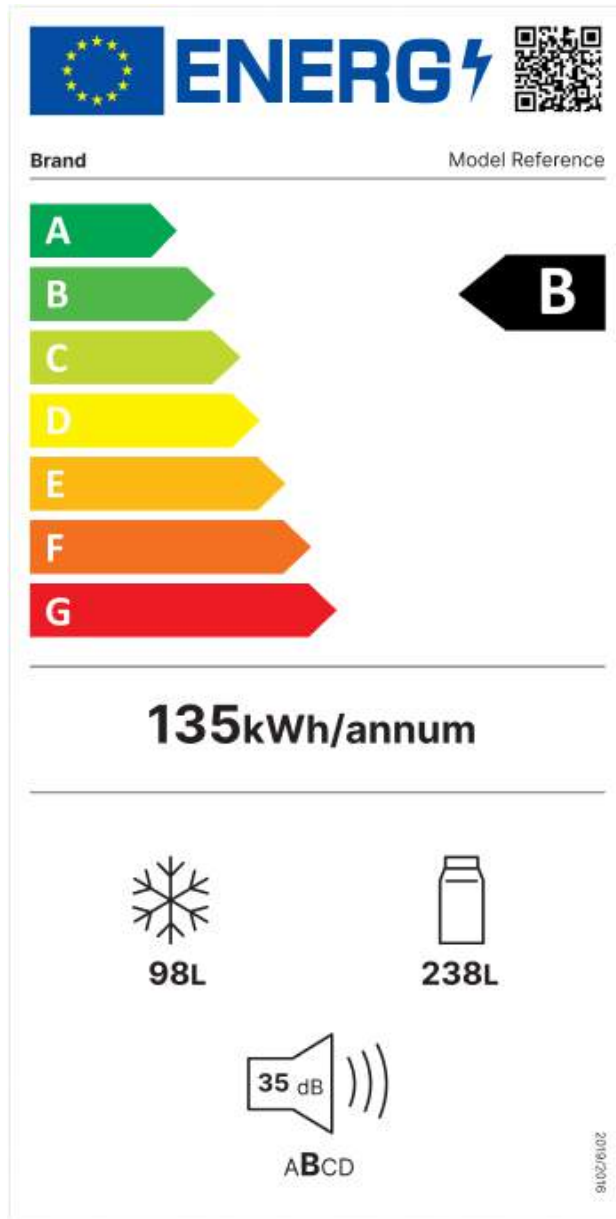


Figure 8: A Sample Energy Label for a fridge sold in the EU.

Proposal to show comparative performance across product categories: It may be beneficial for labels to show performance across products in the space heating category, for example, as opposed to the current, siloed approach of comparing products in the same class (e.g., gas boilers, heat pumps, etc.) only to one another. The EU is proposing such a change, which would include putting gas boilers and heat pumps on the same

label to highlight the inefficiency of gas.¹⁰³ This revision to current energy labelling would support deploying more efficient technology, specifically heat pumps. This revision would mean condensing gas boilers would be downgraded from their average A-rated efficiency class (the best) to an average of F (the second worst).

Recommendation for updating tiered labelling system in China: In 2013, CLASP authored a report, *Market Analysis of China Energy Efficiency Products*, which revealed that many products available on the market were at Tier 1, the highest efficiency tier, making a label update necessary.¹⁰⁴

CLASP recommended a tiered approach to energy labelling where Tier 1 represented the top 5 per cent of most energy-efficient products, Tier 2 represented only the top 10 per cent of efficient appliances, and the remaining products were evenly distributed across the remaining labelling categories. CLASP further suggested that an automatic revision of the Tier requirements should be initiated when 10 per cent of products in the market achieve Tier 1 performance or 25 per cent of products achieve Tier 2 performance. This would ensure that higher-efficiency products are continually differentiated from other appliances on the market.

Labelling study with focus groups and surveys in Thailand and China: A labelling study utilizing surveys and focus groups could help NRCan understand what information consumers find most valuable and test labelling redesigns.

In a recent labelling study in **Thailand**,¹⁰⁵ CLASP found that electricity cost information benefits customers. In contrast, efficiency metrics (e.g., SEER), GHG emissions, or information about the product technology confused customers, leading to inefficient choices. In an earlier study in **China**, CLASP similarly found that consumers want information about energy consumption and are confused by technical details.¹⁰⁶

¹⁰³ Richard Lowes et al., “The perfect fit: Shaping the Fit for 55 package to drive a climate-compatible heat pump market.”

¹⁰⁴ Jayond Li et al., “Market Analysis of China Energy Efficient Products (MACEEP).”

¹⁰⁵ CLASP, “Air Conditioner Labeling in Thailand: Key Findings and Recommendations.”

¹⁰⁶ CLASP, “Promoting China’s Online Labelling Solutions”, n.d.

