# The 2018 International Energy Efficiency Scorecard

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June 2018

Report I1801

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## Acknowledgments

This report was made possible through the generous support of a foundation wishing to remain anonymous and through internal ACEEE funding. The authors gratefully acknowledge the reviewers, colleagues, and sponsors who supported this report. External review and support does not imply affiliation or endorsement. External expert reviewers included:

Adam Hinge, Sustainable Energy Partnerships
Aimee McKane, Manage Energy
Barbara Schlomann, Fraunhofer Institute for Systems and Innovation Research
Ben King, US Department of Energy
Benoît Lebot, International Partnership for Energy Efficiency Cooperation
Brett Feldman, Navigant Research
Chiamiao Liu, Industrial Technology Research Institute, Taiwan
Elizabeth Sendich, US Energy Information Administration
Howard Geller, Southwest Energy Efficiency Project
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Matthew Lam, Office of Energy Efficiency, Natural Resources Canada
Padu Padmanabhan, Strategic Energy
Rob Murray-Leach, Energy Efficiency Council, Australia
Jimmy Kumana, Kumana & Associates

Internal reviewers included Jennifer Amann, Naomi Baum, Neal Elliott, Therese Langer, Steve Nadel, and Lowell Ungar. We would also like to thank Mary Robert Carter for her administrative help. Last, we would like to thank Fred Grossberg for developmental editing and managing the editorial process; Elise Marton, Sean O'Brien, and Roxanna Usher for copy editing; Eric Schwass for publication design; and Dawn Selak and Wendy Koch for their help in launching this report.

## Executive Summary

Energy efficiency is often the least expensive way to meet new demand for energy. Governments that encourage investment in energy efficiency and implement policies in support of energy efficiency save citizens money, reduce dependence on energy imports, and decrease pollution. Yet energy efficiency remains massively underutilized globally despite its proven multiple benefits and its potential to become the single largest resource to meet growing energy demand worldwide.

The fourth 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 78% of all the energy consumed on the planet and more than 80% of the world's gross domestic product (GDP) in 2014. 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. 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 59/41 between policy and performance. Policy metrics highlight best practices implemented by a country, such as national energy savings 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.

Italy and Germany tied for first place, earning the highest overall score of 75.5 out of 100 possible points. Rounding out the top five were France, the United Kingdom, and Japan. France took first place in the transportation category, Japan topped the industry category, and the buildings and national efforts sections were led by Spain and Germany, respectively. The lowest-scoring countries were the United Arab Emirates and Saudi Arabia, with 18 points and 16.5 points, respectively. South Africa rounded out the bottom three with 23.5 points. Figure ES1 shows *Scorecard* rankings by country.

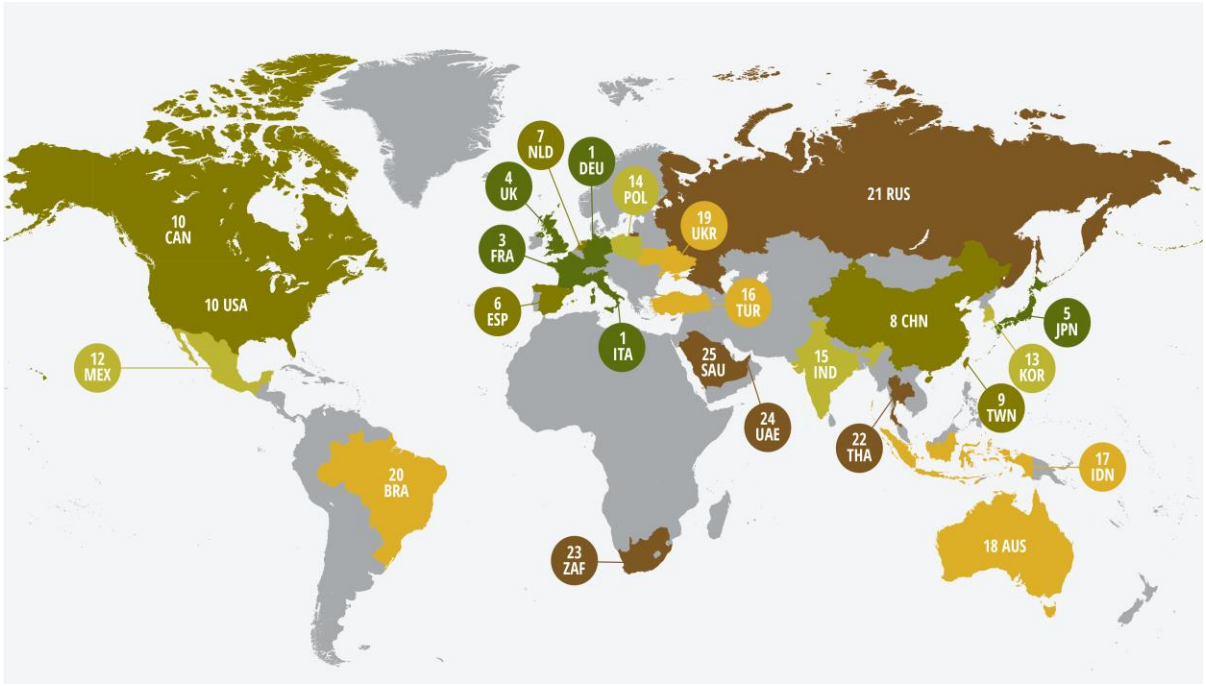


Figure ES1. Rankings by country

Mexico was the most improved country this year, with its score of 54 up 17 points from 2016. Indonesia and the Netherlands also saw significant improvements to their scores in 2018, gaining 7.5 and 6.5 points, respectively. South Africa and Korea saw the largest drops in scores.

Our results indicate that all the economies evaluated in this report still have substantial opportunities for improvement. These are particularly important to pursue given that energy efficiency can save money and resources while helping to meet national greenhouse gas reduction targets. The average score for this edition of the report was just 50.5 points. Low-scoring developing countries such as Brazil, Thailand, and South Africa, and more-developed nations like Saudi Arabia and the United Arab Emirates that have historically focused less on policies to address energy consumption all have great potential to use efficiency to foster continued economic growth without resource constraints. Other more-developed countries could use efficiency to protect their consumers from price volatility, make their economies more competitive by lowering the cost of doing business, and reduce pollution by cutting emissions.

The United States ranked 10th out of 25 countries, tying with Canada. Its score dropped to 55.5 points from 61.5 points in the previous edition due to policy changes and some revisions to our scoring methodology. This report offers a number of recommendations that would help the United States continue to make progress in implementing efficiency policies and reducing energy consumption.

## Introduction

Energy efficiency is often the least-cost means of meeting new demand for energy services. Not only does it reduce overall energy consumption and thereby reduce dependency on energy imports, but it encourages development and creates jobs. Governments that promote investment in energy efficiency and implement supporting policies save citizens money, reduce the potential for crisis and conflict, and decrease pollution. In 2016 the world would have used 12% more energy had it not been for energy efficiency improvements since 2000. These energy efficiency gains allowed households across the world to spend 10 to 30% less than they otherwise would have on their annual energy bills in 2016 (IEA 2017a).

Energy efficiency is particularly important given that the global demand for energy has risen rapidly. The world's total primary energy consumption more than doubled between 1973 and 2015. In 2015 the world consumed 13,647 million tonnes of oil equivalent (Mtoe), of which coal, oil, and natural gas made up 81% (IEA 2017d). Global energy demand is projected to grow another 30% by 2040 as emerging markets develop and increase their standard of living (IEA 2017d). This growth will be accompanied by the need to move energy resources across national borders, setting up opportunities for energy dependence and geopolitical confrontation. Yet energy efficiency remains massively underutilized globally despite its proven multiple benefits and its potential to become the single largest resource for meeting growing energy demand worldwide (IEA 2014).

Additionally, energy efficiency is an essential tool for protecting public health and the environment. Energy efficiency reduces greenhouse gases and harmful criteria pollutants by decreasing the amount of fossil fuels needed to meet energy demand (Costello et al. 2009; HEI 2017). The pollution that is avoided has direct effects on the environment and the health of people living in these countries. Energy efficiency also minimizes the impact of natural disasters on vulnerable populations and strengthens electric grid reliability, helping to avoid blackouts and ensure resilience in the face of storms, floods, and other natural disasters.

*The 2018 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 78% of all the energy consumed on the planet and account for more than 80% of the world's gross domestic product (GDP) in 2014 (World Bank 2018b).

This fourth edition of the *Scorecard* serves three purposes. First, it presents a basic comparison of energy use and efficiency policy efforts in the top energy-consuming countries. Second, it identifies a number of best practices and policies that countries can implement to take advantage of untapped efficiency potential. Last, it shows where the United States stands on the global energy efficiency stage and provides recommendations for further policy improvements. We hope the 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. We ranked the countries on each of the metrics, highlighting best practices in countries that performed well and areas for improvement in countries that did not.

Although we recognize that a number of variables affect energy use, including wealth, climate, geography, and demography, we largely avoided adjusting the data to reflect those impacts and did so only when the case for adjustment was compelling. 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 rationale we used to choose the countries we evaluated, the methodology we used to rate each country on the 36 metrics, and the differences in our ratings approach from the 2016 edition (Kallakuri et al. 2016).

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

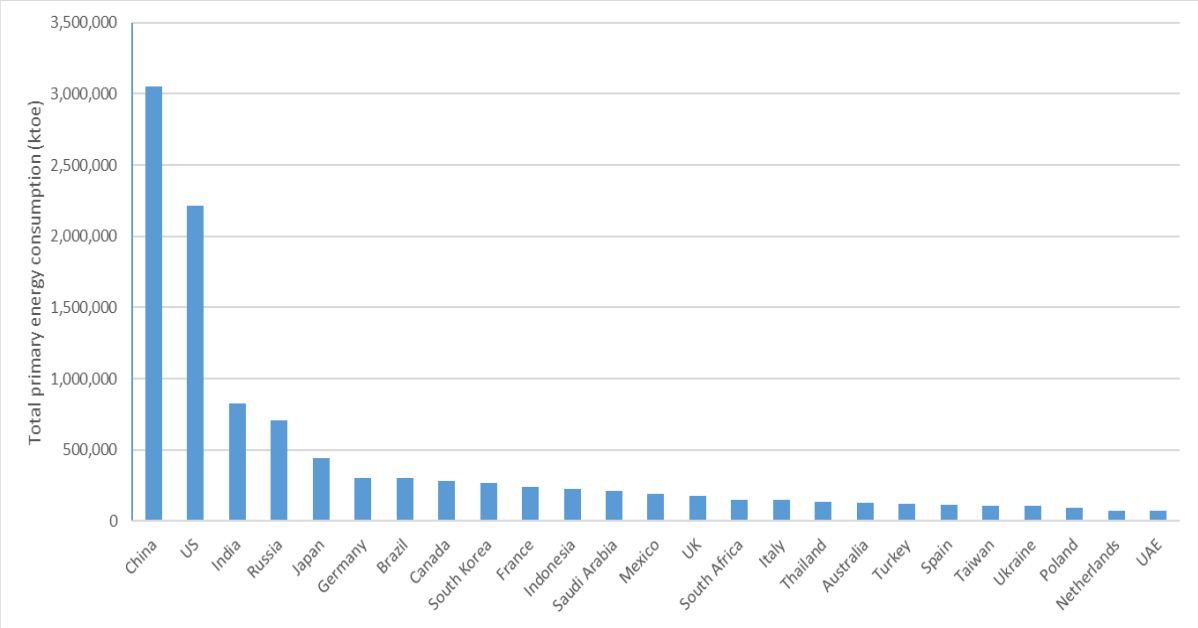


**Figure 1. Total primary energy consumption of top energy consumers, in kilotonnes of oil equivalent (ktoe). Data are for 2014. *Source:* IEA 2018d.**

We added two new countries to our analysis this year: Ukraine and the United Arab Emirates (UAE). Iran is also among the world's largest energy consumers but is not included in this year's report due to data limitations. We hope to be able to include Iran in the 2020 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 hasn't been subjected to conversion or transformation through any engineering process.

