2022 INTERNATIONAL ENERGY EFFICIENCY SCORECARD

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April 2022
ACEEE Report

ACEEE

Contents

About ACEEE

The **American Council for an Energy-Efficient Economy** (ACEEE), a nonprofit research organization, develops policies to reduce energy waste and combat climate change. Its independent analysis advances investments, programs, and behaviors that use energy more effectively and help build an equitable clean energy future.

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Acknowledgments

This report was made possible through internal ACEEE funding. The authors gratefully acknowledge external reviewers, internal reviewers, and colleagues who supported this report. External review and support do not imply affiliation or endorsement. External expert reviewers and experts who responded to our data requests included the following:

Ahmed Samir Elbermbali, Clean Energy Business Council, U.A.E.
Alan Meier, Lawrence Berkeley National Laboratory
Alessandro Fiorini, Italian National Agency for New Technologies, Energy and Sustainable Economic Development (ENEA), Italy
Alessandro Federici, ENEA, Italy
Alfred Hartzenburg, Green Industry Specialists (Pty) Ltd., South Africa
Barbara Schlomann, Fraunhofer Institute for Systems and Innovation Research
Brett Feldman, Guidehouse
Brendan Haley, Efficiency Canada
Carine Sebi, Grenoble Ecole de Management, France
Conrado Augustus de Melo, Federal University of ABC, Brazil
Christian Brand, University of Oxford
Dario Di Santo, Federazione Italiana per l'uso Razionale dell'Energia (FIRE), Italy
Diego Ponce de Leon Barido, East Bay Community Energy
Elizabeth Sendich, U.S. Energy Information Administration
Hongyou Lu, Lawrence Berkeley National Laboratory
John A. "Skip" Laitner, Economic and Human Dimensions Research Associates
Juan Ignacio Navarrete, National Commission for the Efficient Use of Energy, Mexico
Lawrence Plumb, retired from Verizon
Matthew Lam, Office of Energy Efficiency, Natural Resources Canada
Meredydd Evans, Pacific Northwest National Laboratory
Michele Preziosi, ENEA, Italy
Mirjam Harmelink, TU Delft, Netherlands
Moncef Krarti, University of Colorado
Nan Zhou, Lawrence Berkeley National Laboratory
Osamu Kimura, Central Research Institute of Electric Power Industry, Japan
Paolo Zangheri, ENEA, Italy
Raul Talan, Trust for Saving Electric Energy (FIDE), Mexico
Richard Larmour, University of Cape Town, South Africa
Ridah Sabouni, ICF
Rob Murray-Leach, Energy Efficiency Council, Australia
Roberta Quadrelli, International Energy Agency
Sarina Cotroneo and colleagues, Office of Energy Efficiency, Natural Resources Canada
Samuel Thomas, Regulatory Assistance Project
Sangeeta Mathew, Alliance for an Energy Efficient Economy, India
Sho Hirayama, Jyukankyo Research Institute Inc., Japan
Stefan Thomas, Wuppertal Institute, Germany

Szymon Peryt, Statistics Poland
Thomas K. Dreessen, EPS Capital Corp.
Uwe Bigalke, Deutsche Energie-Agentur GmbH (dena)—German Energy Agency
Veit Bürger, Öko-Institut e.V., Germany
Zack Hsieh, Industrial Technology Research Institute, Taiwan
Zafar Said, University of Sharjah, U.A.E.

Internal reviewers included Jennifer Amann, Naomi Baum, Neal Elliot, Bryan Howard, Lowell Ungar, and Amber Wood. The authors also gratefully acknowledge the assistance of Alexander Jarrah. Last, we would like to thank Mary Robert Carter for managing the editing process, Mariel Wolfson for developmental editing, Keri Schreiner for copy editing, Roxanna Usher for proofreading, Kate Doughty for graphics design, and Wendy Koch and Ben Somberg for their help in launching this report.

Suggested Citation

Subramanian, S., H. Bastian, A. Hoffmeister, B. Jennings, C. Tolentino, S. Vaidyanathan, and S. Nadel. 2022. *2022 International Energy Efficiency Scorecard.* Washington, DC: American Council for an Energy-Efficient Economy. www.aceee.org/research-report/i2201.

Executive Summary

KEY FINDINGS

This report examines the energy efficiency and carbon reduction policies and performance of 25 of the world's top energy-consuming countries.

- First place goes to France, leading the *International Scorecard* for the first time with an overall score of 74.5 out of 100 possible points. France also earned the top spot in the transportation category.
- Rounding out the top five are the United Kingdom (#2), Germany and the Netherlands (tied at #3), and Italy (#5).
- This year, the Netherlands was the most improved country. It has robust building retrofit policies, and a large share of its new vehicle sales are electric.
- No country achieved a perfect score, and the average score declined slightly from 2018, indicating that countries have achieved limited progress in the past few years. Many of our metrics reflect data up to 2018, and most are unlikely to account for the effects of the COVID-19 pandemic. Many countries submitted updated climate targets for 2030 and made new commitments for net-zero greenhouse gas emissions at the 26th United Nations Climate Change Conference of the Parties (COP 26); the scores do not reflect the effects of these new commitments.
- Energy efficiency is an important tool to address climate change; to reduce energy consumption and make progress on their climate goals, countries will need to step up their efforts.

Energy efficiency plays an essential role in mitigating climate change and is often the least expensive way to meet new energy demand. The Intergovernmental Panel on Climate Change's *Sixth Assessment Report* estimates that the world is on a trajectory to hit or exceed 1.5 degrees Celsius of warming in the next 20 years unless actions are taken to substantially reduce greenhouse gas (GHG) emissions.

Governments that encourage investment in energy efficiency and implement policies to support energy efficiency save citizens money, create jobs, and improve public health by decreasing pollution. These benefits are especially important as the world continues to deal with the impacts of a global health crisis. Yet energy efficiency remains massively

underutilized globally despite its proven multiple benefits and its potential to achieve significant reductions in emissions by 2040.[1]

This fifth edition of ACEEE's *International Energy Efficiency Scorecard* examines the efficiency policies and performance of 25 of the world's top energy-consuming countries. Together, these nations represent 82% of the energy consumed on the planet, and they accounted for more than 80% of the world's gross domestic product (GDP) in the most recent year for which reliable data are available. We evaluated and scored each country's efficiency efforts using 36 policy and performance metrics spread over four categories: buildings, industry, transportation, and overall national energy efficiency progress.[2] We allocated 25 points to each of these four categories and awarded the maximum number of points for each metric to at least one country.

Like the previous edition, this year's *Scorecard* gives more weight to policy actions, with the point allocation split 60/40 between policy and performance. Policy metrics highlight best practices implemented by a country, such as national energy savings goals and GHG reduction targets, vehicle fuel economy standards, or energy efficiency standards for appliances and equipment. Performance metrics measure energy use per unit of activity or service extracted—for example, the average on-road miles per gallon (mpg) for passenger vehicles or the energy consumed per square foot of floor space in residential buildings. We provide only 40% of the points to performance due to limited data availability on performance for most sectors included in our report. When more performance data become available in the future, we plan to increase the weight we assign to performance, as is currently the case in the transportation chapter.

France earned the highest overall score of 74.5 out of 100 possible points, followed closely by the United Kingdom with 72.5 points. Rounding out the top five were Germany, the Netherlands, and Italy. France took first place in the transportation category, while Japan earned first place in the industry section. The Netherlands took the top spot in the buildings category and ranked first, along with Germany, in the national efforts section. The lowest-scoring countries were South Africa and the United Arab Emirates, with 23.5 points and 21.5 points, respectively. Saudi Arabia rounded out the bottom three with 25 points. Figure ES1 shows *Scorecard* rankings by country. Data availability was an issue for these lower-ranked countries, as we could not give points where we did not have data.

[1] *Energy Efficiency 2020* (Paris: IEA).

[2] Although energy efficiency in the power sector is not included in the *Scorecard*, we assess the efficiency of thermal power plants as part of countries' national efforts.

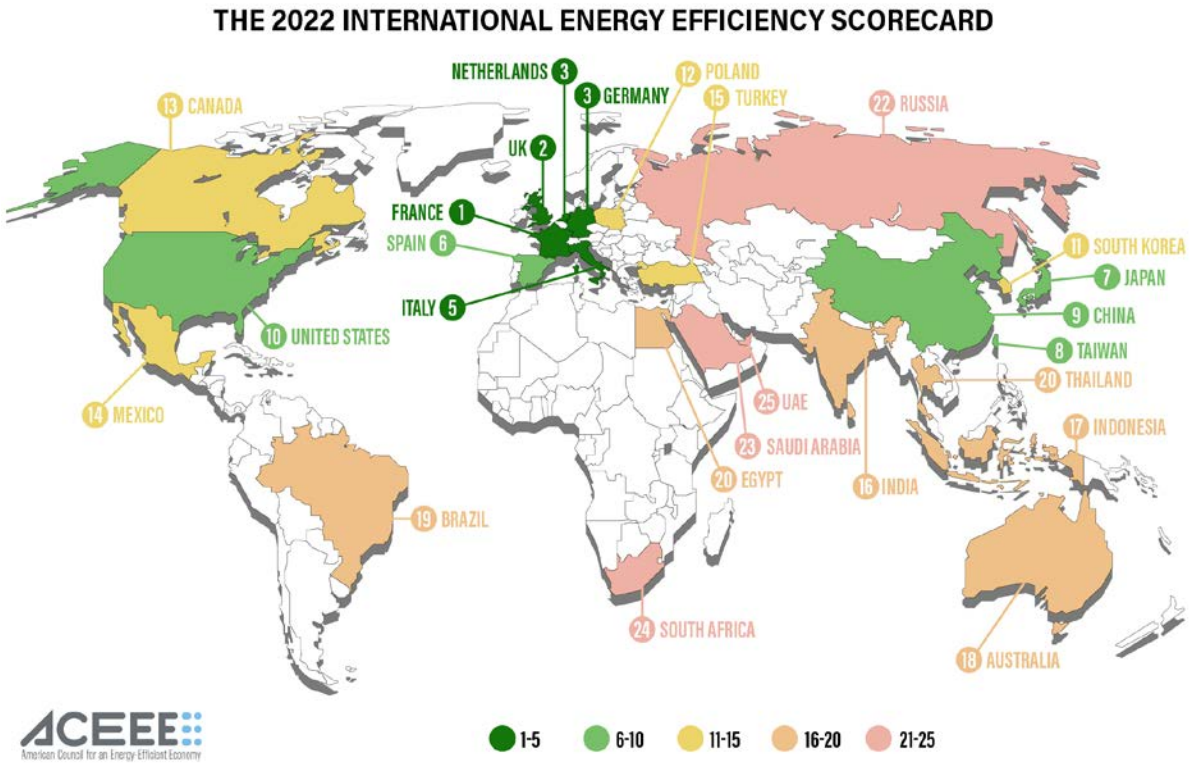

Figure ES1. Rankings by country

The Netherlands was the most improved country this year in terms of ranking. It gained 6.5 points and tied for third compared to seventh in 2018. Although Saudi Arabia ranked close to last in this edition, it still gained more points (8.5) than any other country. Italy and Canada saw declines in both scores and rank in this report.

The United States saw no change in ranking from 2018, coming in 10th out of 25 countries. Its overall score dropped slightly to 54 points from 55.5 points in the previous edition due to weaker policies and performance in the transportation category.

Our results indicate that all economies evaluated in this report still lag behind where they need to be. Opportunities for improvement are particularly important to pursue given that energy efficiency can save money and reduce pollution while helping to meet national GHG reduction targets. The average score for this *Scorecard* edition was just 48.5 points, slightly less than half the 100 points available for best-in-class performance on all metrics. Low-scoring countries with emerging economies (such as Egypt, Thailand, and South Africa) and higher-income nations that have historically given less attention to policies that address energy consumption (such as Saudi Arabia and the United Arab Emirates) all have great potential to use efficiency to foster continued economic growth without resource constraints. Other more-developed countries, including the United States, need to be more aggressive about meeting their climate targets and could use energy efficiency to do so.

Introduction

Energy efficiency is often the least-cost means of meeting new demand for energy services while also addressing climate change. The Intergovernmental Panel on Climate Change (IPCC) recently released its *Sixth Assessment Report*, which shows that the planet will likely hit or exceed 1.5 degrees Celsius of warming in the next 20 years without significant intervention to reduce greenhouse gas (GHG) emissions (IPCC 2021). The report finds that warmer temperatures will affect all regions globally and will exacerbate extreme weather events and other impacts. Transformative action is needed immediately to reduce the global carbon footprint. In November 2021, countries gathered for the 26th United Nations Climate Change Conference of the Parties (COP 26) to commit to goals and actions that meaningfully reduce GHG emissions. Many countries set targets or made pledges for net-zero emissions at COP 26—including countries evaluated in our report such as Australia, Canada, India, Russia, Saudi Arabia, Thailand, Turkey, United Arab Emirates, and the United States—while China and Japan had pledged to achieve net-zero emissions in previous years. As part of COP 26, countries also submitted updated nationally determined contributions or climate targets for 2030. However, many targets fall short of what is required to meet net-zero goals.

Decarbonization in the buildings, industrial, and transportation sectors will require a multipronged policy approach. For example, electrification of most fossil-fuel end uses in buildings (i.e., heating, cooling, and cooking) is one approach to reduce emissions. In the industrial sector, policies include incentivizing the procurement of low-carbon materials in the public and private sector and providing financial support for low-emission technologies. Decarbonizing transport will involve policies that both shift the economy to low-carbon transit options and support infrastructure and incentives for electric vehicles (EVs).

Energy efficiency plays a key role in meeting countries' national targets to reduce overall GHG emissions, while also lowering overall energy consumption and encouraging economic development by creating jobs. Governments that promote investment in energy efficiency and implement supporting policies also save their citizens money and decrease pollution. These benefits are especially significant as the world continues to grapple with the effects of the COVID-19 pandemic. The International Energy Agency (IEA) estimates that in 2019, approximately 200 million tons of carbon dioxide (CO_2) emissions were avoided globally due to energy efficiency improvements; it also estimates that global government stimulus spending on energy efficiency could create almost 2 million jobs in the next two years (IEA 2020a).

Energy efficiency is particularly important given that both the global demand for energy and GHG emissions have risen rapidly in the past two decades. The world's total primary energy consumption more than doubled between 1980 and 2019. Energy-related emissions increased by 10 gigatonnes since 2000 and reached a peak in 2018–2019 (IEA 2021c). IEA's Stated Policies Scenario projects global energy demand to grow another 25% by 2040 as emerging markets develop and increase their standard of living (IEA 2019b). Yet energy

efficiency remains massively underutilized globally despite its proven multiple benefits and its potential to supply almost 50% of the necessary GHG emissions reductions needed to meet the Paris Agreement by 2040 (IEA 2018a; UNFCCC 2022). Energy efficiency also has the potential to become the single largest resource for moderating the growth in energy demand worldwide (IEA 2014). By reducing the need to burn the fossil fuels that emit harmful criteria pollutants, energy efficiency helps to protect public health (Costello et al. 2009; HEI 2017).

Energy efficiency also minimizes the risk of energy disruptions resulting from climate-change-induced extreme weather patterns while both lowering the impact of natural disasters on vulnerable populations and strengthening electric grid reliability. This reliability can, in turn, help to prevent power outages and ensure resilience in the face of storms, floods, and other natural disasters.

The 2022 International Energy Efficiency Scorecard examines the energy efficiency policies and performance of 25 of the world's top energy-consuming countries. Together, these countries represent 82% of all the energy consumed on the planet and account for more than 80% of the world's gross domestic product (GDP) in the most recent year for which reliable data are available (EIA 2021c; World Bank 2022b).

This fifth edition of the *Scorecard* serves two purposes. First, it presents a basic comparison of energy use and efficiency policy efforts in the top energy-consuming countries. Second, it identifies best practices and policies that countries can implement to take advantage of untapped efficiency potential. We hope that our report's findings will generate discussion among stakeholders to promote energy efficiency globally.

We used 36 metrics to evaluate each country's national commitment to energy efficiency as well as its efficiency policies and performance in the buildings, industry, and transportation sectors. Table 2 shows a complete list of our metrics. We ranked the countries on each metric, highlighting best practices in countries that performed well and areas for improvement in countries that did not. Although we recognize that many variables affect energy use—including wealth, climate, geography, economic structure, and demography—we largely avoided adjusting the data to reflect those impacts. Because our goal was to evaluate energy use across countries, we chose to present the data in the least processed form that allows for meaningful comparison.

Methodology

This section outlines the reasoning behind our choice of countries to evaluate, the methodology we used to rate each country on the 36 metrics, and the differences in our ratings approach from the 2018 edition *(*Castro-Alvarez et al. 2018).

We evaluated the countries that are among the top energy consumers worldwide. Figure 1 compares primary energy use in the countries we selected.[1]

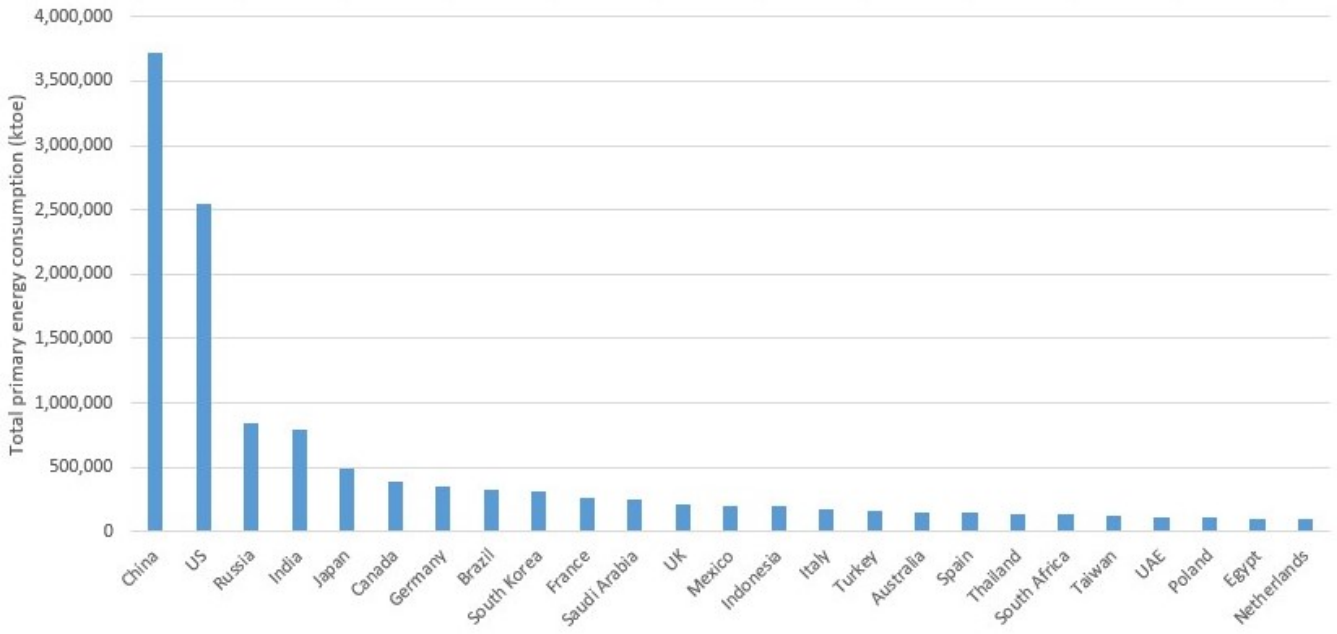

Figure 1. Total primary energy consumption of top energy consumers, in kilotonnes of oil equivalent (ktoe). Data are for 2018. Source: EIA 2021c.

We replaced Ukraine with Egypt in our analysis this year due to the significant drop in Ukraine's energy consumption since the last *Scorecard* edition; this drop appears to be due to multiple causes, including the country's loss of authority over Crimea, the conflict in heavily industrial regions bordering Russia, and energy efficiency improvements triggered by the cutoff of gas supplies from Russia (Kholod et al. 2018; M. Evans, senior staff scientist, pers. comm., December 17, 2021). Iran is also among the world's largest energy consumers (approximately 300,000 ktoe) but is not included in this year's report due to data availability limitations. We hope to be able to include Iran in a future edition of the report. Table 1 shows the population, market exchange rate GDP, and energy use by sector for each of our evaluated countries.

[1] *Primary* energy is the energy contained in raw fuels that has not been subjected to conversion or transformation through any engineering process.

Table 1. GDP and energy consumption of top energy-consuming countries in 2018 (descending order of total primary energy consumption)

Country	GDP (trillion 2010 US$)	Population	Total primary energy* consumption (ktoe)	Total final energy** consumption (ktoe)	Buildings total final energy consumption (ktoe)	Industry total final energy consumption (ktoe)	Transportation total final energy consumption (ktoe)
China	10.87	1,392,730,000	3,718,702	2,066,635	441,675	997,672	327,235
U.S.	17.96	326,838,199	2,549,250	1,594,129	488,534	276,582	638,100
Russia	1.74	144,477,859	839,258	514,447	185,283	138,955	101,017
India	2.83	1,352,642,283	789,955	609,865	203,838	206,087	103,767
Japan	6.17	126,529,100	484,993	283,020	90,937	82,211	70,550
Canada	1.92	37,065,178	383,135	206,063	62,535	45,839	68,195
Germany	3.93	82,905,782	349,110	222,678	83,162	57,957	56,141
Brazil	2.33	209,469,320	322,822	224,620	39,134	75,242	83,449
South Korea	1.45	25,549,606	313,353	182,205	42,923	49,371	35,147
France	2.93	67,101,930	259,508	151,378	59,928	27,828	45,310
Saudi Arabia	0.70	33,702,757	256,405	148,039	24,039	48,210	45,454
U.K.	2.87	66,460,344	208,673	128,743	55,044	21,619	41,433
Mexico	1.31	126,190,782	201,530	124,616	22,122	37,344	53,257
Indonesia	1.15	267,670,549	200,258	156,055	40,912	50,157	54,378
Italy	2.15	60,421,760	171,976	119,063	48,798	24,388	35,579
Turkey	1.25	82,340,090	161,031	102,961	33,084	32,734	27,972
Australia	1.42	24,982,688	150,786	83,350	18,801	22,417	33,993
Spain	1.54	46,797,754	148,115	86,152	25,587	20,110	32,225
Thailand	0.44	69,428,454	140,546	100,161	14,178	30,313	27,558
South Africa	0.43	57,792,520	138,621	71,344	19,456	24,551	19,214
Taiwan	0.61	23,589,000	119,066	71,544	10,903	23,731	12,091
U.A.E.	0.40	9,630,966	116,341	59,746	7,204	33,723	12,761
Poland	0.63	37,974,750	110,932	75,899	27,545	16,337	22,384
Egypt	0.29	98,423,602	101,690	61,358	17,465	17,546	18,000
Netherlands	0.95	17,231,624	96,542	58,131	16,332	14,206	10,937

***Primary energy is the energy contained in raw fuels that has not been subjected to conversion or transformation through any engineering process. **Final energy consumption is the total energy consumed by all end uses such as in the buildings, industry, and transportation sectors. Sources: EIA 2021c; IEA 2021c; World Bank 2022b, 2022d.**

Whenever possible, we collected data and indicators on energy consumption and energy efficiency policy from centralized, internationally recognized sources such as the IEA, the World Bank, the Organization for Economic Co-operation and Development (OECD), the U.S. Energy Information Administration (EIA), and the International Council on Clean Transportation (ICCT). We supplemented this information with country-level research by ACEEE staff. We sought the counsel of in-country and subject matter experts by circulating data requests to confirm that we had accessed the most accurate information and by providing them with a draft of our report to review.

We examined energy efficiency in the buildings, industry, and transportation sectors. We also evaluated, as a separate category, national efforts toward improving energy efficiency. We chose and designed metrics based on the availability of relevant, accurate data and on standard practice in other analyses of multisectoral energy efficiency.

We used both policy and performance-oriented metrics. Policy metrics highlight best practices in government actions and can be either qualitative or quantitative. Examples include national targets for energy efficiency, building and appliance labeling, and fuel economy standards for vehicles. The performance-oriented metrics are quantitative and measure energy use per unit of activity or service extracted. Examples include the efficiency of thermal power plants, energy intensities of buildings and industry, and average on-road vehicle fuel economy.

It is important to note that we do not score countries on the implementation or enforcement of these policies. While we recognize that implementing and enforcing policies is critical to achieving energy savings, we currently do not have the data to accurately score these efforts.

This year, we split the point allocation 60/40 between policy and performance metrics compared to 59/41 in 2018. This weighting reflects the fact that the performance metrics are partially affected by factors other than energy efficiency, such as the ability to purchase a personal vehicle.

The maximum possible score for a country was 100. We awarded up to 25 points in each of the four categories: national efforts, buildings, industry, and transportation. We allocated the points available within each category according to the recommendations of our expert advisers. We awarded the highest score available for a given metric to at least one country, which means that countries have the potential to obtain a score of 100. However, no country scored full points on all the metrics, indicating that all countries need to do more to meet their energy reduction and climate goals. Table 2 presents a snapshot of the metrics and point allocations. Bolded metrics signify a change in point allocation from the last *Scorecard* edition. We describe the metrics in greater detail in subsequent chapters.

Table 2. Metrics for all sectors

Metric	Type	2018 points	2022 points
National efforts			
Change in energy intensity between 2013 and 2018	Performance	6	6
Spending on energy efficiency	Policy	5	5
Energy savings and climate goals	Policy	3	3
Efficiency of thermal power plants	Performance	3	3
Tax credits and loan programs	Policy	2	2
Spending on energy efficiency RD&D	Policy	2	2
Size of the energy service company (ESCO) market	Performance	2	2
Water efficiency policy	Policy	1	1
Data availability	Policy	1	1
Buildings			
Appliance and equipment standards	Policy	5	5
Residential building codes	Policy	3	3
Commercial building codes	Policy	3	3
Building retrofit policies	Policy	4	4
Building rating and disclosure	Policy	2	2
Appliance and equipment labeling	Policy	2	2
Energy intensity in residential buildings	Performance	3	3
Energy intensity in commercial buildings	Performance	3	3
Industry			
Energy intensity of the industrial sector	Performance	6	6
Voluntary energy performance agreements with manufacturers	Policy	3	4
Policy to encourage energy management	Policy	2	3
Minimum efficiency standards for electric motors	Policy	2	2
Mandate for plant energy managers	Policy	2	2
Mandatory energy audits	Policy	2	2
Investment in manufacturing research and development (R&D)	Policy	2	2
Share of combined heat and power (CHP) in total installed capacity	Performance	2	1
Policy to encourage CHP	Policy	2	1

Metric	Type	2018 points	2022 points
Agriculture energy intensity	Performance	2	2
Transportation			
Fuel economy standards for light-duty vehicles	Policy	4	4
Fuel economy of light-duty vehicles	Performance	3	3
Electric vehicle sales share*	Performance	-	3
Vehicle miles traveled per capita	Performance	3	3
Fuel economy standards for heavy-duty tractor trucks	Policy	3	3
Energy intensity of freight transport	Performance	3	-
Freight transport per unit of economic activity	Performance	2	2
Smart freight initiatives	Policy	1	1
Investment in rail transit versus roads	Policy	3	3
Use of public transit	Performance	3	3
	Total	100	100

***New metric added since the last edition of this report.**

Data and Analysis Limitations

It is challenging to find a methodology that adequately captures progress on policies and performance at the intersection of energy efficiency and climate-related efforts while allowing comparison across a range of countries. Physical factors such as geographic size, climate, elevation, and availability of natural resources affect the energy a country uses, and ultimately impact the amount of GHG emissions a country produces. For example, climate heavily influences the energy used for heating and cooling buildings, while land area and topography affect the energy used for transportation.

Economic structure is another factor that governs energy use and emissions. Agriculture and labor-based economies tend to have lower energy consumption than industrialized ones. Among industrialized countries, manufacturing economies are generally more energy intensive than those that are service based. Changes to a country's economic structure over time can affect energy use as well as GHG emissions. In concert with expert opinion, we avoided adjusting for physical or economic factors unless we felt it was absolutely necessary (e.g., adjusting building energy intensity for climate or adjusting for each country's industrial mix), since we do not aim to provide more than a basic comparison of energy use and policies. Data availability also played a role in this decision, as it was difficult to find consistent data on adjustment factors for all the countries analyzed in this report.

Demographic composition and population density also affect overall emissions due to differences in energy consumption, as do other social factors such as income levels and

energy inequality. For example, a country with high energy consumption among some users but with limited energy access can appear to emit fewer GHGs in a comparison of per capita emissions across countries. These conditions are difficult to control for, and we were not able to account for them in our scoring methodology. As with physical and economic factors, we made only modest adjustments to raw data to enable basic comparisons across countries.

The COVID-19 pandemic has also changed energy consumption trends, global emissions, and other energy efficiency and climate efforts that pertain to this report's analysis. Given the lag in data collection for many of our metrics, these trends may not be captured in this edition, but future *Scorecard* editions will certainly reflect the impacts of this health crisis.

The most significant limiting factor for our analysis was the availability of consistent, comprehensive data. Not all countries track data specific to energy efficiency, such as national government spending on energy efficiency or the energy intensity of freight transportation. In a few cases in which data were unavailable, we assigned scores based on our best estimates from related information and expert opinion; we indicate these cases in our presentation of results. However, countries scored a zero if we were unable to track down any information for a particular metric. We also used data from the previous edition of the *Scorecard* for metrics that lacked updated sources. In some cases, our choice of metrics to cover key aspects of energy efficiency and energy use in each sector was limited by a lack of data consistency. Of the 900 data pieces we attempted to collect for this *Scorecard*, we were unable to find any information—or a reasonable estimate or proxy—for approximately 13%.

Additionally, a country's energy efficiency can be evaluated in many ways. Our methodology could have used various alternative metrics or different relative values for the metrics, which would have resulted in different rankings. We also acknowledge that translating continuous variables into categorical scores is imprecise and requires subjective decision making about where to draw cutoff points.

Finally, our analysis includes a few subnational policy efforts that affect the country as a whole. These efforts can sometimes be as effective as—or even more effective than—national policies. Their relative importance varies among nations, however, and the widespread collection and analysis of regional information were beyond the scope of this report.

COMPARING ACEEE'S *INTERNATIONAL ENERGY EFFICIENCY SCORECARD* WITH OTHER RATING PRODUCTS

The *International Energy Efficiency Scorecard* is not the only report that attempts to rank countries on their energy efficiency performance and policies. While we evaluate the 25 top energy-consuming countries across 36 different policy and performance metrics to obtain a combined score for each, other research efforts use different methodologies. Following is a brief description of three of the most well-known rating products and how they differ from ACEEE's evaluation.

REGULATORY INDICATORS FOR SUSTAINABLE ENERGY (RISE)

The RISE project is a World Bank initiative that assesses a country's policy and regulatory support for sustainable energy (ESMAP 2020). It covers three energy pillars: electricity access, energy efficiency, and renewable energy. The scorecard uses 26 indicators in 138 countries to evaluate sustainable energy progress through on-the-ground data collection efforts on policy actions only. Similar to ACEEE's *International Scorecard,* RISE's energy efficiency indicators are focused on the buildings, industrial, and transportation sectors.

THE ENERGY PROGRESS REPORT (PREVIOUSLY, THE GLOBAL TRACKING FRAMEWORK)

As a complement to the RISE project, the World Bank has partnered with IEA, the International Renewable Energy Agency, the United Nations Statistics Division, and the World Health Organization to track how countries are performing with regard to meeting their own sustainable energy goals as well as Sustainable Development Goal 7 (IEA et al. 2021). As with RISE, energy efficiency is one component of the evaluation of sustainable energy efforts. The report also looks at access to electricity, renewable energy, access to clean fuels and technologies for cooking, and international financial flows. The *Energy Progress Report* was previously known as the *Global Tracking Framework* and released its latest edition in 2021.

ODYSSEE-MURE / ECEEE ENERGY EFFICIENCY SCOREBOARD

The Odyssey-Mure/eceee *Scoreboard* compares information on energy efficiency–related indicators and the quantitative impacts of policies in all European Union (EU) member states and some additional European countries (Odyssee-Mure 2022). The primary objective of the *Scoreboard* is to assess a given country's level of energy efficiency, progress in energy efficiency since 2010, and future potential for efficiency progress through policies. The first two components measure performance and are adjusted for structural differences, such a country's climate or industrial mix. The last component considers the quantitative impact of policies on energy consumption and GHG emissions. The *Scorecard* weighs each of the three components equally and combines them into one overall score.

Results

OVERALL

France took first place in this edition of the *Scorecard* with the highest overall score of 74.5 out of 100 possible points. The United Kingdom took the second spot, and Germany and the Netherlands tied for third. France also topped the transportation category, while Japan earned first place in the industry category. The Netherlands led the buildings section and tied with Germany for first in the national efforts. The lowest-scoring countries were South Africa and the United Arab Emirates, with 23.5 and 21.5 points, respectively. Saudi Arabia rounded out the bottom three with 25 points.[2]

Although the United Kingdom ranked high in this edition, its score is not fully reflective of the policies included in its recent net-zero climate strategy (UK Department for Business, Energy & Industrial Strategy 2021). The strategy has been criticized for providing insufficient detail and policies on how it will deliver sector-specific emissions reductions, resulting in a lawsuit against the United Kingdom's government (Carrington 2022).

The Netherlands was the most improved country this year, ranking third out of the 25 countries evaluated. In the 2018 edition, it ranked seventh out of 25. The Netherlands improved the most in the transportation category, earning a perfect score for its share of EVs and gaining points in multiple other transportation metrics. It also obtained additional points for building retrofit policies and improved residential building energy intensity. Italy and Canada fell the furthest in rank; Italy dropped four ranks and Canada fell by three. Italy lost points in the buildings section, but managed to rank within the top five, whereas Canada did poorly in the transportation category.

The United States saw no change in ranking from 2018. Its overall score dropped slightly, however, due to weaker policies and performance for transportation-related metrics.

For a few of the lower-scoring countries, particularly Saudi Arabia and the United Arab Emirates, scores were not fully representative of efforts on energy efficiency. Their rankings may have been affected by problems we encountered in finding reasonable data. However, we may see scoring changes in future editions as countries work to fulfill the new pledges and commitments made at COP 26.

[2] We recognize that for the EU countries, many of the policies evaluated in this report stem from directives issued by the EU. However, because each country is free to interpret some of these directives differently, we scored them on their individual actions.

Figure 2 shows the overall rankings for our evaluated countries. Table 3 shows country rankings and scores in each of the four categories. Table 4 lists the scores for all 25 countries by metric, and table 5 shows changes in scores and rankings over time. Figure 3 shows the results from table 3 by sector and country, illustrating the large overall difference between the highest- and lowest-ranking countries. Figure 3 also shows that all countries have substantial room for improvement. See Appendix C for a summary of each country's results, strongest policy areas, areas for improvement, and resources for further information.