What the label could have

Canada's EnerGuide label should be updated to a simplified label with relative energy efficiency denoted with stars, like Egan & Waide's recommendation for the U.S., that ranks efficiency alphabetically, like the EU's, or with numbered tiers, like China's. Additionally, broadening the categories would provide a more holistic comparison for consumers rather than the narrow model class categories displayed on the current continuous scale. For example, all full-size refrigerator-freezers could be one category rather than siloed to narrow categories based on style and size. Additionally, all types of heating systems could be shown on a continuous efficiency scale, as proposed in the EU, to improve transparency of the relative efficiencies of different heating technologies.

9. Digital labelling

Limitations of the current label

The EnerGuide label is currently required in the form of a physical tag, either adhesive or hanging, on the appliance in-store. Given the growing share of appliance and equipment sales in Canada made online, it is a significant lost opportunity that the same efficiency information is not required on appliance retailers' websites. Consumers unaware of NRCan's "Searchable product list," which provides online data on appliance product efficiency, may inadvertently purchase less efficient appliances, due to the lack of readily available energy data. Often the only indication of product efficiency online is if it is advertised as ENERGY STAR-certified.

The Canada Green Buildings Strategy states that NRCan will be "[m]odernizing the EE Act to update the suite of legislative tools needed to account for the realities of today's online retail environment for energy-using products and equipment," hinting at digital labelling.

How it is done in other jurisdictions

China e-commerce digital energy label and app: Although energy labelling is required in all venues in China, there was widespread noncompliance and mislabelling in China's online retail. As in Canada, online retail accounts for over half of appliance sales.

In response to this issue, CLASP partnered with the China National Institute of Standards (CNIS) to help link T-mall, China's leading online retailer, to the China Energy Label database. This has allowed the online retailer to verify a product's compliance status and pull critical information about its performance directly from the regulator for display on the website, helping ensure accuracy.

But consumers shopping in the real world are not left out: the China Energy Label database can be accessed through a QR code on the physical label, providing “a wealth of new information like using the product, repairs and replacement, recycling options, seasonal energy consumption, and updates on government policy and testing data.”¹⁰⁷

The European Union: In the EU, the Ecodesign for Sustainable Products Regulation (ESPR) will require the creation of a Digital Product Passport – an online infrastructure for storing and serving trusted information regarding key aspects of a regulated product's sustainability. The passport will transparently provide consumers with information about “durability and reparability, the recycled content or the availability of spare parts of a product.”¹⁰⁸

What the EnerGuide label could do

Digital (electronic) labels should be required for all appliances that are sold online. Digital labelling can include much more information than a space-constrained physical label, such as electricity cost information calculated for the viewer's location. On the other hand, digital labelling brings new requirements, such as specifications for the presentation of

¹⁰⁷ “China Launches Digital Energy Label & App.”

¹⁰⁸ Alison Gracee and Marco Grippa, “Ecodesign for Sustainable Products Regulation - European Commission.”

labels in digital format (whether linked or immediately visible, resolution in pixels, minimum size, etc.), and obligations on retailers (not just manufacturers, who are responsible for physical labelling).

10. Expanded product categories

Limitations of the current label

The EnerGuide label is currently only mandatory for clothes dryers, clothes washers (including integrated washer-dryers), dishwashers, freezers, electric ranges, cooktops and ovens, refrigerators and refrigerator-freezers, miscellaneous refrigeration products, and room air conditioners.¹⁰⁹ Notably absent from this list is space and water heating equipment, which account for the majority of building-related energy consumption and GHG emissions.

How it is done in other jurisdictions

The United States: The EnerGuide label is also mandatory for furnaces, boilers, heat pumps, central air conditioners, water heaters, ceiling fans, pool heaters, and televisions in the U.S.¹¹⁰

The European Union: In addition to the categories for which there is mandatory energy labelling in Canada, the EU's Energy Labelling regulation also applies to space and water heaters, air conditioners, local space heaters, ventilation units, televisions, smartphones and tablets, lighting, and tires.¹¹¹

What the EnerGuide label could do

¹⁰⁹ Natural Resources Canada, "The EnerGuide Label."

¹¹⁰ Federal Trade Commission. "How To Use the EnergyGuide Label to Shop for Home Appliances."

¹¹¹ Directorate-General for Energy of the European Commission. "Product List: All the Products Covered by the Directive 2009/125/EC and Regulation (EU) 2017/1369."

As EnerGuide labels provide consumers with the information necessary to make informed purchasing decisions, mandatory EnerGuide labelling should be expanded to more product categories, including space and water heating, televisions, gas cooking appliances, lighting products, microwave ovens, and dehumidifiers, among others.

Conclusion

Energy efficiency is an often overlooked solution to the concurrent climate and affordability crises. By modernizing the Energy Efficiency Act, Natural Resources Canada can transform Canada's appliance and equipment efficiency regulations into a powerful tool for reaching net-zero emissions by 2050 and making life more affordable for Canadians.

Ten ways that the Energy Efficiency Act could be updated include introducing mandatory review cycles, codifying no backsliding on standards, enabling broader definitions, leveling the playing field between fuel sources, setting standards for greenhouse gases and other pollutants, considering system efficiency, requiring demand flexibility for key appliances (e.g. electric storage water heaters), improving the EnerGuide label design, introducing digital labelling and expanding the categories for which EnerGuide labels are mandatory.