Table 1. GDP and energy consumption of top energy-consuming countries in 2014 (alphabetical order)

| 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) |
|---|---|---|---|---|---|---|---|
| Australia | 1.27 | 23,460,694 | 125,255 | 80,893 | 17,688 | 24,196 | 31,754 |
| Brazil | 2.43 | 204,213,133 | 303,178 | 231,819 | 37,372 | 80,661 | 86,438 |
| Canada | 1.77 | 35,544,564 | 278,817 | 196,249 | 60,961 | 43,856 | 61,499 |
| China | 8.33 | 1,364,270,000 | 2,953,515 | 1,868,170 | 375,742 | 967,124 | 278,424 |
| France | 2.74 | 66,331,957 | 242,723 | 145,627 | 58,352 | 24,799 | 43,366 |
| Germany | 3.63 | 80,982,500 | 305,721 | 216,322 | 85,094 | 54,882 | 54,998 |
| India | 2.13 | 1,293,859,294 | 826,191 | 556,044 | 207,045 | 192,188 | 78,563 |
| Indonesia | 0.94 | 255,131,116 | 224,533 | 162,069 | 67,639 | 40,470 | 44,024 |
| Italy | 2.04 | 60,789,140 | 146,773 | 116,571 | 44,207 | 25,280 | 37,009 |
| Japan | 5.91 | 127,276,000 | 439,228 | 294,493 | 99,781 | 83,537 | 71,535 |
| Mexico | 1.17 | 124,221,600 | 188,162 | 118,720 | 21,644 | 33,807 | 51,287 |
| Netherlands | 0.85 | 16,865,008 | 72,933 | 56,749 | 15,446 | 13,214 | 10,280 |
| Poland | 0.53 | 38,011,735 | 94,036 | 65,235 | 26,750 | 14,148 | 15,639 |
| Russia | 1.67 | 143,819,666 | 724,519 | 458,738 | 151,974 | 125,885 | 94,747 |
| Saudi Arabia | 0.65 | 30,776,722 | 213,358 | 141,686 | 20,312 | 48,736 | 43,922 |
| South Africa | 0.41 | 54,146,735 | 145,593 | 74,481 | 21,882 | 27,391 | 17,878 |
| South Korea | 1.23 | 50,746,659 | 268,427 | 170,294 | 39,192 | 49,293 | 31,866 |
| Spain | 1.37 | 46,480,882 | 114,559 | 78,642 | 25,536 | 19,229 | 28,098 |
| Taiwan | 0.53 | 23,403,635 | 110,232 | 68,014 | 9,509 | 22,810 | 12,182 |
| Thailand | 0.38 | 68,416,772 | 134,868 | 96,629 | 16,957 | 29,888 | 22,342 |
| Turkey | 1.02 | 77,030,628 | 121,502 | 85,545 | 29,713 | 25,289 | 20,569 |
| UAE | 0.35 | 9,070,867 | 73,193 | 51,244 | 6,352 | 27,654 | 11,976 |
| UK | 2.62 | 64,613,160 | 179,891 | 122,452 | 51,305 | 22,789 | 39,767 |
| Ukraine | 0.13 | 45,271,947 | 105,708 | 61,430 | 25,018 | 20,571 | 10,327 |
| US | 16.17 | 318,563,456 | 2,216,808 | 1,531,428 | 492,097 | 268,409 | 617,076 |

*Sources:* IEA 2018d; World Bank 2018b; World Bank 2018e

Whenever possible we collected data and indicators on energy consumption and energy efficiency policy from centralized, internationally recognized sources such as the International Energy Agency (IEA), the World Bank, the World Energy Council, the Organization for Economic Co-operation and Development (OECD), 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 providing them with a draft of our report to review.

As table 1 indicates, we examined energy efficiency in the buildings, industry, and transportation categories. We also evaluated, as a separate category, national efforts toward improving energy efficiency. In some cases, we chose and designed metrics based on the availability of relevant, accurate data and standard practice.

Metrics are either policy or performance oriented. Policy metrics highlight best practices 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.

This year the point allocation is split 59/41 between policy and performance metrics compared to 60/40 in 2016. This weighting reflects the fact that the performance metrics in part measure 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 if any country were to emulate the top practices and results in every metric, it could obtain a score of 100. However no country scored full points on all the metrics, indicating that all of them have room for improvement. Table 2 presents a snapshot of the metrics and point allocations. We describe the metrics in greater detail in subsequent chapters.

Table 2. Metrics for all sectors

| Metric | Type | 2016 points | 2018 points |
|---|---|---|---|
| National efforts | | | |
| Change in energy intensity between 2010 and 2015 | Performance | 6 | 6 |
| Spending on energy efficiency | Policy | 5 | 5 |
| Energy savings goals | Policy | 3 | 3 |
| Efficiency of thermal power plants | Performance | 3 | 3 |
| Tax credits and loan programs | Policy | 2 | 2 |
| Spending on energy efficiency R&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 |

| Metric | Type | 2016 points | 2018 points |
|---|---|---|---|
| Buildings | | | |
| Appliance and equipment standards | Policy | 5 | 5 |
| Residential building codes | Policy | 4 | 3 |
| Commercial building codes | Policy | 4 | 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 | 2 | 3 |
| Energy intensity in commercial buildings | Performance | 2 | 3 |
| Industry | | | |
| Energy intensity of the industrial sector | Performance | 6 | 6 |
| Voluntary energy performance agreements with manufacturers | Policy | 3 | 3 |
| Policy to encourage energy management | Policy | 2 | 2 |
| 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 | 2 |
| Policy to encourage CHP | Policy | 2 | 2 |
| 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 |
| Fuel economy standards for heavy-duty tractor trucks | Policy | 3 | 3 |
| Vehicle miles traveled per capita | Performance | 3 | 3 |
| Freight transport per unit of economic activity | Performance | 3 | 2 |
| Energy intensity of freight transport | Performance | 3 | 3 |
| Use of public transit | Performance | 3 | 3 |
| Investment in rail transit versus roads | Policy | 3 | 3 |
| Smart freight initiatives* | Policy | – | 1 |
| | **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 energy efficiency efforts and allows 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. 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. 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 the economic structure of a country over time can affect energy use. In general, we avoided adjusting for physical or economic factors unless we felt it was absolutely necessary (e.g., adjusting building energy intensity for climate and adjusting for the industrial mix in each country), since we do not aim to provide more than a basic comparison of energy use and policies.

Demographic composition and population density also affect overall energy consumption, as do other social factors such as income levels and energy inequity. For example, a country with high energy consumption among some users but with limited energy access can appear energy efficient in a comparison of energy use per capita across countries. These conditions are difficult to control for, and we were not always 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 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 the energy consumption per square foot of residential building area 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. 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 pieces of data we attempted to collect for this edition of the *Scorecard*, we were unable to find any information or come up with a reasonable estimate for approximately 5%. Additionally, there are many ways to evaluate energy efficiency in a country. Our methodology, while reasonable, could have used a variety of alternative metrics or different relative values for the metrics, which would have resulted in changes in the rankings. We also acknowledge that translating continuous variables into categorical scores is imprecise and requires some subjective decision making about where to draw cut points.

Finally, to a small extent our analysis includes subnational policy efforts where such policies 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 have chosen to evaluate the 25 of the top energy-consuming countries across 36 different policy and performance metrics to come up with a combined score for each, other research efforts have used different methodologies. Below 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. It covers three energy pillars: energy access, energy efficiency, and renewable energy. The scorecard uses 27 indicators in 111 countries to evaluate sustainable energy progress through on-the-ground data collection efforts on policy actions only. Additionally, for energy efficiency, efforts are focused on only the buildings and industrial sectors, while ACEEE's *International Scorecard* evaluates energy performance and efficiency policies in buildings, industry, and transportation.

#### Global Tracking Framework (GTF)

As a complement to the RISE project, the World Bank has partnered with IEA to track how countries are performing with regard to meeting their own sustainable energy goals as well as broader Sustainable Development Goals (SDG). 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, and access to clean fuels and technologies for cooking.

#### Odyssey-MURE Energy Efficiency Scoreboard

The Odyssey-MURE Scoreboard provides information on energy efficiency–related indicators and policies in all European Union member countries. The primary objective of the Scoreboard is to assess the level of energy efficiency present in a given country, the trends in energy efficiency, and the future potential for efficiency progress through policies. Unlike ACEEE's *International Scorecard*, Odyssey-MURE evaluates policy and performance separately for each EU member country.

## Results

### *OVERALL*

Germany and Italy tied for first place with the highest overall score of 75.5 out of 100 possible points. France took first place in the transportation category, Japan topped the industry category, and the buildings and national efforts sections were led by Spain and Germany, respectively. The lowest-scoring countries were the United Arab Emirates and

Saudi Arabia, with 16.5 and 18 points, respectively. South Africa rounded out the bottom three with 23.5 points.[2]

Mexico was the most improved country this year, ranking 12th out of the 25 countries evaluated. In the 2016 edition it ranked 19th out of 23. Mexico sits just below the United States and Canada this year. The North American Free Trade Association (NAFTA) provides these countries with an incentive to meet the same product standards and implement similar efficiency programs to ensure that free trade in the region is not impeded. Taiwan also showed significant overall progress, rising from 13th in 2016 to 9th in 2018.

Mexico improved the most in the industry and national efforts categories, and Taiwan had the greatest improvement in national efforts and buildings. Mexico recently enacted mandates for periodic energy audits and on-site energy managers in large industrial facilities. Both Mexico and Taiwan have reduced the energy intensity of their economies in recent years. Taiwan has reduced energy use in its commercial and residential buildings in particular.

For a few of the lower-scoring countries, particularly Saudi Arabia and the United Arab Emirates, scores were not necessarily representative of national efforts on energy efficiency. They may have been affected by problems we encountered in our efforts to find reasonable data.

Figure 2 displays 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 for each country, illustrating the large overall difference between the highest-ranking 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, policy areas in which the country is strongest, areas for improvement, and resources for further information.