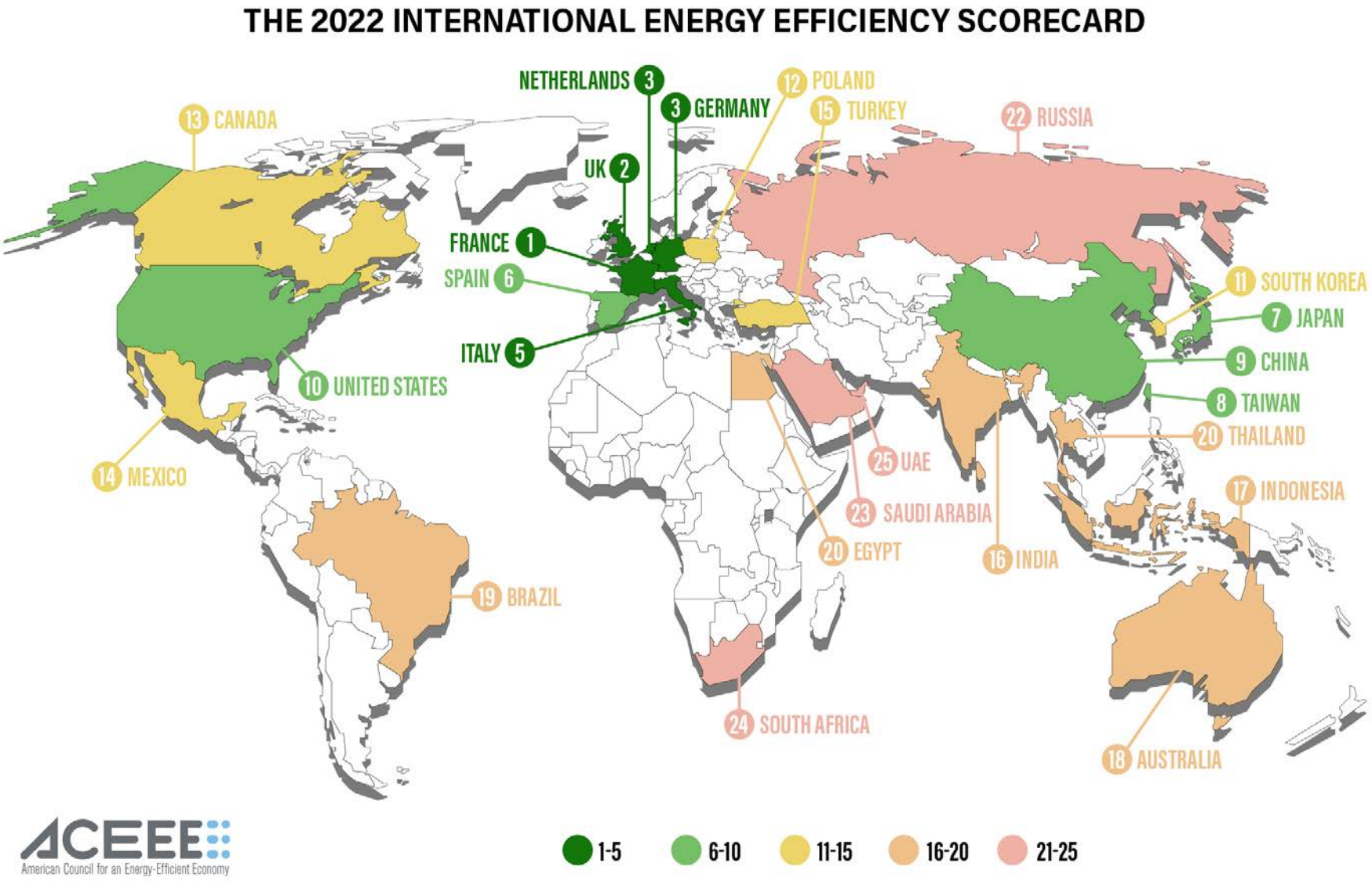

Figure 2. Rankings by country

Table 3. Final scores and rankings

Total (100 points)		
Country	Score	Rank
France	74.5	1
U.K.	72.5	2
Netherlands	71.5	3
Germany	71.5	3
Italy	68.5	5
Spain	66	6
Japan	63.5	7
Taiwan	58.5	8
China	57.5	9
US	54	10
South Korea	53	11
Poland	51	12
Canada	49.5	13
Mexico	46	14
Turkey	45.5	15
India	41.5	16
Indonesia	38	17
Australia	35.5	18
Brazil	34	19
Egypt	31.5	20
Thailand	31.5	20
Russia	28	22
Saudi Arabia	25	23
South Africa	23.5	24
U.A.E.	21.5	25

National efforts (25 points)		
Country	Score	Rank
Netherlands	18	1
Germany	18	1
Japan	17.5	3
France	17.5	3
Taiwan	17.5	3
Italy	17	6
Canada	17	6
US	16.5	8
U.K.	15.5	9
Spain	14.5	10
China	14	11
Poland	13	12
Australia	12.5	13
South Korea	11.5	14
Egypt	11	15
India	9.5	16
Mexico	9	17
Turkey	9	17
Thailand	8	19
South Africa	7.5	20
U.A.E.	7	21
Brazil	6.5	22
Indonesia	6.5	22
Russia	4.5	24
Saudi Arabia	4	25

Buildings (25 points)		
Country	Score	Rank
Netherlands	22.5	1
France	21	2
Spain	20.5	3
Germany	20	4
U.K.	19.5	5
China	19.5	5
Poland	18.5	7
US	17	8
Italy	17	8
South Korea	16	10
Mexico	15	11
Canada	14.5	12
Australia	14.5	12
Taiwan	14.5	12
Turkey	14	15
Saudi Arabia	13.5	16
Japan	13.5	16
Brazil	12	18
South Africa	11.5	19
Indonesia	10.5	20
U.A.E.	9.5	21
India	9.5	21
Russia	8.5	23
Thailand	8	24
Egypt	6	25

Industry (25 points)		
Country	Score	Rank
Japan	21	1
U.K.	20.5	2
Germany	19.5	3
Italy	18.5	4
France	18	5
Spain	16	6
Taiwan	16	6
Indonesia	15	8
South Korea	15	8
Netherlands	15	8
Turkey	13.5	11
Mexico	13.5	11
Thailand	12.5	13
India	12.5	13
US	12	15
Russia	10	16
China	9.5	17
Brazil	9	18
Canada	9	18
Egypt	8	20
Poland	7.5	21
Australia	6	22
Saudi Arabia	5.5	23
U.A.E.	3	24
South Africa	1	25

Transportation (25 points)		
Country	Score	Rank
France	18	1
U.K.	17	2
Italy	16	3
Netherlands	16	3
Spain	15	5
China	14.5	6
Germany	14	7
Poland	12	8
Japan	11.5	9
South Korea	10.5	10
Taiwan	10.5	10
India	10	12
Canada	9	13
Turkey	9	13
Mexico	8.5	15
U.S.	8.5	15
Brazil	6.5	17
Egypt	6.5	17
Indonesia	6	19
Russia	5	20
South Africa	3.5	21
Thailand	3	22
Australia	2.5	23
Saudi Arabia	2	24
U.A.E.	2	24

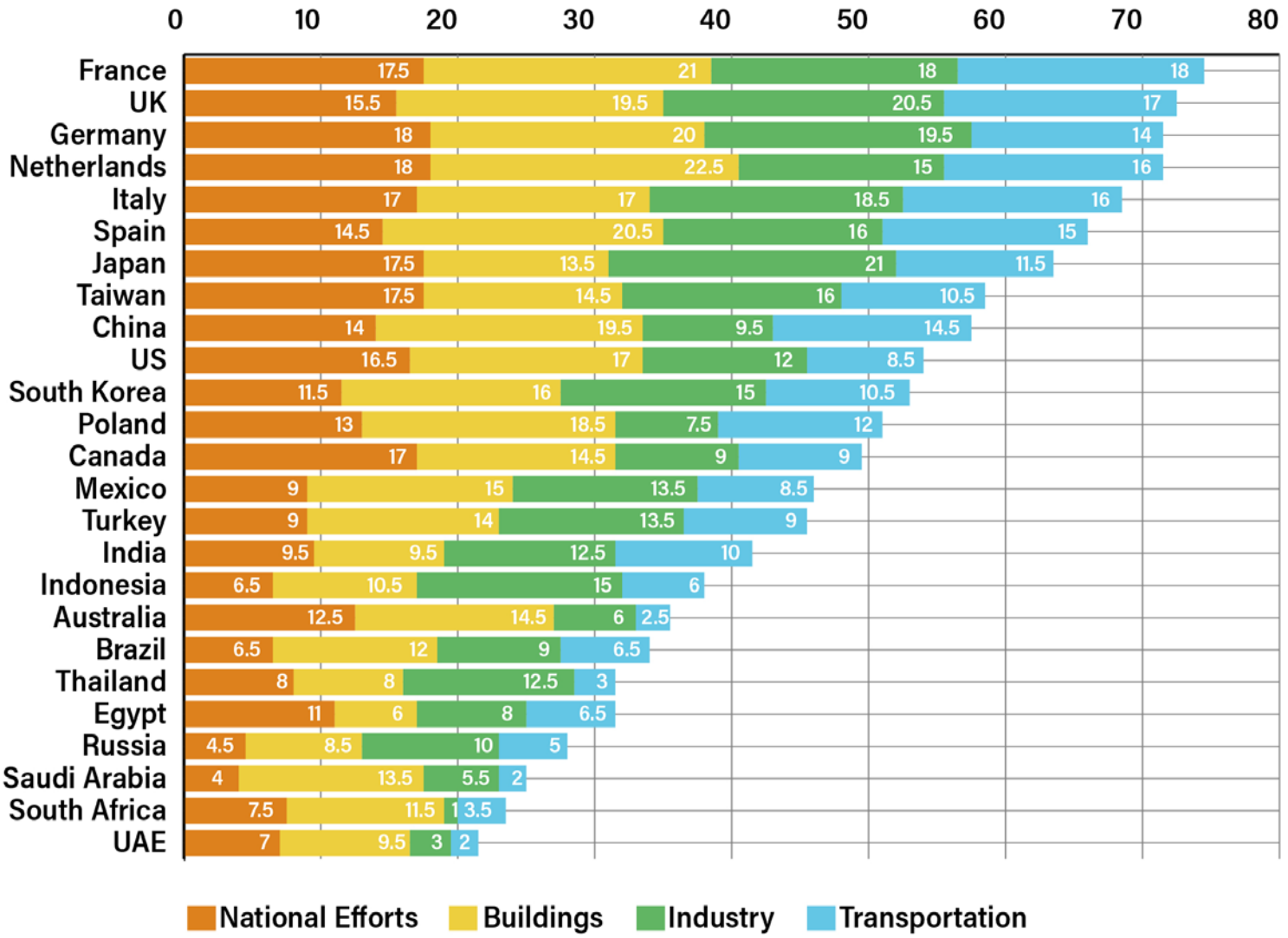

Figure 3. Overall scores and rankings

Table 4. Scores for all metrics by category

Metric	Max. points	Australia	Brazil	Canada	China	Egypt	France	Germany	India	Indonesia
National efforts total	**25**	**12.5**	**6.5**	**17**	**14**	**11**	**17.5**	**18**	**9.5**	**6.5**
Change in energy intensity (2013–2018)	6	3	0	2	6	5	5	4	5	2
Spending on energy efficiency	5	2	0	5	0	0	3	4	0	0
Spending on energy efficiency RD&D	2	0.5	1	2	0	0	1.5	1	0	0
Energy savings and climate goals	3	2	2	2	2	2	3	3	1	1
Tax credits and loan programs	2	1	1	2	1	2	2	2	1	1
Efficiency of thermal power plants	3	1.5	1	1	1.5	1.5	1	1.5	0.5	0.5
Size of the ESCO market	2	0.5	1	1.5	2	0	1	1.5	1	1.5
Water efficiency policy	1	1	0	0.5	1	0	0	0	0.5	0.5
Data availability	1	1	0.5	1	0.5	0.5	1	1	0.5	0
Buildings total	**25**	**14.5**	**12**	**14.5**	**19.5**	**6**	**21**	**20**	**9.5**	**10.5**
Residential building codes	3	2.5	2	2.5	2.5	0	3	3	1	1
Commercial building codes	3	2.5	0	2.5	3	0	3	3	2.5	2.5
Appliance and equipment standards	5	1.5	1.5	4.5	4.5	0.5	4	4	0	0
Appliance and equipment labeling	2	1.5	1.5	1	2	1.5	2	2	1.5	1
Building retrofit policies	4	2	1	3	2	0	4	3	1	0
Building rating and disclosure	2	1	0.5	0.5	1	0	2	2	0	1
Energy intensity in residential buildings	3	0.5	3	0	2.5	2.5	1	1	2	2.5
Energy intensity in commercial buildings	3	3	2.5	0.5	2	1.5	2	2	1.5	2.5
Industry total	**25**	**6**	**9**	**9**	**9.5**	**8**	**18**	**19.5**	**12.5**	**15**
Energy intensity of the industrial sector	6	2	0	1	0	5	4	4	0	4
Voluntary energy performance agreements with manufacturers	4	0	4	4	0	2	4	4	4	4
Mandate for plant energy managers	2	0	0	0	2	0	0	0	2	2
Mandatory energy audits	2	0	0	0	2	0	2	2	2	2
Policy to encourage energy management	3	0	1	1	1	1	3	3	1	1
CHP share in total installed capacity	1	0	0.5	0.5	0.5	0	0	0.5	0.5	0
Policy to encourage CHP	1	0	0.5	0.5	0.5	0	0.5	1	0.5	0
Minimum efficiency standards for electric motors	2	1	2	1	1	0	2	2	1	0
Investment in manufacturing R&D	2	1	0	1	1	0	2	2	0	0
Agriculture energy intensity	2	2	1	0	1.5	0	0.5	1	1.5	2

Metric	Max. points	Australia	Brazil	Canada	China	Egypt	France	Germany	India	Indonesia
Transportation total	**25**	**2.5**	**6.5**	**9**	**14.5**	**6.5**	**18**	**14**	**10**	**6**
Fuel economy standards for light-duty vehicles	4	0	1	3	3	0	4	4	2	0
Fuel economy of light-duty vehicles	3	0	1	0	1	0	3	2	3	0
Electric vehicle sales share	3	0	0	1	1	0	2	2	0	0
Vehicle miles traveled per capita	3	0.5	2	0	2.5	2.5	1	0.5	3	3
Fuel economy standards for heavy-duty tractor trucks	3	0	0	3	2	0	1	1	0	0
Freight transport per unit of economic activity	2	0.5	0.5	0.5	0	0	1.5	1	0	0
Smart freight initiatives	1	0	0	1	1	0	1	1	0	0
Investment in rail transit versus roads	3	1	0	0	1	2	3	1	0	0
Use of public transit	3	0.5	2	0.5	3	2	1.5	1.5	2	3
Total	**100**	**35.5**	**34**	**49.5**	**57.5**	**31.5**	**74.5**	**71.5**	**41.5**	**38**

Metric	Max. points	Italy	Japan	Mexico	Netherlands	Poland	Russia	Saudi Arabia	South Africa
National efforts total	**25**	**17**	**17.5**	**9**	**18**	**13**	**4.5**	**4**	**7.5**
Change in energy intensity (2013–2018)	6	2	5	4	5	5	0	2	3
Spending on energy efficiency	5	4	1	0	2	0	0	0	0
Spending on energy efficiency RD&D	2	1	2	0.5	2	0.5	0	0	0
Energy savings and climate goals	3	3	3	1	2	2	2	1	2
Tax credits and loan programs	2	2	2	1	2	1	2	0	1
Efficiency of thermal power plants	3	2.5	3	1	2.5	2	0	1	0.5
Size of the ESCO market	2	1	0.5	0.5	1.5	1.5	0.5	0	0
Water efficiency policy	1	0.5	0	0	0.5	0	0	0	0.5
Data availability	1	1	1	1	0.5	1	0	0	0.5
Buildings total	**25**	**17**	**13.5**	**15**	**22.5**	**18.5**	**8.5**	**13.5**	**11.5**
Residential building codes	3	2.5	2.5	1.5	3	3	2	2.5	2.5
Commercial building codes	3	2.5	2	1.5	3	3	2	2.5	2.5
Appliance and equipment standards	5	4	2	2	4	4	0	1.5	0.5
Appliance and equipment labeling	2	2	1	1	2	2	1.5	1.5	2
Building retrofit policies	4	3	2	3	4	3	2	3	2

Metric	Max. points	Italy	Japan	Mexico	Netherlands	Poland	Russia	Saudi Arabia	South Africa
Building rating and disclosure	2	1	0.5	0	2	2	1	0.5	0
Energy intensity in residential buildings	3	0	2	3	2	0.5	0	2	1
Energy intensity in commercial buildings	3	2	1.5	3	2.5	1	0	0	1
Industry total	**25**	**18.5**	**21**	**13.5**	**15**	**7.5**	**10**	**5.5**	**1**
Energy intensity of the industrial sector	6	4	6	4	4	2	0	2	0
Voluntary energy performance agreements with manufacturers	4	4	4	4	4	0	4	0	0
Mandate for plant energy managers	2	2	2	0	0	0	0	0	0
Mandatory energy audits	2	2	2	2	2	2	2	0	0
Policy to encourage energy management	3	1	1	1	0	0	1	0	0
CHP share in total installed capacity	1	0.5	0	0	1	0.5	1	0	0
Policy to encourage CHP	1	0.5	1	0.5	0.5	0.5	0	0	0.5
Minimum efficiency standards for electric motors	2	2	2	1	2	2	0	1	0
Investment in manufacturing R&D	2	1	1.5	0	1.5	0.5	0.5	0.5	0.5
Agriculture energy intensity	2	1.5	1.5	1	0	0	1.5	2	0
Transportation total	**25**	**16**	**11.5**	**8.5**	**16**	**12**	**5**	**2**	**3.5**
Fuel economy standards for light-duty vehicles	4	4	2	1	4	4	0	1	0
Fuel economy of light-duty vehicles	3	3	2	1	3	2	0	0	1
Electric vehicle sales share	3	1	0	0	3	0	0	0	0
Vehicle miles traveled per capita	3	1	1.5	1.5	1.5	1.5	2	1	2.5
Fuel economy standards for heavy-duty tractor trucks	3	1	1	0	1	1	0	0	0
Freight transport per unit of economic activity	2	1.5	2	1	1.5	0.5	0	0	0
Smart freight initiatives	1	1	1	1	1	0	0	0	0
Investment in rail transit versus roads	3	2	0	2	0	1	1	0	0
Use of public transit	3	1.5	2	1	1	2	2	0	0
Total	100	68.5	63.5	46	71.5	51	28	25	23.5

Metric	Max. points	South Korea	Spain	Taiwan	Thailand	Turkey	U.A.E.	U.K.	U.S.
National efforts total	25	11.5	14.5	17.5	8	9	7	15.5	16.5

Metric	Max. points	South Korea	Spain	Taiwan	Thailand	Turkey	U.A.E.	U.K.	U.S.
Change in energy intensity (2013–2018)	6	2	4	5	2	1	2	5	3
Spending on energy efficiency	5	0	3	1	0	1	0	2	3
Spending on energy efficiency RD&D	2	2	0.5	1	0	0.5	0	1.5	1.5
Energy savings and climate goals	3	2	2	2	1	2	3	2	2
Tax credits and loan programs	2	2	2	2	1	1.5	0	1.5	2
Efficiency of thermal power plants	3	2.5	2	3	2	1	1	2	2
Size of the ESCO market	2	0.5	0	1.5	1.5	1.5	1	0.5	1.5
Water efficiency policy	1	0	0.5	1	0.5	0	0	0	0.5
Data availability	1	0.5	0.5	1	0	0.5	0	1	1
Buildings total	**25**	**16**	**20.5**	**14.5**	**8**	**14**	**9.5**	**19.5**	**17**
Residential building codes	3	2.5	3	2	2.5	2	2.5	3	2.5
Commercial building codes	3	3	3	2	2.5	2	2.5	3	2.5
Appliance and equipment standards	5	3	4	0.5	0	0.5	0	2.5	5
Appliance and equipment labeling	2	2	2	2	0	1	1.5	2	1.5
Building retrofit policies	4	3	3	2	1	3	1	4	3
Building rating and disclosure	2	1	2	1	0	2	0.5	2	0.5
Energy intensity in residential buildings	3	0.5	1.5	2.5	1.5	2.5	1	1	0.5
Energy intensity in commercial buildings	3	1	2	2.5	0.5	1	0.5	2	1.5
Industry total	**25**	**15**	**16**	**16**	**12.5**	**13.5**	**3**	**20.5**	**12**
Energy intensity of the industrial sector	6	2	3	4	0	2	1	6	3
Voluntary energy performance agreements with manufacturers	4	4	4	2	4	4	2	4	2
Mandate for plant energy managers	2	0	0	2	2	0	0	0	0
Mandatory energy audits	2	2	2	2	2	2	0	2	0
Policy to encourage energy management	3	1	2	1	1	1	0	3	1
CHP share in total installed capacity	1	0.5	0.5	0.5	0.5	0.5	0	0.5	0.5
Policy to encourage CHP	1	0.5	0	0.5	0	1	0	0.5	1
Minimum efficiency standards for electric motors	2	2	2	2	1	1	0	2	2

Metric	Max. points	South Korea	Spain	Taiwan	Thailand	Turkey	U.A.E.	U.K.	U.S.
Investment in manufacturing R&D	2	2	1	0.5	0.5	0.5	0	1.5	2
Agriculture energy intensity	2	1	1.5	1.5	1.5	1.5	0	1	0.5
Transportation total	**25**	**10.5**	**15**	**10.5**	**3**	**9**	**2**	**17**	**8.5**
Fuel economy standards for light-duty vehicles	4	3	4	2	0	0	0	4	2
Fuel economy of light-duty vehicles	3	2	3	2	1	3	1	3	0
Electric vehicle sales share	3	1	1	0	0	0	0	2	1
Vehicle miles traveled per capita	3	0	1.5	2.5	2	2	1	1	0
Fuel economy standards for heavy-duty tractor trucks	3	0	1	0	0	0	0	0	3
Freight transport per unit of economic activity	2	1.5	1	1.5	0	1	0	2	1
Smart freight initiatives	1	1	0	0	0	0	0	1	1
Investment in rail transit versus roads	3	0	2	1	0	1	0	3	0
Use of public transit	3	2	1.5	1.5	0	2	0	1	0.5
Total	**100**	**53**	**66**	**58.5**	**31.5**	**45.5**	**21.5**	**72.5**	**54**

Table 5. Changes in score by country between 2016 and 2022

Country	2016 points	2016 rank	2018 points	2018 rank	2022 points	2022 rank
Australia	41	16	40.5	18	35.5	18
Brazil	32.5	22	36.5	20	34	19
Canada	59	10	55.5	10	49.5	13
China	64	6	59.5	8	57.5	9
Egypt	–	–	–	–	31.5	20
France	67.5	4	73.5	3	74.5	1
Germany	73.5	1	75.5	1	71.5	3
India	48.5	14	50.5	15	41.5	16
Indonesia	37.5	18	45	17	38	17
Italy	68.5	2	75.5	1	68.5	5
Japan	68.5	2	67	5	63.5	7
Mexico	37	19	54	12	46	14
Netherlands	58	11	65	7	71.5	3
Poland	53.5	12	51	14	51	12
Russia	38	17	34.5	21	28	22
Saudi Arabia	15.5	23	16.5	25	25	23
South Africa	33	21	23.5	23	23.5	24
South Korea	61.5	8	52.5	13	53	11
Spain	62	7	65.5	6	66	6
Taiwan	51	13	57	9	58.5	8
Thailand	36.5	20	29	22	31.5	20
Turkey	46.5	15	50	16	45.5	15
U.A.E.	–	–	18	24	21.5	25
U.K.	65	5	73	4	72.5	2
Ukraine	–	–	38	19	–	–
U.S.	61.5	8	55.5	10	54	10

(–) Indicates the country was not included in the scoring for the given year

As table 5 shows, over the past three editions of the *International Scorecard*, a few European countries have made steady improvements in their scores, claiming many of the top spots in the rankings throughout the period. Taiwan has also continued to make steady progress in its scores and ranks. However, scores for countries such as Canada, Australia, and Russia are trending downward due to a combination of methodology and policy changes over the years.

POLICY METRICS

While sector scores are informative, the breakdown in how countries score on individual policy versus performance metrics is also revealing. The leading countries continue to perform strongly when we look at their policy metric scores. Table 6 shows the points breakdown for these metrics for this edition and the 2018 *Scorecard*. Bolded metrics signify a change in point allocation between the two editions.

Table 6. Point allocation for policy metrics

Metric	2018 points	2022 points
National efforts		
Spending on energy efficiency	5	5
Energy savings and climate goals	3	3
Tax credits and loan programs	2	2
Spending on energy efficiency RD&D	2	2
Water efficiency policy	1	1
Data availability	1	1
Buildings		
Appliance and equipment standards	5	5
Residential building codes	3	3
Commercial building codes	3	3
Building retrofit policies	4	4
Building rating and disclosure	2	2
Appliance and equipment labeling	2	2
Industry		
Voluntary agreements with manufacturers	**3**	**4**
Energy management policy	**2**	**3**
Standards for motors	2	2

Metric	2018 points	2022 points
Mandate for energy managers	2	2
Mandatory energy audits	2	2
Investment in manufacturing R&D	2	2
CHP policy	2	1
Transportation		
Fuel economy standards for light-duty vehicles	4	4
Fuel economy standards for heavy-duty tractor trucks	3	3
Investment in rail transit versus roads	3	3
Smart freight initiatives	1	1
Total	59	60

Table 7 shows the rankings.

Table 7. Countries ranked by total score on policy metrics (60 possible points)

Country	Points	Rank
France	51	1
Germany	49	2
Italy	47	3
U.K.	45.5	4
Spain	43.5	5
Netherlands	43	6
Canada	41	7
U.S.	39	8
Japan	36.5	9
South Korea	36.5	9
China	34	11
Poland	32.5	12
Taiwan	30.5	13
Turkey	26.5	14

Country	Points	Rank
Mexico	25	15
India	21.5	16
Australia	21.5	16
Russia	21	18
Brazil	19.5	19
Thailand	19	20
Indonesia	17	21
Saudi Arabia	15	22
South Africa	14.5	23
U.A.E.	13	24
Egypt	11.5	25

Table 7 shows that almost all the evaluated EU countries scored high on policy metrics, as did the United Kingdom and Canada. The EU is taking the most action on energy efficiency and decarbonization through policies and programs, particularly in its buildings and industry efficiency policies. EU member states also perform well on policy metrics due to their compliance with common EU directives such as the Ecodesign Directive and the Energy Labelling Framework Regulation. Most of the countries that scored well on the policy metrics have some sort of unifying national energy-reduction and climate goal in place. However, it is important to note that scoring countries on their policies can also be challenging due to the diverse policy structures across the evaluated countries.

PERFORMANCE METRICS

Table 8 shows the breakdown of points allocated to performance metrics for this edition and for the 2018 *Scorecard* edition, and table 9 shows the country scores. Metrics that are bolded in table 8 signify a change in point allocation between the two *Scorecard* editions.

Table 8. Point allocation for performance metrics

Metric	2018 points	2022 points
National efforts		
Change in energy intensity	6	6
Efficiency of thermal power plants	3	3
Size of the ESCO market	2	2
Buildings		
Energy intensity in residential buildings	3	3
Energy intensity in commercial buildings	3	3

Metric	2018 points	2022 points
Industry		
Energy intensity of the industrial sector	6	6
CHP installed capacity	2	1
Energy intensity of agriculture	2	2
Transportation		
Fuel economy of light-duty vehicles	3	3
Electric vehicle sales share	-	3
Vehicle miles traveled per capita	3	3
Energy intensity of freight transport	3	-
Freight transport per unit of economic activity	2	2
Use of public transit	3	3
Total	41	40

Table 9. Countries ranked by total score on performance metrics (40 possible points)

Country	Points	Rank
Netherlands	28.5	1
Taiwan	28	2
Japan	27	3
U.K.	27	3
China	23.5	5
France	23.5	5
Germany	22.5	7
Spain	22.5	7
Italy	21.5	9
Indonesia	21	10
Mexico	21	10
Egypt	20	12
India	20	12
Turkey	19	14
Poland	18.5	15
South Korea	16.5	16
U.S.	15	17
Brazil	14.5	18
Australia	14	19
Thailand	12.5	20
Saudi Arabia	10	21
South Africa	9	22

Country	Points	Rank
Canada	8.5	23
U.A.E.	8.5	23
Russia	7	25

Table 9 shows a more mixed group of leaders. The EU nations did not dominate the top positions; instead, the high scorers included Taiwan, Japan, and the United Kingdom. Among the developed countries, Australia, Canada, and the United States did poorly on the performance metrics. However, as we discussed earlier, rating countries on their energy performance is difficult given the number of factors that impact energy use; the vast differences in demography, climate, and economic conditions among nations; and the inconsistent access to standardized data for all countries. The combination of policy and performance metrics gives us a more complete picture of the progress a given country is making on energy efficiency.

National Efforts

This section examines overall energy efficiency performance across all sectors of the economy, as well as the national government's commitment to and leadership on efficiency. We evaluated the change in energy intensity in each country and scored related cross-sectoral policies, such as financial investments in energy efficiency programs in general, and in research, development, and demonstration (RD&D) in emerging technologies specifically. We also scored countries on their national energy-saving targets and climate goals, as well as on their tax incentives and loan programs aimed at engaging the private sector. We evaluated the total market size of energy service companies (ESCOs) and compared the efficiencies of thermoelectric power plants. We included a metric to evaluate water efficiency efforts since water and energy use are inherently linked. Finally, we awarded one point to countries that track and disclose information related to energy efficiency, because a country's understanding of how it uses energy is critical to evaluating its efficiency potential.

As in prior years, the EU countries stood out for having aggressive national energy savings targets as well as programs such as loans and tax incentives to encourage private investment in energy efficiency. Germany tied with the Netherlands for the top spot in the national efforts category. This is the Netherlands' first time in the lead, with 18 out of a possible 25 points. France, Japan, and Taiwan followed with a score of 17.5 points each. Germany scored well by earning high points for tax incentives and loan programs, energy savings and climate goals, and a few other metrics, highlighting the government's dedication to using energy efficiency to reduce overall consumption and GHG emissions. The Netherlands' performance in national efforts results from high scores on national energy reduction and climate targets, RD&D spending, and tax incentives. The lowest scorers in this section were Saudi Arabia (4 points) and Russia (4.5 points). The United States ranked eighth, earning the same spot as in the last edition of the *Scorecard* despite earning one more point compared to last time. In this edition, the United States lost points for its energy efficiency spending, but earned back points for reentering the Paris Agreement. Table 10 shows national effort scores by country.

Table 10. National efforts scores

Country	Total score	Change in energy intensity	Energy efficiency spending	Energy efficiency RD&D spending	Energy savings and climate goals	Tax incentives and loan programs	Efficiency of thermal power plants	Size of the ESCO market	Water efficiency policy	Data availability
Max. score	25	6	5	2	3	2	3	2	1	1
Netherlands	18	5	2	2	2	2	2.5	1.5	0.5	0.5
Germany	18	4	4	1	3	2	1.5	1.5	0	1
France	17.5	5	3	1.5	3	2	1	1	0	1
Japan	17.5	5	1	2	3	2	3	0.5	0	1
Taiwan	17.5	5	1	1	2	2	3	1.5	1	1
Canada	17	2	5	2	2	2	1	1.5	0.5	1
Italy	17	2	4	1	3	2	2.5	1	0.5	1
U.S.	16.5	3	3	1.5	2	2	2	1.5	0.5	1
U.K.	15.5	5	2	1.5	2	1.5	2	0.5	0	1
Spain	14.5	4	3	0.5	2	2	2	0	0.5	0.5
China	14	6	0	0	2	1	1.5	2	1	0.5
Poland	13	5	0	0.5	2	1	2	1.5	0	1
Australia	12.5	3	2	0.5	2	1	1.5	0.5	1	1
South Korea	11.5	2	0	2	2	2	2.5	0.5	0	0.5
Egypt	11	5	0	0	2	2	1.5	0	0	0.5
India	9.5	5	0	0	1	1	0.5	1	0.5	0.5

Country	Total score	Change in energy intensity	Energy efficiency spending	Energy efficiency RD&D spending	Energy savings and climate goals	Tax incentives and loan programs	Efficiency of thermal power plants	Size of the ESCO market	Water efficiency policy	Data availability
Mexico	9	4	0	0.5	1	1	1	0.5	0	1
Turkey	9	1	1	0.5	2	1.5	1	1.5	0	0.5
Thailand	8	2	0	0	1	1	2	1.5	0.5	0
South Africa	7.5	3	0	0	2	1	0.5	0	0.5	0.5
U.A.E.	7	2	0	0	3	0	1	1	0	0
Brazil	6.5	0	0	1	2	1	1	1	0	0.5
Indonesia	6.5	2	0	0	1	1	0.5	1.5	0.5	0
Russia	4.5	0	0	0	2	2	0	0.5	0	0
Saudi Arabia	4	2	0	0	1	0	1	0	0	0

CHANGE IN ENERGY INTENSITY (6 POINTS)

Energy intensity is the ratio of each country's energy consumed compared to its total economic output. Using standard practices, we calculated energy intensity as the total primary energy consumed per dollar of market-exchange-rate GDP. The lower the energy intensity, the higher the energy efficiency of the economy. We ranked countries by comparing the improvement in energy intensity between 2013 and 2018. A country's energy intensity can vary from year to year due to many factors, including shifts in economic composition and structure. Evaluating the change in intensity over time, as well as across other sectors such as buildings and industry, allows us to account for some of that fluctuation and to better evaluate the impact of efficiency on energy use. We updated the period to 2013–2018 (from 2010–2015 in the previous edition) to reflect the most recent widely available data. Finally, a reduction in energy intensity should not be mistaken for a reduction in total energy consumption; the total energy consumption of many countries was higher in 2018 than in 2013 (EIA 2021c).

Countries with a reduction of 20% or more in primary energy intensity between 2013 and 2018 received 6 points. Those with a reduction of 11–19.9% earned 5 points; a 9–10.9% reduction earned 4 points; a 7–8.9% reduction earned 3 points; a 4–6.9% reduction earned 2 points; and a 0–3.9% reduction scored 1 point. Brazil and Russia were the only countries that increased energy intensity over this period, and hence they received no points.

Table 11 shows the scores for each country.

Table 11. Scores for percentage change in primary energy intensity

Country	Percentage change in energy intensity, 2013–2018	Score
China	–22.7%	6
U.K.	–15.5%	5
Poland	–13.0%	5
Netherlands	–12.9%	5
Egypt	–12.3%	5
Taiwan	–12.0%	5
India	–11.9%	5
France	–11.7%	5

Country	Percentage change in energy intensity, 2013–2018	Score
Japan	–11.4%	5
Germany	–9.8%	4
Mexico	–9.5%	4
Spain	–9.3%	4
Australia	–8.6%	3
South Africa	–8.4%	3
U.S.	–8.1%	3
Saudi Arabia	–6.8%	2
South Korea	–6.6%	2
Canada	–6.5%	2
Thailand	–6.3%	2
Italy	–5.9%	2
U.A.E.	–5.5%	2
Indonesia	–4.6%	2
Turkey	–1.4%	1
Russia	2.7%	0
Brazil	3.2%	0

Sources: EIA 2021c; World Bank 2022b

EFFICIENCY EFFECT

We calculated energy intensity at the highest level of aggregation (total primary energy consumed per dollar of market-exchange-rate GDP). However, energy efficiency improvement is not the only factor that may influence a decline in energy use. Changes in a country's economic structure, such as shifting away from energy-intensive industries into less-intensive service activities, may have an impact on energy use that is equal to or greater than energy efficiency improvements alone. The International Energy Agency has developed a metric based on a decomposition analysis to more accurately determine the extent of energy efficiency improvements' impact on overall energy use. This metric, called the *efficiency effect*, analyzes changes in the amount of energy used per unit of gross value added in each sector of an economy, providing a more accurate reflection of energy efficiency progress. We continue to explore whether we can locate data on the efficiency effect for all our evaluated countries; once this is possible, we can incorporate this metric in future *Scorecard* editions.

ENERGY EFFICIENCY SPENDING (5 POINTS)

We scored this metric on the basis of total investments in energy efficiency by the national government and the utility sector. In some countries, the national government controls the utility sector, while in others—notably the United States and Canada—the utility sector is regulated primarily by states or provinces. Therefore, to be able to compare countries, we combined spending by utilities and by the national government in each country into a single expenditure. While this metric does not measure how effectively the money is spent, it is an indication of overall commitment to energy efficiency.

The data for this metric continue to be some of the most challenging to collect. In some cases, we used publicly available information about national spending, while in other cases we averaged budgets for government and utility programs that span multiple years. When we used multiyear budgets, we divided them by the lifetime of the programs to derive an annual figure. We also used data from the last edition of the *Scorecard*, as many countries have not released updated figures. Finally, many countries do not track separate investment data for utility spending on energy efficiency. In such cases, we assumed that the utilities had small efficiency budgets relative to government investment.

We awarded 5 points for per capita spending of $95 or more, 4 points for $60–94.99, 3 points for $15–59.99, 2 points for $10–14.99, and 1 point for $5–9.99. Table 12 shows total spending per capita.

Table 12. Scores for spending on energy efficiency ranked by total spending per capita

Country	Annual government spending ($)	Annual utilities spending ($)	Total spending ($/capita)	Score
Canada	2,851,542,744	857,954,279	97.60	5
Germany	7,085,991,600	No data available	85.47	4
Italy	3,779,195,520	No data available	62.55	4
U.S.	1,077,000,000	6,832,400,000	24.20	3
Spain	1,013,941,698	80,000	21.67	3
France	1,077,313,054	No data available	16.05	3
Netherlands	243,346,008	No data available	14.12	2
Australia	35,000,000	292,265,458	13.10	2
U.K.	30,273,459	638,494,773	10.06	2
Turkey	712,768,000	No data available	8.66	1
Taiwan	144,000,320	37,080,082	7.68	1
Japan	695,947,930	No data available	5.50	1
South Korea	No data available	98,000,000	1.90	0
Poland	68,662,232	No data available	1.81	0
South Africa	16,075,566	44,000,000	1.04	0
Brazil	40,000,000	151,000,000	0.91	0
China	No data available	448,000,000	0.32	0
Indonesia	10,000,000	No data available	0.04	0
Mexico	3,769,068	196,955	0.03	0
Thailand	No data available	1,000,000	0.01	0
India	14,046,776	No data available	0.01	0
Egypt	No data available	No data available	-	0
Russia	No data available	No data available	-	0
Saudi Arabia	No data available	No data available	-	0
U.A.E.	No data available	No data available	-	0

Sources: IEA 2016; World Bank 2022d; Janeiro et al. 2016; ACEEE research

ENERGY EFFICIENCY RD&D SPENDING (2 POINTS)

To complement the energy efficiency spending metric, we included a more narrowly defined metric for per capita investment in energy efficiency RD&D by the national government. These data are much more readily available from the IEA. In a few cases, data may include spending on only research and development (R&D). We gave 2 points for per capita spending of at least $4, 1.5 points for at least $3, 1 point for at least $1, and 0.5 point for at least 20 cents. Table 13 shows the scores on this metric by country.

Table 13. Scores for spending on energy efficiency RD&D

Country	Spending ($/capita)	Score
Canada	$6.76	2
Japan	$5.53	2
South Korea	$5.38	2
Netherlands	$4.41	2
U.S.	$3.89	1.5
U.K.	$3.88	1.5
France	$3.14	1.5
Germany	$1.94	1
Brazil	$1.31	1
Italy	$1.31	1
Taiwan	$1.24	1
Australia	$0.94	0.5
Mexico	$0.67	0.5
Spain	$0.30	0.5
Poland	$0.29	0.5
Turkey	$0.22	0.5
India	$0.09	0
South Africa	$0.01	0
China	No data available	0
Egypt	No data available	0
Indonesia	No data available	0
Russia	No data available	0

Country	Spending ($/capita)	Score
Saudi Arabia	No data available	0
Thailand	No data available	0
U.A.E.	No data available	0

Sources: IEA 2021b; World Bank 2022d; ACEEE country research

It should be noted that due to inconsistencies in the availability of data on national energy efficiency spending, it is possible that some of the results for total efficiency spending include energy efficiency RD&D expenditure. There is some overlap in the United States, for instance, because national spending includes the budget of the U.S. Department of Energy (DOE) Office of Energy Efficiency and Renewable Energy, which is tasked with investing in energy efficiency R&D and clean energy technology.

ENERGY SAVINGS AND CLIMATE GOALS (3 POINTS)

Energy savings and climate goals spur innovation and articulate national priorities on decarbonization and sector-specific energy efficiency. Having goals helps countries measure progress toward a target, making energy efficiency more tangible and helping quantify necessary reductions in a country's overall GHG emissions. We awarded 3 points for goals requiring energy savings of more than 1% of a country's overall energy consumption per year. Countries received 2 points for mandatory energy savings goals that target less than 1% of overall energy consumption or a GHG reduction target. We awarded 1 point to countries with an energy intensity target. Most countries had at least a GHG reduction target stemming from their emissions-reduction commitments to the United Nations Framework Convention on Climate Change (UNFCCC). Table 14 shows the scores for energy savings goals.

TAX INCENTIVES AND LOAN PROGRAMS (2 POINTS)

This metric scored a government's commitment to encouraging private investment in energy efficiency. Energy efficiency investments more than pay for themselves over time, but the up-front cost of the technology, upgrade, or program is a common barrier. Government loan programs and tax credits can help lower or spread out these up-front costs, which better enables projects to pay back their costs. In some countries, tax credits and government programs provide support for underinvested communities. These incentives can also make market conditions for energy efficiency more favorable, attracting additional private investment.

We gave the full 2 points to countries with both loan programs and tax incentives that cover more than one economic sector, and 1 point to countries with either loan programs or tax incentives that cover more than one economic sector. We also awarded 1 point to countries with single-sector loans and credits and 0.5 point for tax incentives or loan programs available for just one sector. Table 14 shows the results.