As Canada has the most energy-intensive economy of IEA member countries, it is essential to draw on the successes of other countries' appliance and equipment efficiency legislation for an Energy Efficiency Act for the 21st century. Given the long lifespan of many types of appliances and equipment, particularly heating systems (15-20+ years), it is essential to modernize the Energy Efficiency Act now, in recognition that many of the appliances and equipment bought in 2030 could still be in use in 2050, when Canada has committed to reaching net-zero emissions.

Bibliography

Abhilash Kantamneni. "Energy Poverty in Canada." Efficiency Canada. Accessed September 17, 2024.
<https://www.energycanada.org/energy-poverty-in-canada/>.

Alison Gracee and Marco Grippa. "Ecodesign for Sustainable Products Regulation - European Commission." ecos, March 5, 2024. https://commission.europa.eu/energy-climate-change-environment/standards-tools-and-labels/products-labelling-rules-and-requirements/sustainable-products/ecodesign-sustainable-products-regulation_en.

A.O. Smith. "Demand Response, Time-of-Use Options Added to A. O. Smith Mobile App," October 6, 2020.
<https://www.hotwater.com/newsroom/demand-response-time-of-use-options.html>.

Aoki, Kenji. "Korea Enhances Energy Efficiency Standard for Home Appliances." Envilience ASIA, December 31, 2020. https://envilience.com/regions/east-asia/kr/report_2847.

Archer, John. "Samsung Has Found A Solution To Its 8K TV Power Problems. Here's How It Works." Forbes. Accessed May 24, 2024. <https://www.forbes.com/sites/johnarcher/2023/02/27/samsung-has-found-a-solution-to-its-8k-tv-power-problems-heres-how-it-works/>.

Australian Department of Climate Change, Energy, the Environment and Water. "Greenhouse and Energy Minimum Standards Act 2012." Australian Federal Register of Legislation, September 21, 2023.
<https://www.legislation.gov.au/C2012A00132/latest>.

---. "Greenhouse and Energy Minimum Standards (Household Refrigerating Appliances) Determination 2019." Federal Register of Legislation, August 15, 2019.
<https://www.legislation.gov.au/F2019L01066/asmade>.

Cadeo Group. "Power Drive Systems: Energy Savings and Non-Energy Benefits in Constant & Variable Load Applications." Northwest Energy Efficiency Alliance, June 16, 2020.
<https://www.nema.org/docs/default-source/motor-and-generator-guides-and-resources-library/power-drive-systems-energy-savings-and-non-energy-benefits-in-constant-and-variable-load-applications.pdf>.

Canadian Electricity Advisory Council. "Powering Canada: A Blueprint for Success." Government Of Canada. Natural Resources Canada, June 10, 2024. <https://natural-resources.canada.ca/our-natural-resources/energy-sources-distribution/electricity-infrastructure/the-canada-electricity-advisory-council/powering-canada-blueprint-for-success/25863>.

Caroline Lee, Jason Dion, and Christiana Guertin. "Bigger, Cleaner, Smarter: Pathways for Aligning Canadian Electricity Systems with Net Zero." Canadian Climate Institute, May 2022.
<https://climateinstitute.ca/wp-content/uploads/2022/05/Bigger-Cleaner-Smarter-May-4-2022.pdf>.

Casey Crownhart. "Everything You Need to Know about the Wild World of Heat Pumps." MIT Technology Review, February 14, 2023. <https://www.technologyreview.com/2023/02/14/1068582/everything-you-need-to-know-about-heat-pumps/>.

CLASP. "Air Conditioner Labeling in Thailand: Key Findings and Recommendations." Policy Brief, January 6, 2021. <https://www.clasp.ngo/research/all/air-conditioner-labeling-in-thailand-key-findings-and-recommendations/>.

CLASP. "China Launches Digital Energy Label & App." Accessed May 6, 2024. <https://www.clasp.ngo/updates/china-launches-digital-energy-label-app/>.

Clean BC. "Highest Efficiency Equipment Standards Regulatory Consultation," December 22, 2023. https://www2.gov.bc.ca/assets/gov/farming-natural-resources-and-industry/electricity-alternative-energy/energy-efficiency/highest_efficiency_equipment_standards_-_consultation.pdf.

Commission Regulation (EC) No 640/2009 of 22 July 2009 implementing Directive 2005/32/EC of the European Parliament and of the Council with regard to ecodesign requirements for electric motors (Text with EEA relevance), 191 OJ L § (2009). <http://data.europa.eu/eli/reg/2009/640/oj/eng>.

Commission Regulation (EU) 2019/1781 of 1 October 2019 laying down ecodesign requirements for electric motors and variable speed drives pursuant to Directive 2009/125/EC of the European Parliament and of the Council, amending Regulation (EC) No 641/2009 with regard to Ecodesign requirements for glandless standalone circulators and glandless circulators integrated in products and repealing Commission Regulation (EC) No 640/2009, 272 OJ L § (2019). <http://data.europa.eu/eli/reg/2019/1781/oj/eng>.

Commission Regulation (EU) No 206/2012 of 6 March 2012 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for air conditioners and comfort fans, 072 OJ L § (2012). <http://data.europa.eu/eli/reg/2012/206/oj/eng>.