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

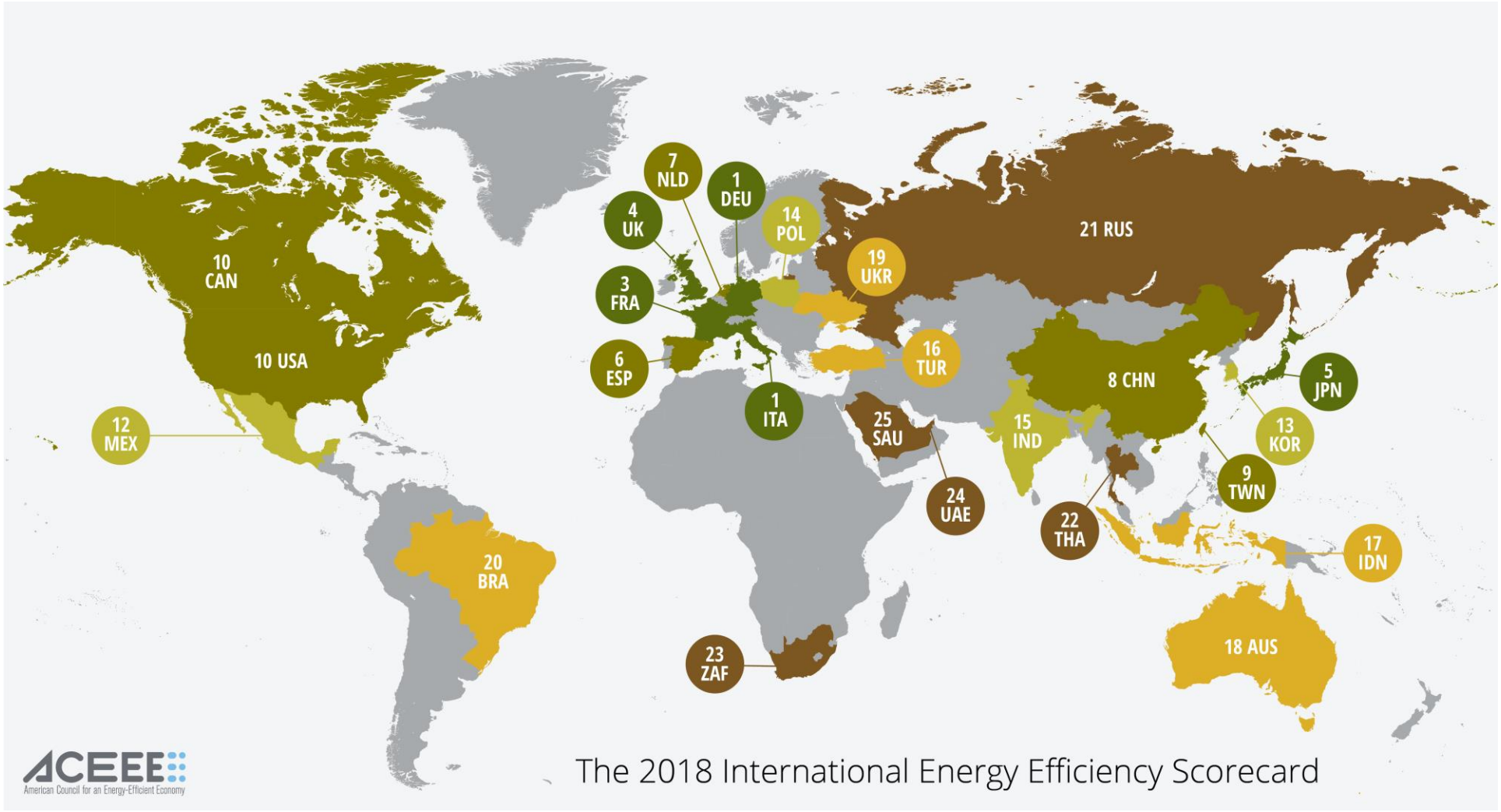


Figure 2. Rankings by country

Table 3. Final scores and rankings

| Total (100 points) | | |
|---|---|---|
| Country | Score | Rank |
| Germany | 75.5 | 1 |
| Italy | 75.5 | 1 |
| France | 73.5 | 3 |
| UK | 73 | 4 |
| Japan | 67 | 5 |
| Spain | 65.5 | 6 |
| Netherlands | 65 | 7 |
| China | 59.5 | 8 |
| Taiwan | 57 | 9 |
| Canada | 55.5 | 10 |
| US | 55.5 | 10 |
| Mexico | 54 | 12 |
| South Korea | 52.5 | 13 |
| Poland | 51 | 14 |
| India | 50.5 | 15 |
| Turkey | 50 | 16 |
| Indonesia | 45 | 17 |
| Australia | 40.5 | 18 |
| Ukraine | 38 | 19 |
| Brazil | 36.5 | 20 |
| Russia | 34.5 | 21 |
| Thailand | 29 | 22 |
| South Africa | 23.5 | 23 |
| UAE | 18 | 24 |
| Saudi Arabia | 16.5 | 25 |

| National efforts (25 points) | | |
|---|---|---|
| Country | Score | Rank |
| Germany | 22 | 1 |
| UK | 18.5 | 2 |
| Italy | 18 | 3 |
| Japan | 17.5 | 4 |
| France | 17 | 5 |
| Canada | 17 | 5 |
| Netherlands | 16 | 7 |
| US | 15.5 | 8 |
| Spain | 14.5 | 9 |
| Taiwan | 14 | 10 |
| China | 13 | 11 |
| Poland | 13 | 11 |
| Turkey | 11.5 | 13 |
| India | 10.5 | 14 |
| Australia | 10 | 15 |
| Indonesia | 10 | 15 |
| Ukraine | 10 | 15 |
| South Korea | 9.5 | 18 |
| Mexico | 9 | 19 |
| Brazil | 7 | 20 |
| Thailand | 6.5 | 21 |
| Russia | 6 | 22 |
| UAE | 5.5 | 23 |
| South Africa | 4.5 | 24 |
| Saudi Arabia | 3 | 25 |

| Buildings (25 points) | | |
|---|---|---|
| Country | Score | Rank |
| Spain | 22 | 1 |
| France | 21 | 2 |
| UK | 21 | 2 |
| Netherlands | 21 | 2 |
| Germany | 20 | 5 |
| Italy | 20 | 5 |
| China | 19 | 7 |
| Poland | 18 | 8 |
| Mexico | 18 | 8 |
| Australia | 17 | 10 |
| Turkey | 16.5 | 11 |
| US | 16 | 12 |
| Taiwan | 15.5 | 13 |
| Canada | 15 | 14 |
| Japan | 14.5 | 15 |
| South Korea | 13 | 16 |
| South Africa | 11.5 | 17 |
| Brazil | 11 | 18 |
| Indonesia | 10 | 19 |
| Russia | 9 | 20 |
| India | 8.5 | 21 |
| UAE | 7 | 22 |
| Ukraine | 6.5 | 23 |
| Thailand | 5.5 | 24 |
| Saudi Arabia | 4 | 25 |

| Industry (25 points) | | |
|---|---|---|
| Country | Score | Rank |
| Japan | 21.5 | 1 |
| Germany | 20.5 | 2 |
| Italy | 20.5 | 2 |
| UK | 19.5 | 4 |
| France | 18 | 5 |
| Mexico | 17.5 | 6 |
| Taiwan | 16.5 | 7 |
| South Korea | 16.5 | 7 |
| Spain | 15.5 | 9 |
| Turkey | 15.5 | 9 |
| Netherlands | 15.5 | 9 |
| Indonesia | 15 | 12 |
| India | 14.5 | 13 |
| US | 13 | 14 |
| Ukraine | 13 | 14 |
| Thailand | 12.5 | 16 |
| China | 12 | 17 |
| Canada | 10.5 | 18 |
| Russia | 10 | 19 |
| Poland | 10 | 19 |
| Brazil | 7.5 | 21 |
| Australia | 6 | 22 |
| Saudi Arabia | 5.5 | 23 |
| UAE | 4 | 24 |
| South Africa | 1.5 | 25 |

| Transportation (25 points) | | |
|---|---|---|
| Country | Score | Rank |
| France | 17.5 | 1 |
| India | 17 | 2 |
| Italy | 17 | 2 |
| China | 15.5 | 4 |
| UK | 14 | 5 |
| Japan | 13.5 | 6 |
| South Korea | 13.5 | 6 |
| Spain | 13.5 | 6 |
| Canada | 13 | 9 |
| Germany | 13 | 9 |
| Netherlands | 12.5 | 11 |
| Brazil | 11 | 12 |
| Taiwan | 11 | 12 |
| US | 11 | 12 |
| Indonesia | 10 | 15 |
| Poland | 10 | 15 |
| Mexico | 9.5 | 17 |
| Russia | 9.5 | 17 |
| Ukraine | 8.5 | 19 |
| Australia | 6.5 | 20 |
| Turkey | 6.5 | 20 |
| South Africa | 6 | 22 |
| Thailand | 4.5 | 23 |
| Saudi Arabia | 4 | 24 |
| UAE | 1.5 | 25 |