Table 14. Scores for energy savings goals and for tax incentives and loan programs

Country	Energy savings goals	Score	Tax incentives and loan programs	Score	Total score
France	> 1%	3	Multisector loans and credits	2	5
Germany	> 1%	3	Multisector loans and credits	2	5
Italy	> 1%	3	Multisector loans and credits	2	5
Japan	> 1%	3	Multisector loans and credits	2	5
Canada	GHG	2	Multisector loans and credits	2	4
Egypt	Unspecified energy goal and GHG	2	Multisector loans and credits	2	4
Netherlands	Unspecified energy goal and GHG	2	Multisector loans and credits	2	4
Russia	Energy intensity and GHG	2	Multisector loans and credits	2	4
South Korea	Unspecified energy goal and GHG	2	Multisector loans and credits	2	4
Spain	Energy intensity and GHG	2	Multisector loans and credits	2	4
Taiwan	Energy intensity and GHG	2	Multisector loans and credits	2	4
U.S.	GHG	2	Multisector loans and credits	2	4
Turkey	Unspecified energy goal and GHG	2	Multisector loans and credits for one sector only	2	3.5
U.K.	GHG	2	Multisector credits and loans for one sector only	1.5	3.5
Australia	Energy intensity and GHG	2	Multisector loans	1	3
Brazil	< 1%	2	Multisector loans	1	3

Country	Energy savings goals	Score	Tax incentives and loan programs	Score	Total score
China	Unspecified energy goal and GHG intensity	2	Loans and credits for one sector only	1	3
Poland	< 1% and GHG	2	Multisector loans	1	3
South Africa	Unspecified energy goal	2	Multisector credits	1	3
U.A.E.	> 1%	3	None	0	3
India	GHG intensity	1	Multisector loans	1	2
Indonesia	Energy intensity	1	Loans and credits for one sector only	1	2
Mexico	Energy intensity	1	Multisector loans	1	2
Thailand	Energy intensity	1	Multisector credits	1	2
Saudi Arabia	Energy intensity	1	None	0	1

Sources: UNFCCC 2021; tax incentives and loan programs: IEA 2022b; ACEEE country research

EFFICIENCY OF THERMAL POWER PLANTS AND TRANSMISSION AND DISTRIBUTION LOSSES (3 POINTS)

The world produces more than 60% of all electricity from thermal power plants that use fossil fuels (IEA 2021e). This metric evaluated the efficiency of a country's nonnuclear thermal power plants as well as the efficiency of delivering the power to customers. We accounted for both the efficiency of converting heat to electricity in the plant (that is, *operational efficiency*) and the losses in the electrical distribution system. In many cases, we used data from the previous *Scorecard* because we were unable to obtain updated data for operational efficiency. As such, scores may not represent a country's recent progress on this metric.

The machinery that a plant uses for thermal generation determines its operational efficiency. Supercritical steam generators and combined-cycle power plants have higher operating efficiencies, and countries can use these technologies to achieve a higher power-sector efficiency.

Countries can also improve efficiency by reducing technical and nontechnical losses in the transmission and distribution (T&D) system. Technical losses occur as energy is dissipated during the various stages of delivering heat and electricity to consumers. Nontechnical

losses include pilferage, administrative billing or metering errors that mislead customers about their true energy use, and equipment errors (World Bank 2009).

The prior *Scorecard* edition gave countries credit for the proportion of electricity generation that comes from renewable sources. To simplify the scoring this year, we decided to exclude consideration of countries' renewable generation. Instead, the points were split equally between operational efficiency and T&D losses. We awarded the full 1.5 points to countries with an operational efficiency of 44% or more, 1 point for 40–43.9%, and 0.5 points for 35–39.9%. For T&D losses, we awarded 1.5 points for losses less than 5%, 1 point for losses of 5–7.9%, and 0.5 points for losses of 8–9.9%. Table 15 shows the data and scores for this metric.

Table 15. Scores for efficiency of thermal power plants

Country	Operational efficiency of thermal power plants (%)	Score	Transmission and distribution losses (%)	Score	Total score
Japan	44.5%	1.5	4.3%	1.5	3
Taiwan	46.0%	1.5	4.0%	1.5	3
Italy	50.0%	1.5	5.8%	1	2.5
Netherlands	43.1%	1	4.8%	1.5	2.5
South Korea	40.8%	1	3.3%	1.5	2.5
Poland	42.1%	1	6.1%	1	2
Spain	44.9%	1.5	9.6%	0.5	2
Thailand	41.0%	1	6.1%	1	2
U.K.	48.0%	1.5	8.4%	0.5	2
U.S.	41.0%	1	5.9%	1	2
Australia	34.0%	0	4.0%	1.5	1.5
China	35.6%	0.5	5.5%	1	1.5
Egypt	45.9%	1.5	11.0%	0	1.5
Germany	37.5%	0.5	5.3%	1	1.5
Brazil	43.2%	1	15.8%	0	1
Canada	38.1%	0.5	8.7%	0.5	1
France	31.8%	0	6.3%	1	1
Mexico	41.2%	1	13.8%	0	1
Saudi Arabia	32.2%	0	6.8%	1	1

Country	Operational efficiency of thermal power plants (%)	Score	Transmission and distribution losses (%)	Score	Total score
Turkey	43.6%	1	14.8%	0	1
U.A.E.	33.9%	0	6.8%*	1	1
India	35.6%	0.5	20.7%	0	0.5
Indonesia	34.5%	0	9.4%	0.5	0.5
South Africa	34.7%	0	8.4%	0.5	0.5
Russia	24.6%	0	10.0%	0	0

***U.A.E. data on T&D losses are from 2014, but more recent data from Dubai only show higher efficiency (DEWA 2021). Sources: WEC 2016; World Bank 2022a; EIA 2017b, 2021b; ACEEE country research.**

SIZE OF THE ESCO MARKET (2 POINTS)

ESCOs are businesses that provide various energy efficiency–related services and improvement measures. The ESCO market's presence and size in a country partially reflect the efforts to advance energy efficiency through effective business models and creative financing. Due in part to its strong government support, China is far ahead of the curve here and leads the global ESCO market.

Performance contracting is a key product of the ESCO market, and one that is particularly useful in addressing the cost and technical expertise barriers to disseminating energy efficiency technology. Under performance contracting, a company acts as a project manager for a range of tasks and assumes the project's technical and performance risks. Performance contracting services include developing, designing, and arranging financing; installing and maintaining equipment; and measuring, monitoring, and verifying the project's energy savings. These services are bundled into the project's budget, and the ESCO is repaid through the dollar savings generated via reduced energy consumption and cost. Utilities, private companies, or a government agency may own an ESCO.

We gave 2 points for an ESCO market size of at least 0.09% of GDP, 1.5 points for at least 0.02% of GDP, 1 point for at least 0.008% of GDP, and 0.5 point for at least 0.003% of GDP. Table 16 shows the results. Because ESCO definition varies from country to country, these data may not be directly comparable.

Table 16. Scores for size of the ESCO market relative to GDP

Country	% of GDP	Score
China	0.1354%	2
Taiwan	0.0843%	1.5
Turkey	0.0500%	1.5

Country	% of GDP	Score
Poland	0.0437%	1.5
Thailand	0.0389%	1.5
U.S.	0.0307%	1.5
Indonesia	0.0263%	1.5
Germany	0.0229%	1.5
Canada	0.0228%	1.5
Netherlands	0.0224%	1.5
Brazil	0.0169%	1
U.A.E.	0.0132%	1
India	0.0123%	1
Italy	0.0108%	1
France	0.0083%	1
Russia	0.0077%	0.5
South Korea	0.0056%	0.5
Japan	0.0051%	0.5
Australia	0.0040%	0.5
Mexico	0.0040%	0.5
U.K.	0.0038%	0.5
South Africa	0.0028%	0
Spain	0.0012%	0
Egypt	No data available	0
Saudi Arabia	No data available	0

Sources: Panev et al. 2014; Bertoldi, Boza-Kiss, and Toleikyte 2019; IEA 2018c; ACEEE country research

WATER EFFICIENCY (1 POINT)

Investments aimed at reducing water demand can also reduce energy consumption. Water and energy are linked, intersecting on both the supply side (electricity generation and water/wastewater facilities) and the end-use side (the residential, commercial, industrial, and agriculture sectors). This energy–water nexus is apparent in the massive amounts of water needed to produce and deliver electricity. Coal, nuclear, and concentrating solar-thermal electricity generation are water intensive. Water is needed to create steam and to power turbines; it is also used for cooling and then either lost in the process or discharged back

into the environment. At the same time, it takes immense amounts of energy to clean and transport water. Pumps, motors, and building equipment in water and wastewater utilities consume a great deal of energy. On the end-use side, energy and water are inseparable in our homes, businesses, and industrial facilities—such as in the use of hot water. Given this close relationship, improvements in water efficiency generally result in energy savings (Berg and Ribeiro 2018).

Countries can improve their energy efficiency by adopting water-saving mandates and implementing water efficiency programs. We gave 1 point to countries with both a national water law that incorporates conservation principles and a water efficiency program aimed at consumers. Countries that have either a water law or a water efficiency program received 0.5 point. We did not investigate the enforcement or effectiveness of these water efficiency programs. Table 17 shows the results.

Table 17. Scores for water efficiency

Country	Water efficiency efforts	Law	Program	Score
Australia	Law and program	National Water Initiative	Water Efficiency Labeling and Standards (WELS)	1
China	Law and program	2009 Circular Economy Promotion Law of the People's Republic of China	Water Efficiency Labeling Program	1
Taiwan	Law and program	Water Supply Act	Provision within the Water Supply Act	1
Canada	Law	Canada Water Act		0.5
India	Program		Water Efficient Products–India (WEP–I) program	0.5
Indonesia	Law	Law on Water Resources Development (Law No. 11 of 1974)		0.5
Italy	Program		Water Bonus under Italian Budget Law 2021	0.5
Netherlands	Law	Dutch Water Act		0.5
South Africa	Law	National Water Resource Strategy under the National Water Act		0.5

Country	Water efficiency efforts	Law	Program	Score
Spain	Law	Revised Water Law (approved by Royal Legislative Decree 1/2001)		0.5
Thailand	Law	Water Resources Act		0.5
U.S.	Program		WaterSense	0.5
Brazil	None			0
Egypt	None			0
France	None			0
Germany	None			0
Japan	None			0
Mexico	None			0
Poland	None			0
Russia	None			0
Saudi Arabia	None			0
South Korea	None			0
Turkey	None			0
U.A.E.	None			0
U.K.	None			0

Source: ACEEE country research

DATA AVAILABILITY (1 POINT)

To fully understand their energy efficiency potential, countries must identify key GHG and energy-related performance indicators across multiple sectors and track the data over time. Energy efficiency indicators can be different at the city, state/province, or country level and for different climate zones and political structures. Countries that track this information will gain insights into energy and emissions trends that can assist them with effective policy decisions.

We looked at each of the three end-use energy sectors evaluated in this report, along with national efforts, and calculated the percent of data available for each country across all 36 metrics. We gave 1 point to countries that had at least 90% of the data accessible for the evaluated metrics. Countries earned 0.5 point if at least 80% of their data were available to

us. We awarded no points to countries with little information available through either centralized or country-specific sources. Table 18 shows the scores.

Table 18. Scores for data availability

Country	Data availability (%)	Score
Germany	100%	1
Italy	100%	1
Poland	100%	1
Taiwan	100%	1
Australia	97%	1
Mexico	97%	1
U.K.	97%	1
U.S.	97%	1
Canada	94%	1
Japan	94%	1
France	92%	1
China	89%	0.5
South Korea	89%	0.5
Spain	89%	0.5
India	86%	0.5
Netherlands	83%	0.5
Turkey	83%	0.5
Brazil	81%	0.5
Egypt	81%	0.5
South Africa	81%	0.5
Russia	75%	0
Thailand	72%	0
Indonesia	69%	0
Saudi Arabia	61%	0
U.A.E.	53%	0

Source: ACEEE country research

NATIONAL EFFORTS BEST PRACTICES

Germany. Germany has emerged as a global leader in advancing energy efficiency with strong national policies and targets. In coordination with the EU's Energy Efficiency Directive to target a 32.5% reduction in primary and final energy consumption by 2030 and a national 50% reduction target in primary energy use by 2050, Germany adopted the Energy Efficiency Strategy 2050. It also released a second National Action Plan on Energy Efficiency (NAPE 2.0) which identifies various focus areas in which action can be taken to improve sector-wide energy efficiency. These areas and actions include the following:

- Tax incentives to refurbish the national building stock and decarbonize the heating and cooling infrastructure
- Increased government funding for energy efficiency in the industrial sector through efficient technologies and reductions in process heat
- Upgrading energy efficiency measures in the transportation sector

The Netherlands. The Netherlands has shown continual improvement in scores by taking important steps to reduce energy consumption and GHG emissions. Its ambitious 2019 Climate Agreement directs the country to reduce GHG emissions 49% by 2030 and 95% by 2050 with respect to 1990 levels. The approaches identified in the Climate Agreement acknowledge energy efficiency as an essential tool in meeting the country's GHG goals. As with Germany, the EU's Energy Efficiency Directive guides Dutch energy efficiency policy and goals. The Dutch National Energy and Climate Plan (NECP) establishes measures to achieve the EU's energy efficiency goal of 32.5% by 2030. Policies, measures, and programs included in the NECP focus on energy efficiency in the built environment and energy savings requirements for the industrial sector.

Buildings

Buildings use an estimated 30% of the energy consumed worldwide (UNEP 2020). In this section, countries could earn up to 25 points across eight metrics for energy efficiency policies and programs targeted at residential and commercial buildings. We focused on several best-practice policies that have the largest potential for energy and GHG savings in buildings; these include building energy codes, appliance standards and labeling, building energy benchmarking and disclosure policies, and retrofit policies. We also included a metric that scored countries on the energy use intensity of residential and commercial buildings to evaluate the performance of each country's existing building stock.

The Netherlands took first place in the buildings section, with a total score of 22.5 points out of 25. Like many of the EU countries, the Netherlands performed well on policy metrics. It excelled in the building energy codes and retrofit categories, earning the top score for both metrics. The Dutch government has also implemented mandatory building rating systems, as well as appliance performance standards and labeling programs.

Three European countries (France, Spain, and Germany) followed closely behind the Netherlands. Due largely to their compliance with the EU's Energy Performance Building Directive, the three countries had similar scores for energy codes and appliance standards and labeling; their scores differed slightly for building retrofit policies and energy use intensity.

Rounding out the top five is China, the top-ranking non-European country. China has implemented comprehensive policies to address its buildings-related energy use. It received credit for its comprehensive appliance standards and labeling program as well as for its building energy codes. Table 19 shows the total scores and individual metric scores for all countries in the buildings section.

Table 19. Scores for buildings

Country	Total score	Residential building codes	Commercial building codes	Appliance and equipment standards	Appliance and equipment labeling	Building retrofit policies	Building rating and disclosure	Energy intensity in residential buildings	Energy intensity in commercial buildings
Max. score	25	3	3	5	2	4	2	3	3
Netherlands	22.5	3	3	4	2	4	2	2	2.5
France	21	3	3	4	2	4	2	1	2
Spain	20.5	3	3	4	2	3	2	1.5	2
Germany	20	3	3	4	2	3	2	1	2
China	19.5	2.5	3	4.5	2	2	1	2.5	2
U.K.	19.5	3	3	2.5	2	4	2	1	2
Poland	18.5	3	3	4	2	3	2	0.5	1
Italy	17	2.5	2.5	4	2	3	1	0	2
U.S.	17	2.5	2.5	5	1.5	3	0.5	0.5	1.5
South Korea	16	2.5	3	3	2	3	1	0.5	1
Mexico	15	1.5	1.5	2	1	3	0	3	3
Australia	14.5	2.5	2.5	1.5	1.5	2	1	0.5	3
Canada	14.5	2.5	2.5	4.5	1	3	0.5	0	0.5
Taiwan	14.5	2	2	0.5	2	2	1	2.5	2.5
Turkey	14	2	2	0.5	1	3	2	2.5	1
Japan	13.5	2.5	2	2	1	2	0.5	2	1.5

Country	Total score	Residential building codes	Commercial building codes	Appliance and equipment standards	Appliance and equipment labeling	Building retrofit policies	Building rating and disclosure	Energy intensity in residential buildings	Energy intensity in commercial buildings
Saudi Arabia	13.5	2.5	2.5	1.5	1.5	3	0.5	2	0
Brazil	12	2	0	1.5	1.5	1	0.5	3	2.5
South Africa	11.5	2.5	2.5	0.5	2	2	0	1	1
Indonesia	10.5	1	2.5	0	1	0	1	2.5	2.5
India	9.5	1	2.5	0	1.5	1	0	2	1.5
U.A.E.	9.5	2.5	2.5	0	1.5	1	0.5	1	0.5
Russia	8.5	2	2	0	1.5	2	1	0	0
Thailand	8	2.5	2.5	0	0	1	0	1.5	0.5
Egypt	6	0	0	0.5	1.5	0	0	2.5	1.5

New in This Section

As part of the building retrofit policies metric, we highlighted policies and programs that assist low-income households in improving the energy efficiency of their homes. We also updated our scoring methodology for appliance standards to emphasize standards for appliances and equipment with the greatest energy-savings potential.

RESIDENTIAL AND COMMERCIAL BUILDING CODES (3 POINTS EACH)

We based scores for residential and commercial building codes on the presence of national mandatory energy codes and the technical areas they cover. Within each buildings sector (residential and commercial), we awarded 1 point to countries with mandatory national building codes. Many countries do not set federal codes but rather develop model energy codes that can be adopted by states, territories, and localities. Countries with high adoption rates of model codes that cover the majority of their populations (often called *mixed codes*) received 0.5 point; those with low code adoption rates, voluntary codes, or no codes received no points.

We also examined whether the energy codes covered key technical areas as follows:

- *BUILDING SHELL*
    - *Insulation in walls and ceiling.* Does the code require levels of insulation for building shell components that are relevant to the climate?
    - *U-factors and shading/solar heat gain coefficient for windows.* Does the code require U-factors and shading/solar heat gain coefficients for windows and doors that are relevant to the climate? The U-factor measures the rate of heat transfer through a window and rates how well the window insulates. The solar heat gain coefficient measures the fraction of solar energy transmitted, indicating how well the window blocks heat from solar radiation.
    - *Air sealing.* Does the code require buildings to meet certain air tightness levels, verified by testing?
- *BUILDING SYSTEMS*
    - *Efficient lighting.* Does the code include minimum standards for lighting efficiency, lamps, and/or lighting controls?
    - *Efficient heating, ventilating, and air-conditioning systems.* Does the code require a level of efficiency for heating, ventilating, and cooling systems? Does the code have design requirements for these systems?
    - *Efficient water heating.* Does the code require minimum efficiency levels for hot-water systems?

We allocated 2 points based on the code's building technical requirements (building shell and systems). Countries meeting five or six of the technical requirements earned the full 2 points. Those satisfying three or four requirements earned 1.5 points, while those meeting two earned 1 point, and those meeting one earned 0.5 point. In theory, we recognize the importance of scoring each country on the stringency of these requirements, but we lacked the available data to do so.

Further, while we do not score building codes on implementation or compliance, we fully recognize that implementation and enforcement are critical to advancing energy savings in buildings. We also recognize that these key factors vary widely across countries and that many countries lack meaningful enforcement policies and processes. Unfortunately, we do not have the data to score countries on their implementation and enforcement at this time. When reviewing each country's scores, please keep in mind that while they may have adopted a code with several technical requirements, it does not guarantee that new construction is meeting those requirements. Our scores are a high-level analysis of adopted building codes, but they do not capture the entire picture of code stringency and enforcement.

Tables 20 and 21 show scores for the residential and commercial sectors, respectively.

Table 20. Scores for residential building codes

Country	Code type	Code type score	Number of technical requirements covered (out of 6)	Score for technical requirements	Combined score
France	Mandatory	1	6	2	3
Germany	Mandatory	1	5	2	3
Netherlands	Mandatory	1	5	2	3
Poland	Mandatory	1	5	2	3
Spain	Mandatory	1	5	2	3
U.K.	Mandatory	1	6	2	3
Australia	Mixed	0.5	6	2	2.5
China*	Mixed	0.5	5	2	2.5
Italy	Mixed	0.5	5	2	2.5
Saudi Arabia	Mandatory	1	4	1.5	2.5
South Africa	Mandatory	1	4	1.5	2.5
South Korea	Mandatory	1	4	1.5	2.5

Country	Code type	Code type score	Number of technical requirements covered (out of 6)	Score for technical requirements	Combined score
Canada	Mixed	0.5	5	2	2.5
Japan**	Voluntary	0.5	6	2	2.5
U.A.E.	Mixed	0.5	5	2	2.5
U.S.	Mixed	0.5	6	2	2.5
Thailand	Mandatory	1	3	1.5	2.5
Brazil	Mandatory	1	2	1	2
Russia	Mandatory	1	2	1	2
Taiwan	Mandatory	1	2	1	2
Turkey	Mandatory	1	2	1	2
Mexico	Voluntary	0	4	1.5	1.5
India	Voluntary	0	2	1	1
Indonesia	Mandatory	1	0	0	1
Egypt***	Voluntary	0	5	0	0

***China's residential building code does not apply to rural areas, and we therefore score it as a "mixed" requirement rather than "mandatory" since the code does not cover a significant proportion of the population. **Japan earns points for its voluntary code because it has benefits in place for exceeding the minimum code and strict noncompliance penalties for buildings that have chosen not to adhere to standards. *** Egypt does not receive points for this metric because it is unclear whether the Egyptian government has officially adopted the energy code. Sources: GBPN 2021; University of São Paolo (Brazil); Sheta 2018 (Egypt); BCAP 2022; Kwatra 2021 (India); ICC 2016 (Mexico); BPIE 2012 (Poland); Matrosov, Chao, and Majersik 2007 (Russia); SBCNC 2018a (Saudi Arabia); ACEEE data requests.**

Table 21. Scores for commercial building codes

Country	Code type	Code type score	Number of technical requirements covered (out of 6)	Score for technical requirements	Combined score
China	Mandatory	1	5	2	3
France	Mandatory	1	6	2	3
Germany	Mandatory	1	6	2	3
Netherlands	Mandatory	1	6	2	3

Country	Code type	Code type score	Number of technical requirements covered (out of 6)	Score for technical requirements	Combined score
Poland	Mandatory	1	5	2	3
South Korea	Mandatory	1	5	2	3
Spain	Mandatory	1	6	2	3
U.K.	Mandatory	1	6	2	3
Australia	Mixed	0.5	6	2	2.5
Italy	Mixed	0.5	5	2	2.5
Saudi Arabia	Mandatory	1	4	1.5	2.5
South Africa	Mandatory	1	4	1.5	2.5
Canada	Mixed	0.5	5	2	2.5
India	Mixed*	0.5	5	2	2.5
Indonesia	Mandatory	1	4	1.5	2.5
Thailand	Mandatory	1	4	1.5	2.5
U.A.E.	Mixed	0.5	5	2	2.5
U.S.	Mixed	0.5	6	2	2.5
Japan	Mixed	0.5	4	1.5	2
Russia	Mandatory	1	2	1	2
Turkey	Mandatory	1	2	1	2
Taiwan	Mandatory	1	2	1	2
Mexico	Voluntary	0	4	1.5	1.5
Brazil	No Codes	0	0	0	0
Egypt	Voluntary	0	0	0	0

***India has state-led commercial building codes, but few states have chosen to adopt mandatory codes. Sources: GBPN 2021; LNBL 2015 (China); U.S. DOE 2015 (China); Kwatra 2021 (India); BCAP 2022; BPIE 2012 (Poland); Ananwattanaporn et al. 2021 (Thailand); ACEEE data requests.**

APPLIANCE AND EQUIPMENT STANDARDS (5 POINTS)

Policies requiring minimum energy performance standards (MEPS) for appliances and equipment could receive up to 5 points. For this edition of the *Scorecard*, we updated the scoring methodology to emphasize MEPS targeting appliances and equipment with the

greatest savings potential. We allocated 3 points for standards covering five energy-intensive end uses: space heating, spacing cooling, water heating, refrigeration, and lighting. To receive points for covering these end uses, countries had to have standards covering every appliance or equipment outlined in table 22 below. Countries could receive 3 points for covering at least four end uses, 2 points for three end uses, and 1 point for two end uses.

Table 22. Standards required to receive points for covering energy-intensive end uses

End use	Appliance and equipment standards required to receive points
Space heating	Boiler/Packaged Terminal Unit (PTU)
	Furnace/heat pump
Air-conditioning	Central AC/heat pump
	Room AC
	Chiller
Water heating	Instantaneous water heater
	Storage water heater
Refrigeration	Freezer
	Refrigerator (including refrigerator-freezers)
	Walk-in cooler and freezer
	Commercial refrigeration equipment
Lighting	Linear fluorescent
	General service lighting
	HID High intensity discharge (HDS) (including metal halide, high pressure sodium (HPS) and low pressure sodium (LPS))

We also awarded up to 2 points for the total number appliance standards across a broader set of product categories. Table 23 shows the point allocation for the number of product categories that the standards cover. The table in Appendix B describes our product category groupings.

Table 23. Point allocation for the number appliance and equipment standards

Number of appliance categories with minimum energy performance standards (MEPS)	Points
> 40	2
31–40	1.5
21–30	1
< 21	0.5

This metric does not measure the stringency of these standards, the percentage of energy consumption that the standards cover, or compliance with the standards. We recognize how widely these factors vary across countries and how significantly they impact the overall effect of energy efficiency standards. However, given the lack of consistent data for many countries, we cannot consistently and accurately incorporate these factors into our scoring at this time. As you review the rankings, please keep in mind that a country's official policies do not guarantee adherence to the standards.

APPLIANCE AND EQUIPMENT LABELING (2 POINTS)

Labeling programs help consumers make purchasing decisions by disclosing how much energy an appliance or a particular piece of equipment uses relative to similar products of the same type.[5] Labels typically display this comparative information using either a categorical rating or a continuous scale. Categorical labels give appliance models distinct rankings or scores based on energy use or efficiency, while continuous scales mark the high and low ends of energy use or efficiency among models and place each model in the appropriate place along the continuum. Figure 4 shows two example labels: the EU's categorical labeling scheme, which awards a letter grade to products,[6] and the U.S. EnergyGuide program, which uses a continuous-scale labeling scheme.

[5] For the *International Scorecard*, we focus on comparative energy use information labels. We do not include voluntary endorsement labels at this time.

[6] The EU updated its appliance label in 2021, redesigning the layout and recalibrating the previous A+++ to G scoring. More than 90% of products were previously labeled A+ or above. The upgrade aims to ensure continued innovation in energy efficiency (Tedstone 2017).

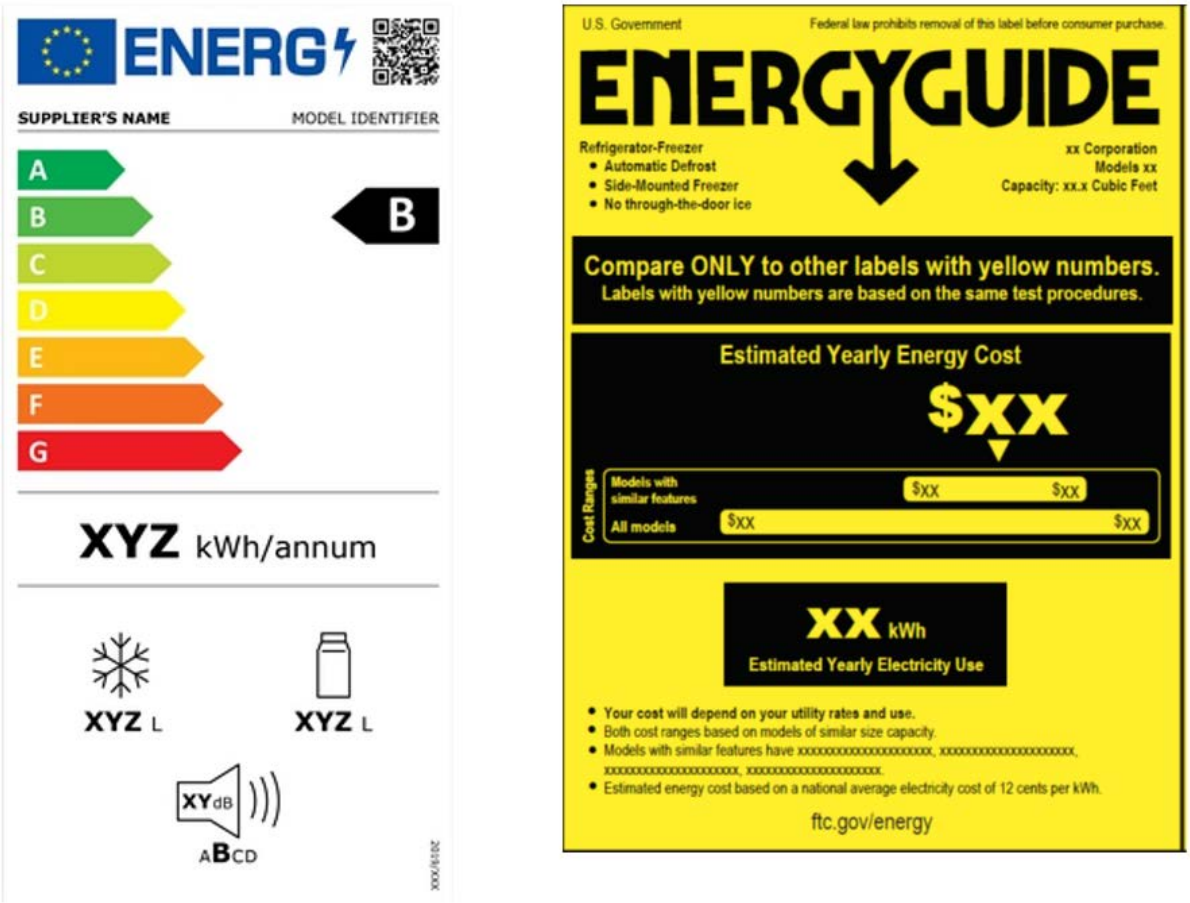

Figure 4. Categorical (left) and continuous (right) styles for appliance labeling

Only countries with mandatory appliance and equipment labeling could earn points for this metric. We gave 1 point for categorical labels and 0.5 point for continuous labels, as categorical labels have proven to be better understood and more motivating than continuous labels (Thorne and Egan 2002). We awarded an additional 1 point to countries with labels covering at least 15 appliance category groups and 0.5 point to those with labels covering at least five appliance groups. Table 24 shows the scores on this metric.

Table 24. Scores for appliance and equipment standards (left) and labeling (right)

Country	Number of appliances with minimum energy performance standards (MEPS)	Score	Number of key appliance groups with MEPS	Score	Total score	Mandatory or voluntary	Categorical or continuous	Score	Appliance groups	Score	Total score
U.S.	42	2	4	3	5	Mandatory	Continuous	0.5	17	1	1.5
China	40	1.5	4	3	4.5	Mandatory	Categorical	1	34	1	2
Canada	39	1.5	4	3	4.5	Mandatory	Continuous	0.5	7	0.5	1
France	42	2	3	2	4	Mandatory	Categorical	1	25	1	2
Germany	42	2	3	2	4	Mandatory	Categorical	1	25	1	2
Italy	42	2	3	2	4	Mandatory	Categorical	1	25	1	2
Netherlands	42	2	3	2	4	Mandatory	Categorical	1	25	1	2
Poland	42	2	3	2	4	Mandatory	Categorical	1	25	1	2
Spain	42	2	3	2	4	Mandatory	Categorical	1	25	1	2
South Korea	30	1	3	2	3	Mandatory	Categorical	1	21	1	2
U.K.	38	1.5	2	1	2.5	Mandatory	Categorical	1	24	1	2
Japan	24	1	2	1	2	Voluntary	Categorical	0	18	1	1
Mexico	23	1	2	1	2	Mandatory	Continuous	0.5	14	0.5	1
Australia	20	0.5	2	1	1.5	Mandatory	Categorical	1	14	0.5	1.5
Saudi Arabia	13	0.5	2	1	1.5	Mandatory	Categorical	1	11	0.5	1.5
Brazil	12	0.5	2	1	1.5	Mandatory	Categorical	1	14	0.5	1.5

Country	Number of appliances with minimum energy performance standards (MEPS)	Score	Number of key appliance groups with MEPS	Score	Total score	Mandatory or voluntary	Categorical or continuous	Score	Appliance groups	Score	Total score
Turkey	20	0.5	1	0	0.5	Mandatory	Categorical	1	1	0	1
Taiwan	18	0.5	0	0	0.5	Mandatory	Categorical	1	15	1	2
South Africa	15	0.5	0	0	0.5	Mandatory	Categorical	1	16	1	2
Egypt	11	0.5	1	0	0.5	Mandatory	Categorical	1	10	0.5	1.5
U.A.E.	10	0	0	0	0	Mandatory	Categorical	1	10	0.5	1.5
India	9	0	0	0	0	Mandatory	Categorical	1	7	0.5	1.5
Thailand	4	0	0	0	0	Voluntary	Categorical	0	0	0	0
Indonesia	1	0	0	0	0	Mandatory	Categorical	1	2	0	1
Russia	1	0	0	0	0	Mandatory	Categorical	1	13	0.5	1.5

Sources: CLASP 2022; IEA 2022b; APEC EGEEC 2012 (Japan); Certification Quality Conformity (CQC) 2021 (Russia); Russian Federation 2021 (Russia)

BUILDING RETROFIT POLICIES (4 POINTS)

Globally, the existing building stock tends to be old and inefficient, providing a tremendous opportunity for energy savings. Countries can more fully capture building energy savings by adopting policies to require efficiency improvements during a building redesign or retrofit. While building energy codes usually apply only to new construction, many countries extend code requirements to major building renovations. In this edition of the *Scorecard,* all European countries have mandatory building energy codes for existing buildings (GBPN 2021; IEA 2022b; Concerted Action EPBD 2016).

For this *International Scorecard*, we awarded up to 4 points for countries with retrofit policies. We awarded 3 points to countries with codes that require energy-efficient upgrades within a specific time frame; require that overall building energy performance improves when any building extension, addition, or conversion is done; or prohibit renting out or selling a building with poor energy performance (BPIE 2015). We awarded 2 points to countries with energy codes that mandate energy-efficient upgrades for only the renovated area of the building. Countries with state or provincial codes that apply to at least two-thirds of the population also received 2 points. Countries earned 1 point if they have mandatory national, state, or provincial codes that cover residential or commercial buildings, but not both. We awarded 1 extra point to countries with federal incentives to encourage retrofits. Table 25 summarizes the presence or absence of retrofit policies in the evaluated countries, along with their corresponding scores.

Table 25. Scores for building retrofit policies

Country	Building retrofit policies	Score	Incentives	Score	Total score
France	Mandatory national codes apply to residential and commercial renovations Building performance standards for residential and commercial buildings	3	Loans and rebates	1	4
Netherlands	Mandatory national codes apply to residential and commercial renovations Building performance standards for office buildings	3	Tax deductions	1	4
U.K.	Mandatory national code applies to residential and commercial renovation Building performance standards for rental properties	3	Grants and tax reductions	1	4

Country	Building retrofit policies	Score	Incentives	Score	Total score
Canada	State or provincial codes that cover two-thirds of population apply to residential and commercial renovations	2	Loans, grants, and rebates	1	3
Germany	Mandatory national codes apply to residential and commercial renovations	2	Loans and grants	1	3
Italy	Mandatory national codes apply to residential and commercial renovations	2	Tax rebates	1	3
Mexico	Mandatory national codes apply to residential and commercial renovations	2	Loans	1	3
Poland	Mandatory national codes apply to residential and commercial renovations	2	Grants	1	3
Saudi Arabia	Mandatory national codes apply to residential and commercial renovations	2	Rebates	1	3
South Korea	Mandatory national codes apply to residential and commercial buildings	2	Rebates	1	3
Spain	Mandatory national codes apply to residential and commercial buildings	2	Loans and grants	1	3
Turkey	National mandatory codes apply to residential and commercial buildings	2	Loans	1	3
U.S.	State or provincial codes cover two-thirds of population apply to residential and commercial renovations	2	Loans and rebates	1	3
Australia	State or provincial codes vary in coverage of residential and commercial buildings	1	Grants	1	2
China	Mandatory nation codes apply to renovations in commercial buildings and urban residential buildings, but not to rural residential buildings	1	Grants and subsidies	1	2

Country	Building retrofit policies	Score	Incentives	Score	Total score
Japan	National codes apply to commercial retrofit projects of 2,000 sq. meters or more	1	Grants	1	2
Russia	Mandatory national codes apply to renovations for some buildings	2	None	0	2
South Africa	Mandatory national codes apply to residential and commercial renovations	2	None	0	2
Taiwan	Mandatory national codes apply to any retrofit projects of 1,000 sq. meters or more	2	None	0	2
Brazil	No code or policy	0	Loans	1	1
India	Voluntary national codes apply to some buildings	0	Loans	1	1
Thailand	No code or policy	0	Grants	1	1
U.A.E.	No code or policy	0	Incentives	1	1
Egypt	No code or policy	0	None	0	0
Indonesia	No code or policy	0	None	0	0

Sources: IEA 2022b; GBPN 2021; BCAP 2021; Baker McKenzie 2021 (Brazil); Mo 2017 (China); Schimschar 2020 (Egypt); Journal of Al-Azhar University Engineering Sector (Egypt); European Commission (Netherlands); KfW 2021 (Germany); IBEC 2016 (Japan); SEforAll (Japan); WRI Ross Center 2016 (Mexico); Concerted Action EPBD 2016 (Poland); Saudi Building Code (SBC) National Committee (Saudi Arabia); ICC 2016 (Mexico); Odyssee-Mure 2021 (Spain); CCAP 2012 (Thailand); Hinge and Brocklehurst 2021.

BUILDING RETROFIT PROGRAMS FOR LOW-INCOME HOUSING

Low-income households typically live in older, less efficient buildings than households in other income groups. While these households have the most to gain from energy efficiency measures, they often face implementation barriers such as lack of financial capital for efficiency investments. In fact, in some instances, energy policies can result in unevenly distributed costs and benefits. National incentive programs are an important tool to even out these effects by delivering energy efficiency improvements and addressing energy poverty in low-income communities.

These policies can look different around the world. Some countries support energy efficiency retrofit measures to lower energy consumption directly. Examples of this include the U.S. federal Weatherization Assistance Program (WAP), Habiter Mieux in France, and the United Kingdom's Affordable Warmth Grants. These programs often incorporate information and guidance schemes as well.

Some countries may have energy policies that are not climate-centered, but rather are embedded in social welfare policies. These policies can, for instance, focus on housing quality and aim to ensure that all homes sold or rented are energy efficient to maintain tenant comfort and health.

In this edition of the *Scorecard,* national incentive programs for efficiency improvements to low-income communities count toward the building retrofits score. ACEEE is exploring ways to capture the wider breadth of equitable retrofit policies in a separate metric for future *Scorecard* editions.

Sources: Noka et al. 2019; Ugarte et al. 2016

BUILDING RATING AND DISCLOSURE POLICIES (2 POINTS)

We based scores for this buildings-related metric on the presence of a mandatory building rating system and the mandatory disclosure of energy use. A building rating provides building owners and occupants information regarding the energy usage and costs associated with that building, similar to the information provided by an appliance label. Disclosure of a building's energy use can help owners, tenants, and financiers recognize the benefits of energy efficiency at the time of a purchase, lease, or refinance. Disclosure also provides important insights for policymakers seeking to improve building energy performance.

We gave the full 2 points to countries with rating and disclosure requirements applicable to all buildings (new and existing, commercial and residential). We gave 1 point to countries with mandatory building rating policies that apply only to new buildings or only to a subset of buildings (e.g., commercial but not residential). Table 26 lists the scores on this metric.