Dingell, Debbie. H.R.7962: To amend the Energy Policy and Conservation Act to modify the definition of water heater under energy conservation standards, and for other purposes (2022). <https://www.congress.gov/bill/117th-congress/house-bill/7962>.

Efficiency Nova Scotia. "Shift and Save - Water Heater Controllers." Accessed May 31, 2024. <https://www.energycns.ca/residential/services-rebates/shift-and-save/>.

Egan, Christine, and Paul Waide. "A Multi-Country Comparative Evaluation of Labelling Research," 811– 22, 2005. https://www.eceee.org/static/media/uploads/site-2/library/conference_proceedings/eceee_Summer_Studies/2005c/Panel_4/4190egan/paper.pdf.

"Eligibility | Yukon Energy." Accessed May 31, 2024. <https://yukonenergy.ca/energy-in-yukon/saving-energy/peak-smart/eligibility>.

- Energy conservation standards, 42 United States Code § 6295. Accessed May 24, 2024.
<https://www.govinfo.gov/app/details/USCODE-2010-title42/USCODE-2010-title42-chap77-subchapIII-partA-sec6295>.
- ENERGY STAR. "Product Finder – ENERGY STAR Certified Furnaces." U.S Department of Energy. Accessed July 31, 2024. https://www.energystar.gov/productfinder/product/certified-furnaces/results?page_number=0.
- Environment and Climate Change Canada. "Greenhouse gas sources and sinks in Canada: Executive summary 2024." Government of Canada, May 2, 2024. <https://www.canada.ca/en/environment-climate-change/services/climate-change/greenhouse-gas-emissions/sources-sinks-executive-summary-2024.html>
- . "Temperature Change in Canada." Research. Government Of Canada, July 25, 2024. <https://www.canada.ca/en/environment-climate-change/services/environmental-indicators/temperature-change.html>.
- . "Understanding the Canadian Environmental Protection Act." Government of Canada, May 19, 2022. <https://www.canada.ca/en/services/environment/pollution-waste-management/understanding-environmental-protection-act.html>.
- European Commission. Commission Regulation (EU) No 206/2012 of 6 March 2012 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for air conditioners and comfort fans, 072 OJ L § (2012).
<http://data.europa.eu/eli/reg/2012/206/oj/eng>.
- . European Commission. Commission Regulation (EU) No 814/2013 of 2 August 2013 implementing Directive 2009/125/EC of the European Parliament and of the Council with regard to ecodesign requirements for water heaters and hot water storage tanks, 239 OJ L § (2013).
<http://data.europa.eu/eli/reg/2013/814/oj/eng>
- "Features to Consider | ENERGY STAR." Accessed May 7, 2024.
https://www.energystar.gov/products/smart_home_tips/features_and_functionality.
- Full Spectrum Technology Group. "What Internet Speed Do I Need For A Smart Home?" Accessed June 20, 2024. <https://www.fullspectrumtg.com/what-internet-speed-do-i-need-for-a-smart-home-2/>.
- Gard-Murray, Alexander, Brendan Haley, Sarah Miller, and Mathieu Poirier. "The Cool Way to Heat Homes: Installing Heat Pumps Instead of Central Air Conditioners in Canada." *Building Decarbonization Alliance, Canadian Climate Institute, Efficiency Canada, Greenhouse Institute.*, August 2023.
- Gateway Fiber. "How Much Internet Speed Does Smart Home Need?" Accessed June 20, 2024.
<https://www.gatewayfiber.com/blog/how-much-internet-speed-do-you-need-for-a-smart-home>.