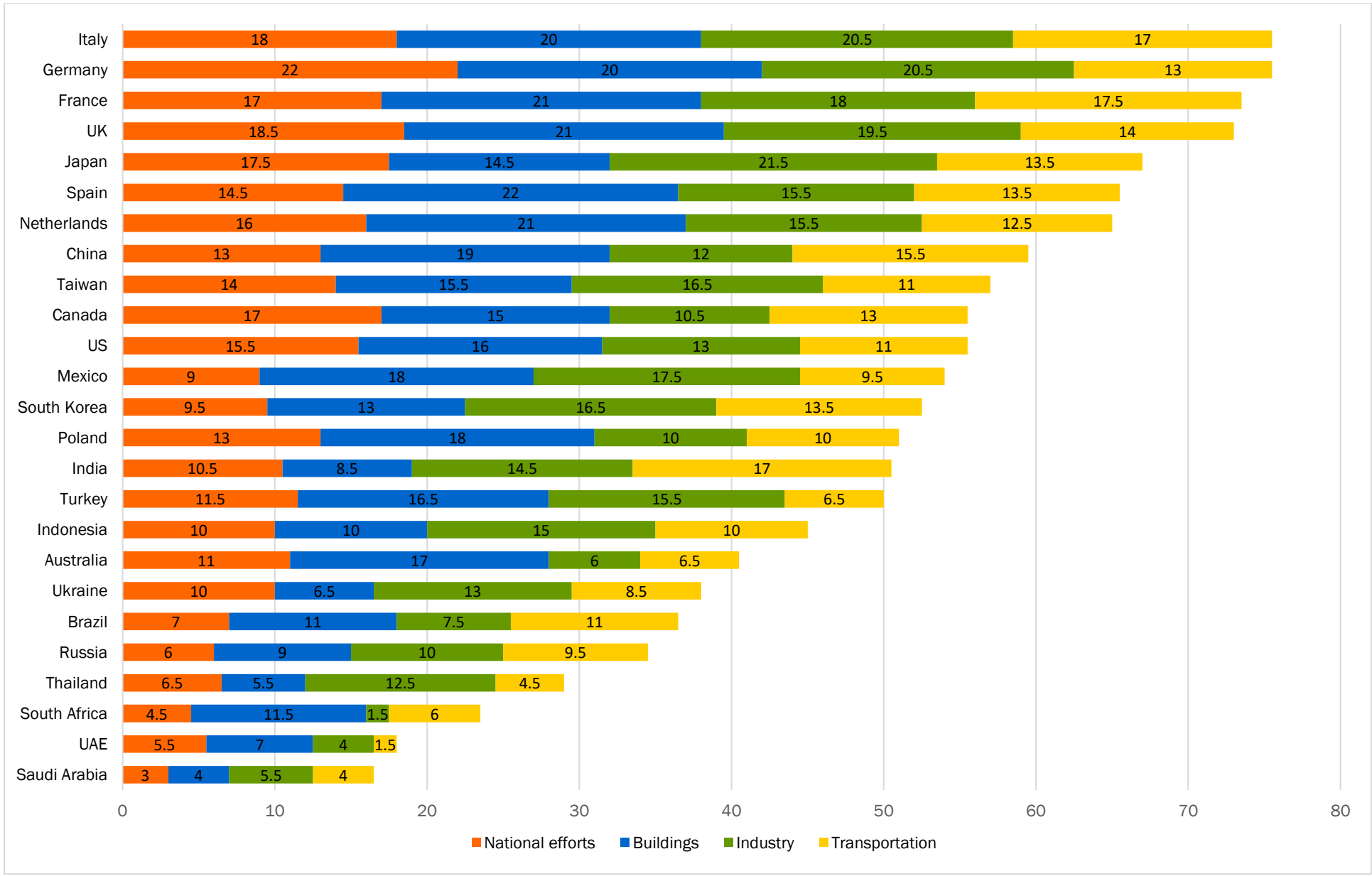


**Figure 3. Overall scores and rankings**

Table 4. Scores for all metrics by category

| Metric | Max. points | Australia | Brazil | Canada | China | France | Germany | India | Indonesia |
|---|---|---|---|---|---|---|---|---|---|
| **National efforts total** | **25** | **11** | **7** | **17** | **13** | **17** | **22** | **10.5** | **10** |
| Change in energy intensity (2010–2015) | 6 | 4 | 0 | 3 | 6 | 3 | 4 | 3 | 5 |
| Spending on energy efficiency | 5 | 1 | 0 | 4 | 0 | 3 | 5 | 0 | 0 |
| Energy savings goals | 3 | 1 | 2 | 1 | 1 | 3 | 3 | 3 | 2 |
| Efficiency of thermal power plants | 3 | 1 | 3 | 3 | 2 | 1 | 2 | 1 | 1 |
| Tax credits and loan programs | 2 | 1 | 1 | 2 | 0.5 | 2 | 2 | 2 | 1 |
| Spending on energy efficiency R&D | 2 | 0.5 | 0 | 1.5 | 0 | 1.5 | 2 | 0.5 | 0 |
| Size of the ESCO market | 2 | 0.5 | 0.5 | 1 | 2 | 2 | 2 | 0.5 | 0 |
| Water efficiency policy | 1 | 1 | 0.5 | 0.5 | 1 | 0.5 | 1 | 0 | 1 |
| Data availability | 1 | 1 | 0 | 1 | 0.5 | 1 | 1 | 0.5 | 0 |
| **Buildings total** | **25** | **17** | **11** | **15** | **19** | **21** | **20** | **8.5** | **10** |
| Appliance and equipment standards | 5 | 2 | 1 | 4 | 4 | 4 | 4 | 1 | 0 |
| Residential building codes | 3 | 3 | 1 | 2.5 | 2.5 | 3 | 3 | 0 | 2.5 |
| Commercial building codes | 3 | 3 | 0 | 2.5 | 2.5 | 3 | 3 | 2 | 2.5 |
| Building retrofit policies | 4 | 3 | 1 | 3 | 2 | 4 | 3 | 0 | 0 |
| Building rating and disclosure | 2 | 1 | 0.5 | 0.5 | 1 | 2 | 2 | 1 | 0 |
| Appliance and equipment labeling | 2 | 1.5 | 2 | 1 | 2 | 2 | 2 | 1 | 1 |
| Energy intensity in residential buildings | 3 | 1 | 2.5 | 0.5 | 3 | 1 | 1.5 | 1.5 | 1.5 |
| Energy intensity in commercial buildings | 3 | 2.5 | 3 | 1 | 2 | 2 | 1.5 | 2 | 2.5 |
| **Industry total** | **25** | **6** | **7.5** | **10.5** | **12** | **18** | **20.5** | **14.5** | **15** |
| Energy intensity of the industrial sector | 6 | 2 | 1 | 2 | 0 | 6 | 5 | 1 | 5 |
| Voluntary energy performance agreements with manufacturers | 3 | 0 | 2 | 3 | 0 | 3 | 3 | 3 | 3 |
| Mandate for plant energy managers | 2 | 0 | 0 | 0 | 2 | 0 | 0 | 2 | 2 |
| Mandatory energy audits | 2 | 0 | 0 | 0 | 2 | 2 | 2 | 2 | 2 |
| CHP share in total installed capacity | 2 | 0.5 | 0.5 | 0.5 | 1 | 0 | 1 | 0.5 | 0 |
| Policy to encourage CHP | 2 | 0 | 1 | 1 | 1 | 1 | 2 | 1 | 0 |
| Minimum efficiency standards for electric motors | 2 | 1 | 1 | 2 | 1 | 2 | 2 | 1 | 0 |
| Policy to encourage energy management | 2 | 0 | 1 | 1 | 2 | 2 | 2 | 2 | 1 |
| Investment in manufacturing R&D | 2 | 1.5 | 0 | 1 | 1 | 1.5 | 1.5 | 0 | 0 |
| Agriculture energy intensity | 2 | 1 | 1 | 0 | 2 | 0.5 | 2 | 2 | 2 |
| **Transportation total** | **25** | **6.5** | **11** | **13** | **15.5** | **17.5** | **13** | **17** | **10** |
| Fuel economy standards for light-duty vehicles | 4 | 0 | 2 | 3 | 3 | 4 | 4 | 3 | 0 |
| Fuel economy of light-duty vehicles | 3 | 0 | 2 | 1 | 1 | 3 | 2 | 3 | 2 |
| Fuel economy standards for heavy-duty tractor trucks | 3 | 0 | 0 | 3 | 2 | 0 | 0 | 1 | 0 |
| Vehicle miles traveled per capita | 3 | 0.5 | 2 | 0.5 | 2.5 | 2 | 0.5 | 3 | 3 |
| Freight transport per unit of economic activity | 2 | 3 | 2 | 2 | 2 | 1 | 1 | 2 | 1 |
| Energy intensity of freight transport | 3 | 1 | 1 | 1 | 0 | 2 | 2 | 0 | 0 |
| Use of public transit | 3 | 1 | 2 | 0.5 | 3 | 1.5 | 1.5 | 3 | 3 |
| Investment in rail transit versus roads | 3 | 1 | 0 | 1 | 1 | 3 | 1 | 2 | 1 |
| Smart freight initiatives | 1 | 0 | 0 | 1 | 1 | 1 | 1 | 0 | 0 |
| **Total** | **100** | **40.5** | **36.5** | **55.5** | **59.5** | **73.5** | **75.5** | **50.5** | **45** |

| Metric | Max. points | Italy | Japan | Mexico | Netherlands | Poland | Russia | Saudi Arabia | South Africa |
|---|---|---|---|---|---|---|---|---|---|
| **National efforts total** | **25** | **18** | **17.5** | **9** | **16** | **13** | **6** | **3** | **4.5** |
| Change in energy intensity (2010–2015) | 6 | 3 | 5 | 2 | 4 | 5 | 1 | 2 | 3 |
| Spending on energy efficiency | 5 | 4 | 2 | 0 | 2 | 1 | 0 | 0 | 0 |
| Energy savings goals | 3 | 3 | 3 | 1 | 3 | 3 | 1 | 1 | 0 |
| Efficiency of thermal power plants | 3 | 2 | 2 | 2 | 2 | 1 | 1 | 0 | 0 |
| Tax credits and loan programs | 2 | 2 | 2 | 1 | 2 | 1 | 2 | 0 | 1 |
| Spending on energy efficiency R&D | 2 | 1.5 | 2 | 0.5 | 1.5 | 0.5 | 0 | 0 | 0 |
| Size of the ESCO market | 2 | 1.5 | 0.5 | 0.5 | 0 | 1 | 0.5 | 0 | 0 |
| Water efficiency policy | 1 | 0 | 0 | 1 | 0.5 | 0 | 0 | 0 | 0.5 |
| Data availability | 1 | 1 | 1 | 1 | 1 | 0.5 | 0.5 | 0 | 0 |
| **Buildings total** | **25** | **20** | **14.5** | **18** | **21** | **18** | **9** | **4** | **11.5** |
| Appliance and equipment standards | 5 | 4 | 2 | 3 | 4 | 4 | 0 | 0 | 1 |
| Residential building codes | 3 | 3 | 2.5 | 2.5 | 3 | 3 | 2 | 1.5 | 3 |
| Commercial building codes | 3 | 3 | 2 | 3 | 3 | 3 | 2 | 1.5 | 3 |
| Building retrofit policies | 4 | 3 | 3 | 2 | 3 | 3 | 2 | 0 | 0 |
| Building rating and disclosure | 2 | 2 | 0.5 | 0 | 2 | 2 | 1 | 0 | 0 |
| Appliance and equipment labeling | 2 | 2 | 1 | 1.5 | 2 | 2 | 1.5 | 0 | 1.5 |
| Energy intensity in residential buildings | 3 | 0.5 | 2 | 3 | 1.5 | 0.5 | 0 | 1 | 1 |
| Energy intensity in commercial buildings | 3 | 2.5 | 1.5 | 3 | 2.5 | 0.5 | 0.5 | 0 | 2 |
| **Industry total** | **25** | **20.5** | **21.5** | **17.5** | **15.5** | **10** | **10** | **5.5** | **1.5** |
| Energy intensity of the industrial sector | 6 | 5 | 6 | 5 | 5 | 3 | 0 | 2 | 0 |
| Voluntary energy performance agreements with manufacturers | 3 | 3 | 3 | 3 | 2 | 0 | 3 | 0 | 0 |
| Mandate for plant energy managers | 2 | 2 | 2 | 2 | 0 | 0 | 0 | 0 | 0 |
| Mandatory energy audits | 2 | 2 | 2 | 2 | 2 | 2 | 2 | 0 | 0 |
| CHP share in total installed capacity | 2 | 1.5 | 0 | 0 | 2 | 1.5 | 2 | 0 | 0 |
| Policy to encourage CHP | 2 | 1 | 2 | 1 | 1 | 1 | 0 | 0 | 1 |
| Minimum efficiency standards for electric motors | 2 | 2 | 2 | 2 | 2 | 2 | 0 | 1 | 0 |
| Policy to encourage energy management | 2 | 2 | 1 | 1 | 0 | 0 | 1 | 0 | 0 |
| Investment in manufacturing R&D | 2 | 0.5 | 2 | 0 | 1.5 | 0.5 | 0.5 | 0.5 | 0.5 |
| Agriculture energy intensity | 2 | 1.5 | 1.5 | 1.5 | 0 | 0 | 1.5 | 2 | 0 |
| **Transportation total** | **25** | **17** | **13.5** | **9.5** | **12.5** | **10** | **9.5** | **4** | **6** |
| Fuel economy standards for light-duty vehicles | 4 | 4 | 3 | 1 | 4 | 0 | 0 | 2 | 0 |
| Fuel economy of light-duty vehicles | 3 | 3 | 2 | 1 | 2 | 2 | 1 | 0 | 2 |
| Fuel economy standards for heavy-duty tractor trucks | 3 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Vehicle miles traveled per capita | 3 | 2.5 | 1.5 | 2 | 1 | 1 | 1.5 | 2 | 2.5 |
| Freight transport per unit of economic activity | 2 | 0 | 0 | 0 | 1 | 3 | 3 | 0 | 0 |
| Energy intensity of freight transport | 3 | 2 | 2 | 1 | 2 | 1 | 0 | 0 | 0 |
| Use of public transit | 3 | 1.5 | 2 | 2.5 | 1.5 | 2 | 2 | 0 | 1.5 |
| Investment in rail transit versus roads | 3 | 3 | 1 | 1 | 0 | 1 | 2 | 0 | 0 |
| Smart freight initiatives | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 0 |
| **Total** | **100** | **75.5** | **67** | **54** | **65** | **51** | **34.5** | **16.5** | **23.5** |