Table 26. Scores for building rating and disclosure programs

Country	Building rating	Buildings covered	Score
France	Mandatory	All	2
Germany	Mandatory	All	2
Netherlands	Mandatory	All	2
Poland	Mandatory	All	2
Spain	Mandatory	All	2
Turkey	Mandatory	All	2
U.K.	Mandatory	All	2
Australia	Mandatory	Some	1
China	Mandatory	Some	1
Indonesia	Mandatory	Some	1
Italy	Mandatory	Some	1
Russia	Mandatory	Some	1
South Korea	Mandatory	Some	1
Taiwan	Mandatory	Some	1
Brazil*	Voluntary	All	0.5
Canada*	Voluntary	Some	0.5
Japan*	Voluntary	All	0.5
Saudi Arabia	Voluntary	All	0.5
U.A.E.**	Mandatory	Some	0.5
U.S.*	Voluntary	All	0.5
Egypt	No labeling	-	0
India	Voluntary	Some	0
Mexico	Voluntary	Some	0
South Africa	No labeling	-	0
Thailand	No labeling	-	0

***We awarded partial points for voluntary programs in Brazil, Canada, Japan, and the United States because these programs have been used on a substantial number of buildings to date. **We awarded only partial points to the United Arab Emirates for mandatory codes in Dubai and Abu Dhabi because while they cover a large proportion of the country's building stock, they are not mandatory at the national level. Sources: IEA 2022b; Baker McKenzie 2021; Building Rating (China); Enervision 2021**

(Canada); MeetMED 2020 (Egypt); Korea Energy Agency 2015 (South Korea); Park et al. 2015 (South Korea); Energy Charter Secretariat 2014 (Turkey); ACEEE data requests.

ENERGY INTENSITY OF RESIDENTIAL AND COMMERCIAL BUILDINGS (3 POINTS EACH)

Energy intensity is a function of a building's energy use and the efficiency of its structure, equipment, and appliances. Various factors affect a building's energy use, including its floor area, geographic location and climate, number of occupants, and level of economic activity (IPEEC 2015). To evaluate the energy intensity of buildings, we relied on GDP, population size, and commercial and residential floor area. We adjusted energy intensities for climate and service-sector GDP.

RESIDENTIAL

We used two metrics to evaluate energy use and compare the energy intensity of residential buildings across the evaluated countries. We included both metrics in this report because no single metric is perfect. First, we looked at residential energy use intensity (energy use per unit of floor area). This relationship reveals how homes and other residential unit types are performing relative to the amount of floor space. As buildings become more efficient through improved equipment and appliances, and tighter building envelopes, less energy is required to serve the same amount of space. Second, we looked at residential energy use per capita. This allows us to see building energy use across countries relative to the number of people served.

The average floor area of homes differs across the countries we scored. The average house in the United States, Canada, and Australia is nearly double the size of an average dwelling in many other countries. Further, while some types of home energy use (e.g., for lighting, space heating, and space cooling) grow with increasing building size, other uses (e.g., for cooking, refrigeration, and water heating) are largely independent of size (IPEEC 2015). This makes countries with large homes look more efficient than those with smaller living spaces when measured by energy use intensity.

We followed the same methodology for both energy use per floor area (energy use intensity) and energy use per capita. Many of the major economies track residential floor area and/or residential floor area per capita because these data are included in their census. In developed economies, energy use per capita has generally stayed the same or grown very slowly, while energy use per capita in developing countries continues to grow as people gain access to more building services and amenities (IPEEC 2015).

We used final energy[7] consumption of residential buildings because primary energy use by sector was not available for every country. We weighted energy intensity based on typical heating degree days (HDDs) and cooling degree days (CDDs) and the percentage of overall residential energy use that space heating and cooling account for in each country.[8] This adjustment allows a fairer comparison among countries with different heating and cooling needs; it also normalizes buildings located in extreme climates relative to those in milder climates. Appendix A details the process we used to normalize the portion of energy used for heating and cooling in residential buildings.

Commercial[9]

We compared the energy intensity of commercial buildings using two metrics to evaluate building energy use.[10] We looked at commercial energy use per dollar of service-sector GDP to isolate energy use trends from differences in overall GDP. Also, as with residential buildings, we looked at commercial building energy use intensity (energy use per total floor area) to reveal trends based on commercial building size. Since many countries do not consistently track floor area, particularly in the commercial sector, we were forced to use data from varying years to calculate our energy intensity estimates.

Countries could receive up to 6 points for the combined residential and commercial energy intensity metrics. We purchased data for residential and commercial floor space for a subset of countries from IEA's Energy Efficiency Indicators database and cannot share the specific data for each country in a table (IEA 2021a). Instead, figures 5 and 6 show the results for residential and commercial energy use intensity per floor area. In the figures, horizontal red lines delineate the thresholds we used to allocate points for the metrics.

Tables 27 and 28 show the point allocation for residential building energy use per capita and commercial building energy use per GDP, respectively. Tables 29 and 30 list the energy intensity data and scores for the residential and commercial building sectors, respectively. Because we normalized residential-building energy intensity for heating and cooling to

[7] *Final energy consumption* is the energy used by all end uses. For buildings, final energy consumption would be the energy used by all residential buildings or services (commercial) buildings. Final energy consumption is sometimes referred to as *site energy consumption*.

[8] Heating degree days and cooling degree days are measurements designed to reflect the demand for energy needed to heat or cool a home or business to a human comfort level of 18°C (65°F).

[9] The data we used on service buildings included both private and public commercial buildings.

reflect variations in climate between countries, the results in table 29 should be interpreted as relative intensities.

Table 27. Scoring criteria for residential energy intensity

Final energy use per capita (MMBtus/capita)	Score
< 6	1.5
6–11.9	1
12–17.9	0.5
≥ 18	0

Table 28. Scoring criteria for commercial energy intensity

Final energy use per service-sector GDP (MMBtus/$GDP)	Score
< 450	1.5
450–649	1
650–849	0.5
≥ 850	0

Table 29. Scores for energy intensity in residential buildings

Country	Score for MMBtus/m^2	MMBtus/capita	Score for MMBtus/capita	Total score
Brazil	1.5	4.89	1.5	3
Mexico	1.5	5.63	1.5	3
China	1.5	8.74	1	2.5
Egypt	1	5.43	1.5	2.5
Indonesia	1	4.61	1.5	2.5
Taiwan	1.5	8.84	1	2.5
Turkey	1.5	9.01	1	2.5
India	0.5	4.91	1.5	2
Japan	1.5	13.05	0.5	2
Netherlands	1.5	16.09	0.5	2

Country	Score for MMBtus/m^2	MMBtus/capita	Score for MMBtus/capita	Total score
Saudi Arabia	1	10.92	1	2
Spain	1	13.63	0.5	1.5
Thailand	0	5.18	1.5	1.5
France	0.5	17.62	0.5	1
Germany	1	18.29	0	1
South Africa	0	9.43	1	1
U.A.E.	0	8.98	1	1
U.K.	0.5	16.90	0.5	1
Australia	0.5	23.42	0	0.5
Poland	0	13.13	0.5	0.5
South Korea	0.5	28.71	0	0.5
U.S.	0.5	30.96	0	0.5
Canada	0	29.37	0	0
Italy	0	19.94	0	0
Russia	0	24.66	0	0

Sources: IEA 2018c (energy consumption in buildings); IEA Energy Efficiency Indicators 2021 (for floor space); IPEEC 2015; Lychuk et al. 2012 (Russia); Huo et al. 2019 (China); Krarti 2019 (Egypt); Krarti, Aldubyan, and Williams 2020 (Saudi Arabia) ; AEEE 2018 (India); ACEEE estimates based on Solidiance 2013 (Thailand); UNECE 2004 (Thailand); EU Buildings Observatory 2021; ACEEE data requests; World Bank 2022b (population data).

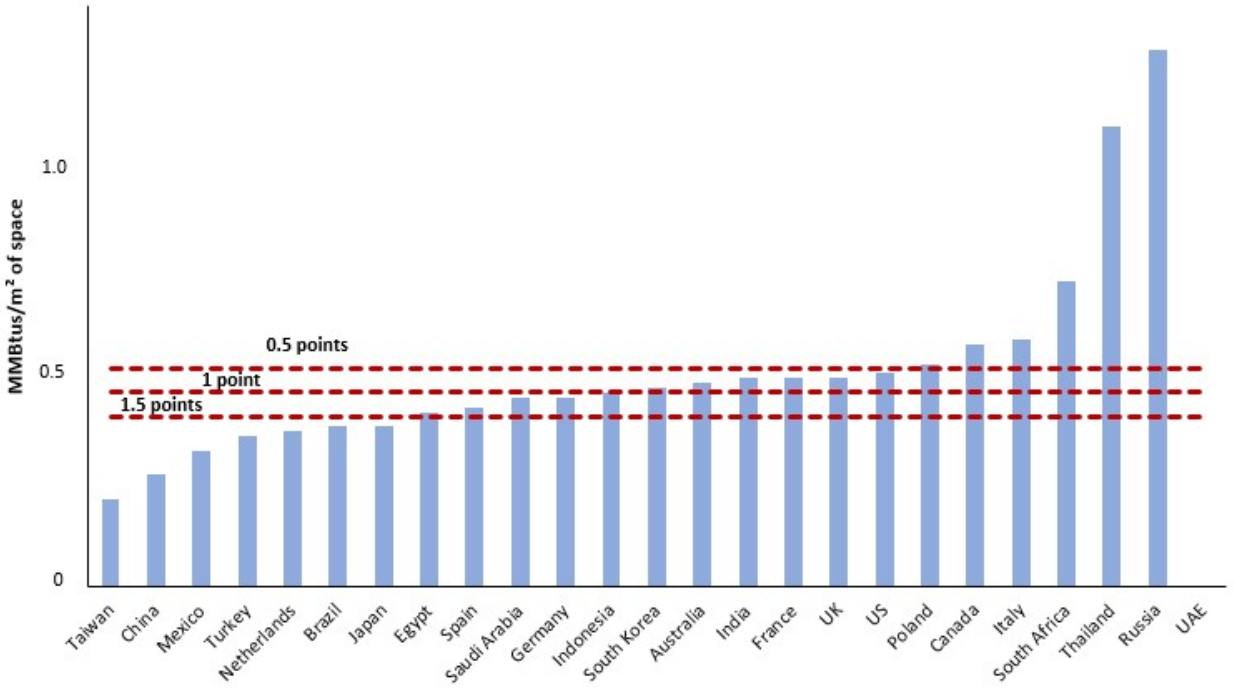

Figure 5. Final energy use intensity in residential buildings (MMBtus/m²). Sources: IEA's Energy Efficiency Indicators 2021; see table 29 footnote for sources for countries not included in the IEA dataset. Countries with no data points are included at the very end of the horizontal axis in the figure without any data (e.g., U.A.E).

Table 30. Scores for energy intensity in commercial buildings

Country	Score for MMBtus/m²	MMBtus/ service $GDP	Score for MMBtus/service $GDP	Total score
Australia	1.5	346	1.5	3
Mexico	1.5	203	1.5	3
Brazil	1	345	1.5	2.5
Indonesia	1.5	480	1.0	2.5
Netherlands	1	405	1.5	2.5
Taiwan	1.5	524	1.0	2.5
China	1.5	650	0.5	2
France	0.5	444	1.5	2
Germany	1	472	1.0	2
Italy	0.5	469	1.0	2
Spain	0.5	409	1.5	2
U.K.	1.5	334	1.5	2

Country	Score for MMBtus/m^2	MMBtus/ service $GDP	Score for MMBtus/service $GDP	Total score
Egypt	1	930	0.0	1.5
India	0.5	753	0.5	1.5
Japan	0.5	450	1.0	1.5
U.S.	1	625	1.0	1.5
Poland	1	885	0.0	1
South Africa	1	922	0.0	1
South Korea	1	1051	0.0	1
Turkey	0.5	730	0.5	1
Canada	0	819	0.5	0.5
Thailand	0	764	0.5	0.5
U.A.E.	0	650	0.5	0.5
Russia	0	1576	0.0	0
Saudi Arabia	0	1282	0.0	0

Sources: IEA 2018c (energy consumption in buildings); IEA Energy Efficiency Indicators 2021 (for floor space data); IPEEC 2015; Lychuk et al. 2012 (Russia); Huo et al. 2019 (China); BPIE 2011 (Netherlands, Spain); Krarti 2019 (Egypt); Krarti, Aldubyan, and Williams 2020 (Saudi Arabia); AEEE 2018 (India); ACEEE estimates based on Solidiance 2013 (Thailand); UNECE 2004 (Thailand); EU Buildings Observatory 2021; ACEEE data requests; World Bank 2022e (GDP)

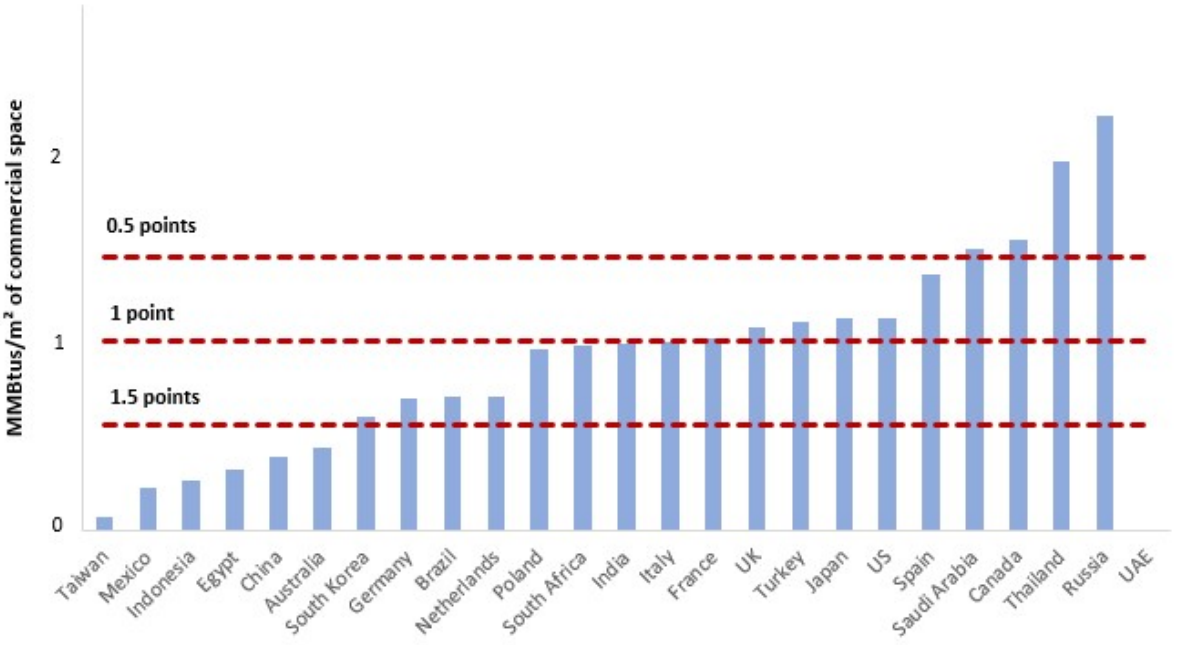

Figure 6. Final energy use intensity in commercial buildings (MMBtus/m²). Sources: based on IEA's Energy Efficiency Indicators 2021; see table 30 footnote for sources for countries not included in the IEA dataset. Countries with no data points are included at the very end of the horizontal axis in the figure without any data (e.g., U.A.E).

BUILDINGS BEST PRACTICES

The Netherlands. The Netherlands has comprehensive energy codes for both residential and commercial buildings that earn it full points in the building code metric. In January 2021, the country began requiring new construction buildings to meet "Almost Energy Neutral" criteria. These requirements are akin to zero-energy requirements in which buildings produce at least as much energy as the consume (Bodelier 2021). The country has adopted the EU's appliance standards, which cover 42 products and require appliance labels for 25 products. In 2018, the Netherlands introduced building performance requirements for office buildings that go into effect in 2023 (European Commission 2018). The country also requires that both residential and commercial buildings receive building performance certificates that rate their energy efficiency on an A–G scale (with "A" indicating a high-efficiency rating and "G" indicating a low-efficiency rating) (European Commission 2018). All these programs demonstrate that the Netherlands is committed to improving the performance of both its existing and new buildings.

United States. Like the Netherlands, the United States is a longtime leader in energy efficiency policies for buildings. While U.S. residential and commercial building codes are implemented at the state level, they are still some of the most aggressive in the world and include strict requirements for building envelope, heating and cooling, and lighting. U.S. building energy codes are expected to save 46 quadrillion British thermal units (48.5 exajoules) of energy cumulatively by 2040 (DOE 2014). The United States is also far and away the leader in appliance and equipment standards, with 52 standards on record.

Products covered by these standards represent all major residential and a majority of commercial building end uses in the country. The 40 standards introduced during the Obama administration alone will save 43.8 quads of energy by 2030, according to the U.S. Department of Energy's Appliance and Equipment Standards Program.

Saudi Arabia. In 2018, Saudi Arabia updated the Saudi Building Code (SBC 601 and 602), to increase the stringency of existing energy efficiency requirements and introduce additional requirements (SBCNC 2018b). The code updates specifically targeted design considerations that would impact cooling loads, including thermal transfer coefficients for the building shell, windows, and insulation. However, the extent to which Saudi Arabia enforces the code is unclear, and our current scoring methodology does not consider enforcement. Saudi Arabia's score also improved this year because we identified new data sources that allowed us to capture the country's buildings policies more accurately. For example, the country received points for appliance standards targeting a variety of product categories including air-conditioning equipment, lighting, refrigeration, and water heating. We also awarded Saudi Arabia points for its appliance labeling system, which was updated in 2018 (SEEC 2018). Lastly, we identified the needed data for calculating energy use intensity for residential and commercial buildings this year; as a result, Saudi Arabia earned an additional point for energy use intensity of residential buildings, which we were unable to calculate in previous editions.

Industry

The industrial sector accounts for more than half of the world's total final energy consumed—and more than any other end-use sector (EIA 2019).[11] In this *International Scorecard*, we captured energy efficiency policy and performance in industry using a total of 10 metrics. The maximum a country could score in this section was 25 points. We evaluated the energy intensity of industry and the presence of policies and practices to improve it, including voluntary agreements to increase industrial efficiency, national mandates for energy managers, energy audits in large facilities, and investment in industry-specific R&D.[12] We scored countries on the share of combined heat and power (CHP) in their overall electric power sector capacity and on policies implemented to encourage CHP. We also looked at

[11] The term *industrial sector* as used here follows the EIA definition and includes energy-intensive manufacturing, non-energy-intensive manufacturing, non-manufacturing industries, and agriculture.

[12] We use the term *voluntary agreement* here in keeping with IEA's established definition—that is, a contract between government and industry to make energy efficiency improvements or negotiated targets, with commitments and time schedules to that end.

policies to support the integration of energy efficiency into corporate management practices through energy management systems (EnMS)—including facilities certified by ISO 50001 (the global EnMS standard)—and accounted for the presence of MEPS for motors.[13] Finally, we evaluated countries' overall agricultural energy intensity.

Japan had the highest score (21 points), earning the top spot through its portfolio of regulatory measures, voluntary actions, and financial incentives to encourage greater energy efficiency, as well as the low energy intensity of its industry. The United Kingdom finished in second place with 20.5 points, followed by Germany in third place (19.5 points) and Italy in fourth (18.5 points). The top scoring countries typically had lower energy intensities, more robust voluntary agreements with manufacturing companies to improve energy efficiency, mandatory energy audits, and robust motor standards that met or exceeded international standards.

Policies to address energy efficiency in the industrial sector vary considerably among countries, and no country received a perfect score in this section. As with the 2018 *Scorecard*, the European countries did a consistently good job across all metrics, and they stand out for their voluntary agreements, motor standards, and mandatory energy audits for facilities. All countries have some room for improvement.

Table 31 shows each country's section total and scores on individual metrics. In addition to the *Scorecard* metrics, there are other industrial decarbonization efforts that are emerging as key trends across the globe. These efforts are likely to significantly contribute to mitigating emissions from the industrial sector in the long term; they include strategies and technologies such as carbon capture, utilization, and storage (CCUS); public procurement of low-carbon materials; industrial heat pumps; substitution of low-carbon fuels such as hydrogen; and electrification.

[13] Companies use EnMS to establish and integrate policies and procedures for systematically tracking, analyzing, and improving energy efficiency. ISO 50001 specifies requirements for establishing, implementing, maintaining, and improving an EnMS (DOE 2021a). The EnMS abbreviation is intended to avoid confusion with an energy management system (EMS), which may refer to computerized controls and supervisory control and data acquisition (SCADA) systems in the United States.

Table 31. Industry sector scores

Country	Total score	Energy intensity of industry	Voluntary agreements	Mandate for energy managers	Mandatory energy audits	EnMS policy	CHP installed capacity	CHP policy	Motor standards	R&D investment	Agricult. energy intensity
Max. score	25	6	4	2	2	3	1	1	2	2	2
Japan	21	6	4	2	2	1	0	1	2	1.5	1.5
U.K.	20.5	6	4	0	2	3	0.5	0.5	2	1.5	1
Germany	19.5	4	4	0	2	3	0.5	1	2	2	1
Italy	18.5	4	4	2	2	1	0.5	0.5	2	1	1.5
France	18	4	4	0	2	3	0	0.5	2	2	0.5
Spain	16	3	4	0	2	2	0.5	0	2	1	1.5
Taiwan	16	4	2	2	2	1	0.5	0.5	2	0.5	1.5
Indonesia	15	4	4	2	2	1	0	0	0	0	2
Netherlands	15	4	4	0	2	0	1	0.5	2	1.5	0
South Korea	15	2	4	0	2	1	0.5	0.5	2	2	1
Turkey	13.5	2	4	0	2	1	0.5	1	1	0.5	1.5
Mexico	13.5	4	4	0	2	1	0	0.5	1	0	1
Thailand	12.5	0	4	2	2	1	0.5	0	1	0.5	1.5
India	12.5	0	4	2	2	1	0.5	0.5	1	0	1.5
U.S.	12	3	2	0	0	1	0.5	1	2	2	0.5
Russia	10	0	4	0	2	1	1	0	0	0.5	1.5

Country	Total score	Energy intensity of industry	Voluntary agreements	Mandate for energy managers	Mandatory energy audits	EnMS policy	CHP installed capacity	CHP policy	Motor standards	R&D investment	Agricult. energy intensity
China	9.5	0	0	2	2	1	0.5	0.5	1	1	1.5
Brazil	9	0	4	0	0	1	0.5	0.5	2	0	1
Canada	9	1	4	0	0	1	0.5	0.5	1	1	0
Egypt	8	5	2	0	0	1	0	0	0	0	0
Poland	7.5	2	0	0	2	0	0.5	0.5	2	0.5	0
Australia	6	2	0	0	0	0	0	0	1	1	2
Saudi Arabia	5.5	2	0	0	0	0	0	0	1	0.5	2
U.A.E.	3	1	2	0	0	0	0	0	0	0	0
South Africa	1	0	0	0	0	0	0	0.5	0	0.5	0

New in This Section

We added a new measure to score the energy management systems (EnMS) policy metric, making the category worth up to 3 points total. Countries earned points based on their national policies to encourage EnMS and their total number of ISO-50001-certified manufacturing facilities as a fraction of their total facilities. We also increased the maximum number of points that countries could earn from voluntary agreements and incentives to 4 points due to our assessment of the importance of agreements and incentives in industrial decarbonization. To accommodate these score changes, we reduced the maximum scores possible in both the CHP installed capacity and CHP policy metrics to 1 point each.

ENERGY INTENSITY OF INDUSTRY (6 POINTS)

Countries vary widely in the mix and structure of their industrial sectors. Energy consumption also varies from one economy to another, depending on the size and type of the predominant industries. Processes used within a given industry can also differ across regions, which can significantly affect energy use. For this reason, benchmarking the energy intensities of industry subsectors is essential to understanding and optimizing energy use in each subsector. However, such information is not tracked consistently across all countries. The scope of this *Scorecard*—and this metric—is limited to activities within each country's borders. Although imports and exports have a profound impact on global emissions, we lack sufficient data at this time to fully account for them.

For our rankings, we measured the energy intensity of industry as a whole using energy consumed (measured in thousands of British thermal units, or kBtus) per dollar of industrial GDP.[14] First, we calculated raw energy intensities using overall industrial energy consumption and overall industrial GDP (IEA 2022a; World Bank 2022c). Then, to adjust for differences in the mix of industries, we used a weighting factor that assumes that the pattern of intensities among the countries' industry subsectors will be fairly similar. To calculate this weighting factor, we used country-specific data where possible; otherwise, we assumed that the energy mix of U.S. industries is applicable to that of other countries lacking necessary data (EIA 2017a, 2021a). Appendix A offers a complete description of these steps.

Devising a performance metric that allows a representative comparison of industrial energy intensity is inherently problematic. Although several methodological approaches can be used, each has distinct advantages and disadvantages. We chose to compare a weighted measure of energy intensity for each country based on the intensity of the individual

[14] Our primary data source for this metric is IEA, which groups industries into the following categories: iron and steel; chemical and petrochemical; nonferrous metals; nonmetallic minerals; transport equipment; machinery; mining and quarrying; food and tobacco; paper, pulp, and printing; wood and wood products; textiles and leather; construction; and nonspecified. These data do not include energy consumption in agriculture.

industry groupings that make up its industrial sector. Our method therefore attempts to account for structural differences across countries and, in our professional judgment, provides a more meaningful comparison than other options. However, this approach is more complicated and requires us to make many assumptions about industrial energy mix, potentially disadvantaging countries with limited data. Appendix A offers more details about data availability.

To facilitate a more meaningful evaluation—and better inform energy policy—comparisons must be made between similar industry subsectors across the world. We suggest that countries should report both energy consumption data and value added by each type of industry. Countries that report energy consumption data and value added by industry type provide greater understanding of industrial energy consumption. International harmonization on the definitions of industrial subsectors would also help to ensure fairer comparisons.[15][16]

Countries with the lowest weighted energy consumption per dollar of industrial GDP (specifically, less than 2 kBtus per dollar of industrial GDP) received 6 points. Table 32 shows the point allocation for industrial energy intensity. Table 33 lists the results by country.

Table 32. Point allocation for energy intensity of industry

kBtus per dollar of industrial GDP	Points
< 2	6
≤ 2.5	5
≤ 3.5	4
≤ 4.5	3
≤ 6.5	2
≤ 7.5	1
> 7.5	0

[15] Some cases raised concerns about the representative nature of country data related to final energy consumption by industry grouping. For example, 97% of final energy consumption in Saudi Arabia is reported as nonspecified, which distorts results. To address this problem, we moved half of Saudi Arabia's nonspecified energy consumption to the mining and quarrying category. Data for the United Arab Emirates were adjusted in the same manner. We made no adjustments to other countries, but this issue warrants further investigation.

[16] Enhanced collection of primary data and knowledge infrastructure is an important and often overlooked step for more effective policy design.

Table 33. Scores for energy intensity of the industrial sector[17]

Country	Relative intensity factor	kBtus/$	Joules/$	Score
U.K.	0.76	1.45	1,527	6
Japan	1.05	1.90	2,006	6
Egypt	0.28	2.00	2,110	5
Netherlands	0.81	2.53	2,672	4
Indonesia	0.59	2.55	2,687	4
Taiwan	0.75	2.61	2,750	4
Italy	1.16	2.74	2,895	4
Germany	1.20	2.82	2,975	4
France	1.14	2.93	3,088	4
Mexico	0.70	3.11	3,282	4
Spain	1.28	3.56	3,757	3
U.S.	1.28	4.04	4,266	3
Turkey	1.14	4.55	4,797	2
South Korea	0.92	4.62	4,872	2
Poland	1.49	5.09	5,370	2
Australia	2.02	6.23	6,576	2
Saudi Arabia	1.21	6.25	6,597	2
U.A.E.	1.02	6.82	7,190	1
Canada	1.82	7.01	7,396	1
India	0.68	7.61	8,033	0
Thailand	0.89	7.86	8,294	0
Brazil	1.28	8.19	8,639	0
China	1.15	8.56	9,033	0
South Africa	1.12	11.66	12,300	0
Russia	1.2	12.58	40,654	0

Sources: IEA 2022a; World Bank 2022c

[17] Industrial energy intensity is inherently limited by the structural difference in the industrial sector among the different countries. Please note the limitations of the methodology in Appendix A and use caution when interpreting results.

INTERNATIONAL INDUSTRIAL DECARBONIZATION COMMITMENTS

International commitments and targets are an important means of accelerating decarbonization. They act as both direction for policy measures and as market signals to promote products with lower carbon intensities. Although few international commitments have set specific targets for countries' industrial sectors, such commitments will likely become more prominent, especially as industrial emissions reductions lag behind improvements in other parts of the economy. To meet the emissions targets established in the 2015 Paris Climate Agreement, cement emissions must decrease by 85–91% and steel emissions by 93–100% globally by 2050 (Liebling et al. 2020). To accommodate this need for drastic transformation, climate action plans must include robust goals for industrial decarbonization.

The EU, for example, has established a New Industrial Strategy for Europe, which is essential to meeting the EU's goal of climate neutrality by 2050. Despite lacking specific reduction goals for the industrial sector, the strategy includes measures—such as a shift to a circular economy—that would reduce demands for new materials by expanding reuse, remanufacturing, and recycling; establish a zero-carbon steel-making process; and support energy efficiency improvements and transition mechanisms for industry (European Commission 2020). During the G7 Climate and Environmental Ministerial in 2021, U.S. Secretary of Energy Jennifer Granholm helped launch the new G7 Industrial Decarbonization Agenda. This agenda includes an initiative to reduce GHG emissions from heavy industry through market regulation, standards development, procurement strategies, and joint research (DOE 2021b). Other countries will need to adopt similar strategies and incorporate specific emissions targets for industry into their climate commitments to substantially move the needle on industrial decarbonization.

VOLUNTARY AGREEMENTS WITH MANUFACTURERS (4 POINTS)

We based the scoring for this metric on the presence of a national government program for entering into voluntary agreements with manufacturing sector businesses to improve energy efficiency.

We gave the highest score of 4 points if a program exists that establishes voluntary agreements between government and manufacturers for reducing consumption and offers incentives or other financial support for achievements and/or participation. We increased the total possible score for this metric compared to the previous *Scorecard* due to the growing importance of agreements and incentives as part of national industrial decarbonization policies. Countries with agreements that do not offer incentives received 2 points. Table 34 shows these data and scores by country.

MANDATE FOR ENERGY MANAGERS (2 POINTS)

We scored this metric according to whether a country had a national law or regulation requiring large industrial facilities to employ an onsite energy management expert. A dedicated onsite energy manager can improve process performance, identify waste, and maximize the efficient use of energy resources (Southern Tier CEC 2020). However, despite the economic benefits of reduced energy waste and the increased economic productivity of having such an onsite expert, few of the 25 countries required one.

Countries that mandated an onsite energy manager received 2 points. Table 34 shows the results.

MANDATORY ENERGY AUDITS (2 POINTS)

Periodic energy audits can help businesses identify opportunities to improve energy efficiency, benchmark improvements, and identify negative trends.

We awarded 2 points to a country if it had a national law or regulation requiring periodic energy audits of large industrial facilities. Table 34 also shows our findings on this metric.

Table 34. Scores for voluntary agreements with manufacturers, mandates for energy managers, and mandatory energy audits

Country	Voluntary agreements with manufacturers	Score	Mandate for energy managers	Score	Mandatory energy audits	Score	Total score
India	Agreements and incentives	4	Yes	2	Yes	2	8
Indonesia	Agreements and incentives	4	Yes	2	Yes	2	8
Italy	Agreements and incentives	4	Yes	2	Yes	2	8
Japan	Agreements and incentives	4	Yes	2	Yes	2	8
Thailand	Agreements and incentives	4	Yes	2	Yes	2	8
France	Agreements and incentives	4	No	0	Yes	2	6
Germany	Agreements and incentives	4	No	0	Yes	2	6

Country	Voluntary agreements with manufacturers	Score	Mandate for energy managers	Score	Mandatory energy audits	Score	Total score
Mexico	Agreements and incentives	4	No	0	Yes	2	6
Netherlands	Agreements and incentives	4	No	0	Yes	2	6
Russia	Agreements and incentives	4	No	0	Yes	2	6
South Korea	Agreements and incentives	4	No	0	Yes	2	6
Spain	Agreements and incentives	4	No	0	Yes	2	6
Taiwan	Agreements	2	Yes	2	Yes	2	6
Turkey	Agreements and incentives	4	No	0	Yes	2	6
U.K.	Agreements and incentives	4	No	0	Yes	2	6
China	No agreements	0	Yes	2	Yes	2	4
Brazil	Agreements and incentives	4	No	0	No	0	4
Canada	Agreements and incentives	4	No	0	No	0	4
Egypt	Agreements	2	No	0	No	0	2
Poland	No agreements	0	No	0	Yes	2	2
U.A.E.	Agreements	2	No	0	No	0	2
U.S.	Agreements	2	No	0	No	0	2
Australia	No agreements	0	No	0	No	0	0
Saudi Arabia	No agreements	0	No	0	No	0	0
South Africa	No agreements	0	No	0	No	0	0

Sources: IEA 2022b; ACEEE country research

POLICY TO ENCOURAGE ENERGY MANAGEMENT (3 POINTS)

One way that national governments can improve energy efficiency in industries is by encouraging the implementation of EnMS in industrial companies and at their facilities. An EnMS standard can provide guidance for industrial and commercial facilities to integrate energy efficiency into their management practices, such as by fine-tuning production processes and improving the energy efficiency of systems (McKane et al. 2009). Some policies may also require companies to account for relevant national or international standards. In 2011, the ISO adopted the ISO 50001 EnMS standard, which provides a common framework for industrial facilities, commercial facilities, or entire organizations (ISO 2011). Energy planning, management, implementation, training, and auditing are all vital to the standard. As of 2019, more than 42,215 sites worldwide had achieved ISO 50001 certification (ISO 2021), and the number of ISO 50001-certified facilities increased from 20,785 to 42,215 between 2017 and 2019 alone (ISO 2021). The growth of ISO 50001 is expected to accelerate even further as an increasing number of companies integrate this standard into their corporate sustainability strategies and supplier requirements, and are recognized internationally for their achievements through programs such as the Clean Energy Ministerial's Energy Management Leadership Awards.[18]

The previous edition of the *Scorecard* awarded 1 point to countries with a national policy to encourage EnMS that referenced ISO 50001, and it awarded an additional point for countries that had more than 500 ISO 50001-certified facilities. However, because the number of certified ISO 50001 facilities in a country depends on factors such as the status of industrialization, the country's size and industrial mix, and the presence of foreign industrial multinationals, this year we awarded points based on relative energy management participation. We did this by calculating the percentage of ISO 50001-certified facilities out of total manufacturing facilities in each country. We awarded 3 points to each country that had national policies to encourage EnMS *and* more than 0.66 in relative energy management participation—which we calculated on a weighted scale with Germany, the country with the highest number of ISO 50001-certified facilities. We assigned Germany a 1.00, and every other country received a score between 0 and 1.00 based on their percentage of participation relative to Germany. Countries with a national EnMS policy in place and 0.33–0.66 in our calculated energy management participation received 2 points, while those with an EnMS policy and 0.0–0.32 in relative energy management participation were awarded 1 point. Those countries without a national policy to encourage EnMS received no points.

Table 35 shows the scores for this metric.

[18] It is important to note that some countries have decided to adopt other certification standards that are not 50001 compliant. This metric cannot account for such differences, and therefore these data may not entirely reflect an accurate state of EnMS activity in those countries.

Table 35. Scores for policies to encourage EnMS

Country	Energy management policy	Number of ISO 50001-certified facilities (2019)	Relative energy management participation	Score
Germany	Yes	13,122	1.00	3
France	Yes	6,751	0.99	3
U.K.	Yes	3,203	0.69	3
Spain	Yes	3,219	0.55	2
China	Yes	2,943	0.25	1
Italy	Yes	2,823	0.22	1
Egypt	Yes	53	0.20	1
India	Yes	961	0.13	1
Indonesia	Yes	76	0.07	1
Taiwan	Yes	347	0.07	1
Russia	Yes	390	0.05	1
South Korea	Yes	107	0.04	1
Turkey	Yes	416	0.03	1
Brazil	Yes	96	0.02	1
Thailand	Yes	221	0.01	1
U.S.	Yes	145	0.01	1
Canada[19]	Yes	20	0.01	1
Mexico	Yes	56	0.01	1
Japan	Yes	27	0.01	1
Netherlands	No	211	0.09	0
U.A.E.	No	84	0.08	0

[19] To help implement ISO 50001 in commercial and industrial buildings, Natural Resources Canada provides financial assistance up to 60% of eligible costs for for-profit organizations and up to 75% of eligible costs for not-for-profit organizations up to a maximum of $40,000 per facility.

Country	Energy management policy	Number of ISO 50001-certified facilities (2019)	Relative energy management participation	Score
Poland	No	263	0.03	0
South Africa	No	15	0.01	0
Australia	No	31	0.01	0
Saudi Arabia	No	27	0.01	0

Sources: UNIDO 2021; ISO 2021; ACEEE country research

CHP INSTALLED CAPACITY (1 POINT)

CHP systems generate electricity and useful thermal energy in a single, integrated system. Using CHP systems is much more efficient than the separate generation of thermal energy and electricity because heat that is normally wasted in conventional power generation is recovered to meet thermal demands. Despite being cost intensive, CHP represents an opportunity for thermal integration to enhance the energy efficiency of industrial facilities. Current data do not allow for the differentiation between overall CHP and CHP in industrial thermal processes.

For this metric, we awarded a point according to the share of electrical CHP capacity in each country's overall electric power sector. Information on installed capacity is more readily available for a greater number of countries than other CHP data that may be more indicative of a country's CHP use. For example, evaluating the share of electricity that CHP systems actually produce may better measure a country's use of CHP as a key technology. Further, as a measure of industrial efficiency, it would be most useful to look at the share of industrial CHP in industrial electricity consumption. However, due to limited data availability, we focused instead on the overall installed capacity of CHP. Any indicator is highly subject to the technical potential for CHP in a given country. It is also important to note that while most CHP is installed in the industrial sector, some countries show greater use of CHP in commercial, institutional, and municipal applications.

This metric does not account for the increasing capacity of renewable or nuclear energy offsetting the share of CHP in installed capacity. This is one of the reasons we reduced the point allocation for this category. Future *Scorecard* editions may be able to use the share of CHP capacity compared to the share of fossil fuel capacity in each country.

We gave the highest score (1 point) to countries in which CHP makes up at least 35% of the installed power capacity. Countries with at least 5% of installed power capacity from CHP earned 0.5 points. Table 36 shows the results by country.

Table 36. Scores for share of CHP in installed capacity

Country	% of CHP in installed capacity	Score
Russia	57.79%	1
Netherlands	38.42%	1
Poland	21.04%	0.5
Germany	19.65%	0.5
Italy	13.70%	0.5
China	13.00%	0.5
Taiwan	11.35%	0.5
Brazil	10.59%	0.5
South Korea	9.82%	0.5
India	9.60%	0.5
Thailand	8.87%	0.5
U.K.	8.10%	0.5
U.S.	7.31%	0.5
Turkey	7.16%	0.5
Canada	6.80%	0.5
Spain	5.44%	0.5
Japan	4.90%	0
France	3.77%	0
Mexico	2.80%	0
Indonesia	> 2.0%	0
South Africa	0.53%	0
Australia	< 1.0%	0
Egypt	< 1.0%	0
Saudi Arabia	< 1.0%	0
U.A.E.	< 1.0%	0

Source: ACEEE country research

CHP POLICY (1 POINT)

Countries can encourage or discourage CHP deployment in many ways. This new policy metric recognizes countries for their adoption of policies and other regulations that promote CHP system deployment. First, we looked for the presence of a national goal or target for CHP. We then looked for other supportive policies, including tax credits, financial incentives, or regulatory support for CHP production. Countries could earn up to 1 point for policies to encourage CHP.