- Government of Canada, Public Works and Government Services Canada. "Canada Gazette, Part 1, Volume 158, Number 25: Regulations Amending the Energy Efficiency Regulations, 2016 (Amendment 18)." Government of Canada, Public Works and Government Services Canada, Integrated Services Branch, Canada Gazette, June 22, 2024. <https://www.gazette.gc.ca/rp-pr/p1/2024/2024-06-22/html/reg1-eng.html>.
- Gruenwald, Talor, Brady A. Seals, Luke D. Knibbs, and H. Dean Hosgood. "Population Attributable Fraction of Gas Stoves and Childhood Asthma in the United States." *International Journal of Environmental Research and Public Health* 20, no. 1 (January 2023): 75. <https://doi.org/10.3390/ijerph20010075>.
- Hilo by Hydro-Québec. "Hilo Is Offering the First-Ever Smart Solution for Electric Water Heaters That Meets Québec's Public Health Requirements.," December 16, 2021. <https://www.hiloenergie.com/en-ca/nouvelles/partnership-hilo-hydrosolution-water-heater/>.
- IEA. *Canada 2022 Energy Policy Review*. IEA Energy Policy Reviews. Paris: OECD Publishing, 2022. <https://www.oecd.org/publications/canada-2022-energy-policy-review-a440d879-en.htm>.
- IEA Technology Collaboration Programme. "PEET Efficiency Trends Analysis." 4E PEET, January 30, 2021. https://www.iea-4e.org/wp-content/uploads/publications/2021/01/4E-PEET-Efficiency-Trends-Report-2018_19.pdf.
- International Energy Agency. "Canada 2022 Energy Policy Review," 2022. <https://www.oecd-ilibrary.org/content/publication/a440d879-en>.
- Jake Marin. "What Makes Heat Pumps So Efficient Anyway?" Northeast Energy Efficiency Partnerships, January 28, 2015. <https://neep.org/blog/what-makes-heat-pumps-so-efficient-anyway>.
- Jason Dion, Anna Kanduth, Jeremy Moorhouse, and Dale Beugin. "Canada's Net Zero Future: Finding Our Way in the Global Transition." Canadian Institute for Climate Choices, February 2021. https://climatechoices.ca/wp-content/uploads/2021/02/Canadas-Net-Zero-Future_FINAL-2.pdf.
- Jayond Li, Steven Zeng, Hu Bo, and Zheng Tan. "Market Analysis of China Energy Efficient Products (MACEEP)." CLASP, Top10 China, September 2013. https://www.clasp.ngo/wp-content/uploads/2021/01/09_2013_Market-Analysis-China-Energy-Efficient-Products_Extended-Executive-Summary.pdf.
- Jess Burgess, Geneviève Gauthier, and Pierre Gravel-Primeau. "Standards to Enable Automated Demand Response in Canada." CSA Group, May 2022. <https://www.csagroup.org/wp-content/uploads/CSA-Group-Research-Standards-to-Enable-Automated-Demand-Response-in-Canada.pdf>.
- Kevin Lane. "Lighting." IEA, July 11, 2023. <https://www.iea.org/energy-system/buildings/lighting>.

Kevin Lockhart. "Efficiency Canada: Public Review of Proposed Changes to the 2020 National Model Codes." Efficiency Canada, November 28, 2023. <https://www.energycanada.org/wp-content/uploads/2023/11/Efficiency-Canada-Public-review-of-proposed-changes-to-the-2020-National-Model-Codes.pdf>.

Lauren Boucher, "How National Appliance and Equipment Energy Conservation Standards Can Improve Public Health and Advance Justice40 Initiative Goals", CLASP, 2024. <https://www.clasp.ngo/research/all/us-health-energy-conservation-standards/>.

Lebel, Eric D., Colin J. Finnegan, Zutao Ouyang, and Robert B. Jackson. "Methane and NOx Emissions from Natural Gas Stoves, Cooktops, and Ovens in Residential Homes." *Environmental Science & Technology* 56, no. 4 (February 15, 2022): 2529–39. <https://doi.org/10.1021/acs.est.1c04707>.

Legislative Services Branch. "Canadian Net-Zero Emissions Accountability Act (S.C. 2021, c. 22)." Justice Laws Website - Government of Canada, September 10, 2024. <https://laws-lois.justice.gc.ca/eng/acts/c-19.3/fulltext.html>.

Lowell Ungar. "Demand Flexibility of Water Heaters." ACEEE, August 2023. https://www.aceee.org/sites/default/files/pdfs/demand_flexibility_of_water_heaters_-_encrypt.pdf.

Lynskey, Dorian. "How the Compact Disc Lost Its Shine." *The Guardian*, May 28, 2015, sec. Music. <https://www.theguardian.com/music/2015/may/28/how-the-compact-disc-lost-its-shine>.

Marco Grippa, Davide Sabbadin, Gunnar Boye Olesen, and Jan Tichelaar. "Comments on the Regulations About Ecodesign and Energy Labelling Requirements for Space and Water Heaters." Brussels: Environmental Coalition on Standards; European Environmental Bureau; Cool Products, June 2023. https://ecostandard.org/wp-content/uploads/2023/06/ECOS_EEB_Coolproducts_Space-and-water-heaters.pdf.

Minister of Justice. "Energy Efficiency Act (S.C. 1992, c. 36)." Government Of Canada, December 14, 2017. <https://lois-laws.justice.gc.ca/eng/acts/E-6.4/>.

National Association of Home Builders and Bank of America Home Equity. "Study of Life Expectancy of Home Components," 2007. <https://hiabc.ca/wp-content/uploads/2011/09/Study-of-Life-Expectancy-of-Home-Components.pdf>.

National Electrical Manufacturers Association. "Power Index Calculation Procedure—Standard Rating Methodology for Power Drive Systems and Complete Drive Modules," February 25, 2022. <https://www.nema.org/standards/view/power-index-calculation-procedure-standard-rating-methodology-for-power-drive-systems-and-complete-drive-modules>.