| Metric | Max. points | South Korea | Spain | Taiwan | Thailand | Turkey | UAE | Ukraine | UK | US |
|---|---|---|---|---|---|---|---|---|---|---|
| **National efforts total** | **25** | **9.5** | **14.5** | **14** | **6.5** | **11.5** | **5.5** | **10** | **18.5** | **15.5** |
| Change in energy intensity (2010–2015) | 6 | 2 | 2 | 5 | 1 | 4 | 2 | 6 | 5 | 3 |
| Spending on energy efficiency | 5 | 0 | 4 | 1 | 0 | 1 | 0 | 0 | 4 | 4 |
| Energy savings goals | 3 | 2 | 3 | 1 | 2 | 1 | 3 | 1 | 3 | 0 |
| Efficiency of thermal power plants | 3 | 1 | 2 | 1 | 1 | 2 | 0 | 0 | 2 | 2 |
| Tax credits and loan programs | 2 | 2 | 1 | 1 | 1 | 1 | 0 | 1 | 2 | 2 |
| Spending on energy efficiency R&D | 2 | 1 | 0.5 | 1.5 | 0 | 0.5 | 0 | 0 | 1 | 2 |
| Size of the ESCO market | 2 | 1 | 1 | 2 | 1 | 1 | 0.5 | 1.5 | 0.5 | 1 |
| Water efficiency policy | 1 | 0 | 0.5 | 1 | 0.5 | 0.5 | 0 | 0 | 0 | 0.5 |
| Data availability | 1 | 0.5 | 0.5 | 0.5 | 0 | 0.5 | 0 | 0.5 | 1 | 1 |
| **Buildings total** | **25** | **13** | **22** | **15.5** | **5.5** | **16.5** | **7** | **6.5** | **21** | **16** |
| Appliance and equipment standards | 5 | 3 | 4 | 1 | 0 | 3 | 1 | 0 | 4 | 5 |
| Residential building codes | 3 | 3 | 3 | 2.5 | 0 | 2 | 1.5 | 1 | 3 | 2.5 |
| Commercial building codes | 3 | 3 | 3 | 2.5 | 2 | 2 | 1.5 | 1 | 3 | 2.5 |
| Building retrofit policies | 4 | 1 | 3 | 3 | 1 | 2 | 0 | 0 | 3 | 2 |
| Building rating and disclosure | 2 | 0 | 2 | 0 | 0 | 2 | 0.5 | 0 | 2 | 0.5 |
| Appliance and equipment labeling | 2 | 2 | 2 | 1.5 | 1 | 2 | 1 | 1.5 | 2 | 1.5 |
| Energy intensity in residential buildings | 3 | 1 | 2.5 | 2.5 | 1.5 | 2.5 | 1.5 | 1.5 | 1.5 | 1 |
| Energy intensity in commercial buildings | 3 | 0 | 2.5 | 2.5 | 0 | 1 | 0 | 1.5 | 2.5 | 1 |
| **Industry total** | **25** | **16.5** | **15.5** | **16.5** | **12.5** | **15.5** | **4** | **13** | **19.5** | **13** |
| Energy intensity of the industrial sector | 6 | 4 | 5 | 4 | 1 | 4 | 1 | 0 | 6 | 3 |
| Voluntary energy performance agreements with manufacturers | 3 | 3 | 3 | 0 | 3 | 3 | 2 | 3 | 3 | 2 |
| Mandate for plant energy managers | 2 | 0 | 0 | 2 | 2 | 0 | 0 | 2 | 0 | 0 |
| Mandatory energy audits | 2 | 2 | 2 | 2 | 2 | 2 | 0 | 2 | 2 | 0 |
| CHP share in total installed capacity | 2 | 0.5 | 0.5 | 1.5 | 0.5 | 0.5 | 0 | 1.5 | 0.5 | 0.5 |
| Policy to encourage CHP | 2 | 1 | 0 | 1 | 0 | 2 | 0 | 1 | 1 | 2 |
| Minimum efficiency standards for electric motors | 2 | 2 | 2 | 2 | 1 | 1 | 1 | 0 | 2 | 2 |
| Policy to encourage energy management | 2 | 1 | 1 | 1 | 1 | 1 | 0 | 1 | 2 | 1 |
| Investment in manufacturing R&D | 2 | 2 | 0.5 | 1.5 | 0.5 | 0.5 | 0 | 0.5 | 1.5 | 2 |
| Agriculture energy intensity | 2 | 1 | 1.5 | 1.5 | 1.5 | 1.5 | 0 | 2 | 1.5 | 0.5 |
| **Transportation total** | **25** | **13.5** | **13.5** | **11** | **4.5** | **6.5** | **1.5** | **8.5** | **14** | **11** |
| Fuel economy standards for light-duty vehicles | 4 | 4 | 4 | 0 | 0 | 0 | 0 | 0 | 4 | 3 |
| Fuel economy of light-duty vehicles | 3 | 1 | 2 | 3 | 2 | 3 | 0 | 2 | 2 | 0 |
| Fuel economy standards for heavy-duty tractor trucks | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 3 |
| Vehicle miles traveled per capita | 3 | 1.5 | 1 | 1.5 | 2.5 | 2.5 | 1.5 | 2 | 1 | 0 |
| Freight transport per unit of economic activity | 2 | 0 | 2 | 1 | 0 | 0 | 0 | 0 | 0 | 1 |
| Energy intensity of freight transport | 3 | 2 | 1 | 2 | 0 | 1 | 0 | 0 | 2 | 1 |
| Use of public transit | 3 | 2 | 1.5 | 1.5 | 0 | 0 | 0 | 2.5 | 1 | 1 |
| Investment in rail transit versus roads | 3 | 2 | 2 | 2 | 0 | 0 | 0 | 2 | 3 | 1 |
| Smart freight initiatives | 1 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 1 |
| **Total** | **100** | **52.5** | **65.5** | **57** | **29** | **50** | **18** | **38** | **73** | **55.5** |

Table 5. Changes in score by country between 2014 and 2018

| Country | 2014 points | 2014 rank | 2016 points | 2016 rank | 2018 points | 2018 rank |
|---|---|---|---|---|---|---|
| Australia | 49 | 10 | 41 | 16 | 40.5 | 18 |
| Brazil | 30 | 15 | 32.5 | 22 | 36.5 | 20 |
| Canada | 50 | 9 | 59 | 10 | 55.5 | 10 |
| China | 58 | 5 | 64 | 6 | 59.5 | 8 |
| France | 61 | 4 | 67.5 | 4 | 73.5 | 3 |
| Germany | 65 | 1 | 73.5 | 1 | 75.5 | 1 |
| India | 45 | 11 | 48.5 | 14 | 50.5 | 15 |
| Indonesia | – | – | 37.5 | 18 | 45 | 17 |
| Italy | 64 | 2 | 68.5 | 2 | 75.5 | 1 |
| Japan | 57 | 6 | 68.5 | 2 | 67 | 5 |
| Mexico | 29 | 16 | 37 | 19 | 54 | 12 |
| Netherlands | – | – | 58 | 11 | 65 | 7 |
| Poland | – | – | 53.5 | 12 | 51 | 14 |
| Russia | 35 | 14 | 38 | 17 | 34.5 | 21 |
| Saudi Arabia | – | – | 15.5 | 23 | 16.5 | 25 |
| South Africa | – | – | 33 | 21 | 23.5 | 23 |
| South Korea | 44 | 12 | 61.5 | 8 | 52.5 | 13 |
| Spain | 54 | 8 | 62 | 7 | 65.5 | 6 |
| Taiwan | – | – | 51 | 13 | 57 | 9 |
| Thailand | – | – | 36.5 | 20 | 29 | 22 |
| Turkey | – | – | 46.5 | 15 | 50 | 16 |
| UAE | – | – | – | – | 18 | 24 |
| UK | 57 | 6 | 65 | 5 | 73 | 4 |
| Ukraine | – | – | – | – | 38 | 19 |
| US | 42 | 13 | 61.5 | 8 | 55.5 | 10 |

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

Table 5 shows that over the past three editions of the *International Scorecard*, the European countries have made steady improvements in their scores, claiming many of the top spots in the rankings between 2014 and 2018. The United States, Canada, and China have seen significant fluctuations in their scores. Both countries peaked in 2016 and have seen slight dips in their scores in 2018 due to methodology and policy changes. Among the developing countries, India and Mexico have continued to make steady progress in their scores and ranks.

### *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 breakdown of points for these metrics for both this edition and the previous edition of the *Scorecard*.

**Table 6. Point allocation for policy metrics**

| Metric | 2016 points | 2018 points |
|---|---|---|
| National efforts | | |
| Spending on energy efficiency | 5 | 5 |
| Energy savings goals | 3 | 3 |
| Tax credits and loan programs | 2 | 2 |
| Spending on energy efficiency R&D | 2 | 2 |
| Water efficiency policy | 1 | 1 |
| Data availability | 1 | 1 |
| Buildings | | |
| Appliance and equipment standards | 5 | 5 |
| Residential building codes | 4 | 3 |
| Commercial building codes | 4 | 3 |
| Building retrofit policies | 4 | 4 |
| Building rating and disclosure | 2 | 2 |
| Appliance and equipment labeling | 2 | 2 |
| Industry | | |
| Voluntary agreements with manufacturers | 3 | 3 |
| Energy management policy | 2 | 2 |
| Standards for motors | 2 | 2 |
| Mandate for energy managers | 2 | 2 |
| Mandatory energy audits | 2 | 2 |
| Investment in manufacturing R&D | 2 | 2 |
| CHP policy | 2 | 2 |

| Metric | 2016 points | 2018 points |
|---|---|---|
| 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 |
| **Total** | **60** | **59** |

Table 7 shows the rankings.

**Table 7. Countries ranked by total score on policy metrics (59 possible points)**

| Country | Points | Rank |
|---|---|---|
| Italy | 50 | 1 |
| Germany | 49.5 | 2 |
| France | 49 | 3 |
| UK | 48.5 | 4 |
| Japan | 42 | 5 |
| US | 41 | 6 |
| Netherlands | 41 | 6 |
| Spain | 41 | 6 |
| Canada | 40 | 9 |
| South Korea | 36 | 10 |
| China | 32.5 | 11 |
| Mexico | 30.5 | 12 |
| Poland | 30 | 13 |
| India | 28.5 | 14 |
| Taiwan | 27.5 | 15 |
| Turkey | 27 | 16 |
| Australia | 22.5 | 17 |
| Russia | 21 | 18 |
| Indonesia | 18 | 19 |
| Ukraine | 18 | 19 |
| Thailand | 16.5 | 21 |
| Brazil | 15.5 | 22 |

| Country | Points | Rank |
|---|---|---|
| UAE | 11.5 | 23 |
| South Africa | 11 | 24 |
| Saudi Arabia | 7.5 | 25 |

Table 7 shows that many EU countries scored high on policy metrics, as did Japan and the United States. However it is important to note that these European nations are subject to EU laws and regulations on energy efficiency and that their impressive performance on policy metrics is not necessarily indicative of their own national efforts. Nevertheless, the EU is taking the most action on energy efficiency through policies and programs, particularly in their buildings and industry efficiency policies. Most of the countries that scored well on the policy metrics have some sort of unifying national energy-reduction goal in place.

### *PERFORMANCE METRICS*

Table 8 shows the breakdown of points allocated to performance metrics for this edition and the 2016 edition of the *International Scorecard*, and table 9 shows the country scores.