We awarded the full point to countries with both a national target for CHP deployment and supportive policies (such as incentives) in place. Countries with either a national target or incentives received 0.5 points. Policies in some countries may apply primarily to a segment of CHP systems, which may be determined by the type of fuel resources locally available or the optimal system size for certain industries. For example, CHP policies in India and Brazil are mostly limited to biomass-based applications and apply mainly to the sugar industries. Table 37 shows the criteria and scores for CHP policy.

Table 37. Scores for CHP policy

Country	CHP target	CHP incentives	Score
Germany	Yes	Yes	1
Japan	Yes	Yes	1
Turkey	Yes	Yes	1
U.S.	Yes	Yes	1
Brazil	No	Yes	0.5
Canada	No	Yes	0.5
China	Yes	No	0.5
France	No	Yes	0.5
India	No	Yes	0.5
Italy	No	Yes	0.5
Mexico	No	Yes	0.5
Netherlands	No	Yes	0.5
Poland	No	Yes	0.5
South Africa	Yes	No	0.5
South Korea	No	Yes	0.5
Taiwan	No	Yes	0.5
U.K.	No	Yes	0.5
Australia	No	No	0
Egypt	No	No	0

Country	CHP target	CHP incentives	Score
Indonesia	No	No	0
Russia	No	No	0
Saudi Arabia	No	No	0
Spain	No	No	0
Thailand	No	No	0
U.A.E.	No	No	0

Source: ACEEE country research

STANDARDS FOR MOTORS (2 POINTS)

Electric motors (and the systems they drive) consume more than 65% of the electricity that industry requires (Gomez et al. 2020). In industrial applications, three-phase electric motors are used to drive pumps, fans, compressors, and other processing equipment. Many countries have established mandatory motor efficiency standards for converting electricity to shaft power. We scored this metric according to whether or not a country had MEPS in place for three-phase electric motors.

International standards classify motors on a scale of energy efficiency from lowest efficiency (IE1) to highest efficiency (IE4). We scored this metric according to the efficiency classification of the MEPS in place for electric motors. Countries with a MEPS of IE3 or higher earned 2 points. Countries with a MEPS of IE2 or lower earned 1 point. Table 38 shows the details and scoring for this metric.

Table 38. MEPS for motors

Country	Mandatory MEPS for motors	Score
Brazil	Yes, > IE3	2
France	Yes, > IE3	2
Germany	Yes, > IE3	2
Italy	Yes, > IE3	2
Japan	Yes, > IE3	2
Netherlands	Yes, > IE3	2
Poland	Yes, > IE3	2
South Korea	Yes, > IE3	2
Spain	Yes, > IE3	2

Country	Mandatory MEPS for motors	Score
Taiwan	Yes, > IE3	2
U.K.	Yes, > IE3	2
U.S.	Yes, > IE3	2
Australia	Yes	1
Canada	Yes	1
China	Yes	1
India	Yes	1
Mexico	Yes	1
Saudi Arabia	Yes	1
Thailand	Yes	1
Turkey	Yes	1
Egypt	No	0
Indonesia	No	0
Russia	No	0
South Africa	No	0
U.A.E.	No	0

Sources: WEG Industries 2021; ACEEE country research

INVESTMENT IN R&D (2 POINTS)

Although industrial R&D spending is not exclusively focused on energy efficiency, energy efficiency is a major outcome of R&D investments, which reduce waste and improve productivity (Laitner et al. 2012). The spending we included in this metric therefore represents R&D activities carried out in the business enterprise sector regardless of their applications. We divided total R&D spending in the industrial sector by industrial GDP and report the results as a percentage of total industrial GDP.

We gave countries the full 2 points for investment in R&D equal to or greater than 8% of industrial GDP, and 1.5 points for investment of 5–7.9% of industrial GDP. Investment of 3–4.9% earned 1 point, and investment of 1–2.9% earned 0.5 point. Table 39 shows the results.

Table 39. Scores for investment in industrial R&D

Country	2018 investment in industrial R&D (% of industrial GDP)	Score
South Korea	15.84%	2
U.S.	12.69%	2
France	9.11%	2
Germany	8.73%	2
U.K.	7.67%	1.5
Japan	7.17%	1.5
Netherlands	5.59%	1.5
China	4.93%	1
Italy	4.62%	1
Australia	4.46%	1
Spain	3.49%	1
Canada	3.14%	1
Poland	2.35%	0.5
Taiwan	2.28%	0.5
Russia	1.42%	0.5
Thailand	1.23%	0.5
South Africa	1.20%	0.5
Saudi Arabia	1.07%	0.5
Turkey	1.06%	0.5
India	0.94%	0
U.A.E.	0.94%	0
Brazil	0.56%	0
Egypt	0.34%	0
Mexico	0.23%	0
Indonesia	0.16%	0

Sources: UNESCO 2022; World Bank 2022c; ACEEE country research

ENERGY INTENSITY OF AGRICULTURE (2 POINTS)

The agricultural sector's energy intensity across countries greatly depends on the processes involved and the climatic conditions. However, because agriculture is a key economic sector

for many countries and can also be very energy intensive, there is value in assessing it separately from the intensity of the other industrial sectors we cover—despite the sector's differences in crop mix, animal agriculture, and conditions across countries. Various crop production and animal agriculture practices require direct consumption of fuel and electricity, and the production of agricultural inputs, such as fertilizers and pesticides, requires indirect energy use. Sourcing and transporting water are additional factors affecting energy use and energy intensity in the agricultural sector.

In this sector, energy use can be particularly high in colder regions or in countries with heavily industrialized food production processes; countries in warmer regions or those that are still developing and rely on human and animal labor will obviously use less energy. We did not attempt to capture the impacts of highly industrialized agricultural systems.

We measured energy intensity in agriculture as the amount of energy consumed per dollar of agricultural GDP. Countries with an energy intensity of less than 0.05 kilograms of oil equivalent (koe) per dollar of agricultural GDP received the full 2 points for this metric. Table 40 outlines the scoring, and table 41 shows the results by country.

Table 40. Point allocation for energy intensity of agriculture

Energy intensity of agriculture (koe/$ of agricultural GDP)	Points
< 0.05	2
< 0.10	1.5
< 0.15	1
< 0.20	0.5
> 0.20	0

Table 41. Scores for energy intensity of agriculture

Country	Energy intensity of agriculture (koe/$ agricultural GDP)	Score
Saudi Arabia	0.0111	2
Indonesia	0.0121	2
Australia	0.0494	2
China	0.0538	1.5
Turkey	0.0545	1.5
Taiwan	0.0567	1.5
Italy	0.0707	1.5

Country	Energy intensity of agriculture (koe/$ agricultural GDP)	Score
India	0.0771	1.5
Spain	0.0800	1.5
Russia	0.0850	1.5
Japan	0.0858	1.5
Thailand	0.0873	1.5
Brazil	0.1006	1
Mexico	0.1084	1
South Korea	0.1139	1
U.K.	0.1151	1
Germany	0.1317	1
U.S.	0.1503	0.5
France	0.1721	0.5
South Africa	0.2036	0
Egypt	0.2299	0
Poland	0.2741	0
Canada	0.2826	0
Netherlands	0.3430	0
U.A.E.	No data available	0

Source: ACEEE country research

INDUSTRY BEST PRACTICES

Italy. Industrial energy efficiency measures can be capital intensive, which is a significant barrier in furthering industrial decarbonization. The incentive and research and development (R&D) policies of Italy and some other EU member states serve as prime examples of how government programs can mitigate such barriers. Italy's Nuova Sabatini subsidy seeks to increase the competitiveness and energy efficiency of Italian manufacturing by improving access to new, more-efficient, and less carbon-intensive machinery and industrial equipment for small and medium enterprises. The recently updated Stability Law also supports efficiency improvements in industry by offering tax credits for companies investing in industrial R&D, including experimental development and the production and testing of emerging technologies (Malinausakaite et al. 2019).

These policies have combined to help Italy reach one of the lowest weighted industrial energy intensity of all the countries we evaluated for the *Scorecard*.

Germany. Germany and several other EU countries have robust policies in place to ensure that energy audits and management are maximized to better pursue industrial energy efficiency. These policies serve as the bedrock of EU industrial efficiency policy. However, Germany has emerged as a leader in the space, even among other EU countries. Germany has an industrial electricity tax, set at EUR 20.5/MWh. Since 2012, large energy users in Germany have been eligible to apply for a 90% reduction of this tax liability if they can prove that they have implemented an energy management system certified to ISO 50001 or to the German national standard (DIN EN 160001). As of 2014, it was estimated that approximately 25,000 firms were eligible to receive tax exemptions, which (if claimed) would total EUR 2.3 billion (IEA 2018b). The program's success in furthering the penetration of energy management into the industrial sector is also demonstrated by the fact that more than 6% of German industrial facilities were ISO 50001 certified in 2020 (UNIDO 2021).

United Kingdom. The United Kingdom has plans to develop a net-zero carbon industrial cluster by 2040. Industrial clusters are hubs of localized, large energy-using manufacturing facilities that are important to both local and national economies. Backed by public investment through the Industrial Strategy Challenge Fund, the United Kingdom is planning to position its industrial clusters as areas for large-scale investment in energy efficiency and demand drivers for low-carbon products and technologies. The United Kingdom's six largest industrial clusters by emissions are responsible for more than 33 megatons of CO_2. Mitigating and minimizing those emissions through new energy efficiency measures, among other policies, will help the United Kingdom on its way to decarbonizing industry, and serve as a primary example for other countries that have the potential to employ an industrial cluster approach to reduce emissions.

South Korea. South Korea's Energy Use Rationalization Act requires enhanced efforts toward energy management and industrial energy efficiency. In support of this law, the Korean Energy Agency (KEA) introduced the Superior-EnMS (S-EnMS) Program, which was modeled on the U.S. Superior Energy Performance Program. As part of S-EnMS, energy-intensive companies voluntarily participate to work toward certification in parallel with ISO 50001 certification. The program also provides training to aid workforce transitions and technical assistance and exempts participants from Korea's mandatory energy audit obligations. The program has so far seen participants from more than 35 sites, representing approximately 4% of Korean industrial energy use. Of those 35 sites, 18 have

obtained S-EnMS certification, helping achieve total annual energy savings of more than 5.2 PJ, with an average energy performance improvement rate of 4.6% (IEA 2018b).

Transportation

Globally, the transportation sector accounts for approximately 24% of CO_2 emissions (IEA 2020b). The scoring methodology in this section includes a combination of policy and performance metrics relating to energy-efficient and low-carbon transportation. Countries could earn a total of 25 points across nine metrics that cover passenger and freight transport. We evaluated passenger transportation efficiency using average on-road passenger-vehicle fuel economy and annual vehicle miles traveled (VMT) per person across the 25 nations. We assessed passenger vehicle efficiency and electrification policies by comparing countries on their light-duty fuel economy standards and the percentage of new vehicle sales that are EVs. We used national spending on rail versus road facilities as an indicator of investment in low-carbon modes in each country, and we used the share of passenger kilometers by public transport to measure the role of public transport in a given nation's transportation sector. We assessed the energy intensity of freight transport using ton-miles moved per unit of GDP. We also scored countries on whether they have a smart freight program in place and whether they have fuel efficiency standards in place for heavy-duty vehicles.

The transportation section of our analysis is heavy on performance metrics; in keeping with our overall approach of presenting data in the simplest meaningful form, we largely avoided adjusting the data to reflect factors that may impact the transportation sector's energy use, such as the price of gasoline or structural changes in the economy. As in previous years, countries generally did not score as well in transportation as in other sectors. We partially attribute this to the fact that cities and provinces typically have more jurisdiction over sustainable transportation policies than national governments.

France leads in this section, earning the top score of 18 points out of a possible 25. The United Kingdom took second place with 17, while Italy and the Netherlands tied for third place with 16, and Spain came in fifth with 15 points. The average score for this section was approximately 9.5 points. More than half of the evaluated countries scored fewer than 10 points, including Canada, Turkey, Mexico, the United States, Brazil, Egypt, Indonesia, Russia, South Africa, Thailand, Australia, Saudi Arabia, and the United Arab Emirates. The United States scored lower in this sector this year than it had previously, mostly due to its March 2020 roll back in fuel economy standards for light-duty vehicles. The United Arab Emirates and Saudi Arabia tied for the lowest score (2 points), due in substantial part to a lack of available transportation data.

Our results show that there is still plenty of progress to be made globally in transportation. Many countries' transportation systems focus heavily on roads and personal vehicles rather

than on more energy-efficient and low-carbon mobility options such as public transit. Table 42 shows the total scores by country and for each metric in the transportation section.

Table 42. Transportation sector scores

Country	Total score	2025 LD fuel economy standard	Average light-duty (LD) on-road fuel economy	Electric vehicle (EV) sales share	VMT per capita	Heavy-duty (HD) fuel economy standard	Ton-mile per $ of GDP	Smart freight programs	Ratio of rail to road investments	% of passenger travel by transit
Max. score	25	4	3	3	3	3	2	1	3	3
France	18	4	3	2	1	1	1.5	1	3	1.5
U.K.	17	4	3	2	1	0	2	1	3	1
Italy	16	4	3	1	1	1	1.5	1	2	1.5
Netherlands	16	4	3	3	1.5	1	1.5	1	0	1
Spain	15	4	3	1	1.5	1	1	0	2	1.5
China	14.5	3	1	1	2.5	2	0	1	1	3
Germany	14	4	2	2	0.5	1	1	1	1	1.5
Poland	12	4	2	0	1.5	1	0.5	0	1	2
Japan	11.5	2	2	0	1.5	1	2	1	0	2
South Korea	10.5	3	2	1	0	0	1.5	1	0	2
Taiwan	10.5	2	2	0	2.5	0	1.5	0	1	1.5
India	10	2	3	0	3	0	0	0	0	2
Canada	9	3	0	1	0	3	0.5	1	0	0.5
Turkey	9	0	3	0	2	0	1	0	1	2
Mexico	8.5	1	1	0	1.5	0	1	1	2	1
U.S.	8.5	2	0	1	0	3	1	1	0	0.5
Brazil	6.5	1	1	0	2	0	0.5	0	0	2

Country	Total score	2025 LD fuel economy standard	Average light-duty (LD) on-road fuel economy	Electric vehicle (EV) sales share	VMT per capita	Heavy-duty (HD) fuel economy standard	Ton-mile per $ of GDP	Smart freight programs	Ratio of rail to road investments	% of passenger travel by transit
Egypt	6.5	0	0	0	2.5	0	0	0	2	2
Indonesia	6	0	0	0	3	0	0	0	0	3
Russia	5	0	0	0	2	0	0	0	1	2
South Africa	3.5	0	1	0	2.5	0	0	0	0	0
Thailand	3	0	1	0	2	0	0	0	0	0
Australia	2.5	0	0	0	0.5	0	0.5	0	1	0.5
Saudi Arabia	2	1	0	0	1	0	0	0	0	0
U.A.E.	2	0	1	0	1	0	0	0	0	0

New in This Section

We added a new metric on the share of new vehicle sales that are electric to reflect the growing market for EVs globally and as a means to gauge whether countries are creating a supportive policy environment for EV deployment. Countries can score up to 3 points for this metric. We also removed one of the energy intensity of freight metrics that was used in the 2018 *Scorecard* that measured intensity in terms of Btu per ton-mile of freight because data were consistently hard to find.

PASSENGER-VEHICLE FUEL ECONOMY STANDARDS AND FUEL ECONOMY FOR LIGHT-DUTY VEHICLES (4 POINTS/3 POINTS)

National fuel economy standards encourage the manufacture and eventual purchase of more-efficient vehicles. For the purposes of this metric, fuel economy standards could include requirements either for miles per gallon (or liters per kilometer) or per-mile CO_2 emissions, as CO_2 standards are met primarily through efficiency improvements. Standards often apply not to individual vehicle fuel economy but to the average fuel economy of a manufacturer's full fleet of vehicles. Several countries have standards in place; however, the real-world impacts of fuel economy standards can sometimes be difficult to estimate due to differences between test results and on-road fuel economy, as well as the frequent presence of credit programs that manufacturers can use to reduce their fleet-wide targets. Nevertheless, standards do indicate a country's commitment to improving light-duty fuel economy.

The second metric, passenger-vehicle fuel economy, is a performance metric that we scored using the average on-road fuel economy of all light-duty vehicles. The presence of fuel economy standards may affect this metric, but a country may also have scored well on it simply because it had a prevalence of low-consuming vehicles.

We used the ICCT's comparison of passenger-vehicle fuel economy standards to rate countries' efforts (ICCT 2021a). To fairly compare standards, the ICCT adjusts standards levels in each country to reflect the relationship between that country's test cycle to estimate fuel economy and the U.S. Corporate Average Fuel Economy (CAFE) test cycle. Countries with standards greater than 60 mpg by 2025 received the full score of 4 points, while countries with standards between 55 and 59 mpg by 2025 received 3 points. Countries with requirements between 47 and 54 mpg received 2 points. Requirements of at least 35 mpg by 2025 received 1 point.

Countries with average on-road light-duty fuel economy greater than 40 mpg received the full 3 points for this metric, while countries with an average between 35 and 39 mpg received 2 points and those averaging between 30 and 34 mpg received 1 point. The cut points to score on-road passenger vehicle fuel economy are lower than the those for the standards metric because real-world fuel economy is typically lower than test values, which capture only a limited range of driving behaviors and conditions. Table 43 shows results and scores for both metrics by country.

Table 43. Scores for fuel economy standards and fuel economy for light-duty vehicles

Country	2025 fuel economy standards (mpg)	Score
France	64.4	4
Germany	64.4	4
Italy	64.4	4
Netherlands	64.4	4
Poland	64.4	4
Spain	64.4	4
U.K.	64.4	4
China	57.9	3
South Korea	56.6	3
Canada	55.2	3
India	49.3	2
Japan	48.5	2
Taiwan	47.1	2
U.S.	47	2
Brazil*	43.9	1
Saudi Arabia	40.0	1
Mexico	39.3	1
Australia	N/A	0
Egypt	N/A	0
Indonesia	N/A	0
Russia	N/A	0
South Africa	N/A	0
Thailand	N/A	0
Turkey	N/A	0
U.A.E.	N/A	0

Country	Average fuel economy in 2017 (mpg)	Average fuel economy in 2017 (l/100 km)	Score
Italy	45.23	5.2	3
France	44.38	5.3	3
Netherlands	43.56	5.4	3
Spain	43.56	5.4	3
Turkey	43.56	5.4	3
India	42	5.6	3
U.K.	40.56	5.8	3
Germany	39.87	5.9	2
Poland	39.2	6	2
Japan	37.94	6.2	2
South Korea	37.34	6.3	2
Taiwan**	35.94	--	2
U.A.E.	34.59	6.8	1
South Africa	31.79	7.4	1
Thailand	31.36	7.5	1
Brazil	30.95	7.6	1
China	30.95	7.6	1
Mexico	30.95	7.6	1
Australia***	29.77	7.9	0
Indonesia	29.77	7.9	0
Egypt	29.4	8	0
Russia	28.69	8.2	0
U.S.	27.35	8.6	0
Canada	26.43	8.9	0
Saudi Arabia	No data available		0

***Brazil's fuel economy standard is voluntary, although there are numerous incentives for compliance in place. **Fuel economy data for Taiwan are from 2019. ***Fuel economy data for Australia are from 2020. Sources: ICCT 2021a; IEA 2019a; ACEEE data request (Taiwan); ACEEE data request (Australia).**

ELECTRIC VEHICLE SALES SHARE (3 POINTS)

EVs will play an important role in lowering the transportation sector's GHG footprint globally. EV markets are still largely in their infancy across the globe. Some countries, however, have seen greater EV adoption than others as a result of taking more steps to support EV deployment, including setting national targets, offering purchase incentives, and investing in EV charging infrastructure. One way to evaluate efforts to facilitate EV adoption is by assessing the EV share of new vehicle sales in each country.

Countries with an EV sales share of 20% or more earned 3 points, while those with a 10–19% share earned 2 points and those with a 2–9% share earned 1 point. We included battery electric vehicle and plug-in hybrid electric vehicle sales when collecting data for this metric. Table 44 shows the scores for this metric.

Table 44. Scores for EV deployment

Country	Total EV passenger vehicle registrations (2020)	EV sales share (%) (2020)	Score
Netherlands	291,447	25.0%	3
Germany	634,236	13.5%	2
France	416,585	11.3%	2
U.K.	435,293	11.3%	2
China	4,514,114	5.7%	1
Spain	88,031	5.0%	1
Italy	99,574	4.3%	1
Canada	209,171	4.2%	1
South Korea	146,591	2.9%	1
U.S.	1,787,221	2.0%	1
Thailand	--	1.04%	0
Taiwan	11,876	1.0%	0
Australia	26,651	0.95%	0
Poland	18,877	0.82%	0
Japan	297,181	0.64%	0
Mexico	7,248	0.26%	0
Brazil	4,944	0.12%	0
India	12,789	0.06%	0
South Africa	1,399	0.06%	0

Country	Total EV passenger vehicle registrations (2020)	EV sales share (%) (2020)	Score
Egypt	No data available		0
Indonesia	No data available		0
Russia	No data available		0
Saudi Arabia	No data available		0
Turkey	No data available		0
U.A.E.	No data available		0

Source: IEA 2021d

VEHICLE MILES TRAVELED PER CAPITA (3 POINTS)

If growth in VMT goes unchecked, improved vehicle fuel economy will not adequately address the transportation sector's energy use over the long term. A VMT-per-capita metric measures the extent to which a country's demand for mobility is met by private vehicles. For this metric, we used the total miles traveled in a year by passenger vehicles in a country, divided by its population in that year. The rankings show how countries compare in passenger vehicle use per capita. Many factors affect VMT in a nation, suggesting a variety of possible normalizations. We used VMT per capita in keeping with our overall approach of presenting data in the simplest meaningful form across the 25 nations.

Countries with an average VMT per capita of no more than 500 received 3 points; 501–1,000 received 2.5 points; 1,001–2,000 received 2 points; 2,001–3,500 received 1.5 points; 3,501–5,000 received 1 point; and 5,001–6,000 received 0.5 point. Table 45 summarizes VMT per capita and all country scores. We present the data in both VMT and VKT (vehicle kilometers traveled). This metric tends to favor developing countries with low personal-vehicle ownership, and it also benefits smaller, more compact countries.

Table 45. Scores for VMT and VKT per person

Country	VMT per capita (2019)	VKT per capita (2019)	Score
India	145	234	3
Indonesia	465	748	3
Egypt	657	1,058	2.5
South Africa	817	1,316	2.5
China	877	1,412	2.5
Taiwan*	900	1,448	2.5

Country	VMT per capita (2019)	VKT per capita (2019)	Score
Turkey	1,057	1,701	2
Brazil	1,199	1,929	2
Russia	1,625	2,616	2
Thailand	1,975	3,179	2
Mexico	2,087	3,358	1.5
Netherlands	2,249	3,619	1.5
Japan	2,387	3,841	1.5
Poland	3,334	5,365	1.5
Spain	3,374	5,430	1.5
France	3,566	5,738	1
U.K.	3,791	6,101	1
Italy	4,116	6,624	1
Saudi Arabia	4,731	7,613	1
U.A.E.	4,978	8,011	1
Australia	5,127	8,251	0.5
Germany	5,781	9,304	0.5
South Korea	6,475	10,421	0
Canada	6,699	10,781	0
U.S.	8,182	13,167	0

***Taiwan's data are from 2020. Sources: ICCT 2021b; Statistics Poland; ACEEE data request (Taiwan).**

FUEL EFFICIENCY STANDARDS FOR HEAVY-DUTY VEHICLES (3 POINTS)

Fuel efficiency standards for heavy-duty vehicles are a relatively new policy development, but they mark an important step toward capturing greater savings in the transportation sector. For purposes of this metric, fuel efficiency standards include standards for either fuel consumption (e.g., gallons per ton-mile) or GHG emissions (e.g., grams CO_2 per ton-mile). The EU and five other countries have fuel efficiency standards in place for heavy-duty vehicles.

Truck types, duty cycles, and test methods vary greatly across countries. To create a relatively straightforward and meaningful comparison of standards, we considered: 1) standards for tractor-trailers only, and 2) the percentage improvement required by model year 2025

relative to the standard's baseline year, which is country specific. Countries received the full 3 points for a reduction of at least 33% by 2025, 2 points for a reduction of 20–32.9%, 1 point for a reduction 1–19.9%, and no points if they did not have a standard in place. Table 46 shows the savings from the standards and scores for each country.

Table 46. Scores for fuel efficiency standards for tractor trucks

Country	% reduction in fuel consumption or CO_2 emissions for tractor trucks	Score
Canada	35%	3
U.S.	35%	3
China	28%	2
France	15%	1
Germany	15%	1
Italy	15%	1
Netherlands	15%	1
Poland	15%	1
Spain	15%	1
Japan	13%	1
Australia	None	0
Brazil	None	0
Egypt	None	0
India	None	0
Indonesia	None	0
Mexico	None	0
Russia	None	0
Saudi Arabia	None	0
South Africa	None	0
South Korea	None	0
Taiwan	None	0
Thailand	None	0
Turkey	None	0
U.A.E.	None	0
U.K.	None	0

Source: ACEEE estimates of percentage energy savings based on heavy-duty fuel economy regulation in each country

ENERGY INTENSITY OF FREIGHT TRANSPORT (2 POINTS)

Freight movement accounts for a significant portion of energy use in the transportation sector and is one of the fastest-growing uses of energy globally. To best estimate the energy intensity of the freight sector in these countries, we considered the ton-miles of goods moved per dollar of GDP.

As with the other performance-based metrics in this section, this metric also reflects differences in economic factors among the included countries, as well as demographic and geographic factors such as population density.

We purchased data for freight ton-kilometers from IEA's Energy Efficiency Indicators database and cannot share the specific data for each country in a table (IEA 2021a). Instead, figure 7 shows the results for freight ton-mile per dollar of GDP, with horizontal red lines delineating the thresholds we used to allocate points for this metric. Table 47 shows the scores. Egypt, Indonesia, Saudi Arabia, South Africa, Thailand, and the United Arab Emirates did not have data available and thus received no points.

Table 47. Scores for freight transport per unit of economic activity

Country	Score
U.K.	2
Japan	2
France	1.5
Taiwan*	1.5
Italy	1.5
Netherlands	1.5
South Korea	1.5
Germany	1
Spain	1
Turkey	1
U.S.	1
Mexico	1
Canada	0.5
Australia	0.5
Brazil	0.5
Poland	0.5
India	0

Country	Score
China	0
Russia	0
Egypt	0
Indonesia	0
Saudi Arabia	0
South Africa	0
Thailand	0
U.A.E.	0

For freight intensity by GDP, *Taiwan's data are from 2020 . Sources: IEA's Energy Efficiency Indicators 2021; OECD 2021a; ACEEE data request (Taiwan).

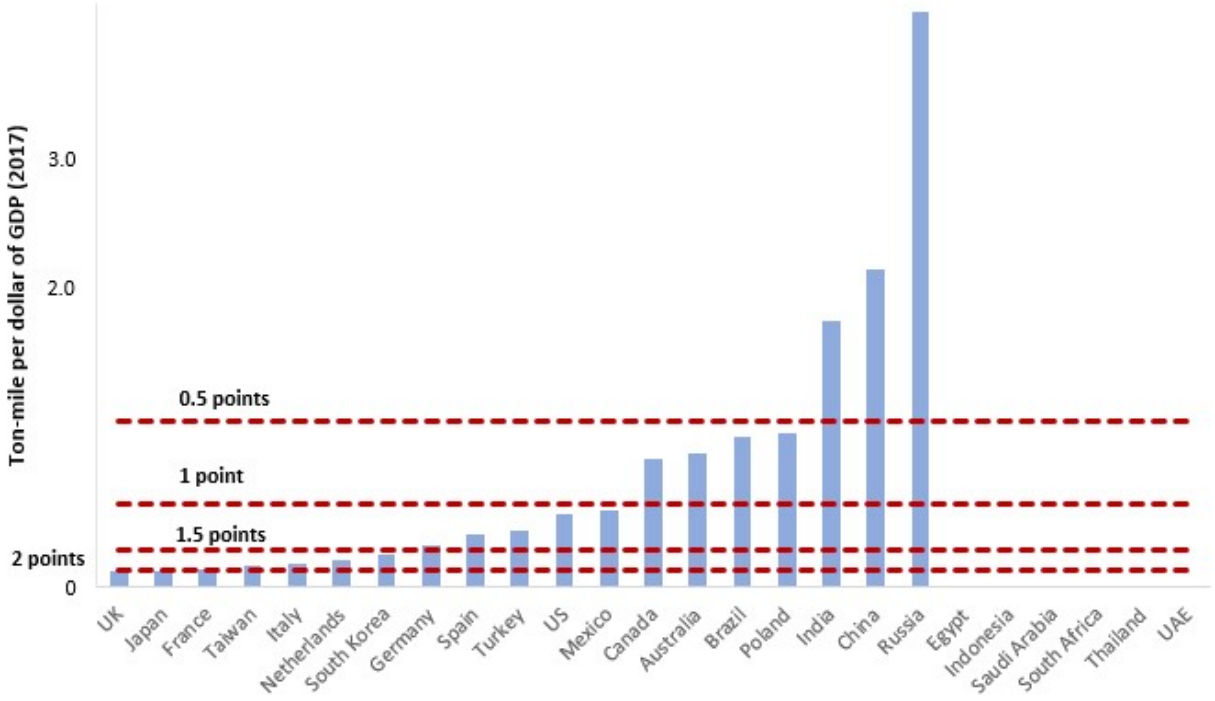

Figure 7. Freight transport per unit of economic activity (ton-mile per dollar of GDP in 2017). Source: IEA's Energy Efficiency Indicators 2021; see table 47 footnote for sources for countries not included in the IEA dataset. Countries with no data points are included at the very end of the horizontal axis in the figure without any data (e.g., Egypt, Indonesia, Saudi Arabia, South Africa, Thailand, and the U.A.E).

SMART FREIGHT INITIATIVES (1 POINT)

National smart freight programs provide domestic and multinational corporations with a framework for streamlining freight operations and reducing their energy consumption and overall freight-sector energy use. These programs can encourage corporations to improve

the fuel efficiency of their freight vehicles, streamline logistics to minimize the trips required, and use more-efficient modes of transporting freight.

We used the Smart Freight Centre's accounting of global smart freight programs to score each of the 25 countries (Smart Freight Centre 2021). Countries that have either a voluntary or mandatory national smart freight program earned 1 point this year. Table 48 shows the results.

Table 48. Scores for national smart freight initiatives

Country	National smart freight program	Program name	Score
Canada	Yes	Canada Smart Way	1
China	Yes	China Green Freight Initiative	1
France	Yes	Objectif CO_2	1
Germany	Yes	Lean and Green Germany	1
Italy	Yes	Lean and Green Italy	1
Japan	Yes	Green Logistics Partnership	1
Mexico	Yes	Transporte Limpio	1
Netherlands	Yes	Lean and Green Netherlands	1
South Korea	Yes	Green and Smart Transportation Partnership	1
U.K.	Yes	Logistics Carbon Reduction Scheme	1
U.S.	Yes	EPA Smart Way	1
Australia	No		0
Brazil	No		0
Egypt	No		0
India	No		0
Indonesia	No		0
Poland	No		0
Russia	No		0
Saudi Arabia	No		0
South Africa	No		0
Spain	No		0
Taiwan	No		0
Thailand	No		0
Turkey	No		0

Country	National smart freight program	Program name	Score
U.A.E.	No		0

Source: Smart Freight Centre 2021

INVESTMENT IN RAIL TRANSIT VERSUS ROADS (3 POINTS)

A nation's investment in public transit is a key indicator of its commitment to low-carbon modes of transportation. We measured each country's investment in public transit as the ratio of national investment in passenger rail versus roads. Using investment in all transit modes would have made for a superior metric, but these data were not readily available. We recognize that in many countries, transit may be funded primarily at the local level; however, actions at the municipal level are beyond the scope of this *Scorecard*. Additionally, this metric does not account for other factors and actions that must occur in tandem with financial investment in order to make expenditure on public transit an effective means of managing energy use in transportation.

Countries with a ratio of at least 1 on rail versus road spending received the full 3 points, those with a ratio of at least 0.5 received 2 points, and those with a ratio of at least 0.15 received 1 point. Table 49 shows the results and scores by country.

Table 49. Scores for investment in rail transit versus roads

Country	2017 investment in rail transit (ratio of $ in rail vs. roads)	Score
U.K.	1.45	3
France	1.03	3
Italy	0.97	2
Mexico	0.76	2
Egypt*	0.73	2
Spain	0.60	2
Russia	0.44	1
Germany	0.40	1
Australia	0.28	1
Turkey	0.28	1
China	0.20	1
Poland	0.16	1
Taiwan**	0.16	1

Country	2017 investment in rail transit (ratio of $ in rail vs. roads)	Score
U.S.	0.14	0
Canada	0.12	0
Brazil	0.00	0
India	0.00	0
Indonesia	0.00	0
Japan	0.00	0
Netherlands	0.00	0
Saudi Arabia	0.00	0
South Africa	0.00	0
South Korea	0.00	0
Thailand	0.00	0
U.A.E.	0.00	0

***Egypt's data are from 2020. **Taiwan's data are from 2020. Source: OECD 2021b.**

USE OF PUBLIC TRANSIT (3 POINTS)

Public transit use is an important factor in the efficiency of a country's overall transportation system. We measured public transit use in the 25 countries by dividing the distance passengers traveled via rail and bus by the total distance passengers traveled across all motorized modes of domestic, land-based inland travel (excluding motorcycles). As with VMT per capita, this metric does not capture various factors that indirectly affect the use of public transport in a country. Nevertheless, because public transit is typically more energy efficient than private vehicles, the percentage of passenger travel made on buses and trains remains a significant indicator of efficiency.

We purchased data for passenger kilometers from IEA's Energy Efficiency Indicators database and cannot share the specific data for each country in a table (IEA 2021a). Instead, figure 8 shows the use of public transit, with horizontal red lines delineating the thresholds we used to allocate points for this metric. Table 50 shows the scores. Saudi Arabia, South Africa, Thailand, and the United Arab Emirates did not have data available and thus received no points.

Table 50. Scores for use of public transit

Country	Score
China*	3
Indonesia	3
South Korea	2
Brazil	2
Japan	2
Russia	2
Turkey	2
Poland	2
India**	2
Egypt***	2
France	1.5
Taiwan****	1.5
Italy	1.5
Spain	1.5
Germany	1.5
Netherlands	1
U.K.	1
Mexico	1
Australia	0.5
Canada	0.5
U.S.	0.5
Thailand	0
South Africa	0
Saudi Arabia	0
U.A.E.	0

Current data for this metric were obtained from a variety of sources. *For China, total inland passenger data are from 2018 via ACEEE data request, and total bus/coach travel data are derived from ACEEE projections. **India's total bus/coach travel data are from 2015. ***Egypt's total inland passenger and total bus/coach travel data are from 2012. ****Taiwan's data are from 2019. The Netherlands' data are derived from ACEEE projections. Mexico's data are from 2019. Sources: IEA's Energy Efficiency Indicators 2021; OECD 2021c; ACEEE data request (China, Egypt, Mexico, Taiwan).

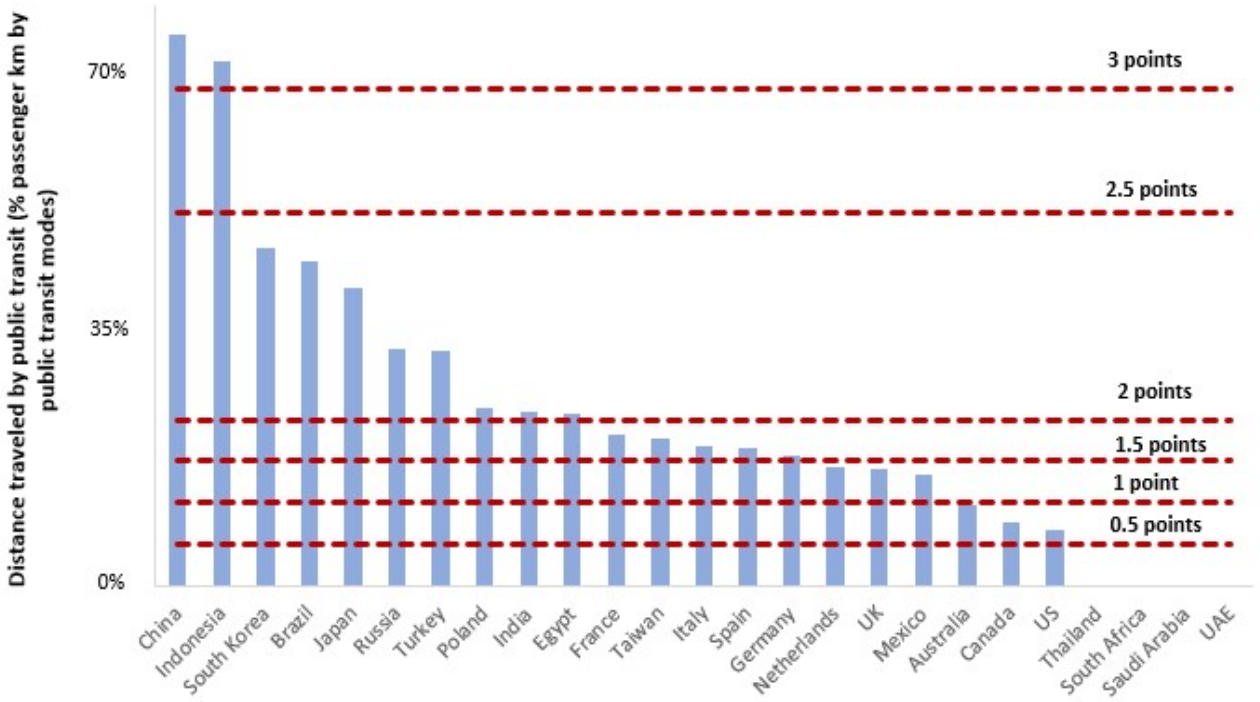

Figure 8. Use of public transit in 2017 (% passenger km by public transit modes). Source: IEA's Energy Efficiency Indicators 2021; see table 50's footnote for sources for countries not included in the IEA dataset. Countries with no data points are included at the very end of the horizontal axis in the figure without any data (e.g., Saudi Arabia, South Africa, Thailand, and the U.A.E).