- Natural Resources Canada. "Amendments to the Energy Efficiency Act Pass in the House of Commons." News releases, May 7, 2009. <https://www.canada.ca/en/news/archive/2009/05/amendments-energy-efficiency-act-pass-house-commons.html>.
- Natural Resources Canada. "Amendments to the Energy Efficiency Regulations, 2016." Government of Canada, July 5, 2024. <https://natural-resources.canada.ca/transparency/acts-and-regulations/forward-regulatory-plan/amendments-the-energy-efficiency-regulations-2016/21709>.
- Natural Resources Canada. "Gas Fireplaces." Government of Canada. Natural Resources Canada, December 12, 2019. <https://natural-resources.canada.ca/energy-efficiency/energy-efficiency-regulations/guide-canadas-energy-efficiency-regulations/gas-fireplaces/6865>.
- . "Appliances—EnerGuide." Natural Resources Canada, March 7, 2019. <https://natural-resources.canada.ca/energy/efficiency/energide-canada/energide-label/reading-label-energide/appliances-energide/13632>.
- . "Canada Gazette, Part 2, Volume 156, Number 26: Regulations Amending the Energy Efficiency Regulations, 2016 (Amendment 17)." Government of Canada. Government of Canada, Public Works and Government Services Canada, Integrated Services Branch, Canada Gazette, December 21, 2022. <https://canadagazette.gc.ca/rp-pr/p2/2022/2022-12-21/html/sor-dors265-eng.html>.
- . "Canada's Energy Efficiency Regulations." Government of Canada, October 10, 2023. <https://natural-resources.canada.ca/energy/regulations-codes-standards/7043>.
- . "Canada's GHG Emissions by Sector, End Use and Subsector – Including Electricity-Related Emissions." Government of Canada. Government of Canada, Natural Resources Canada. Accessed August 20, 2024. <https://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/showTable.cfm?type=HB§or=aaa&juris=ca&n=3&page=0>.
- . "Electric Ranges - Energy Efficiency Regulations." Government of Canada. Natural Resources Canada, June 14, 2019. <https://natural-resources.canada.ca/energy-efficiency/energy-efficiency-regulations/guide-canadas-energy-efficiency-regulations/electric-ranges/6937>.
- . "Energy Efficiency: An Essential Part of Canada's Net-Zero Future - Report to Parliament under the Energy Efficiency Act 2021-2022." Government of Canada, November 29, 2023. https://natural-resources.canada.ca/sites/nrcan/files/www/pdf/publications/emmc/Report_to_Parliament_on_Energy_Efficiency_Nov_2023-EN.pdf.
- . "Energy-Efficient Products: Searchable Product List." Government of Canada. Accessed May 24, 2024. <https://oee.nrcan.gc.ca/pml-lmp/index.cfm?action=app.welcome>

bienvue&_gl=1*1hxjm4x*_ga*NzUyMzk2NjkzLjE3MTUwMDY2NTc.*_ga_C2N57Y7DX5*MTcxNjU1NzI2O C4yMi4xLjE3MTY1NTg2NDMuMC4wLjA.

- . "Gas Ranges - Energy Efficiency Regulations." Government of Canada. Natural Resources Canada, April 30, 2019. <https://natural-resources.canada.ca/energy-efficiency/energy-efficiency-regulations/guide-canadas-energy-efficiency-regulations/gas-ranges/6891>.
- . "General Service Lamps - Technical Bulletin on Developing the Standards." Government of Canada. Natural Resources Canada, August 3, 2022. <https://natural-resources.canada.ca/energy-efficiency/energy-efficiency-regulations/general-service-lamps/24407>.
- . "General Service Lamps and Modified Spectrum Incandescent Lamps - Energy Efficiency Regulations." Government of Canada. Natural Resources Canada, December 8, 2023. <https://natural-resources.canada.ca/energy/regulations-codes-standards/products/6869>.
- . "Guide to Canada's Energy Efficiency Regulations." Government of Canada. Natural Resources Canada, October 3, 2023. <https://natural-resources.canada.ca/energy-efficiency/energy-efficiency-regulations/guide-canadas-energy-efficiency-regulations/6861>.
- . "Heating and Cooling With a Heat Pump." Government Of Canada. Natural Resources Canada, August 9, 2022. <https://natural-resources.canada.ca/energy-efficiency/energy-star-canada/about/energy-star-announcements/publications/heating-and-cooling-heat-pump/6817>.
- . "Oil-Fired Furnaces - Energy Efficiency Regulations." Government of Canada. Natural Resources Canada, May 10, 2021. <https://natural-resources.canada.ca/energy-efficiency/energy-efficiency-regulations/guide-canadas-energy-efficiency-regulations/oil-fired-furnaces/6887>.
- . "Pre-Consultations for Next Amendments - Energy Efficiency Regulations." Government of Canada. Natural Resources Canada, April 30, 2024. <https://natural-resources.canada.ca/energy-efficiency/energy-efficiency-regulations/pre-consultations-for-next-amendments/24439>.
- . "Proposed Approach to Regulating Home Appliances to ENERGY STAR Performance Levels - Pre-Consultations, Webinar #1." April 29, 2021.
- . "Refrigerators and Refrigerator-Freezers." Government Of Canada. Natural Resources Canada, February 15, 2021. <https://natural-resources.canada.ca/energy-efficiency/energy-efficiency-regulations/guide-canadas-energy-efficiency-regulations/refrigerators-and-refrigerator-freezers/6877>.
- . "Residential Water Heating Energy Use and Water Heater Stock Share." Government of Canada. Government of Canada, Natural Resources Canada. Accessed August 20, 2024. <https://oee.nrcan.gc.ca/corporate/statistics/neud/dpa/showTable.cfm?type=HB§or=res&juris=00&y ear=2020&rn=17&page=0>