**Table 8. Point allocation for performance metrics**

| Metric | 2016 points | 2018 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 | 2 | 3 |
| Energy intensity in commercial buildings | 2 | 3 |
| Industry | | |
| Energy intensity of the industrial sector | 6 | 6 |
| CHP installed capacity | 2 | 2 |
| Energy intensity of agriculture | 2 | 2 |
| Transportation | | |
| Fuel economy of light-duty vehicles | 3 | 3 |
| Vehicle miles traveled per capita | 3 | 3 |
| Freight transport per unit of economic activity | 3 | 2 |
| Energy intensity of freight transport | 3 | 3 |
| Use of public transit | 3 | 3 |
| **Total** | **40** | **41** |

Table 9. Countries ranked by total score on performance metrics (41 possible points)

| Country | Points | Rank |
|---|---|---|
| Taiwan | 29 | 1 |
| China | 26.5 | 2 |
| Italy | 26.5 | 2 |
| Germany | 26 | 4 |
| Indonesia | 26 | 4 |
| Japan | 26 | 4 |
| UK | 25.5 | 7 |
| France | 25 | 8 |
| Spain | 24.5 | 9 |
| Netherlands | 24.5 | 9 |
| Mexico | 23.5 | 11 |
| Turkey | 23 | 12 |
| India | 22.5 | 13 |
| Poland | 21.5 | 14 |
| Brazil | 20.5 | 15 |
| Ukraine | 20.5 | 15 |
| Australia | 18 | 17 |
| South Korea | 17 | 18 |
| Canada | 16 | 19 |
| US | 15 | 20 |
| Russia | 14 | 21 |
| South Africa | 12 | 22 |
| Thailand | 12 | 22 |
| Saudi Arabia | 9 | 24 |
| UAE | 6.5 | 25 |

Table 9 shows a more mixed group of leaders. While a few of the EU nations again did well, so did a number of Asian countries such as Taiwan, Indonesia, and Japan. Among the developed countries, Australia, Canada, and the United States did poorly on the performance metrics. However, as discussed earlier, rating countries on their energy performance is very difficult given the number of factors that impact energy use; the vast differences in demography, climate, and economic conditions among nations; and 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 we also scored related cross-sectoral policies. Such policies include financial investments in energy efficiency programs in general, and in research and development (R&D) in emerging technologies specifically. We also scored countries on their national energy-saving targets and 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. Last, we awarded an extra 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.

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. For the fourth time in a row, Germany earned the top spot in the national efforts category, with 22 out of a possible 25 points. The United Kingdom followed with a score of 18.5 points, and Italy was in third place with 18 points. Germany earned the maximum possible points for spending on energy efficiency, highlighting the government's dedication to reducing overall consumption. The United Kingdom's performance in this section results from high scores on national energy reduction targets and on the tax incentives metric. The lowest scorers in this section were Saudi Arabia (3 points), South Africa (4.5 points), and the UAE (5.5 points). The United States took the eighth spot, a considerable drop from the last edition of the *Scorecard*, where it ranked fifth. The United States lost points for stating its intent to withdraw from the Paris Agreement and also in the energy intensity metric. Table 10 shows national efforts scores by country.

Table 10. National efforts scores

| Country | Total score | Change in energy intensity | Energy efficiency spending | Energy efficiency R&D spending | Energy savings 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** |
| Germany | 22 | 4 | 5 | 2 | 3 | 2 | 2 | 2 | 1 | 1 |
| UK | 18.5 | 5 | 4 | 1 | 3 | 2 | 2 | 0.5 | 0 | 1 |
| Italy | 18 | 3 | 4 | 1.5 | 3 | 2 | 2 | 1.5 | 0 | 1 |
| Japan | 17.5 | 5 | 2 | 2 | 3 | 2 | 2 | 0.5 | 0 | 1 |
| France | 17 | 3 | 3 | 1.5 | 3 | 2 | 1 | 2 | 0.5 | 1 |
| Canada | 17 | 3 | 4 | 1.5 | 1 | 2 | 3 | 1 | 0.5 | 1 |
| Netherlands | 16 | 4 | 2 | 1.5 | 3 | 2 | 2 | 0 | 0.5 | 1 |
| US | 15.5 | 3 | 4 | 2 | 0 | 2 | 2 | 1 | 0.5 | 1 |
| Spain | 14.5 | 2 | 4 | 0.5 | 3 | 1 | 2 | 1 | 0.5 | 0.5 |
| Taiwan | 14 | 5 | 1 | 1.5 | 1 | 1 | 1 | 2 | 1 | 0.5 |
| China | 13 | 6 | 0 | 0 | 1 | 0.5 | 2 | 2 | 1 | 0.5 |
| Poland | 13 | 5 | 1 | 0.5 | 3 | 1 | 1 | 1 | 0 | 0.5 |
| Turkey | 11.5 | 4 | 1 | 0.5 | 1 | 1 | 2 | 1 | 0.5 | 0.5 |
| Australia | 11 | 4 | 1 | 0.5 | 1 | 1 | 1 | 0.5 | 1 | 1 |
| India | 10.5 | 3 | 0 | 0.5 | 3 | 2 | 1 | 0.5 | 0 | 0.5 |
| Indonesia | 10 | 5 | 0 | 0 | 2 | 1 | 1 | 0 | 1 | 0 |
| Ukraine | 10 | 6 | 0 | 0 | 1 | 1 | 0 | 1.5 | 0 | 0.5 |
| South Korea | 9.5 | 2 | 0 | 1 | 2 | 2 | 1 | 1 | 0 | 0.5 |
| Mexico | 9 | 2 | 0 | 0.5 | 1 | 1 | 2 | 0.5 | 1 | 1 |
| Brazil | 7 | 0 | 0 | 0 | 2 | 1 | 3 | 0.5 | 0.5 | 0 |
| Thailand | 6.5 | 1 | 0 | 0 | 2 | 1 | 1 | 1 | 0.5 | 0 |
| Russia | 6 | 1 | 0 | 0 | 1 | 2 | 1 | 0.5 | 0 | 0.5 |
| UAE | 5.5 | 2 | 0 | 0 | 3 | 0 | 0 | 0.5 | 0 | 0 |
| South Africa | 4.5 | 3 | 0 | 0 | 0 | 1 | 0 | 0 | 0.5 | 0 |
| Saudi Arabia | 3 | 2 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 |

### *CHANGE IN ENERGY INTENSITY (6 POINTS)*

Energy intensity is the ratio of the energy consumed by each country and its total economic output. We calculated energy intensity using standard practices, 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 improvement in energy intensity between 2010 and 2015. 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 allows us to account for some of that fluctuation and better evaluate the impact of efficiency on energy use. Note that this *Scorecard* differs from the previous edition, which reported the changes in energy intensity that occurred between 2000 and 2013. We shifted to the period between 2010 and 2015 in order to better characterize recent trends. Another point to note is that this evaluation does not account for changes in energy intensity that are the result of major political events. For example, energy intensity in Ukraine decreased over this period not because of active policy efforts but because of conflict in the Crimea region. 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 2015 than in 2010 (IEA 2018d).

Countries with a reduction of 20% or more in primary energy intensity between 2010 and 2015 received 6 points. Those with a reduction of at least 16% earned 5 points; at least 12% earned 4 points; at least 8% earned 3 points; at least 4% earned 2 points; and countries that saw a reduction in energy intensity of 0 to 4% scored 1 point. Brazil was the only country that increased energy intensity over this period and hence 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 2010–2015 | Score |
|---|---|---|
| Ukraine | –23.7% | 6 |
| China | –22.1% | 6 |
| UK | –19.3% | 5 |
| Indonesia | –18.8% | 5 |
| Poland | –18.5% | 5 |
| Japan | –17.9% | 5 |
| Taiwan | –17.1% | 5 |
| Netherlands | –14.8% | 4 |
| Turkey | –14.3% | 4 |
| Australia | –14.2% | 4 |
| Germany | –13.0% | 4 |
| India | –11.6% | 3 |
| US | –10.9% | 3 |
| South Africa | –10.1% | 3 |
| France | –10.1% | 3 |
| Italy | –9.4% | 3 |

| Country | Percentage change in energy intensity 2010–2015 | Score |
|---|---|---|
| Canada | –8.4% | 3 |
| Saudi Arabia | –7.0% | 2 |
| Mexico | –6.9% | 2 |
| UAE | –6.3% | 2 |
| South Korea | –5.9% | 2 |
| Spain | –5.8% | 2 |
| Russia | –3.6% | 1 |
| Thailand | –0.6% | 1 |
| Brazil | 6.2% | 0 |

*Sources:* IEA 2018d; World Bank 2018b.

### *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 the impact of energy efficiency improvements 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 of the sectors of an economy, providing a more accurate reflection of energy efficiency progress. We are considering incorporating this metric in future editions of this *Scorecard* if we are able to collect the required data for all of our countries of interest.

## *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, 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. Many countries do not track separate investment data for utility spending on energy efficiency. In these cases, we assumed that the utilities had small efficiency budgets relative to government investment.

We awarded 5 points for per capita spending of at least $30, 4 points for at least $20 per person, 3 points for at least $15, 2 points for at least $10, and 1 point for at least $5. Table 12 reports total spending per capita.

Table 12. Scores for spending on energy efficiency

| Country | Annual government spending ($) | Annual utilities spending ($) | Total spending ($/capita) | Score |
|---|---|---|---|---|
| Germany | 2,534,854,246 | No data available | 31.30 | 5 |
| Italy | 1,520,912,548 | No data available | 25.02 | 4 |
| Canada | 125,666,195 | 746,764,586 | 24.54 | 4 |
| UK | 724,006,171 | 857,075,898 | 24.47 | 4 |
| Spain | 1,013,941,698 | 80,000 | 21.82 | 4 |
| US | 517,000,000 | 6,038,000,000 | 20.58 | 4 |
| France | 1,077,313,054 | No data available | 16.24 | 3 |
| Netherlands | 243,346,008 | No data available | 14.43 | 2 |
| Japan | 1,689,559,394 | No data available | 13.27 | 2 |
| Taiwan | 113,376,371 | 114,070,824 | 9.69 | 1 |
| Turkey | 712,768,000 | No data available | 9.25 | 1 |
| Poland | 305,449,937 | No data available | 8.04 | 1 |
| Australia | 531,837 | 143,000,000 | 6.12 | 1 |
| South Korea | No data available | 98,000,000 | 1.93 | 0 |
| Brazil | 40,000,000 | 151,000,000 | 0.94 | 0 |
| South Africa | No data available | 44,000,000 | 0.81 | 0 |
| Ukraine | 34,000,000 | No data available | 0.75 | 0 |
| China | No data available | 448,000,000 | 0.33 | 0 |
| Mexico | 2,099,795 | No data available | 0.02 | 0 |
| Thailand | No data available | 1,000,000 | 0.01 | 0 |
| India | 2,542,857 | No data available | 0.00 | 0 |
| Indonesia | No data available | No data available | – | 0 |
| Russia | No data available | No data available | – | 0 |
| Saudi Arabia | No data available | No data available | – | 0 |
| UAE | No data available | No data available | – | 0 |

*Sources:* IEA 2016; IEA 2017a; World Bank 2018d; Janeiro et al. 2016; ACEEE research

### *ENERGY EFFICIENCY R&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 R&D by the national government. These data are much more readily available.

We gave 2 points for per capita spending of at least $3, 1.5 points for at least $2 per person, 1 point for at least $1 per person, and 0.5 point for at least 10 cents per person. Table 13 shows the scores on this metric by country.