TRANSPORTATION BEST PRACTICES

France. France took first place this year in the transportation section with a score of 18 points. The country's National Low-Carbon Strategy for Climate has spurred much of its progress on transportation energy efficiency, outlining a path toward a 29% reduction in transportation-sector GHGs by 2028 from 2013 levels. To achieve this aggressive goal, France has come up with a comprehensive approach that includes increasing the overall efficiency of vehicles by adhering to the EU passenger vehicle standards, as well as by encouraging the purchase of more-efficient vehicles through a bonus/malus program, curbing the demand for mobility services (e.g., by improving land use planning), promoting more-efficient transportation alternatives, and encouraging mode shift for freight travel.

As a result, France has made its way to the top of the 2022 transportation rankings. In 2017, France was among the top five countries for on-road fuel economy, with an average mpg of 44.8 (5.3 liters/100 km). Like Italy, France participates in the EU's ambitious emissions reduction target for new vehicles, which has helped increase on-road fuel efficiency. On the transportation system efficiency side, France spends approximately 3%

more on rail development and maintenance than it does on roads, indicating an effort to ensure that rail is a reliable option for both passengers and freight movement.

The Netherlands. With a score of 16 points, the Netherlands placed fourth in the transportation rankings. The country participates in the EU's mandatory emissions-reduction targets for new cars, which required that cars registered in the EU meet a standard of 95 grams of CO_2 per kilometer by 2021. As a result, the fleet mpg average of passenger vehicles on the road in 2017 was among the highest at 43.56 mpg (5.4 liters/100 km). The Netherlands also leads the pack when it comes to the proportion of new vehicle sales that are EVs: a whopping 25% of new vehicles sold are electric, which is 12 percentage points higher than Germany, which takes second spot for this metric. As a comparison, battery-operated vehicles account for just 2% of total market share in the United States.

Conclusion

The 2022 International Energy Efficiency Scorecard compares energy use, energy efficiency, and climate policies among 25 of the world's top energy-consuming countries. The rankings are dominated by European nations such as France, the United Kingdom, Germany, the Netherlands, and Italy. As we mentioned in our "Methodology section," we awarded full points to the top-performing country on each metric.

Table 51 summarizes the top policy and performance outcomes for each metric.

Table 51. Highest-scoring policies and performances for each metric

Metric	Results	Countries
National efforts		
Change in energy intensity	–22.7% between 2013 and 2018	China
Spending on energy efficiency	$97.6 per capita	Canada
Spending on energy efficiency RD&D	$6.76 per capita	Canada
Energy savings and climate goals	Commitments to energy savings greater than 1% per year and GHG goals	France, Germany, Italy, Japan, United Arab Emirates
Tax credits and loan programs	Federal tax credits and loan programs, both covering multiple sectors	Canada, Egypt, France, Germany, Italy, Japan, Netherlands, Russia, South Korea, Spain, Taiwan, United States

Metric	Results	Countries
Efficiency of thermal power plants	Operational efficiency greater than 44% and T&D losses less than 5%	Japan, Taiwan
Size of the ESCOs market	0.14% of total GDP	China
Water efficiency policy	A national water law with conservation principles, plus implementation of water efficiency programs	Australia, China, Taiwan
Data availability	At least 90% data available for all metrics	Australia, Canada, France, Germany, Italy, Japan, Mexico, Poland, Taiwan, United Kingdom, United States
	Buildings	
Residential building codes	Mandatory building codes covering all six technical-requirement categories	France, United Kingdom
Commercial building codes	Mandatory building codes covering all six technical-requirement categories	France, Germany, Netherlands, Spain, United Kingdom
Appliance and equipment standards	42 mandatory appliance and equipment standards and four key appliance groups with standards	United States
Appliance and equipment labeling	Mandatory categorical program covering 21 or more product categories	China, France, Germany, Italy, Netherlands, Poland, South Korea, Spain, United Kingdom
Building retrofit policies	Mandatory national codes for residential/commercial renovations and federal incentives to encourage retrofits	France, Netherlands, United Kingdom
Building rating and disclosure	Mandatory building energy rating and disclosure policy covering all buildings	France, Germany, Netherlands, Poland, Spain, Turkey, United Kingdom
Energy intensity in residential buildings	4.61 MMBtus per capita Lowest MMBtus/m^2 of residential space	Indonesia Taiwan
Energy intensity in commercial buildings	203 MMBtus per dollar of service-sector GDP Lowest MMBtus/m^2 of commercial space	Mexico Taiwan

Metric	Results	Countries
Industry		
Energy intensity of the industrial sector	1.45 kBtus/$ GDP	United Kingdom
Voluntary energy performance agreements with manufacturers	Government agreements with manufacturers and incentives for a variety of business types	Brazil, Canada, France, Germany, India, Indonesia, Italy, Japan, Netherlands, Mexico, Russia, South Korea, Spain, Thailand, Turkey, United Kingdom
Mandate for plant energy managers	Requirement for a dedicated onsite energy expert	China, India, Indonesia, Italy, Japan, Taiwan, Thailand
Mandatory energy audits	Requirement for periodic energy audits of facilities	China, France, Germany, India, Indonesia, Italy, Japan, Mexico, Netherlands, Poland, Russia, South Korea, Spain, Taiwan, Thailand, Turkey, United Kingdom
Policy to encourage energy management	Energy management policy that references ISO 50001 with a relative energy management participation greater than 0.66	France, Germany, United Kingdom
Share of CHP in total installed capacity	57.8%	Russia
Policy to encourage CHP	Targets for CHP share of energy production and incentives to encourage CHP deployment	Germany, Japan, Turkey, United States
Minimum efficiency standards for electric motors	Mandatory IE3 MEPS	Brazil, France, Germany, Italy, Japan, Netherlands, Poland, South Korea, Spain, Taiwan, Turkey, United Kingdom, United States
Investment in manufacturing R&D	15.84% of total industrial GDP	South Korea
Agriculture energy intensity	0.011 koe per $ of agricultural GDP	Saudi Arabia
Transportation		
Fuel economy standards for light-duty vehicles	64.4 mpg by 2025	France, Germany, Italy, Netherlands, Poland, Spain, United Kingdom
Fuel economy of light-duty vehicles	45.23 mpg	Italy

Metric	Results	Countries
Electric vehicle sales share	25%	Netherlands
Vehicle miles traveled per capita	145 vehicle miles traveled per capita	India
Fuel economy standards for heavy-duty tractor trucks	35% improvement in fuel consumption/CO_2 emissions of tractor trucks	Canada, United States
Freight transport per unit of economic activity	Lowest ton-miles per $ of GDP	United Kingdom
Smart freight initiatives	National smart freight program	Canada, China, France, Germany, Italy, Japan, Mexico, Netherlands, South Korea, United Kingdom, United States
Investment in rail transit versus roads	$1.45 spent on rail transit per $1 spent on roads	United Kingdom
Use of public transit	Highest percentage of total passenger kilometers traveled by public transit	China

Although (as in 2018) no country achieved a perfect overall score in this year's *Scorecard*, 12 countries scored above 50 points. The average 2022 score was 48.5 points, compared with 50.5 points in 2018. The highest individual score this year was 74.5 points, compared with 75.5 in 2018, indicating that the leading countries have not achieved as much progress as expected in their efforts over the past few years.

Methodological changes may have contributed to the slight downward trend in scores. Additionally, in past years, certain metrics relied on publicly accessible datasets that were not available to us this year. In many cases, we used a combination of limited data requests and information from the 2018 *Scorecard* to fill in the blanks. Thus, the scores may not have captured the most recent trends in energy efficiency policies across all the sectors. Also, It is important to note that data for the next iteration of the *Scorecard* will inevitably be impacted by the effects of COVID-19, possibly pushing the average scores down further.

The fact that the average score declined slightly between 2018 and 2022 indicates that there remains significant—and in some cases dramatic—room for improvement in every country analyzed in this edition; this is particularly true in the transportation section. The average score for countries on the transportation metrics was 9.5, and the highest-scoring country earned a total of 18 out of 25 possible points. Of note this year was India's fall to the 12th spot from second place in the transportation category. India lost valuable points in several metrics due to low shares in EVs and declining investment in rail. Countries must address energy use in this sector to meet aggressive reduction targets in line with their voluntary commitments to the Paris Agreement. Future editions of the *Scorecard* will place greater

importance on tracking progress toward climate goals, which will require more investment in sector-specific energy efficiency.

This year, the United States held the same rank (10th) as in 2018. It ranked below both China and Taiwan this year, with a score of 54 points compared with 55.5 in 2018. While some of this minute difference in scores can be attributed to our changes in scoring methodology, the United States mainly lost points in a few transportation section metrics. In particular, scores declined due to the Trump administration's rollback of light-duty fuel economy standards, along with low public transit ridership and relatively little investment in rail.

The countries with the most room for improvement include Russia, Saudi Arabia, South Africa, and the United Arab Emirates. While many of this year's low-scoring countries have either emerging economies, with increasing demand for energy services, or highly energy-intensive economies, they still have plenty of opportunity to build energy efficiency into their continued economic growth. It is also important to note that scores for the United Arab Emirates and Saudi Arabia have increased this year, signifying either progress on energy efficiency in certain sectors or increased data availability.

Nations can learn from one another by emulating best policies, practices, and performance. More-developed countries have a responsibility to lead by example and implement ambitious policies that will further reduce energy consumption and GHG emissions. Less-developed nations have the opportunity to grow sustainably by implementing policies and targets that prioritize energy efficiency and climate goals.

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Appendix A. Energy Intensity

Evaluating the energy intensity of a given economic sector in any country is not straightforward. Numerous factors besides energy efficiency impact energy intensity; these factors include climate, economic composition, and population. As a result, it is difficult to isolate the impact of energy efficiency measures on energy use. For *The 2022 International Energy Efficiency Scorecard*, we used the following methodologies for our buildings-sector and industry-sector intensity metrics. These approaches allowed us to fairly compare intensity across the 25 countries we evaluated by accounting for large differences in climate and economy.

RESIDENTIAL BUILDINGS

We adjusted the share of residential-building energy intensity used for heating and cooling for variations in climate. To achieve this, we first collected data on the percentage of overall residential energy use that heating and cooling account for in each country. We then calculated the building energy intensity of space heating and cooling separately, based on the share of overall energy use that heating and cooling loads account for in each country.

$$Energy\ intensity\ of\ space\ heating\ (E^{\mathrm{H}}) = Energy\ intensity\ (E^{0}) * Share\ of\ space\ heating\ in\ residential\ energy\ use$$

$$Energy\ intensity\ of\ space\ cooling\ (E^{\mathrm{c}}) = Energy\ intensity\ (E^{0}) * Share\ of\ space\ cooling\ in\ residential\ energy\ use$$

E^{0} is the original energy intensity we calculated using total residential energy use in a country (separately by floor area and by population). $E^{\mathrm{H}}$and E^{c} are real values that reflect the countries' heating and cooling energy intensities.

Next, we calculated the ratio of each country's heating degree days (HDDs) and cooling degree days (CDDs) to the average number of HDDs and CDDs of all the countries analyzed.[20]

$$HDD\ ratio = HDD\ of\ country / Average\ HDD\ of\ all\ countries$$

$$CDD\ ratio = CDD\ of\ country / Average\ CDD\ of\ all\ countries$$

[20] Heating degree days and cooling degree days are measurements designed to reflect the demand for energy needed to heat or cool a home or business to a human comfort level of 18 °C (65 °F). We obtained heating and cooling degree day data from the World Resources Institute's Climate Analysis Indicators Tool (CAIT) and from the European Environment Agency.

We used these ratios to normalize the energy intensities of space heating and space cooling. We divided the intensities for space heating and cooling ($E^{H}$and E^{C}) by the HDD and CDD ratios, respectively, to derive energy intensities for space conditioning as if all countries had the same climate.

$$Climate\ adjusted\ energy\ intensity\ of\ space\ heating\ (E^{HC}) = \frac{E^{H}}{HDD\ ratio}$$

$$Climate\ adjusted\ energy\ intensity\ of\ space\ cooling\ (E^{CC}) = \frac{E^{C}}{CDD\ ratio}$$

Finally, we added the climate adjusted space heating and cooling intensities to the unweighted portion of the original intensity.

$$Final\ relative\ energy\ intensity\ (E^{F}) = (E^{0} - E^{H} - E^{C}) + E^{HC} + E^{CC}$$

We used the same methodology for both residential intensity metrics—that is, energy use per floor area, and energy use per capita. The adjustment serves only to allow a fairer comparison among countries with different heating and cooling needs; the relative intensities as calculated should not be interpreted as actual building energy intensity values. For future *Scorecard* editions, we will consider updating our methodology to correct for year-to-year fluctuations in weather. Some countries' HDDs and CDDs vary considerably from year to year, and our current methodology does not account for this variance.

INDUSTRY

We used energy intensity to compare industrial-sector efficiency across countries.[21] To begin, we calculated the raw energy intensity of industry using total energy consumed by industry and total industrial GDP (IEA 2019b; World Bank 2022c) for each country. These data are readily available for all countries.

$$Raw\ energy\ intensity\ of\ a\ country's\ industry\ (I^{c0}) = \frac{Energy\ consumed\ by\ industry\ as\ a\ whole}{GDP\ of\ industry}$$

It would be more accurate to evaluate industry energy intensity as the energy consumed per dollar of value added instead of per GDP. *Value added* is the difference between an industry's gross output (sales or receipts and other operating income, commodity taxes, and inventory change) and the cost of its intermediate inputs (including energy, raw materials,

[21] The industrial sector is generally classified into four subsectors (agriculture, mining, manufacturing, and construction), which are further classified into individual industries (metals, chemicals, food, and so forth). In our analysis, the industry groupings follow the categorization of energy consumption data by the IEA. See www.iea.org/statistics/resources/balancedefinitions/#industry.www.iea.org/statistics/resources/balancedefinitions/#industry.

semi-finished goods, and services purchased from all sources) (BEA 2022). However, this information is not available for all countries.

Using raw energy intensities alone does not offer a meaningful comparison among countries. Both the industrial sector's composition and the energy use of individual industries vary significantly across the 25 countries analyzed. For example, in 2018, the United States' energy consumption was highest in chemicals, while China's energy consumption was highest in food and tobacco production. Additionally, the efficiency of the manufacturing process itself may vary from country to country for the same industry. Generally, across most countries, industries such as machinery and transport equipment tend to have high market value and low energy consumption relative to industries such as steel, pulp and paper, and chemicals, which have low market value and high energy consumption.

To fairly compare the energy intensities of countries' industrial sectors and to account for variation in the mix of individual industries, we developed a weighting factor—the *relative intensity factor*—to normalize raw energy intensities. Due to lack of data availability, we used the same numbers for relative energy intensity found for the previous *Scorecard*. The following describes the methodology we used to find those numbers.

Step 1. Energy Intensities of Industry Groupings

To calculate the relative intensity factors, we needed the energy intensities of industry groupings for each country. Ideally, these would be calculated using the energy consumption of and value added by each industry. While energy consumption data for industry groupings were available (IEA 2022c), value-added data were not consistently available across all countries for the year we evaluated. To address this, we used the energy consumption per value added of U.S. industry groupings to calculate the energy intensities of the same industry groupings in countries with unavailable data, assuming the pattern would be similar. It may be possible to improve this assumption in future *Scorecard* editions by approximating the intensities of unavailable individual countries' industries based on regional similarities where good data are available.

First, we calculated the energy consumed in each industry grouping in each country as a share of total energy consumed in that grouping in all 25 countries (R^{ci}).

$$Energy\ consumption\ ratio\ for\ each\ industry\ grouping\ for\ each\ country\ (R^{ci}) =$$

$$\frac{Energy\ consumed\ by\ a\ country\ in\ a\ particular\ industry\ grouping}{Total\ energy\ consumed\ by\ all\ 25\ countries\ in\ that\ industry\ grouping}$$

We then multiplied each grouping's share of energy consumption by the corresponding U.S. industry intensity of that grouping or by specific country data where possible. This let us derive energy intensities for all 13 groupings of industries in each of the 25 countries analyzed.

$$Derived\ energy\ intensity\ of\ each\ industry\ grouping\ in\ each\ country\ \left(I^{ci}\right) =$$

$$R^{ci} * Corresponding\ energy\ intensity\ of\ the\ industry\ grouping\ in\ the\ United\ States$$

We based U.S. industry intensities on energy consumption in thousand Btus per dollar of value added reported in table 6.1 of the *2014 Manufacturing Energy Consumption Survey* (MECS) (EIA 2017a). For construction, mining and quarrying, and the nonspecified sector, we determined energy intensity using data on the value of shipments and total energy consumption from the *Annual Energy Outlook 2020* (EIA 2021a).

Step 2. Relative Intensity Factors

Next, we normalized these derived intensities for each country to allow us to compare across countries. To normalize, we summed the derived intensities of the 13 industry groupings for each country, calculated the average of the 25 sums, and used this average to normalize the sums themselves to produce a unit-less relative intensity factor for each country.

$$I^{cs}\ for\ each\ country = Sum\ of\ I^{ci}\ of\ 13\ industry\ groupings\ for\ the\ country$$

$$Relative\ intensity\ factor\ for\ each\ country\ (R^{c}) = \frac{I^{cs}\ of\ the\ country}{Average\ I^{cs}\ of\ all\ countries}$$

We then multiplied each country's raw energy intensities by the corresponding relative intensity factors to produce a final weighted energy intensity of the overall industrial sector for each country.

$$Final\ weighted\ energy\ intensity\ for\ each\ country\ I^{w}\ =$$

$$I^{c0}(raw\ energy\ intensity) *\ R^{c}\ (relative\ intensity\ factor)$$

Table A1 shows, for each country, the raw energy intensity, relative intensity factor (data from 2018 *Scorecard*), and weighted energy intensity.

Table A1. Raw intensities, weighting factors, and weighted intensities of the industrial sectors

Country	Raw energy intensity (kBtus/2019$)	Relative intensity factor	Weighted energy intensity (kBtus/2019$)
Australia	3.09	2.02	6.23
Brazil	6.40	1.28	8.19
Canada	3.85	1.82	7.01
China	7.44	1.15	8.56
Egypt	7.18	0.28	2.00
France	2.57	1.14	2.93
Germany	2.35	1.2	2.82
India	11.20	0.68	7.61

Country	Raw energy intensity (kBtus/2019$)	Relative intensity factor	Weighted energy intensity (kBtus/2019$)
Indonesia	4,32	0.59	2.55
Italy	2.37	1.16	2.74
Japan	1.81	1.05	1.90
Mexico	4.44	0.7	3.11
Netherlands	3.13	0.81	2.53
Poland	3.42	1.49	5.09
Russia	10.48	1.2	12.58
Saudi Arabia	5.17	1.21	6.25
South Africa	10.41	1.12	11.66
South Korea	5.02	0.92	4.62
Spain	2.78	1.28	3.56
Taiwan	3.48	0.75	2.61
Thailand	8.83	0.89	7.86
Turkey	3.99	1.14	4.55
U.A.E.	6.68	1.02	6.82
U.K.	1.90	0.76	1.45
U.S.	3.16	1.28	4.04

Sources: IEA 2022c, 2022a; World Bank 2022c

Limitation of Methodology

Devising a performance metric that allows a representative comparison of industrial energy intensity is inherently problematic. Several methodological approaches could be used, each with distinct advantages and disadvantages. One basic approach would be to use total final industrial consumption divided by industrial GDP. This is appealing in its simplicity, but it has clear drawbacks. High energy intensity does not necessarily correspond with wastefulness; it depends on the structure of a country's industrial sector and the mix of individual industries within it. This basic approach does not account for structural differences, and it disadvantages countries with high-consuming, low-value industries. Data availability limited our options such as utilizing a decomposition approach.

A different approach might be to compare the change in energy intensity over a given period. This approach has some advantages. Evaluating progress over time reduces the need to account for structural differences. Additionally, the needed data are more readily available from centralized sources, and the methodology is clear and easy to understand. On the other hand, this approach is sensitive to the period analyzed and other conditions that may be difficult to pinpoint. For example, this method does not account for energy efficiency

investments made prior to the baseline year; this could disadvantage countries that invested in efficiency early. Changes in intensity could also result from factors unrelated to efficiency improvements, such as structural shifts among industries or the effects of an economy-wide recession or a downturn in a specific industry due to market effects.

We chose to compare a weighted measure of energy intensity for each country based on the intensity of the individual industries that make up its industrial sector. Our method therefore accounts for structural differences across countries and, in our judgment, provides a more meaningful analysis than other options. However, this approach is more complicated and requires us to make many assumptions—especially where data are limited. For example, the assumption that relative intensities among industrial subgroups in other countries follow U.S. patterns may not hold true for every country. Also, given the lack of recent data, we had to use the relative intensity factors found for the previous *Scorecard* edition. We thus urge caution in interpreting the rankings resulting from this metric. Figure A1 plots the raw industrial energy intensity of the *Scorecard* countries against the relative intensity figures found for the 2018 *Scorecard* using the methods described above.

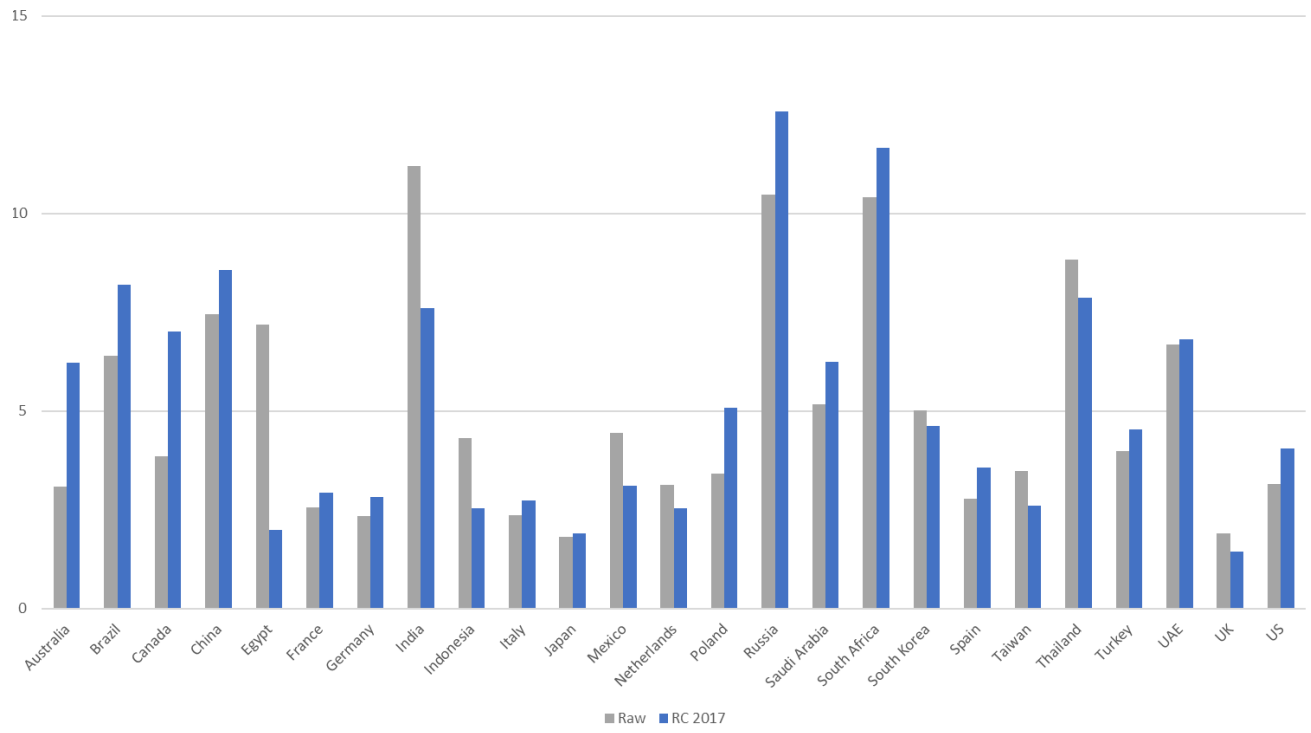


Figure A1. Raw industrial energy intensities and relative intensity factors from the 2018 Scorecard. Sources: IEA 2022c, 2022a; World Bank 2022c.

Appendix B. Appliance Standards Scoring

In the buildings section, we used the following point allocation for the appliance standards metric.

Table B1. Point allocation for appliance standards

Product group	Appliance	Sector	Contribution to total standard count	Comments
Air-conditioning	Central AC/heat pump		1	
	Chiller		1	
	Room AC/mini-split HP, portable AC		2	
	Dehumidifier		1	
Building materials	Envelope		0	Typically covered in building codes
	Window		0	
Compressors	Air compressor	Commercial	1	
	Refrigerant compressor	Commercial	1	
Cooking and dishwashing	Cooktop/hob, oven		1	
	Dishwasher		1	
	Tortilla making machine, rice cooker		1	
	Other (res)—kettle, dish dryer, coffee machine, microwave, etc.		1	
	Other (com)—hot-water dispenser, fryer, etc.		1	
Industrial	Transformer		1	
	Pump systems		1	
	Industrial process chiller		1	
	Industrial blower		1	
	Industrial fans		1	
	Miscellaneous systems		1	
Laundry	Clothes dryer		1	All fuel sources
		Commercial	1	

Product group	Appliance	Sector	Contribution to total standard count	Comments
	Clothes washer, incl. combo washer/dryer	Residential	1	
Lighting	Linear fluorescent—ballasts, lamps		1	
	HID (incl. metal halide, HPS, LPS)—ballasts, lamps, street lighting		1	
	General service lighting—incandescent /halogen, Compact fluorescent lamp (CFL), light emitting diode (LED), reflector lamps		2	
	Signal lighting—traffic signals, exit signs		1	
Miscellaneous	Air cleaner, toilet seat (electric), vacuum cleaner		1	
Motors	Small 1-phase general purpose		1	
Pumps	All other types		1	Different for each country
	Building circulator		1	
Refrigeration	Freezer	Commercial	1	
		Residential	1	
	Refrigerator (incl. refrigerator-freezers)	Commercial	1	
		Residential	1	
	Walk-in cooler and freezer		1	
	Ice machine		1	
	Other res. equipment—wine chiller, kim-chi refrigerator		1	

Product group	Appliance	Sector	Contribution to total standard count	Comments
	Compressor, Refrigerant, Evaporative (CRE)—water cooler, vending machine, beverage cooler, reach-in coolers, refrigerated cabinet		2	
Space heating	Boiler/package terminal units	Commercial	1	All fuel sources
		Residential	1	
	Furnace/heat pump	Commercial	1	All fuel sources
		Residential	1	
	Space heater	Commercial	1	
		Residential	1	All fuel sources
Technology plug-load	Standby		1	
	Television (all screen types)		1	
	Set top box (STB)		1	
	Display (all screen types)	All	1	
	Audio visual	All	1	
	Computer and Information Communications Technology (ICT)	All	1	
	Hard-drive	All	1	
	Networking equipment	All	1	
	Server		1	
	Office imaging equipment		1	
	Battery charger, contactor, external power supply		2	
Ventilation and fans	Ceiling fan		1	
		Commercial	1	

Product group	Appliance	Sector	Contribution to total standard count	Comments
	Integrated/ventilation fans	Residential	1	
	Portable fan		1	
Water heating	Pool heater		1	
	Water heater, instantaneous	Commercial	1	
		Residential	1	
	Water heater, storage	Commercial	1	
		Residential	1	

Appendix C. Country Summaries

Appendix C consists of one-page summaries of the evaluated countries' performance on *The 2022 International Energy Efficiency Scorecard*. These summaries highlight each country's area of strongest performance and areas that need improvement.

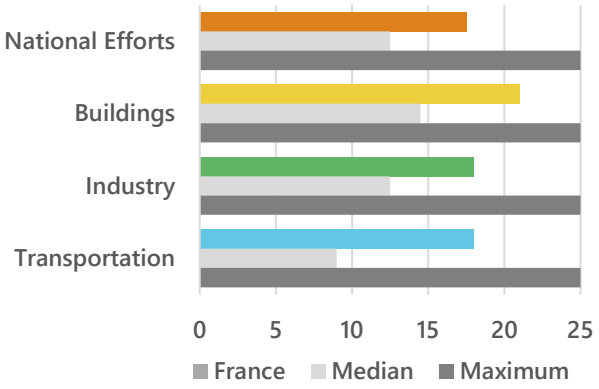
ACEEE'S 2022 INTERNATIONAL ENERGY EFFICIENCY SCORECARD

FRANCE

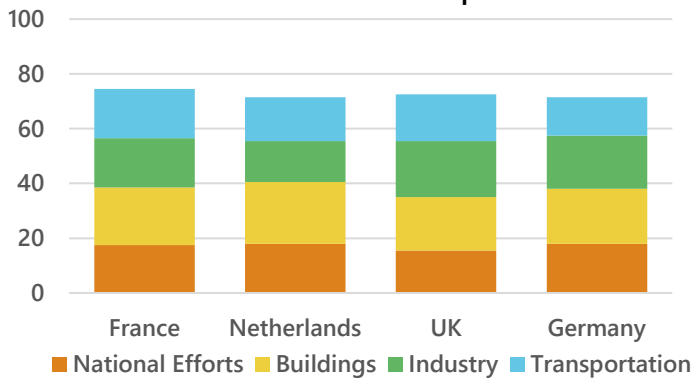
RANK **1/25**

POINTS **74.5/100**

France in the *2022 International Scorecard*



How does France compare to other countries in Europe?



National Efforts

France did well in this category largely due to its participation in European Union (EU) actions. Under the EU's Energy Efficiency Directive, France has made a commitment to reduce energy consumption 20% by 2030 relative to 2012. The country also has a goal to reduce GHG emissions 37% below 2005 levels by 2030. France's National Energy Efficiency Action Plan contains energy efficiency provisions that go beyond those implemented by other members of the EU. The plan includes the White Certificates Trading program, which requires suppliers of energy to meet government-mandated targets for energy savings.

Buildings

France ranked second in the buildings category with a score of 21 points. It has comprehensive residential and commercial buildings codes, which are mandatory across the country. The country's Energy Efficiency Action Plan outlines aggressive policies to increase the number of low energy buildings and commits to the deep renovation of 500,000 dwellings per year. France requires building rating systems and the disclosure of energy use for both residential and commercial buildings. It also has building performance standards for residential and commercial buildings. Of the countries evaluated in this report, France has the most ambitious building retrofit program, but could still benefit from the creation of implementation regulations.

Industry

As in the 2018 *Scorecard*, France placed fifth in the industrial rankings, although it still has plenty of opportunities for improvement. It has a low percentage of installed capacity from CHP, which suggests that the country could benefit from establishing a CHP target and enacting strong incentives aimed at helping to ramp up deployment. Moreover, France's industrial energy use could be managed more effectively if the country were to enact a requirement to have an energy manager on-site in large industrial facilities.

Transportation

France ranked first in transportation. The National Low-Carbon Strategy for Climate has spurred much of France's progress on transportation energy efficiency. The strategy outlines a path toward a 29% reduction in transportation-sector greenhouse gases by 2028 from 2013 levels. To achieve this aggressive goal, France is employing a comprehensive approach that includes increasing the overall efficiency of vehicles by adhering to the EU passenger vehicle standards and encouraging the purchase of more-efficient vehicles, curbing the demand for mobility services, and promoting more-efficient transportation alternatives. France participates in the EU's ambitious emissions reduction target for new vehicles. It spends approximately 3% more on rail development and maintenance than it does on roads, indicating an effort to ensure that rail is a reliable option for both passenger and freight movement.

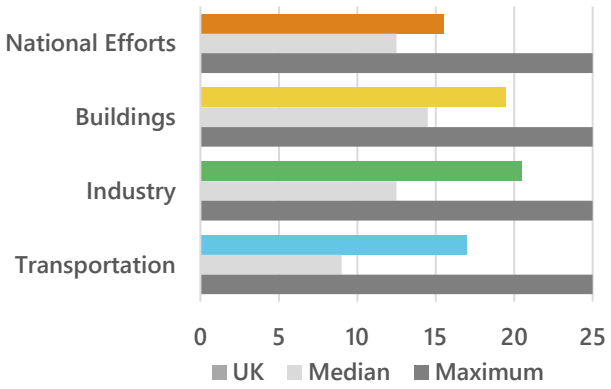
ACEEE'S 2022 INTERNATIONAL ENERGY EFFICIENCY SCORECARD

THE UNITED KINGDOM

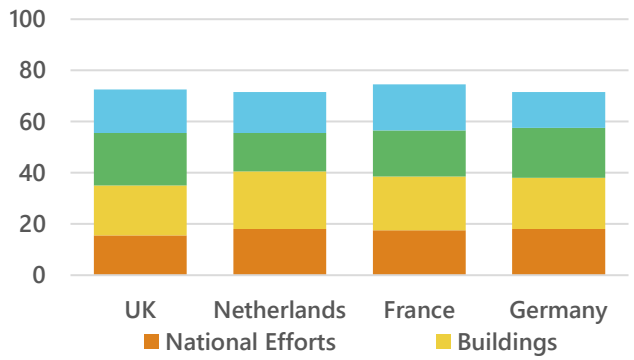
RANK **2/25**

POINTS **72.5/100**

The United Kingdom in the *2022 International Scorecard*



How does the United Kingdom compare to other countries in Europe?



National Efforts

The United Kingdom (UK) has made significant commitments to emissions reduction through its national policies. The country has set a GHG emissions reductions target of 68% below 1990 levels by 2030. The country has highly efficient thermal power plants and makes significant investments in energy efficiency RD&D activities. The United Kingdom could further improve by promoting the market expansion of its ESCOs and by increasing government and utility spending on energy efficiency.

Buildings

The United Kingdom placed fifth in the buildings section of our analysis with a score of 19.5 points. Comprehensive residential and commercial building codes are in place, as is a building energy labeling program. Additionally, the UK has building performance standards for rental properties. While there are retrofit requirements in place for the country's existing building stock, the rate of major renovations in housing is very low and needs to be improved. The UK also has mandatory appliance and equipment standards for 38 products, as well as mandatory labeling requirements for 24 appliance groups.

Industry

The United Kingdom ranked second in the industrial section of the *2022 Scorecard*. The industrial energy intensity of the UK was among the lowest of all the countries analyzed. Moreover, the UK has a strong catalogue of policies aimed at improving the efficiency of its industries. These policies include voluntary agreements with manufacturers to improve energy efficiency and the implementation of energy management systems. Further, the UK has plans to develop a net-zero carbon industrial cluster by 2040 and to position its industrial clusters as areas for large-scale investment in energy efficiency and to drive demand for low carbon products and technologies. The UK could improve its score by requiring large industrial facilities to employ on-site energy managers.

Transportation

The UK ranked second in the transportation section. The country has high fuel economy standards set at 64.4 miles per gallon by 2025 and comparatively high average fuel economy for light-duty vehicles at 40.56 mpg. Electric vehicles consist of a fairly high share of new vehicles at 11.3% of vehicle sales. The UK could improve further by enacting fuel economy standards for heavy-duty vehicles, reducing vehicle miles traveled, and implementing strategies to increase the use of public transit.

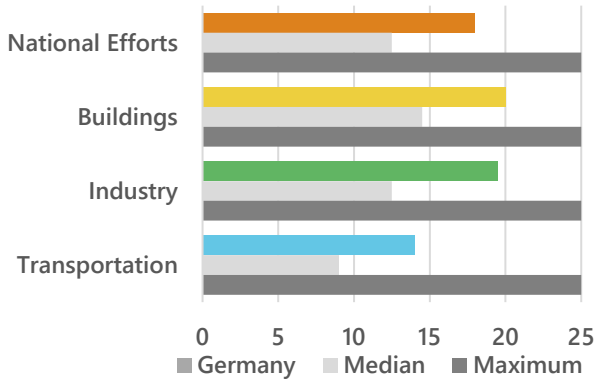
ACEEE'S 2022 INTERNATIONAL ENERGY EFFICIENCY SCORECARD

GERMANY

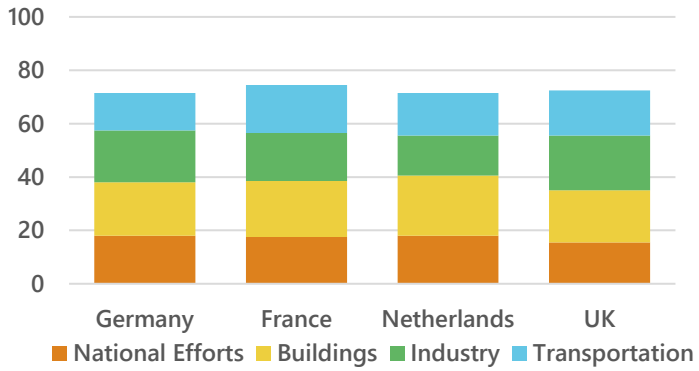
RANK **3/25**

POINTS **71.5/100**

Germany in the *2022 International Scorecard*



How does Germany compare to other countries in Europe?



National Efforts

Germany tied with the Netherlands for first place in national efforts. German policymakers have implemented a comprehensive energy strategy, known as *Energiewende*. The country has set a 32.5% reduction target in primary energy consumption by 2030 and 50% by 2050, relative to 2008. The Climate Action Plan 2050 includes GHG emissions reduction targets of 55% below 1990 levels by 2030 and 80–95% by 2050. The second National Action Plan for Energy Efficiency identifies focus areas to improve efficiency, such as decarbonization of heating and cooling systems. Moreover, Germany has implemented multisector loan programs and tax credits aimed at increasing the deployment of energy-efficient technologies.

Buildings

Germany placed among the top five countries in buildings efficiency. It has comprehensive residential and commercial codes that are mandatory across the country. Adopted in 2002, the National Energy Saving Ordinance sets energy performance requirements for new and existing buildings undergoing major renovations. Germany currently has 42 appliance groups covered by energy performance standards (MEPS) and 25 appliance groups covered by mandatory labels. Germany could improve its score by setting compliance dates for its retrofit policies.

Industry

Germany came in third in the industrial category of the *Scorecard*. The energy intensity of Germany's industrial sector is low compared to other countries analyzed. A voluntary agreement between German industry and the federal government to reduce CO_2 emissions has been in place since 1995. Updates in 2012 set targets for annual reductions in energy intensity in industry until 2022. The country has an industrial electricity tax set at EUR 20.5/MWh, which can be reduced by 90% if large energy users can prove that they have implemented an energy management system certified to ISO 50001 or the German national standard. Germany can improve its ranking in future *Scorecards* by requiring large industrial facilities to employ on-site energy managers.

Transportation

Scoring only 14 out of a possible 25 points in this category, the transportation sector provides energy efficiency opportunities for Germany. Of *International Scorecard* participants, Germany had the second-highest share of new vehicles that are electric, with EVs making up 13.5% of new sales. Outside of the EU's passenger vehicle standards, not many efforts have been made to reduce energy consumption in this sector. Germany's status as an auto manufacturing powerhouse has led to high use of personal vehicles as the primary mode of transport and little interest in investing in rail or other public transit facilities.