- . "Tankless Water Heaters." Government of Canada. Natural Resources Canada, May 11, 2018. <https://natural-resources.canada.ca/energy-efficiency/products/water-heaters/tankless/14541>.
- . "The Canada Green Buildings Strategy: Transforming Canada's Buildings Sector for a Net-Zero and Resilient Future." Government Of Canada. Natural Resources Canada, July 16, 2024. <https://natural-resources.canada.ca/transparency/reporting-and-accountability/plans-and-performance-reports/departmental-strategies/the-canada-green-buildings-strategy-transforming-canadas-buildings-sector-for-net-zer/26065>.
- . "The EnerGuide Label." Government of Canada. Natural Resources Canada, December 5, 2023. <https://natural-resources.canada.ca/energy-efficiency/energuguide/energuguide-label/13609>.
- . "Energy Efficiency Regulations by Province." Government Of Canada. Natural Resources Canada, September 6, 2023. <https://natural-resources.canada.ca/energy-efficiency/energy-efficiency-regulations/energy-efficiency-regulations-province/20986>.
- NBPower. "EcoLink." Accessed May 31, 2024. <http://www.nbpower.com/en/products-services/water-heater-service/for-your-home/ecolink/>.
- Newkirk, Alex, Prakash Rao, and Paul Sheaffer. "U.S. Industrial and Commercial Motor System Market Assessment Report Volume 2: Advanced Motors and Drives Supply Chain Review." Lawrence Berkeley National Lab. (LBNL), Berkeley, CA (United States), June 1, 2021. <https://doi.org/10.2172/1822412>.
- Niels Ladefoged. "EU Requirements (Labelling and Ecodesign) for Heating Appliances: Current Requirements and on-Going Revisions." Presented at the WORKSHOP ON ENABLING DECARBONISATION OF INDIVIDUAL HEATING SYSTEMS, European Commission, November 9, 2023. [https://www.energy-community.org/dam/jcr:e081c7c0-aa91-42cc-883e-b131f2320263/EU%20Commission,%20EU%20requirements%20\(labelling%20and%20ecodesign\)%20for%20heating%20appliances.pdf](https://www.energy-community.org/dam/jcr:e081c7c0-aa91-42cc-883e-b131f2320263/EU%20Commission,%20EU%20requirements%20(labelling%20and%20ecodesign)%20for%20heating%20appliances.pdf).
- Noah Horowitz. "Are Smart Speakers and Streaming Devices Energy Efficient?" NRDC, August 12, 2019. <https://www.nrdc.org/bio/noah-horowitz/are-smart-speakers-and-streaming-devices-energy-efficient>.
- Office of Energy Efficiency & Renewable Energy. "LED Lighting - Energy Saver." U.S. Department of Energy. Accessed September 10, 2024. <https://www.energy.gov/energysaver/led-lighting>.
- Onabola, Christiana O. "Health and Safety Aspects of Demand Response on Electric Storage Water Heaters: A Mini Literature Review." *UBC Sustainability*, August 2018. https://sustain.ubc.ca/sites/default/files/2018-21%20Health%20and%20safety%20aspects%20of%20residential%20water%20heaters_Onabola.pdf.

- Pierre Delforge. "The Methane Math for Gas Tankless Water Heaters." NRDC, September 24, 2020. <https://www.nrdc.org/bio/pierre-delforge/methane-math-gas-tankless-water-heaters>.
- Public Works and Government Services Canada. "Canada Gazette, Part 1, Volume 157, Number 33: GOVERNMENT NOTICES." Government of Canada, August 19, 2023. <https://canadagazette.gc.ca/rp-pr/p1/2023/2023-08-19/html/notice-avis-eng.html>.
- Rao, Prakash, Paul Sheaffer, Yuting Chen, Unique Karki, and Patrick Fitzgerald. "U.S. Industrial and Commercial Motor System Market Assessment Report. Volume 3: Energy Saving Opportunity." Lawrence Berkeley National Lab. (LBNL), Berkeley, CA (United States), July 18, 2022. <https://doi.org/10.2172/1876861>.
- Rheem Manufacturing Company. "How Demand Response Programs Save You Energy and Money." *Water Heating* (blog), October 6, 2022. <https://www.rheem.com/water-heating/articles/how-demand-response-programs-save-you-energy-and-money/s>.
- Richard Lowes, Jan Rosenow, Dominic Scott, Louise Sunderland, Samuel Thomas, Andreas Graf, Marie Baton, Steve Pantano, and Peter Graham. "The Perfect Fit: Shaping the Fit for 55 Package to Drive a Climate-Compatible Heat Pump Market." Regulatory Assistance Project, March 2022. <https://www.raonline.org/knowledge-center/the-perfect-fit-shaping-the-fit-for-55-package-to-drive-a-climate-compatible-heat-pump-market/>.
- Rita Werle. "International Energy Agency Technology Collaboration Programme 4E Energy Efficient End- Use Equipment EMSA Electric Motor Systems Annex." Presented at the IEA's 7th Annual Global Conference on Energy Efficiency Appliance Policy Event: Motor Systems, Sønderborg, Denmark, June 7, 2022. https://www.iea-4e.org/wp-content/uploads/2022/06/IEA_Global_EE_conf_2022_final.pdf.
- Sara Demartini, Marie Baton, and Lina Kelsaite. "Communicating Circular Economy through Appliance Labeling," September 1, 2022. <https://www.clasp.ngo/wp-content/uploads/2022/05/Communicating-Circular-Economy-Through-Labeling-International-Case-Studies-and-Recommendations-for-Thailand.pdf>.
- Sawyer, Dave. "Evidence of Progress: Canadian Emissions down from Peak as Economy Decouples Emissions from Growth." Canadian Climate Institute, May 2, 2024. <https://climateinstitute.ca/news/evidence-of-progress-canadian-emissions-down-from-peak-as-economy-decouples-emissions-from-growth/>.
- "Smart Electric Motor: Technology Innovation as a Key Enabler of Energy Efficiency." Accessed June 20, 2024. <https://www.rvmagnetics.com/smart-electric-motor-technology-innovation-as-a-key-enabler-of-energy-efficiency-88>.