**Table 13. Scores for spending on energy efficiency R&D**

| Country | Spending ($/capita) | Score |
|---|---|---|
| US | $3.94 | 2 |
| Japan | $3.74 | 2 |
| Germany | $3.07 | 2 |
| Canada | $2.79 | 1.5 |
| France | $2.62 | 1.5 |
| Netherlands | $2.34 | 1.5 |
| Taiwan | $2.26 | 1.5 |
| Italy | $2.10 | 1.5 |
| South Korea | $1.96 | 1 |
| UK | $1.51 | 1 |
| Australia | $0.87 | 0.5 |
| Poland | $0.72 | 0.5 |
| Spain | $0.41 | 0.5 |
| Turkey | $0.35 | 0.5 |
| Mexico | $0.24 | 0.5 |
| India | $0.10 | 0.5 |
| South Africa | $0.01 | 0 |
| Brazil | No data available | 0 |
| China | No data available | 0 |
| Indonesia | No data available | 0 |
| Russia | No data available | 0 |
| Saudi Arabia | No data available | 0 |
| Thailand | No data available | 0 |
| UAE | No data available | 0 |
| Ukraine | No data available | 0 |

*Sources:* IEA 2018b; OECD 2018a; 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 R&D expenditure. There is some overlap in the United States, for instance, because national spending includes the budget of the US 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 GOALS (3 POINTS)*

Energy savings goals spur innovation and articulate national priorities on energy efficiency across all sectors of an economy. These goals help measure progress toward a target, making energy efficiency more tangible and yielding quantifiable results (ACEEE 2018a). We awarded 3 points for goals requiring energy savings of more than 1% of a country's overall energy consumption per year. We awarded 2 points to countries with mandatory energy savings goals of less than 1% of overall energy consumption. Countries received 1 point for an energy intensity target or a greenhouse gas (GHG) reduction 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 (UNFCC). 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. These incentives can also make market conditions for energy efficiency more favorable, attracting additional private investment (ACEEE 2018a).

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 |
| India | > 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 |
| Netherlands | > 1% | 3 | Multisector loans and credits | 2 | 5 |
| UK | > 1% | 3 | Multisector loans and credits | 2 | 5 |

| Country | Energy savings goals | Score | Tax incentives and loan programs | Score | Total score |
|---|---|---|---|---|---|
| Poland | > 1% | 3 | Multisector loans | 1 | 4 |
| South Korea | Yes* | 2 | Multisector loans and credits | 2 | 4 |
| Spain | > 1% | 3 | Loans and credits for one sector only | 1 | 4 |
| Brazil | Yes | 2 | Multisector loans | 1 | 3 |
| Canada | GHG | 1 | Multisector loans and credits | 2 | 3 |
| Indonesia | Yes | 2 | Loans and credits for one sector only | 1 | 3 |
| Russia | Energy intensity | 1 | Multisector loans and credits | 2 | 3 |
| Thailand | Yes | 2 | Multisector credits | 1 | 3 |
| UAE | > 1% | 3 | None | 0 | 3 |
| Australia | Energy intensity | 1 | Multisector loans | 1 | 2 |
| Mexico | Energy intensity | 1 | Multisector loans | 1 | 2 |
| Taiwan | Energy intensity | 1 | Multisector loans | 1 | 2 |
| Turkey | GHG | 1 | Multisector loans | 1 | 2 |
| Ukraine | GHG | 1 | Multisector credits | 1 | 2 |
| US | No goal | 0 | Multisector loans and credits | 2 | 2 |
| China | Energy intensity | 1 | Credits for one sector only | 0.5 | 1.5 |
| Saudi Arabia | Energy intensity | 1 | None | 0 | 1 |
| South Africa | No data available | 0 | Multisector credits | 1 | 1 |

* *Yes* denotes that a country has an energy savings goal, but the specific goal either is not specified or is less than 1% of total energy consumption. *Sources:* UNFCCC 2018; tax incentives and loan programs: IEA 2018a; ACEEE country research.

### *EFFICIENCY OF THERMAL POWER PLANTS (3 POINTS)*

The world produces more than 60% of all electricity from thermal power plants that use fossil fuels (IEA 2017c). This metric evaluated the overall efficiency of a country's nonnuclear thermal power plants. We took into account both the efficiency of converting heat to electricity in the plant (called operational efficiency) and the losses in the electrical distribution system. We also gave countries credit for the proportion of electricity generation that comes from renewable sources to ensure we did not penalize countries with smaller shares of thermal electricity generation.

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. Countries can achieve a higher power-sector efficiency by employing such technology.

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

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

We awarded the full 3 points to countries with overall efficiency of 75% or more, 2 points for overall efficiency of more than 45%, and 1 point for overall efficiency of more than 35%. 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 (%) | Transmission and distribution losses (%) | Electricity generation from renewable sources (%) | Overall efficiency of thermal power plants (%) | Score |
|---|---|---|---|---|---|
| Brazil | 43.2% | 15.8% | 75.0% | 84.1% | 3 |
| Canada | 38.1% | 8.9% | 64.7% | 77.0% | 3 |
| Italy | 39.4% | 7.0% | 40.9% | 62.5% | 2 |
| Spain | 44.9% | 9.6% | 36.2% | 62.1% | 2 |
| Turkey | 43.6% | 14.8% | 32.9% | 57.8% | 2 |
| Germany | 37.8% | 3.9% | 31.8% | 56.6% | 2 |
| UK | 42.5% | 8.3% | 27.4% | 55.7% | 2 |
| Japan | 44.2% | 4.4% | 17.4% | 52.3% | 2 |
| China | 35.6% | 5.5% | 25.0% | 50.3% | 2 |
| Netherlands | 43.1% | 4.8% | 14.7% | 49.7% | 2 |
| Mexico | – | – | 16.0% | 47.8% | 2 |
| US | 41.0% | 5.9% | 14.0% | 47.1% | 2 |
| Thailand | 41.0% | 6.1% | 9.0% | 44.1% | 1 |
| Australia | 34.9% | 4.8% | 14.4% | 42.8% | 1 |
| Taiwan | 41.6% | 4.1% | 4.4% | 42.5% | 1 |
| Poland | 34.3% | 6.5% | 14.6% | 42.0% | 1 |
| France | 31.8% | 6.4% | 16.8% | 41.6% | 1 |
| South Korea | 40.8% | 3.3% | 2.1% | 40.7% | 1 |
| Indonesia | 34.5% | 9.4% | 11.2% | 39.0% | 1 |
| India | 32.9% | 19.4% | 15.1% | 37.6% | 1 |
| Russia | 24.6% | 10.0% | 16.9% | 35.3% | 1 |
| South Africa | 34.7% | 8.4% | 2.4% | 33.4% | 0 |
| UAE | 33.9% | 7.2% | 0.2% | 31.6% | 0 |
| Saudi Arabia | 32.2% | 6.8% | 0.0% | 30.0% | 0 |
| Ukraine | 28.5% | 10.8% | 4.6% | 28.8% | 0 |

We calculated overall efficiency by subtracting transmission and distribution losses from operational efficiency and multiplying by the share of thermal generation. We assumed that electricity generation from renewable sources is 100% efficient. *Sources:* WEC 2016a; World Bank 2018a; EIA 2017; ACEEE Mexico data request.

### *SIZE OF THE ESCO MARKET (2 POINTS)*

ESCOs are businesses that provide a variety of energy efficiency–related services and improvement measures. The presence and size of the ESCO market in a country reflect in part the efforts to advance energy efficiency through effective business models and creative financing.

Performance contracting is a key product offered within the ESCO market, and one that is particularly useful in addressing the cost and technical expertise barriers to the dissemination of energy efficiency technology. Under performance contracting, a company acts as a project manager for a range of tasks and assumes the technical and performance risks associated with a project. Services included in performance contracting 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 market size of at least 0.06% of GDP, 1 point for at least 0.03% of GDP, and 0.5 point for at least 0.001% of GDP. Table 16 lists the results. Since the definition of an ESCO varies from country to country, these data may not be directly comparable. We were unable to find data on this metric for several countries.

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

| Country | % of GDP | Score |
|---|---|---|
| France | 0.3700% | 2 |
| China | 0.1695% | 2 |
| Taiwan | 0.1682% | 2 |
| Germany | 0.1517% | 2 |
| Ukraine | 0.0888% | 1.5 |
| Italy | 0.0620% | 1.5 |
| Turkey | 0.0500% | 1 |
| Poland | 0.0437% | 1 |
| US | 0.0398% | 1 |
| Thailand | 0.0396% | 1 |
| South Korea | 0.0384% | 1 |
| Spain | 0.0321% | 1 |
| Canada | 0.0300% | 1 |
| UK | 0.0149% | 0.5 |
| UAE | 0.0098% | 0.5 |
| Russia | 0.0077% | 0.5 |

| Country | % of GDP | Score |
|---|---|---|
| India | 0.0071% | 0.5 |
| Japan | 0.0070% | 0.5 |
| Australia | 0.0056% | 0.5 |
| Mexico | 0.0040% | 0.5 |
| Brazil | 0.0010% | 0.5 |
| Indonesia | No data available | 0 |
| Netherlands | No data available | 0 |
| Saudi Arabia | No data available | 0 |
| South Africa | No data available | 0 |

*Sources:* Panev et al. 2014; Boza-Kiss, Bertoldi, and Economidou 2017; IEA 2017a; 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 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. Conversely, 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—for instance, in the use of hot water. This close relationship means that improvements in water efficiency generally result in energy savings (Young 2013).

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 | Score |
|---|---|---|
| Australia | Law and program | 1 |
| China | Law and program | 1 |
| Germany | Law and program | 1 |
| Indonesia | Law and program | 1 |
| Mexico | Law and program | 1 |

| Country | Water efficiency efforts | Score |
|---|---|---|
| Taiwan | Law and program | 1 |
| Brazil | Law | 0.5 |
| Canada | Law | 0.5 |
| France | Law | 0.5 |
| Netherlands | Law | 0.5 |
| South Africa | Law | 0.5 |
| Spain | Law | 0.5 |
| Thailand | Law | 0.5 |
| Turkey | Law | 0.5 |
| US | Program | 0.5 |
| India | None | 0 |
| Italy | None | 0 |
| Japan | None | 0 |
| Poland | None | 0 |
| Russia | None | 0 |
| Saudi Arabia | None | 0 |
| South Korea | None | 0 |
| UAE | None | 0 |
| UK | None | 0 |
| Ukraine | None | 0 |

*Source:* ACEEE country research

### *DATA AVAILABILITY (1 POINT)*

To fully understand their energy efficiency potential, countries must identify key energy-related performance indicators across multiple sectors and track the data over time. Indicators of energy efficiency 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 trends that can help them plan policy decisions.

We looked at each of the three end-use energy sectors evaluated in this report and gave 1 point to countries that collect energy data and make them easily accessible online through international centralized sources or through a country-specific source. Countries earned 0.5 point if at least some of their data were available from centralized sources. We awarded no points to countries with very little information available through either centralized or country-specific sources. Table 18 displays the scores.