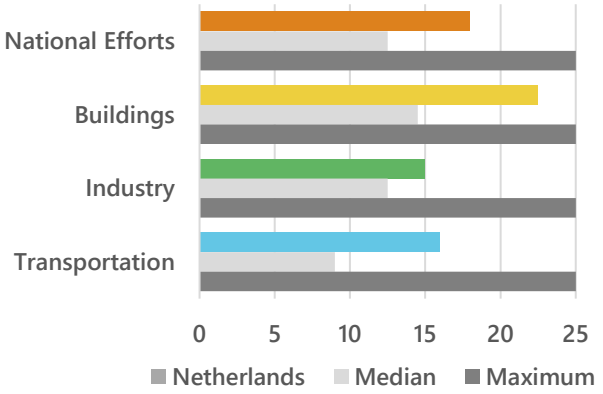
ACEEE'S 2022 INTERNATIONAL ENERGY EFFICIENCY SCORECARD

THE NETHERLANDS

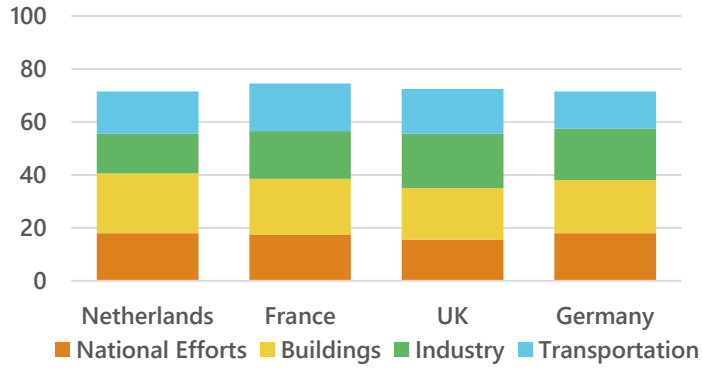
RANK **3/25**

POINTS **71.5/100**

The Netherlands in *the 2022 International Scorecard*



How does the Netherlands compare to other countries in Europe?



National Efforts

The Netherlands tied with Germany for first place in national efforts. The Dutch government's 2019 National Climate Act set a near-term goal to reduce greenhouse gas emissions 49% by 2030 relative to 1990 levels. The country's Climate Agreement lays out sector-specific goals and measures that acknowledge energy efficiency as an important tool. The Dutch National Energy and Climate Plan also includes policies and programs to meet the European Union's goal to increase energy efficiency 32.5% by 2030. The Netherlands continues to decrease its overall energy intensity and increase its expenditure in efficiency-related research, development, and demonstration.

Buildings

The Netherlands also placed first in the buildings category. It has comprehensive residential and commercial building codes that are mandatory across the country. The Netherlands currently has 42 appliance groups covered by energy performance standards (MEPS) and 25 appliance groups covered by mandatory labels. The country also scores well on retrofit policies by having mandatory national codes for building renovations as well as a building performance standard for office buildings. The Netherlands requires building rating systems and the disclosure of energy use for both residential and commercial buildings. The country could improve its score even more by continuing to lower the energy use intensity of its buildings.

Industry

In comparison to other categories, the Netherlands did not perform as well in the industry category, and has ample opportunity to improve. The country has taken steps to increase industrial efficiency through voluntary agreements with the manufacturing sector to reduce consumption and by requiring energy audits of large industrial facilities. However, the Netherlands could prioritize the implementation of energy management policies and focus on greatly reducing energy intensity in its agricultural sector.

Transportation

Compared to prior editions of the *International Scorecard*, the Netherlands has improved its score in the transportation category. The country has the highest share of new vehicle sales that are electric because of supportive policies and fiscal incentives for EVs. Due to its compliance with the European Union's mandatory emissions reduction target for new cars, the Netherlands scored full points for both fuel economy standards and average fuel economy for passenger vehicles. Further energy savings could be gained by improving the country's investment in rail versus road transit, improving the energy intensity of freight transport, and lowering vehicle miles traveled.

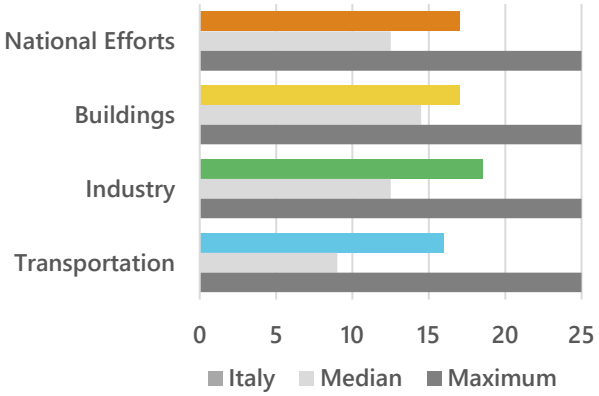
ACEEE'S 2022 INTERNATIONAL ENERGY EFFICIENCY SCORECARD

ITALY

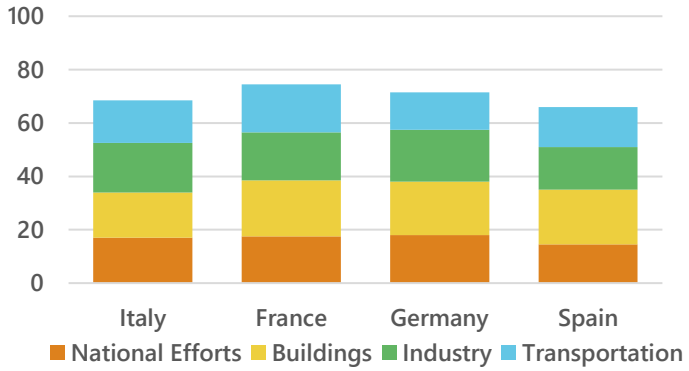
RANK **5/25**

POINTS **68.5/100**

Italy in the *2022 International Scorecard*



How does Italy compare to other countries in Europe?



National Efforts

Italy has a very strong energy efficiency profile. The country is committed to reducing primary energy consumption 43% by 2030 and GHG emissions 33% below 2005 levels by 2030. The country's cross-sectoral White Certificates scheme is one of the primary mechanisms used to achieve EU energy efficiency targets and has been a best practice program since its inception in 2005. Italy had the highest operational efficiency of thermal power plants in the *Scorecard*, and the country offers multisector loans and credits for energy efficiency investments.

Buildings

Italy ranked eighth in the buildings category. Several initiatives exist at the national level to support an increased rate of renovation, including the Conto Termico program, which provides incentives for retrofits and energy efficiency improvements in residential and public buildings. Italy also has mandatory requirements for renovations in residential and commercial buildings. Like other European Union members, Italy currently has 42 appliance groups covered by energy performance standards and 25 appliance groups covered by mandatory labels. Italy can improve by enhancing the energy intensity of its residential building stock.

Industry

Italy placed fourth in industrial energy efficiency. The country has shown a strong commitment to energy efficiency by establishing energy savings targets and requiring plant energy managers to meet them. Italy mandates periodic energy audits in industrial facilities. The country also has implemented a market-based energy efficiency certificate-trading scheme to allow flexibility to industrial facilities looking to meet energy savings goals. Italy also has a high share of installed CHP capacity due in part to its policies to encourage CHP deployment. The Nuova Sabatini subsidy seeks to improve access to new, more efficient, and less carbon intensive machinery and industrial equipment for small and medium enterprises.

Transportation

Italy tied for third place with the Netherlands in the transportation category. The country participates in the EU's vehicle standards and will aim to achieve a fleet-wide average of 64.4 mpg by 2025. Italy's average on-road fuel economy for passenger vehicles of 45.2 mpg is the highest in the *Scorecard*. Italy has a relatively high ratio of investment in rail transit to investment in roads. Further energy savings can be gained by reducing vehicle miles traveled per capita and improving fuel efficiency standards for heavy-duty vehicles.

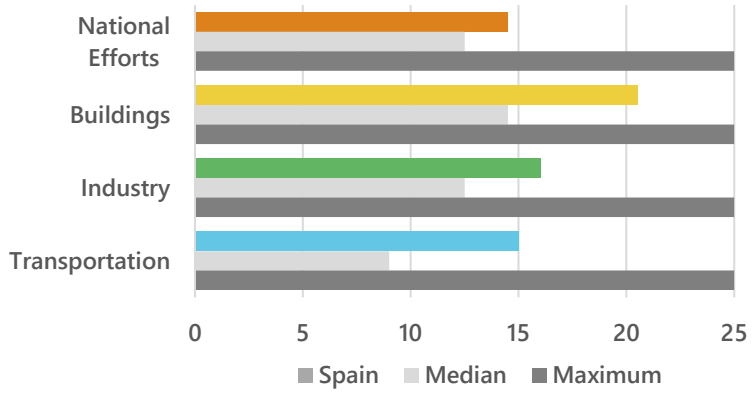
ACEEE'S 2022 INTERNATIONAL ENERGY EFFICIENCY SCORECARD

SPAIN

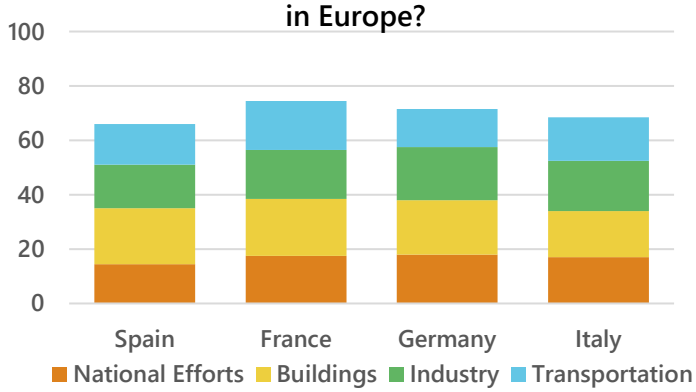
RANK **6/25**

POINTS **66/100**

Spain in the *2022 International Scorecard*



How does Spain compare to other countries in Europe?



National Efforts

Spain set a near-term goal to reduce greenhouse gas emissions 23% below 1990 levels and improve energy efficiency 39.5% by 2030. The country could help achieve this target by increasing its investments in energy efficiency R&D and broadening its energy efficiency loan programs and tax incentives to include more sectors c its economy, as well as increasing the size of its energy service companies market. The country spends a significant amount of money per capita on energy efficiency relative to other countries included in the *Scorecar*

Buildings

Spain placed among the top three countries in the buildings category, largely because it has strong mandatory building codes, which cover a broad range of technical elements, for both residential and commercial buildings. Furthermore, Spain has renovation requirements in place for all buildings as part of its construction code. Spain also has a mandatory program for building labeling and building energy disclosure. Spain can improve by reducing the energy intensity of its residential and commercial building stock.

Industry

Spain has a voluntary agreement in place with businesses in the manufacturing sector and mandates energy audits, but the country has considerable room for improvement in the industrial efficiency category of the *Scorecard*. The country generates very low amounts of electricity from CHP and has no CHP targets or incentives in place. Moreover, it could require large industrial facilities to hire on-site energy managers.

Transportation

Spain improved its score in transportation policies and placed in fifth in this edition of the *Scorecard*. Due to its compliance with the European Union's mandatory emissions reduction target for new cars, Spain scored full points for both fuel economy standards and average fuel economy for passenger vehicles. The country's investment in rail is high compared to other countries in the *Scorecard*. Further energy savings could be gained by encouraging the purchase of electric vehicles, improving the energy intensity of freight transport, and adopting a more stringent fuel economy standard for heavy-duty vehicles.

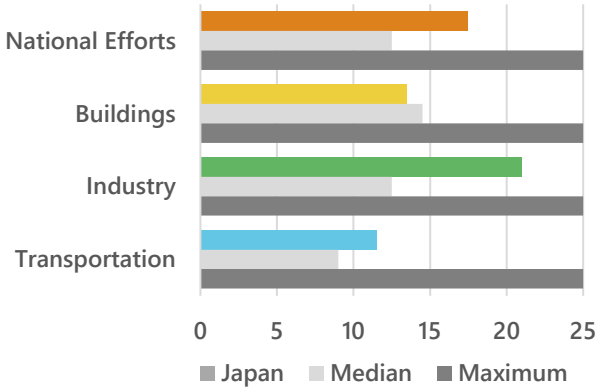
ACEEE'S 2022 INTERNATIONAL ENERGY EFFICIENCY SCORECARD

JAPAN

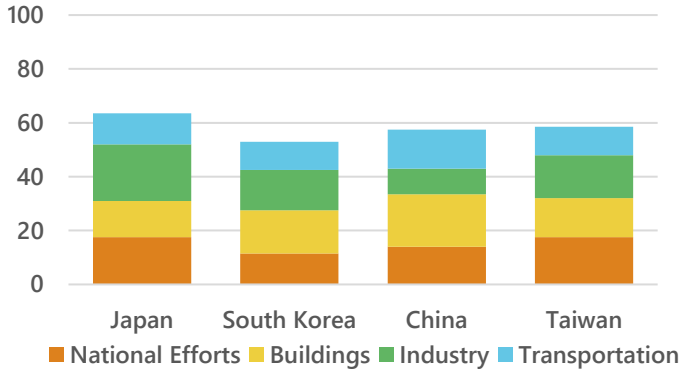
RANK **7/25**

POINTS **63.5/100**

Japan in the *2022 International Scorecard*



How does Japan compare to other countries in Asia?



National Efforts

Japan placed in fourth for national efforts due to the strong energy efficiency policies it has in place. The countr has decreased its energy intensity considerably. In addition, Japan's investment in energy efficiency R&D is among the highest of the 25 countries evaluated. Japan also has strong multisector loan programs and tax incentives aimed at promoting the deployment of energy-efficient technologies. The country's thermal power plants are also highly efficient. However, the country still has room for improvement as its per capita spending on energy efficiency is low.

Buildings

The greatest area for improvement in Japan is in the buildings sector. The country has uneven, nonrequired residential and commercial building codes and its building energy labeling initiatives are only voluntary. Japan also lacks a comprehensive buildings retrofit policy. However, the country does require owners and developers to submit an energy savings plan when undertaking large renovations. Japan has a great opportunity to increase the energy efficiency of its buildings by strengthening building codes, implementing mandatory building labeling programs for all buildings, and expanding minimum energy performance standards to more appliances.

Industry

Japan ranked first in the industrial energy efficiency category. The country has developed a mix of regulatory measures, voluntary actions, and financial incentives to successfully encourage energy efficiency in industry. This has allowed Japan's industrial energy intensity to be among the lowest out of the 25 countries analyzed by the *Scorecard*. The Act Concerning the Rational Use of Energy introduced mandatory energy efficiency requirements for designated industries in 1978. It requires companies to appoint an energy manager and report on the status of energy consumption every year and includes a benchmarking system that obligates businesses to achieve specific energy efficiency targets. There is still room for improvement, however, as Japan has a low percentage of combined heat and power capacity installed.

Transportation

Japan has set fuel economy standards for passenger vehicles of 48.5 mpg by 2025; current average on-road fuel economy is relatively high at 37.94 mpg. Japan is among the countries with the best freight intensity in the *Scorecard*, and the country's Green Logistic Partnership improves freight efficiency. A significant share of Japan's transportation is conducted using public transit. Further energy savings could be gained by improving the country's investment in rail versus road transit, adopting more stringent fuel economy standards for light-duty vehicles, and lowering vehicle miles traveled per capita.

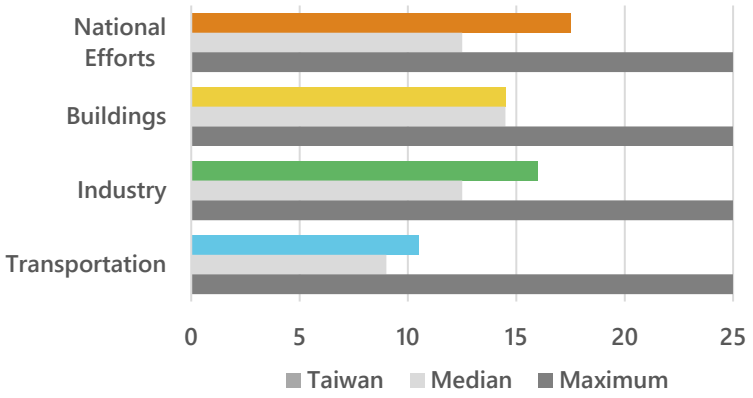
ACEEE'S 2022 INTERNATIONAL ENERGY EFFICIENCY SCORECARD

TAIWAN

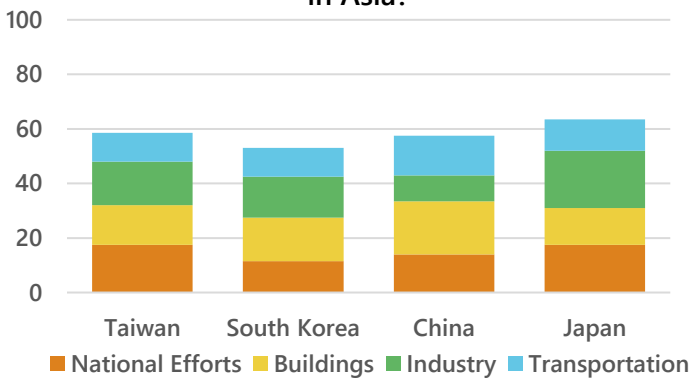
RANK **8/25**

POINTS **58.5/100**

Taiwan in the *2022 International Scorecard*



How does Taiwan compare to other countries in Asia?



National Efforts

Taiwan performed well in its national efforts toward energy efficiency, tying for third place with Japan and France. Taiwan has low economy-wide energy intensity. The country has a national goal to improve energy efficiency by 2% per year, and the energy efficiency of its thermal power plants is among the highest in the *Scorecard*. As a share of its gross domestic product, Taiwan's $760 million ESCO market is among the largest of all countries analyzed. The country can further improve by increasing its per capita energy efficiency spending.

Buildings

Buildings in Taiwan have very low energy-use intensity. Taiwan could benefit from expanding its appliance standards program. Currently, 15 groups of appliances are covered by minimum energy performance standards. Taiwan could also implement building energy labeling and disclosure policies to improve awareness among its citizens.

Industry

Taiwan has a low industrial energy intensity and a strong catalogue of policies aimed at improving the efficiency of its industrial sector. Nevertheless, this sector could further benefit by providing for voluntary agreements between the government and the manufacturing sector aimed at improving energy efficiency, scaling up the number of facilities certified to ISO 50001, and offering incentives for achievements and participation. Taiwan has mandatory energy audits and mandates for energy managers. The country scored well in its share of installed combined heat and power capacity in electricity generation.

Transportation

Taiwan has significant room for improvement in the transportation section. The country could greatly benefit from enacting more stringent fuel economy standards for light- and heavy-duty vehicles. As electric vehicles only make up 1% of new vehicle sales in the country, Taiwan could encourage electric vehicle purchases. Further energy savings could be gained by adopting fuel economy standards for heavy-duty vehicles, improving the country's investment in rail versus road transit, and improving the energy intensity of freight.

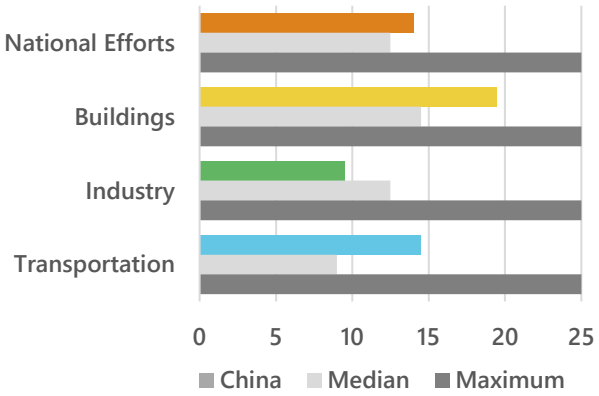
ACEEE'S 2022 INTERNATIONAL ENERGY EFFICIENCY SCORECARD

CHINA

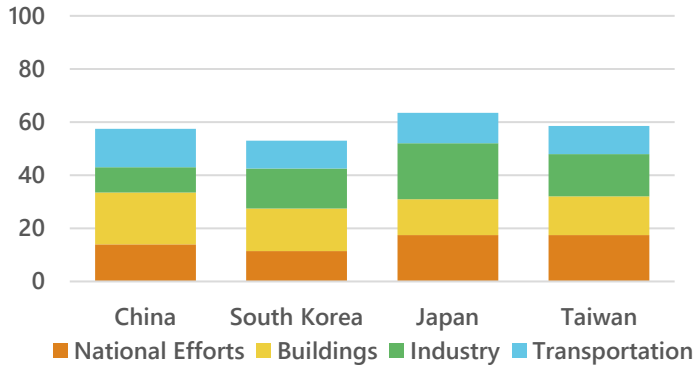
RANK **9/25**

POINTS **57.5/100**

China in the *2022 International Scorecard*



How does China compare to other countries in Asia?



National Efforts

China has greatly reduced primary energy intensity in the last several years and has the largest market served by energy service companies (ESCOs). Government support to ESCOs and programs that created mandatory energy efficiency goals for energy-intensive entities have contributed to a thriving ESCO market in China. However, China has room for improvement on the national efforts front overall. While poor data availability contributed to China's low scores on energy efficiency spending (both overall and R&D), the country could improve its rank by implementing multi-sector loan programs for energy efficiency.

Buildings

China scored well for building energy efficiency policy, earning 19.5 points and ranking fifth. China has strong mandatory codes for commercial buildings and applicable codes for residential buildings, which could be extended to rural areas to be more comprehensive. China has also adopted appliance and equipment standards for 40 products and mandates energy efficiency labeling for some building types. The nation could improve its ranking by requiring rating and disclosure for all buildings and introducing a building retrofit policy for rural residential buildings.

Industry

China ranked towards the bottom in the industry category, earning 17th place. The energy intensity of China's industrial sector is the third highest of the 25 countries analyzed in the *Scorecard*. China could improve in this regard by providing agreements between the government and manufacturers aimed at improving energy efficiency in their operations. China could strengthen efficiency standards for industrial motors and increase investment in industrial R&D to further reduce energy consumption and emissions in the industrial sector.

Transportation

China ranked sixth in transportation efficiency. The country has goals for mandatory fuel economy standards for passenger vehicles of 57.9 mpg by 2025. Standards for heavy-duty vehicles also exist and aim to achieve a 28% reduction in fuel consumption by model year 2025. The country has in place a national smart freight initiative to tackle energy use and emissions in the freight sector. The number of vehicle miles traveled by personal vehicle per person is very low, and the percentage of trips taken by public transit is higher than in any other country.

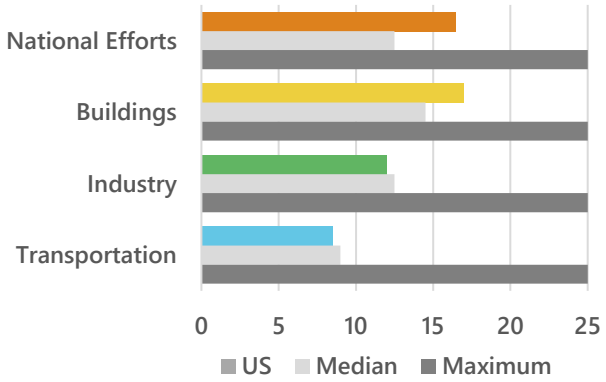
ACEEE'S 2022 INTERNATIONAL ENERGY EFFICIENCY SCORECARD

THE UNITED STATES

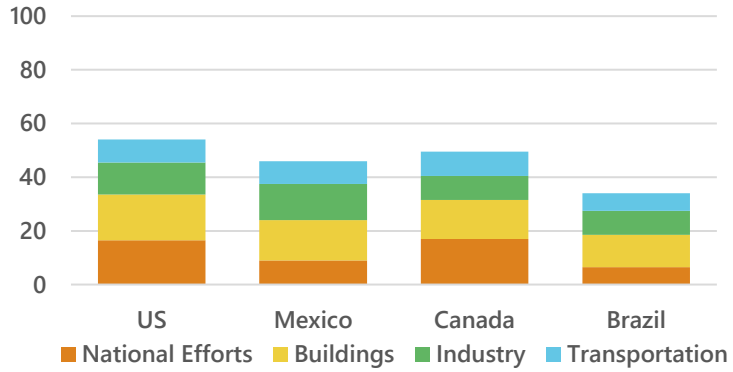
RANK **10/25**

POINTS **54/100**

The US in the *2022 International Scorecard*



How does the US compare to other countries in the Americas?



National Efforts

Since the last edition of the *Scorecard,* the United States has rejoined the Paris Agreement, which although voluntary, reinforces the country's commitment to reducing GHG emissions. However, the United States is one of very few large energy-consuming economies that does not have national energy reduction targets in place. Nevertheless, this country makes significant investments in energy efficiency programs and R&D and has tax incentives and loan programs that apply to multiple sectors. The United States is one of the countries that collects and makes energy data easily accessible to both citizens and international audiences. These efforts are housed in the Energy Information Administration (EIA), which publishes periodic energy data on its website and provides several other tools and services.

Buildings

The United States claims the eighth spot in the buildings section. The country has mandatory appliance and equipment standards, covering more than 50 product categories. Most states provide tools, training, and resources to support the adoption and maintenance of building codes. The United States also has building codes for retrofitting residential and commercial buildings which cover two-thirds of the country's population. The United States could focus on reducing energy use intensity particularly in residential buildings and consider enacting mandatory building labeling policies.

Industry

The United States' performance in the industrial category was average. The United States makes strong investments in manufacturing R&D and has high efficiency standards for motors; however, the country could realize greater energy savings in the industrial sector by expanding the scope of voluntary partnerships between the government and large manufacturers as well as providing financial support for achievements in energy efficiency. The federal government could also encourage greater adoption of a strategic energy management standards such as ISO 50001. The country could increase its rank by requiring energy audits or the employment of energy managers in large industrial facilities.

Transportation

Compared to other *Scorecard* categories, the United States scored lowest in the transportation category, earning 8.5 points out of 25. Annual vehicle miles traveled per capita in personal vehicles is the highest among all the countries on our list at 8,182 miles per capita. Electric vehicles comprised only 2% of all new vehicle sales. Additionally, the average on-road fuel economy of existing light-duty vehicles is one of the poorest, indicating that the United States uses more inefficient vehicles for personal travel compared to other countries. Use of public transit and investment in railways remains low. On the positive side, the United States is among the few countries with heavy-duty vehicle standards in place and has also implemented a smart freight initiative.

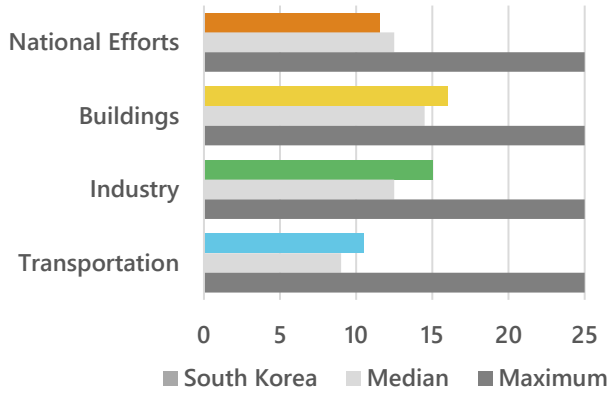
ACEEE'S 2022 INTERNATIONAL ENERGY EFFICIENCY SCORECARD

SOUTH KOREA

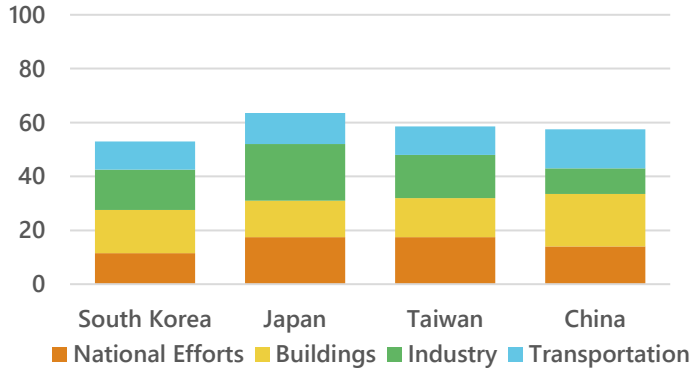
RANK **11/25**

POINTS **53/100**

South Korea in the *2022 International Scorecard*



How does South Korea compare to other countries in Asia?



National Efforts

South Korea ranked 14th in the national efforts category. The country saw a moderate decrease in energy intensity of 6.6% between 2013 and 2018; however, there is still much work to be done should the country wish to meet its ambitious target of reducing energy intensity 38% from 2017 levels by 2040. The country also has a goal of achieving carbon neutrality by 2050. The overall efficiency of thermal power plants in South Korea is impressive, as is the countries expenditures on energy efficiency R&D.

Buildings

South Korea ranked 10th in the buildings category. The country's Building Design Criteria for Energy Saving establishes mandatory energy codes for both residential and commercial buildings, and it has an abundance of appliance and equipment standards in place. South Korea also mandates appliance and equipment labeling as well as building labeling amongst most types of structures. The country's retrofitting codes are also mandatory and apply to both residential and commercial buildings. South Korea's score in the buildings category could be improved by reducing the energy intensity of residential and commercial buildings.

Industry

South Korea saw its highest placement in the industry category. The country has both agreements and incentives in place encouraging manufacturers to limit energy consumption, and it requires that regular energy audits be conducted in manufacturing facilities. South Korea has implemented MEPS IE3 standards for electric motors and has very high rate of investment in industrial R&D as a percentage of industrial GDP. There is no CHP target in place as of yet, but there are incentives to encourage the installation of additional CHP.

Transportation

South Korea tied for 10th in the transportation category. The country boasts the third highest 2025 fuel economy standards of any country assessed in this year's *Scorecard*. The average fuel efficiency of light duty vehicles in 2017 was approximately 37 mpg, and 2.9% of the total vehicle sales in 2020 were electric vehicles. The energy intensity of freight in South Korea is relatively low, and the country's Green & Smart Transportation Partnership serves as one of the few smart freight programs in place anywhere in the world. The country could improve its score in this section by passing fuel economy standards for heavy-duty vehicles.

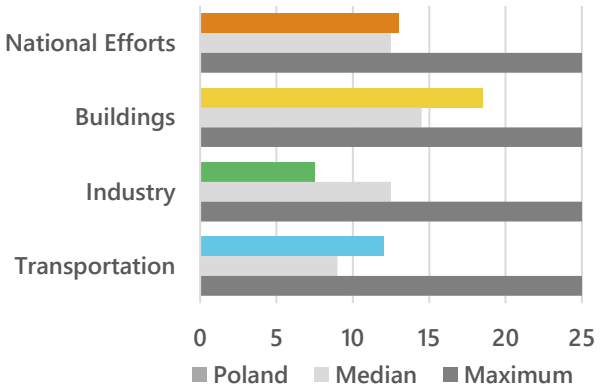
ACEEE'S 2022 INTERNATIONAL ENERGY EFFICIENCY SCORECARD

POLAND

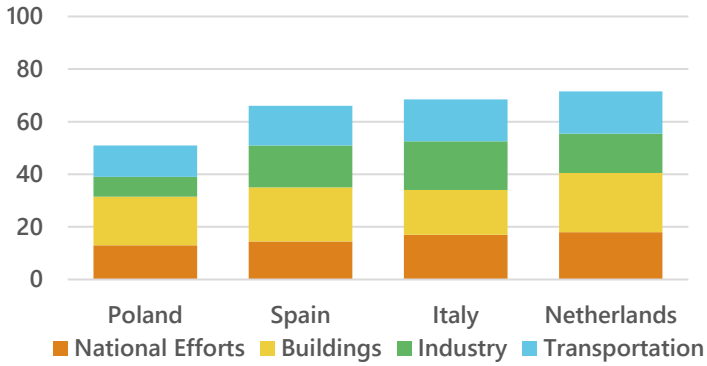
RANK **12/25**

POINTS **51/100**

Poland in the *2022 International Scorecard*



How does Poland compare to other countries in Europe?



National Efforts

Poland ranked 12th in the National Efforts category. The country has pledged to increase energy efficiency 23% by 2030 compared to 2007 levels, and to reduce GHG emissions 7% by 2030 compared to 2005 levels. Poland saw the third-greatest reduction in energy intensity between 2013 and 2018 (a 13% reduction) despite scoring poorly in energy efficiency and energy efficiency R&D spending per capita respectively in this year's *Scorecard*.

Buildings

Poland earned the seventh-highest score in the buildings category. The country has mandatory residential and commercial building energy codes. Like other European Union members, Poland currently has 42 appliance groups covered by energy performance standards (MEPS) and 25 appliance groups covered by mandatory labels. The country also earned full credit for its comprehensive mandatory appliance and equipment labeling policy. Poland could significantly improve its score by decreasing the energy intensity of its buildings.

Industry

Poland places toward the bottom of the pack in the industry category. It is one of just five countries that have no voluntary agreements or incentives for reducing energy consumption and is the only EU country not to have such policies in place. Poland mandates periodic energy audits in industrial facilities; however, it has no national mandate requiring manufacturers to hire energy managers at industrial facilities. Poland has the third-highest percentage of installed CHP of any country scored in this year's *Scorecard* with 21.04%.

Transportation

Poland is an above-average performer in the transportation category. The country participates in the EU's vehicle standards and will aim to achieve a fleet-wide average of 64.4 mpg by 2025. Poland's average on-road fuel economy for passenger vehicles was 39.2 mpg in 2017, ninth overall and the lowest amongst EU countries examined in this year's *Scorecard*. Poland ranked eighth in use of public transit, with 21.5% of total passenger km being traveled by public transit in 2017. In 2020 EV sales comprised only 0.82% of the total vehicles sales within Poland leaving substantial room for growth.

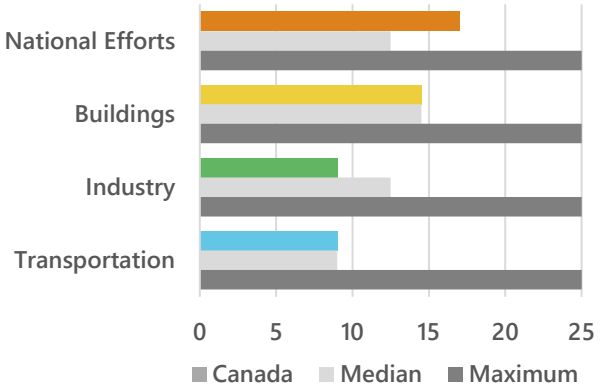
ACEEE'S 2022 INTERNATIONAL ENERGY EFFICIENCY SCORECARD

CANADA

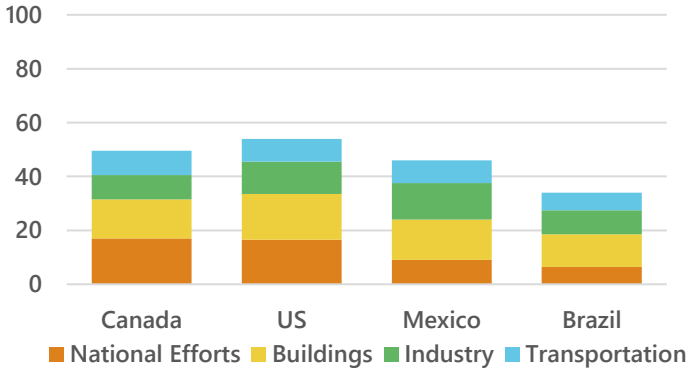
RANK **13/25**

POINTS **49.5/100**

Canada in the *2022 International Scorecard*



How does Canada compare to other countries in the Americas?



National Efforts

Canada does well in the national efforts category. The country's Intended Nationally Determined Contribution (INDC) plan to the UNFCCC aims to achieve an economy-wide target to reduce greenhouse gas emissions 40–45% below 2005 levels by 2030. Investments in energy efficiency per capita are among the highest of the countries analyzed. Moreover, national tax incentives and loan programs exist in multiple sectors to help reach efficiency targets. Despite these efforts, Canada's energy intensity has not declined as much when compared to other countries in the report.

Buildings

Canada is in the middle of the pack for its building energy efficiency policies, due in part to its appliance and equipment standards, which cover 39 products, and to the adoption of its voluntary "EnerGuide" labeling for new and/or renovated homes by some municipalities. The EnerGuide Home Labelling Portal was launched to assist homeowners access energy-related data about their homes online. The Canadian government is investing in building retrofits through the Greener Home Grant Program and setting aside funding from the Canadian Infrastructure Bank for energy-efficient retrofits. Canada can improve its performance by focusing efforts on decreasing energy use intensity in residential and commercial buildings.

Industry

Canada scored low in industrial efficiency. While the country has taken certain steps—such as the Canadian Industry Program for Energy Conservation (CIPEC), a government–industry partnership—to address energy use in the industrial sector, there is still much the country can do. Canada could benefit from establishing a mandate for plant energy managers and mandatory energy audits.

Transportation

Scoring only 9 points out of 25, Canada could benefit from significant improvements to its transportation sector. Like the United States, Canada is a car-heavy economy; as a result, the country has high vehicle miles traveled in personal vehicles per capita. However, Canada has stringent fuel efficiency standards for heavy-duty vehicles and a national smart freight initiative in place. Further energy savings could be gained by increasing investment in rail and encouraging the use of public transit and other modes of efficient transportation. The government's new mandatory sales target for 100% zero emission vehicles by 2035 will also help Canada's rank in future editions of the *Scorecard*.

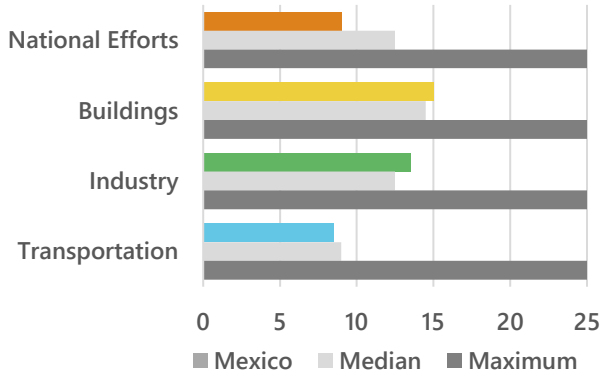
ACEEE'S 2022 INTERNATIONAL ENERGY EFFICIENCY SCORECARD

MEXICO

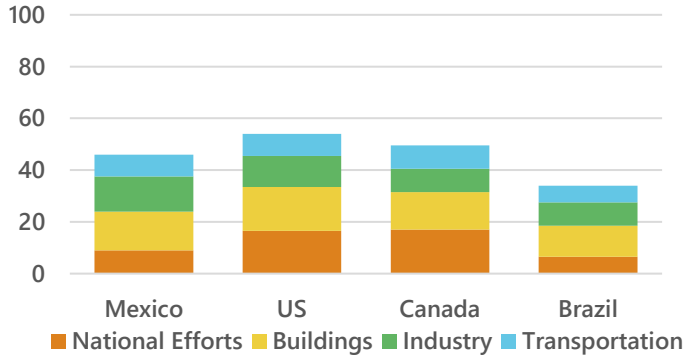
RANK **14/25**

POINTS **46/100**

Mexico in the *2022 International Scorecard*



How does Mexico compare to other countries in the Americas?