“Smart Motor Sensors | SICK.” Accessed June 20, 2024. <https://www.sick.com/ca/en/smart-motor-sensors/w/smart-motor-sensors/>.

Stabenow, Debbie. S.4061: A bill to amend the Energy Policy and Conservation Act to modify the definition of water heater under energy conservation standards, and for other purposes. (2022). <https://www.congress.gov/bill/117th-congress/senate-bill/4061>.

“Standards and Labeling Guidebook, Third Edition,” Unpublished 2021.

Statistics Canada. “Electric Power, Electric Utilities and Industry, Annual Supply and Disposition.” Government Of Canada, May 1, 2024. <https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=2510002101>.

———. “The Daily – Canadian Internet Use Survey, 2022.” Government Of Canada, July 20, 2023. <https://www150.statcan.gc.ca/n1/daily-quotidien/230720/dq230720b-eng.htm>.

———. “Type of Energy Consumed by Manufacturing Sector, 2021 and 2022.” Government Of Canada, October 30, 2023. <https://www150.statcan.gc.ca/n1/daily-quotidien/231030/cg-c003-eng.htm>.

The Globe and Mail. “Higher Energy Efficiency Rules for Appliances Could Raise Costs, Industry Group Says,” May 19, 2021. <https://www.theglobeandmail.com/business/article-higher-energy-efficiency-rules-for-appliances-could-raise-costs/>.

“The Lightbulb Moment: The Rapid Shift to LEDs and Ultra Efficient Lighting.” Accessed May 24, 2024. <https://rapidtransition.org/stories/the-lightbulb-moment-the-rapid-shift-to-leds-and-ultra-efficient-lighting/>.

Trane. “Trane XB Series.” Manufacturer brochure, March 2013. https://www.trane.com/content/dam/Trane/residential/downloads/brochure/airconditioners/72-1276-06_RO.pdf.

United Nations Climate Action. “For a Livable Climate: Net-Zero Commitments Must Be Backed by Credible Action.” United Nations. United Nations. Accessed September 18, 2024. <https://www.un.org/en/climatechange/net-zero-coalition>.

U.S. Department of Energy. “2024-04-24 Energy Conservation Program: Energy Conservation Standards for Dishwashers; Direct Final Rule.” Regulations.gov, April 24, 2024. <https://www.regulations.gov/document/EERE-2019-BT-STD-0039-0065>.

———. “Energy Conservation Program: Energy Conservation Standards for Consumer Conventional Cooking Products; Direct Final Rule.” Regulations.gov, February 14, 2024. https://www.regulations.gov/document/EERE-2014-BT-STD-0005-12825?utm_medium=email&utm_source=govdelivery.

- . "Energy Conservation Program: Energy Conservation Standards for Consumer Furnaces; Final Rule." Regulations.gov, December 18, 2023. <https://www.regulations.gov/document/EERE-2014-BT-STD-0031-4107>.
- . "Energy Conservation Program: Energy Conservation Standards for Electric Motors - Direct Final Rule." the Federal Register, May 2023. <https://www.energy.gov/sites/default/files/2023-05/em-ecs-dfr.pdf>.
- . "Energy Conservation Program: Energy Conservation Standards for General Service Fluorescent Lamps." Federal Register, February 13, 2023. <https://www.federalregister.gov/documents/2023/02/13/2023-02863/energy-conservation-program-energy-conservation-standards-for-general-service-fluorescent-lamps>.
- . "Energy Conservation Program: Energy Conservation Standards for Refrigerators, Refrigerator-Freezers, and Freezers; Direct Final Rule." Regulations.gov, January 17, 2024. <https://www.regulations.gov/document/EERE-2017-BT-STD-0003-0116>.
- Virtual Peaker. "Virtual Peaker Launches First Utility Program in Canada." Accessed May 31, 2024. <https://virtual-peaker.com/news/virtual-peaker-launches-first-utility-program-in-canada/>.

Appendix