National Efforts

Mexico ranked 17th in the national efforts category. The country saw a 9.5% decrease in its energy intensity between 2013 and 2018, and has set a goal of decreasing final energy consumption intensity at least 1.9% annually and reducing GHG emissions 22% by 2030. Mexico was the second-lowest spender in the *Scorecard* in terms of energy efficiency per capita. It spends just $0.67 per capita on energy efficiency R&D.

Buildings

Mexico finished in the top half of the buildings category, ranking 11th among the countries assessed in this year's *Scorecard*. It mandates appliance and equipment labeling on a continuous scale. Mexico also has mandatory national retrofitting codes that apply to both commercial and residential renovations. The country could improve its score in this category by mandating adherence to its residential and commercial building energy codes.

Industry

The country also ranked 11th in the industry category. Mexico has formed both voluntary agreements with manufacturers and provided incentives to encourage energy efficiency. Mexico does not require manufacturing facilities to hire energy managers, but has made periodical energy audits mandatory. The country has efficiency standards for electric motors, however they are less stringent than those of other countries. In 2018 Mexico contributed the equivalent of just 0.23% of industrial GDP to industrial R&D, leaving much room for improvement.

Transportation

Mexico tied for 15th place in the transportation section. The country does not have light-duty or heavy-duty fuel economy standards in place, and the average fuel economy of light-duty vehicles in 2017 was just under 31 mpg. Approximately 13% of the total passenger km traveled in 2017 were traveled via public transit. In 2017, Mexico spent roughly three-quarters as much on rail investments as it did on roadway investments. The country's Transporte Limbo program serves as the country's smart freight program.

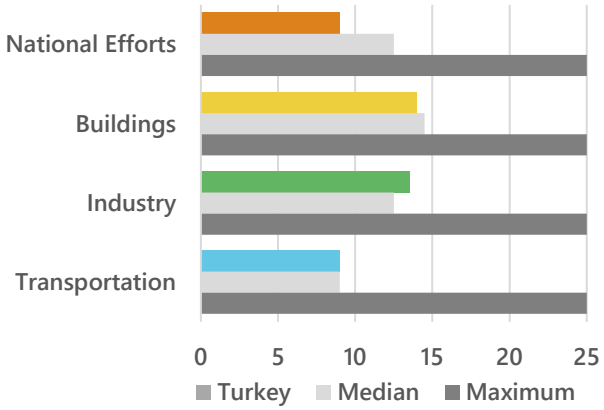
ACEEE'S 2022 INTERNATIONAL ENERGY EFFICIENCY SCORECARD

TURKEY

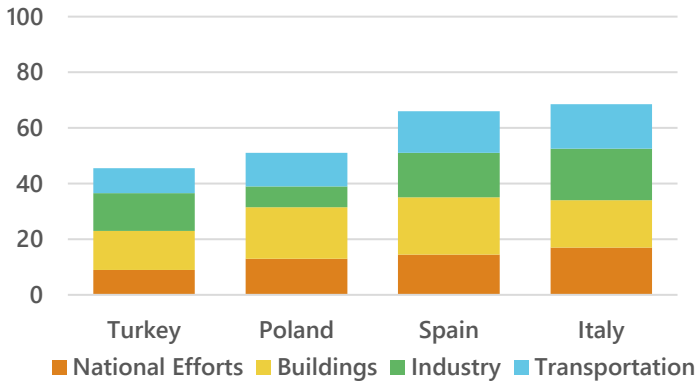
RANK **15/25**

POINTS **45.5/100**

Turkey in the *2022 International Scorecard*



How does Turkey compare to other countries in Europe?



National Efforts

Turkey ranked 17th in the national efforts category. Investments in energy efficiency programs and R&D are relatively low compared to the countries analyzed. However, the country has national tax incentives and loan programs to help reach efficiency targets. In addition, the size of Turkey's ESCO market is relatively large. Nevertheless, there is still room for improvement as the operational efficiency of thermal efficiency plants is low, and Turkey can adopt water savings mandates and implement water efficiency programs.

Buildings

Turkey scored 14 points in buildings energy efficiency. The country currently has 20 appliance groups covered by energy performance standards (MEPS), but only 1 appliance group is covered by mandatory labels. Turkey also has mandatory building labeling policies for all buildings. The country has mandatory building codes for residential and commercial buildings; however, it could improve by introducing additional technical requirements to increase the efficiency of newly constructed buildings and adopting building performance standards for existing buildings.

Industry

Although the country has attractive incentives for energy efficiency in the industrial sector, industrial energy intensity in Turkey remains high. Turkey adopted its 2007 Energy Efficiency Law to support energy efficiency projects and voluntary agreements in industry. If industries are committed to reducing their energy intensity by an average of 10% over a three-year period, the Elektrik Isleri Etüt Idaresi will subsidize 20% of their energy costs during the first year. Turkey also has an energy management systems policy and requires mandatory energy audits. The country could benefit from enacting mandates to employ energy managers in large industrial facilities, growing the number of ISO 50001–certified facilities, and increasing investment in industrial R&D relative to industrial GDP.

Transportation

Although Turkey's light-duty vehicles have a high average fuel economy (43.56 mpg), the country does not yet have 2025 fuel efficiency standards in place for light-duty vehicles. Turkey has relatively low vehicle miles traveled per capita, and a relatively high percentage of transportation is conducted using public transit. Further energy savings could be gained by improving the country's investment in rail versus road transit, improving the energy intensity of freight transport, and adopting fuel efficiency standards for heavy-duty vehicles.

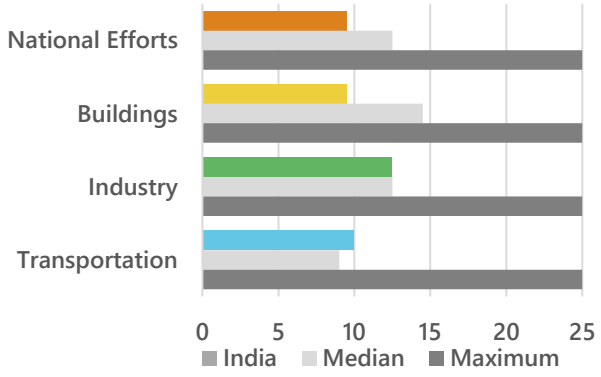
ACEEE'S 2022 INTERNATIONAL ENERGY EFFICIENCY SCORECARD

INDIA

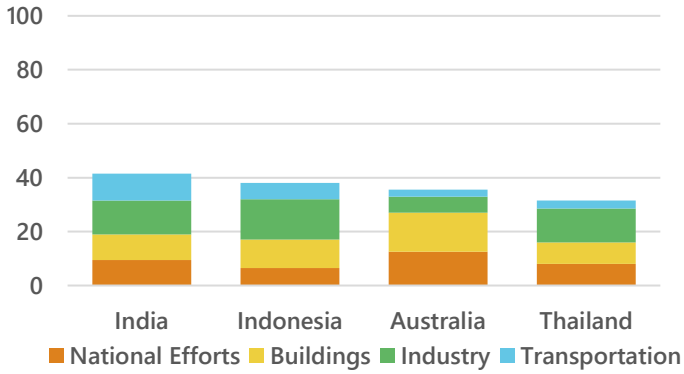
RANK **16/25**

POINTS **41.5/100**

India in the *2022 International Scorecard*



How does India compare to other countries in Asia-Pacific?



National Efforts

India ranked 16th in the national efforts category. The country does not have an energy efficiency goal in place but has committed to reducing the intensity of GHG emissions by 2030. India's government can improve its score by greatly increasing its expenditures in energy efficiency programs and R&D, reducing the T&D losses from power plants, and by continuing to grow its ESCO market.

Buildings

India ranked close to last in the buildings category and has substantial room to improve its efforts to reduce energy consumption and emissions. Most of the country's buildings that will exist in the next 10–20 years are yet to be built. India needs to continue working with states to help with the adoption of both commercial and residential building codes. The country has minimum energy performance standards for only nine products. India has several market transformation initiatives such as the Unnat Jyoti by Affordable LEDs for ALL program and the Super-Efficient Equipment Program.

Industry

Although India performed better in the industrial category than in other policy areas, the country still has opportunities for improvement. Industrial energy intensity remains high and investment in manufacturing R&D is low. However, the Perform, Achieve and Trade (PAT) scheme is a step in the right direction for addressing industrial energy consumption and the successful model is expected to cover more subsectors. The PAT scheme could be improved further by providing more support for energy efficiency in small and medium enterprises.

Transportation

Overall, India ranked in the middle (12th) compared to other countries evaluated in the report. It has far fewer passenger miles traveled per capita than any other country analyzed. India ranks well in terms of passenger vehicle fuel economy. Despite programs such as the Faster Adoption and Manufacturing of Electric Vehicle (FAME) scheme, the country's percentage of new vehicle sales that are electric is low. The government of India does not invest much in rail versus road and could do more to reduce energy and emissions from the freight sector.

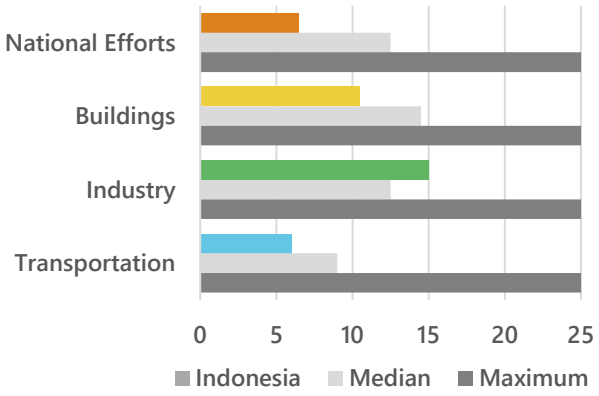
ACEEE'S 2022 INTERNATIONAL ENERGY EFFICIENCY SCORECARD

INDONESIA

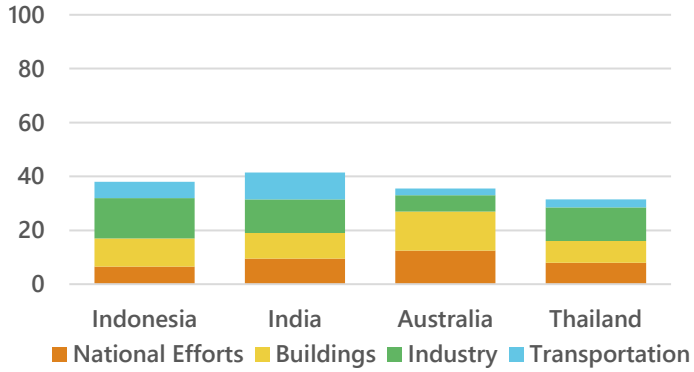
RANK **17/25**

POINTS **38/100**

Indonesia in the *2022 International Scorecard*



How does Indonesia compare to other countries in Asia-Pacific?



National Efforts

Overall, Indonesia's scores were low in the national efforts category, with the country ranking 22nd. With few incentives available for private investment in energy efficiency, the size of its ESCO market remains relatively small. Policies such as tax incentives and government loans for energy efficiency programs can encourage the energy efficiency market in Indonesia, which is estimated to have the highest potential in Southeast Asia. Further, Indonesia can take steps to improve the operational efficiency of thermal power plants and to adopt water efficiency programs.

Buildings

Indonesia can greatly improve in the area of mandatory performance standards and energy labeling schemes for appliances. It has only two appliance groups with mandatory standards or labels. Indonesia has neither policies for energy performance in existing buildings and retrofits nor incentives to encourage retrofits. Indonesia could also benefit by putting in place a national policy for energy information disclosure for all buildings, since its current policy only covers some building types. The country has mandatory building codes for residential and commercial buildings; however, Indonesia could improve by introducing additional technical requirements to increase the efficiency of newly constructed buildings, especially those that are residential.

Industry

Indonesia performed best in the industrial energy efficiency category. The country has energy management policies in place, mandates for energy managers, and energy audit requirements. However, investment in industrial R&D remains low relative to industrial GDP. Indonesia can further improve its industrial energy efficiency by implementing performance standards for motors, enacting policies to encourage the deployment of CHP technologies, and growing the number of ISO 50001 certified facilities.

Transportation

Indonesia was second best in both the category of vehicle miles traveled per capita and use of public transit; however, there is still considerable room for improvement in the transportation sector. Indonesia does not have fuel economy standards for light-duty or heavy-duty vehicles in place. Moreover, investment in rail transit remains low while energy intensity of freight transport remains high. With increases in the demand for mobility, the country must plan to meet this demand by improving public transportation service and infrastructure.

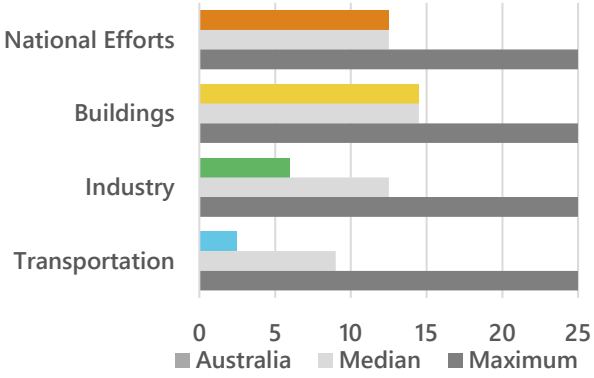
ACEEE'S 2022 INTERNATIONAL ENERGY EFFICIENCY SCORECARD

AUSTRALIA

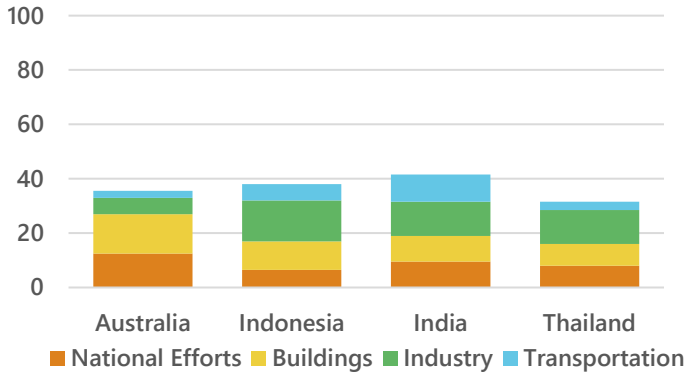
RANK **18/25**

POINTS **35.5/100**

Australia in the *2022 International Scorecard*



How does Australia compare to other countries in Asia-Pacific?



National Efforts

Australia scored 12.5 points in the national efforts category and ranked 13th. The country has a goal of reducing GHG emissions 26–28% below 2005 levels by 2030 and aims to increase energy productivity 40% by 2030. The country also has taken careful steps to safeguard its natural resources through its Water Efficiency Labeling and Standards program and the National Water Initiative. However, Australia could improve its score by increasing government spending on energy efficiency programs and R&D.

Buildings

Australia tied for 12th place in building energy efficiency—its highest placement in any individual category. The country has a mix of voluntary and mandatory energy codes that apply to both residential and commercial buildings. Australia has 20 separate appliance and equipment standards that must be met when outfitting buildings. There are a variety of state and provincial retrofit policies; however, they vary in terms of coverage for buildings. Australia could further improve its score by creating retrofitting policies specific to low-income housing and by decreasing the energy intensity of its residential building stock.

Industry

Australia ranked toward the bottom of the industry category, placing 22nd among countries assessed in this year's *Scorecard*. The country does not mandate the hiring of energy managers within industrial facilities, and it does not require such facilities to perform energy audits. Australia does have standards for electric motors; however, these standards are relatively lenient when compared to those of other countries. There is also a very small share of installed CHP capacity throughout the country, totaling less than 1%.

Transportation

Australia ranked third to last in the transportation category, scoring less than a quarter of the 25 available points. There are no light-duty or heavy-duty fuel economy standards in Australia, and the average fuel economy of a vehicle in 2017 was just under 30 mpg. The country does not have a national smart freight program, and freight movement within the country is relatively energy intensive. Use of public transit within the country is also limited.

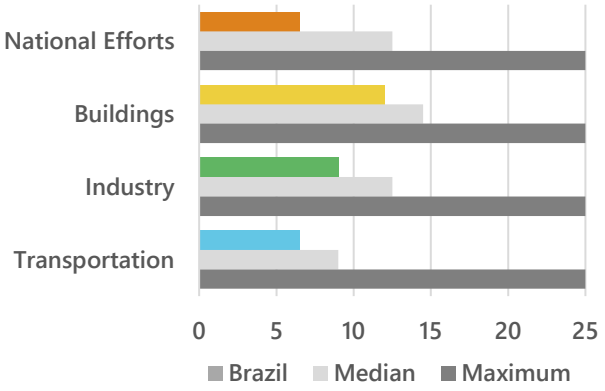
ACEEE'S 2022 INTERNATIONAL ENERGY EFFICIENCY SCORECARD

BRAZIL

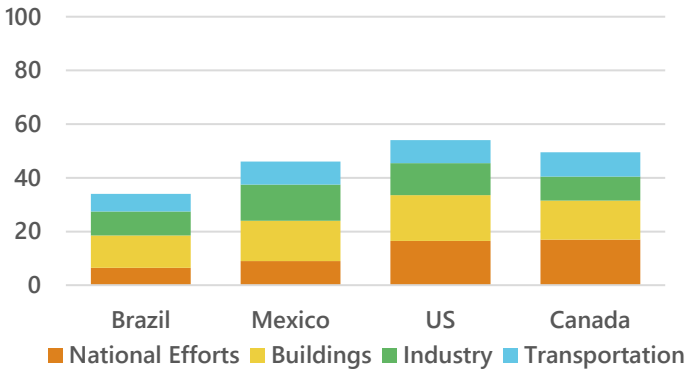
RANK **19/25**

POINTS **34/100**

Brazil in the *2022 International Scorecard*



How does Brazil compare to other countries in the Americas?



National Efforts

Brazil fell into the lowest quartile with its national efforts score. Although the country has an energy reduction goal of 10% by 2030, government expenditure in energy efficiency remains very low compared to other countries analyzed. The lack of energy efficiency incentives such as tax credits makes it difficult for Brazil to reach its efficiency potential. Energy policy in Brazil largely emphasizes renewable energy production, especially in its electricity and transportation sectors.

Buildings

Brazil performs best in the buildings category. In 2013, Brazil enacted a mandatory building performance standard for new residential buildings but still has not adopted a commercial building code. The country has limited appliance and equipment standards, which apply to few products. As space cooling is expected to increase energy use in buildings, it will be important for Brazil to strengthen and improve efficiency in buildings.

Industry

Brazil scored nine points in the industrial category of the *2022 Scorecard*, slightly improving its standing. However, industrial energy intensity remains high in the country, signaling potential for efficiency gains in this sector. Brazil's introduction of efficiency standards for motors and industrial energy performance agreements should be lauded. Implementing a policy on energy management could greatly benefit Brazil's energy efficiency efforts. In particular, the country could also explore requiring energy audits and the hiring of energy managers for large industrial facilities.

Transportation

Brazil scored poorly in the transportation category. The country has passenger vehicle fuel economy standards in place but to date these standards are still voluntary. The Brazilian government could commit to financing more efficient transportation modes, including boosting sales for electric vehicles. Brazil can improve its score by implementing mandatory fuel economy standards for trucks and by shifting some freight traffic to rail or water.

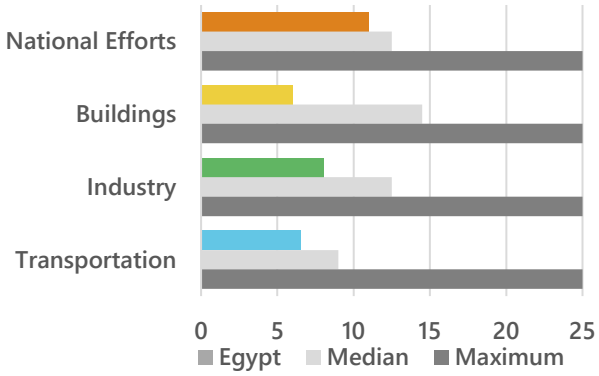
ACEEE'S 2022 INTERNATIONAL ENERGY EFFICIENCY SCORECARD

EGYPT

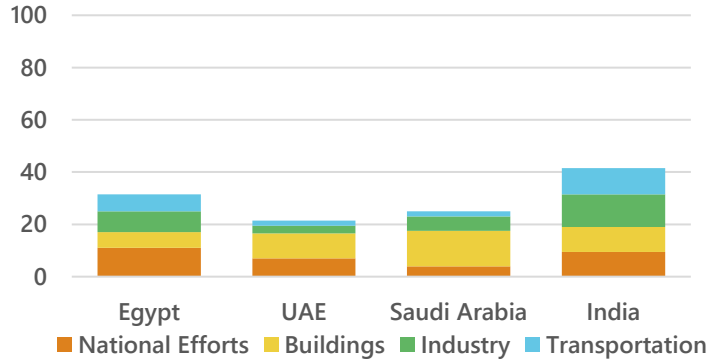
RANK **20/25**

POINTS **31.5/100**

Egypt in the *2022 International Scorecard*



How does Egypt compare to other nearby countries?



National Efforts

Of the categories in the *Scorecard*, Egypt performed best in the national efforts category with a score of 11 out of 25 points. The country has adopted its second National Energy Efficiency Action Plan (NEEAP), which includes a target to reduce Egypt's energy consumption 18% by 2030. Egypt has a relatively low energy intensity and offers multi-sectoral tax credits and loan programs to incentivize energy efficiency. Poor data availability led to low scores for governmental expenditure on R&D and energy efficiency programs.

Buildings

Egypt scored six points for its building efficiency policies and performance. The country has minimum energy performance standards for 11 products and has achieved relatively low building energy intensity. To improve efficiency in this sector, Egypt could adopt mandatory building codes for both residential and commercial buildings. To increase energy savings, the country could also introduce policies targeting building retrofits.

Industry

The energy intensity of Egypt's industry is among the lowest of the countries analyzed. Nevertheless, the country will need to deploy a catalogue of energy efficiency policies aimed at increasing the efficiency of its industrial sector. These policies should include mandates for energy managers and energy audits, and minimum efficiency standards for motors. The country could also focus on strengthening the implementation and use of energy management systems in industrial facilities.

Transportation

Egypt scored low in the transportation section. The country has no fuel economy standards in place for light- or heavy-duty vehicles and had one of the lowest on-road fuel economies (29.4 mpg) of all the countries in the *Scorecard*. Egypt could improve transportation-related efficiency by implementing a smart freight initiative and incentivize electric vehicle sales. However, Egypt makes significant investments in rail transit, perhaps resulting in a relatively high use of public transit by residents.

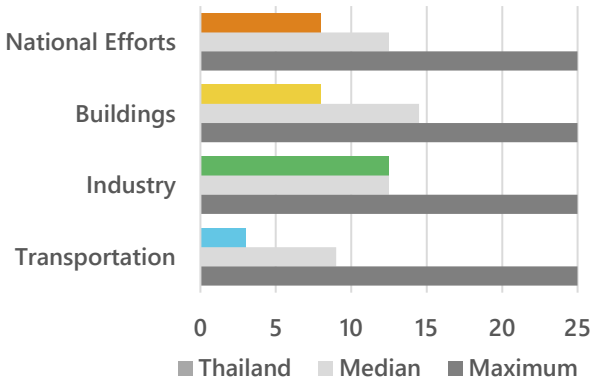
ACEEE'S 2022 INTERNATIONAL ENERGY EFFICIENCY SCORECARD

THAILAND

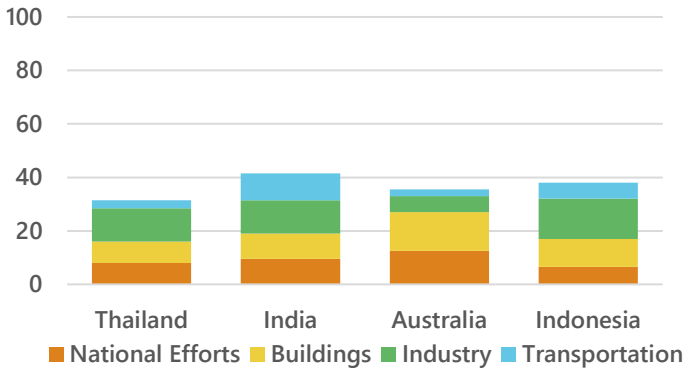
RANK **20/25**

POINTS **31.5/100**

Thailand in the *2022 International Scorecard*



How does Thailand compare to other countries in Asia-Pacific?



National Efforts

Thailand's energy intensity remains high. The country has a goal to reduce energy intensity by 30% in 2036 relative to 2010. Thailand has a sizeable ESCO market and a national water law promoting conservation. Increased data availability on government spending for energy efficiency and R&D could help improve Thailand's score in the national efforts category.

Buildings

Thailand earned the second-lowest score in the buildings category. The country has just four products covered by mandatory minimum energy performance standards and no appliances covered by mandatory labeling. Since the last *Scorecard,* Thailand has adopted mandatory building energy codes for residential and commercial buildings. The country provides grants for building retrofits but could further increase the efficiency of the existing building stock by developing mandatory building retrofit policies. A first step toward a retrofit policy could be developing a program for building performance labeling or disclosure.

Industry

Thailand performed just above average in the industry category and earned 12.5 points for its policies and performance. The country has adopted voluntary energy performance agreements, mandates for energy managers, and mandatory energy audits to increase industrial efficiency. Yet the country's industrial energy intensity is one of the highest among all countries analyzed. Thailand could improve its standing by ramping up policies to encourage energy management in industrial facilities and by adopting more stringent motor efficiency standards.

Transportation

Thailand was among the lowest-scoring countries in the transportation section. The country earned points for vehicle miles traveled; however, its low per capita VMT is likely due to the state of its economy rather than the implementation of energy efficiency strategies. Thailand received one point for having an average fuel economy of 31.4 mpg. Nevertheless, the country has no fuel economy standards for light- or heavy-duty vehicles. We could not find information regarding spending in rail transit and use of public transit.

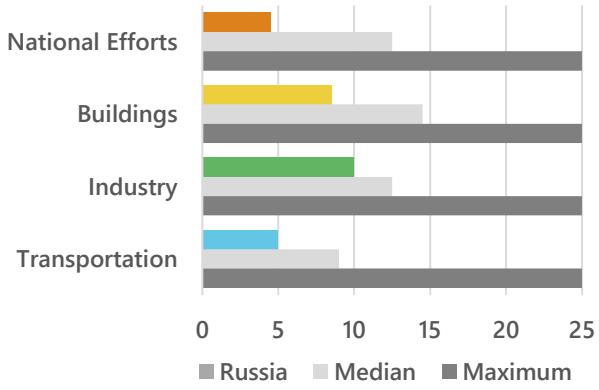
ACEEE'S 2022 INTERNATIONAL ENERGY EFFICIENCY SCORECARD

RUSSIA

RANK 22/25

POINTS 28/100

Russia in the *2022 International Scorecard*



National Efforts

Russia was among the lowest-ranked countries in the national efforts category. The country has multisector loan programs and tax incentives to promote the deployment of energy-efficient technologies. Thermal power plants in Russia are among the least efficient of the 25 countries that we analyzed. Moreover, national government expenditure in energy efficiency programs and R&D remains very low.

Buildings

In the buildings sector, Russia scored 8.5 points. Even though building energy codes are mandatory for both residential and commercial buildings, the country's policies are too weak to stimulate large savings and retrofit policies for existing buildings only apply to some buildings during renovations. Furthermore, appliance and equipment standards apply to only one product. To increase its efficiency in buildings, Russia would benefit from best practices demonstrated in countries such as France, Germany, and the United Kingdom.

Industry

Russia performed best in industrial efficiency. The energy intensity of Russia's industrial sector is high, but a significant portion of the electricity consumed by the sector is generated by combined heat and power, which improves overall efficiency. Despite the high percentage of combined heat and power used, Russia does not have a goal or offer incentives to promote additional combined heat and power capacity. The country does require periodic energy audits of its manufacturing facilities and has agreements and incentives in place between governments and businesses to encourage energy efficiency. However, it has yet to implement mandates to employ energy managers in large industrial facilities and minimum energy performance standards for motors.

Transportation

Russia scored five points in transportation. The country has low vehicle miles traveled per capita and relatively strong investment in rail transit. While it has not yet adopted smart freight initiatives, a high percentage of the country's passenger travel is conducted using public transit when compared to other countries. Further energy savings can be gained by adopting fuel economy standards for light-duty vehicles and improving energy efficiency in freight transportation.

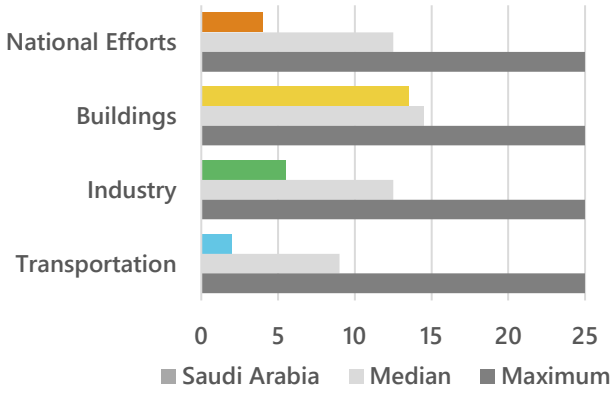
ACEEE'S 2022 INTERNATIONAL ENERGY EFFICIENCY SCORECARD

SAUDI ARABIA

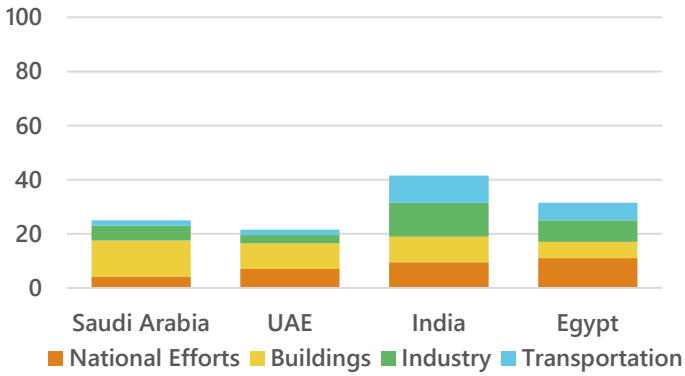
RANK **23/25**

POINTS **25/100**

Saudi Arabia in the *2022 International Scorecard*



How does Saudi Arabia compare to other countries in Asia and North Africa?



National Efforts

Saudi Arabia's energy intensity remains high. We were not able to find information regarding investments in energy efficiency programs or energy efficiency research and development. Saudi Arabia has no tax incentives or loan programs to promote the deployment of energy-efficient technologies.

Buildings

Saudi Arabia has improved its score in buildings energy efficiency policies considerably since the *2018 Scorecard*. In 2018, Saudi Arabia updated the Saudi Building Code (SBC 601 and 602) to increase the stringency of existing energy efficiency requirements and introduce additional requirements. The updates to the code specifically targeted design considerations—such as thermal transfer coefficients for the building shell, windows, and insulation—that would impact cooling loads. Saudi Arabia currently has 13 appliance groups covered by energy performance standards (MEPS) and 11 appliance groups covered by mandatory labels. Despite the gains made by Saudi Arabia, it still has opportunities for improvement; specifically, the country can adopt mandatory building rating and disclosure programs.

Industry

Opportunities to improve efficiency in Saudi Arabia's industrial sector currently exist. The country has minimum energy performance standards for motors in place and its agricultural intensity is among the lowest. However, the country has yet to enact mandates for energy managers and audits, or policies related to energy management systems. Entering into voluntary agreements with manufacturers to improve energy efficiency could demonstrate leadership on the part of the national government and catalyze private action.

Transportation

Saudi Arabia's 2025 fuel economy standards for light-duty vehicles are among the most lenient at 40 mpg. While the presence of the standard itself is encouraging, Saudi Arabia could capture more energy savings by improving these requirements, as well as by adopting new standards for heavy-duty vehicles. Data were not available from Saudi Arabia for several metrics in the transportation category, including the average fuel economy of light-duty vehicles, percentage of new electric vehicles purchased, freight transport per unit of economic activity, energy intensity of freight transport, and investment in rail transit versus roads. Improved data availability from Saudi Arabia could also help the country make progress in the *Scorecard*.

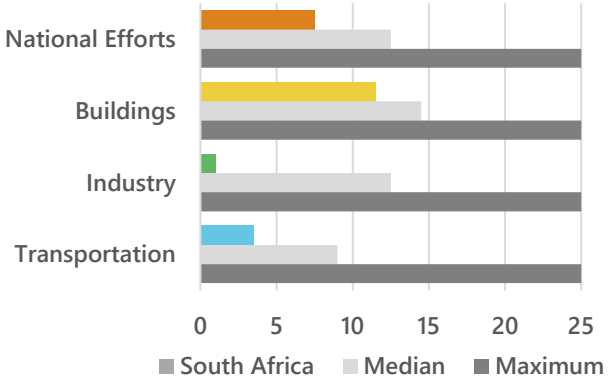
ACEEE'S 2022 INTERNATIONAL ENERGY EFFICIENCY SCORECARD

SOUTH AFRICA

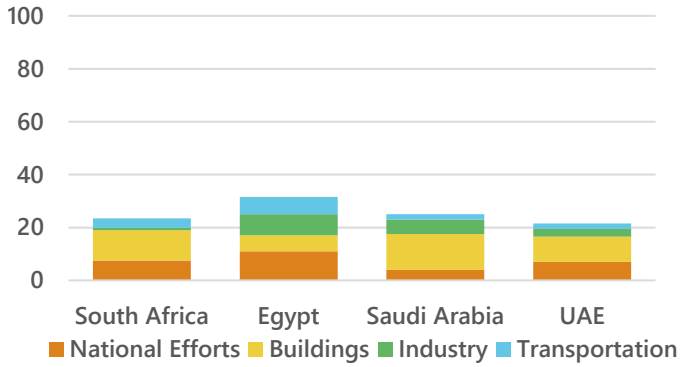
RANK **24/25**

POINTS **23.5/100**

South Africa in the *2022 International Scorecard*



How does South Africa compare to other nearby countries?



National Efforts

The South African government has made a "peak, plateau, decline" commitment for emissions of greenhouse gases through its 2015 Intended Nationally Determined Contribution plan and is targeting a 29% reduction in energy consumption by 2030; however, the country has no formal reduction targets for energy use or emissions. South Africa spends marginal amounts on energy efficiency programs and R&D. The efficiency of its thermal power plants remains low and its ESCO market remains highly unexplored.

Buildings

South Africa performed best in building energy efficiency policies. While it has adopted stringent building energy codes for both new residential and non-residential buildings, the country could build on its existing policies by adopting performance standards and labeling and disclosure policies for buildings. South Africa would also benefit from offering incentives to encourage building retrofits. South Africa currently has 15 appliance groups covered by energy performance standards (MEPS) and 16 appliance groups covered by mandatory labels. The country could make further progress by improving the energy intensity of residential and nonresidential buildings.

Industry

There is great potential for energy savings in South Africa's industrial sector. South Africa scored just one point in this category. The energy intensity of South Africa's industry was among the highest of all countries analyzed. South Africa has adopted a target to install more combined heat and power; however, there is no national policy that implements energy management systems, government-led programs for voluntary agreements with manufacturers to reduce energy use, mandates for energy audits, or performance standards for motors and pumps.

Transportation

South Africa was among the lowest scoring countries in the transportation category. The country has a relatively low number of vehicle miles traveled per capita at 817. South Africa could capture more energy savings by enacting more stringent fuel economy standards for light- and heavy-duty vehicles, increasing investment in rail transit, and implementing strategies to lower the intensity of freight transport. Improved data availability can also help the country make progress in the *Scorecard*.

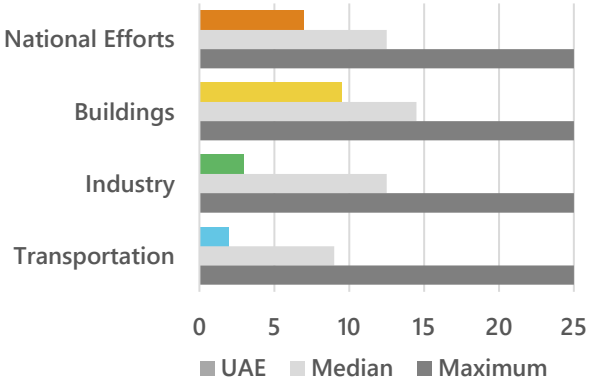
ACEEE'S 2022 INTERNATIONAL ENERGY EFFICIENCY SCORECARD

UNITED ARAB EMIRATES

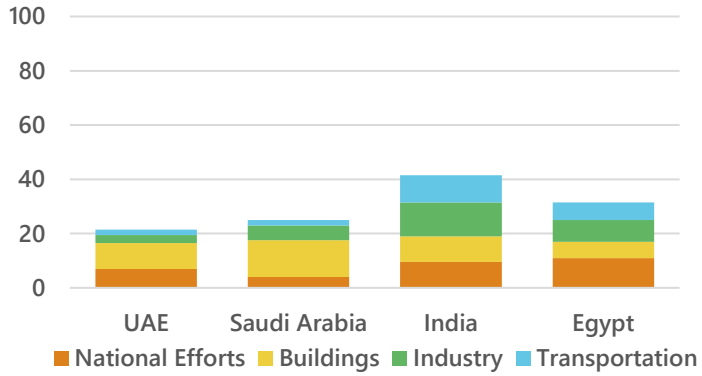
RANK **25/25**

POINTS **21.5/100**

UAE in the *2022 International Scorecard*



How does the UAE compare to other countries in Asia and North Africa?



National Efforts

The United Arab Emirates (UAE) has a goal to improve energy efficiency 40% by 2050 according to the 2017 UAE State of Energy report. Nevertheless, the country has yet to implement the required policies to achieve said goal. We could not find information regarding the size of the UAE's investments in energy efficiency programs or R&D, nor could we confirm the existence of any tax incentives or loan guarantees to promote energy-efficient technologies in this country. The energy intensity of the UAE remains high and its thermal power plants are among the least efficient of all the countries analyzed.

Buildings

The UAE scored 9.5 points for building efficiency. A few emirates have implemented building performance codes for residential and commercial buildings. The nation could adopt these codes on a national level and could improve them by introducing additional requirements beyond thermal efficiency. The UAE currently has 10 appliance groups covered by energy performance standards (MEPS) and 10 appliance groups covered by mandatory labels; however, the UAE could increase the number of appliance groups covered by both MEPS and mandatory labeling. The country could also improve building efficiency by mandating efficiency requirements and requiring all buildings to comply with building rating and disclosure requirements.

Industry

Efforts to improve efficiency in the industrial sector currently exist. The government provides for voluntary agreements with manufacturers to improve energy efficiency. Nevertheless, the energy intensity of the country's industrial sector remains high. The UAE could greatly benefit from establishing mandates for energy managers and audits, and policies related to energy management systems. Providing incentives for the deployment of combined heat and power technologies could also prove to be a powerful tool to improve the efficiency of the UAE's industrial sector.

Transportation

The United Arab Emirates was the lowest scoring country in the transportation section. This was mostly due to the lack of verifiable data. Out of all the metrics analyzed in this section, we could find information only for vehicle miles traveled and fuel economy for light-duty vehicles. The country has a relatively high VMT per capita of 4,978. The UAE's score would benefit from increased data availability.