Table 18. Scores for data availability

| Country | Data availability | Score |
|---|---|---|
| Australia | Widely available | 1 |
| Canada | Widely available | 1 |
| France | Widely available | 1 |
| Germany | Widely available | 1 |
| Italy | Widely available | 1 |
| Japan | Widely available | 1 |
| Mexico | Widely available | 1 |
| Netherlands | Widely available | 1 |
| UK | Widely available | 1 |
| US | Widely available | 1 |
| China | Moderately available | 0.5 |
| India | Moderately available | 0.5 |
| Poland | Moderately available | 0.5 |
| Russia | Moderately available | 0.5 |
| South Korea | Moderately available | 0.5 |
| Spain | Moderately available | 0.5 |
| Taiwan | Moderately available | 0.5 |
| Turkey | Moderately available | 0.5 |
| Ukraine | Moderately available | 0.5 |
| Brazil | Scarce | 0 |
| Indonesia | Scarce | 0 |
| Saudi Arabia | Scarce | 0 |
| South Africa | Scarce | 0 |
| Thailand | Scarce | 0 |
| UAE | Scarce | 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 European Union's Energy Efficiency Directive to target a 20% energy efficiency increase from 2008 levels by 2020 and a 50% reduction in energy use by 2050, Germany released a National Action Plan on Energy Efficiency (NAPE) in 2014. The NAPE identifies a variety of focus areas in which action can be taken to improve sector-wide energy efficiency, including:

- Mobilizing investment to renovate the national building stock to improve its energy efficiency
- Upgrading energy efficiency measures in the transportation sector
- Identifying energy saving as an investment and business model

**Mexico.** While not among the top scorers, Mexico is one of the most improved countries in the national efforts section, having taken steps toward reducing its energy consumption and intensity in recent years. Mexico's National Program for the Sustainable Use of Energy lays out the country's overarching energy efficiency policy. The focus areas identified by this program are:

- Enacting standards based on best available technology
- Providing incentives to consumers so they can replace their old systems with energy-efficient ones
- Implementing communication programs to educate consumers about the benefits of using energy efficiently

The federal government has implemented several programs that follow its own guidelines. For instance, the Efficiency and Sustainability Program for Cities funds improvements aimed at reducing energy consumption in public lighting, municipal buildings, and water management. Other programs include subsidized loans for efficiency improvements in businesses and low-income households, and an energy-efficient procurement policy for the federal government.

## Buildings

Buildings use an estimated 31% of the energy consumed worldwide (IEA 2017a). 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 savings in buildings, such as building energy codes and appliance/equipment standards. Codes and standards regulate product efficiency and energy used in buildings with the goal of reducing both energy consumption and costs. We also compared policies that encourage or require energy efficiency retrofits to existing buildings, and policies that require rating, labeling, and disclosure of energy-use information for both buildings and appliances. Finally, we evaluated the overall energy intensity of residential and commercial buildings across all the countries as an indicator of building energy performance.

Spain took first place in the buildings section with a total score of 22 points out of 25. Like many of the EU countries, Spain performed well on policy metrics in the buildings section; it also had the lowest building energy intensities of the developed countries. Following closely behind were France, the Netherlands, and the United Kingdom. France excelled in the building energy codes and retrofit categories, earning the top score for both metrics. The French government has also implemented mandatory building rating systems and appliance labeling programs. The United States earned the most points for energy efficiency standards for appliances. In general, building rating systems and performance standards for appliances/equipment seem to be standard practice in the countries we evaluated, although the comprehensiveness of the building rating programs and the number of appliances covered by standards varied by country.

China, the top-ranking non-European country, has implemented comprehensive policies to address its buildings-related energy use. China received credit for its comprehensive appliance standards and labeling program as well as its building energy codes for commercial facilities. Table 19 lists the countries' total scores in the buildings section and scores on each metric.

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** |
| Spain | 22 | 3 | 3 | 4 | 2 | 3 | 2 | 2.5 | 2.5 |
| France | 21 | 3 | 3 | 4 | 2 | 4 | 2 | 1 | 2 |
| UK | 21 | 3 | 3 | 4 | 2 | 3 | 2 | 1.5 | 2.5 |
| Netherlands | 21 | 3 | 3 | 4 | 2 | 3 | 2 | 1.5 | 2.5 |
| Germany | 20 | 3 | 3 | 4 | 2 | 3 | 2 | 1.5 | 1.5 |
| Italy | 20 | 3 | 3 | 4 | 2 | 3 | 2 | 0.5 | 2.5 |
| China | 19 | 2.5 | 2.5 | 4 | 2 | 2 | 1 | 3 | 2 |
| Poland | 18 | 3 | 3 | 4 | 2 | 3 | 2 | 0.5 | 0.5 |
| Mexico | 18 | 2.5 | 3 | 3 | 1.5 | 2 | 0 | 3 | 3 |
| Australia | 17 | 3 | 3 | 2 | 1.5 | 3 | 1 | 1 | 2.5 |
| Turkey | 16.5 | 2 | 2 | 3 | 2 | 2 | 2 | 2.5 | 1 |
| US | 16 | 2.5 | 2.5 | 5 | 1.5 | 2 | 0.5 | 1 | 1 |
| Taiwan | 15.5 | 2.5 | 2.5 | 1 | 1.5 | 3 | 0 | 2.5 | 2.5 |
| Canada | 15 | 2.5 | 2.5 | 4 | 1 | 3 | 0.5 | 0.5 | 1 |
| Japan | 14.5 | 2.5 | 2 | 2 | 1 | 3 | 0.5 | 2 | 1.5 |
| South Korea | 13 | 3 | 3 | 3 | 2 | 1 | 0 | 1 | 0 |
| South Africa | 11.5 | 3 | 3 | 1 | 1.5 | 0 | 0 | 1 | 2 |
| Brazil | 11 | 1 | 0 | 1 | 2 | 1 | 0.5 | 2.5 | 3 |
| Indonesia | 10 | 2.5 | 2.5 | 0 | 1 | 0 | 0 | 1.5 | 2.5 |
| Russia | 9 | 2 | 2 | 0 | 1.5 | 2 | 1 | 0 | 0.5 |
| India | 8.5 | 0 | 2 | 1 | 1 | 0 | 1 | 1.5 | 2 |
| UAE | 7 | 1.5 | 1.5 | 1 | 1 | 0 | 0.5 | 1.5 | 0 |
| Ukraine | 6.5 | 1 | 1 | 0 | 1.5 | 0 | 0 | 1.5 | 1.5 |
| Thailand | 5.5 | 0 | 2 | 0 | 1 | 1 | 0 | 1.5 | 0 |
| Saudi Arabia | 4 | 1.5 | 1.5 | 0 | 0 | 0 | 0 | 1 | 0 |

**New in this Section**

We reallocated points for policy and performance metrics, increasing the weight assigned to building energy intensities by 1 point per sector and reducing residential and commercial building codes by 1 point each. We stopped evaluating countries on their code implementation efforts given the difficulties in obtaining information on compliance and enforcement measures across countries. We also adjusted how countries received points for building policies, appliance labeling, and appliance standards.

### *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. Countries with codes that cover the majority of their populations (often called mixed codes) received 0.5 point; those with voluntary or no codes received no points.

We also looked at whether the energy codes covered the following technical areas:

- 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 low maximum U-factors and shading/solar heat gain coefficients for windows and doors? 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?

- Components
    - *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 building shell and technical requirements included in the code. If countries met five or six of the technical requirements, they earned the full 2 points. Countries that satisfied three or four technical requirements earned 1.5 points, those meeting two technical requirements earned 1 point, and those meeting one technical requirement earned 0.5 point. While in theory we recognize the importance of scoring each country on the stringency of these requirements, there were no available data that allowed us to do so.

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

Table 20. Scores for residential building codes

| Country | Code type | Code type score | Score for building shell and technical requirements | Combined score |
|---|---|---|---|---|
| Australia | Mandatory | 1 | 2 | 3 |
| France | Mandatory | 1 | 2 | 3 |
| Germany | Mandatory | 1 | 2 | 3 |
| Italy | Mandatory | 1 | 2 | 3 |
| Netherlands | Mandatory | 1 | 2 | 3 |
| Poland | Mandatory | 1 | 2 | 3 |
| South Africa | Mandatory | 1 | 2 | 3 |
| South Korea | Mandatory | 1 | 2 | 3 |
| Spain | Mandatory | 1 | 2 | 3 |
| UK | Mandatory | 1 | 2 | 3 |
| Canada | Mixed | 0.5 | 2 | 2.5 |
| China | Mixed | 0.5 | 2 | 2.5 |
| Indonesia | Mandatory | 1 | 1.5 | 2.5 |
| Japan* | Voluntary | 0.5 | 2 | 2.5 |
| Mexico | Mandatory | 1 | 1.5 | 2.5 |
| Taiwan | Mandatory | 1 | 1.5 | 2.5 |
| US | Mixed | 0.5 | 2 | 2.5 |
| Russia | Mandatory | 1 | 1 | 2 |
| Turkey** | Mandatory | 1 | 1 | 2 |
| Saudi Arabia | Mandatory | 1 | 0.5 | 1.5 |
| UAE | Mixed | 0.5 | 1 | 1.5 |
| Brazil | Voluntary | 0 | 1 | 1 |
| Ukraine** | Mixed | 0.5 | 0.5 | 1 |
| India | Voluntary | 0 | 0 | 0 |
| Thailand | None | 0 | 0 | 0 |

*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 to adhere to standards. ** Thermal regulation only.
*Sources:* IPEEC 2015m; Young 2014; ICC 2016 (Mexico); IPEEC 2015a–k; Evans, Shui, and Delgado 2009; ACEEE Taiwan data request.

Table 21. Scores for commercial building codes

| Country | Code type | Code type score | Score for building shell and technical requirements | Combined score |
|---|---|---|---|---|
| Australia | Mandatory | 1 | 2 | 3 |
| France | Mandatory | 1 | 2 | 3 |
| Germany | Mandatory | 1 | 2 | 3 |
| Italy | Mandatory | 1 | 2 | 3 |
| Mexico | Mandatory | 1 | 2 | 3 |
| Netherlands | Mandatory | 1 | 2 | 3 |
| Poland | Mandatory | 1 | 2 | 3 |
| South Africa | Mandatory | 1 | 2 | 3 |
| South Korea | Mandatory | 1 | 2 | 3 |
| Spain | Mandatory | 1 | 2 | 3 |
| UK | Mandatory | 1 | 2 | 3 |
| Canada | Mixed | 0.5 | 2 | 2.5 |
| China | Mandatory | 0.5 | 2 | 2.5 |
| Indonesia | Mandatory | 1 | 1.5 | 2.5 |
| Taiwan | Mandatory | 1 | 1.5 | 2.5 |
| US | Mixed | 0.5 | 2 | 2.5 |
| India* | Mixed | 0 | 2 | 2 |
| Japan | Mixed | 0.5 | 1.5 | 2 |
| Russia | Mandatory | 1 | 1 | 2 |
| Thailand | Mandatory | 1 | 1 | 2 |
| Turkey** | Mandatory | 1 | 1 | 2 |
| Saudi Arabia | Mandatory | 1 | 0.5 | 1.5 |
| UAE | Mixed | 0.5 | 1 | 1.5 |
| Ukraine** | Mixed | 0.5 | 0.5 | 1 |
| Brazil | No data available | 0 | 0 | 0 |

*India has state-led commercial building codes, but few states have chosen to adopt mandatory codes. ** Thermal regulation only. *Sources:* IPEEC 2015m; Young 2014; ICC 2016 (Mexico); IPEEC 2015a–k; Evans, Shui, and Delgado 2009; ACEEE country research.

### *APPLIANCE AND EQUIPMENT STANDARDS (5 POINTS)*

Policies requiring minimum energy performance standards (MEPS) for appliances and equipment were eligible for up to 5 points. This metric does not measure the stringency of these standards, the percentage of energy consumption covered by the standards, or compliance with the standards, all of which are important factors impacting the overall effect

of energy efficiency standards. Currently we do not evaluate these aspects because of the lack of consistent data for many countries.

We scored the countries on the basis of the number of appliance and equipment types covered by mandatory energy performance standards. Table 22 shows the point breakdown, and the left side of table 23 shows related scores.

**Table 22. Point allocation for appliance and equipment standards**

| Number of appliance categories with minimum energy performance standards (MEPS) | Points |
|---|---|
| 45+ | 5 |
| 35–45 | 4 |
| 25–34 | 3 |
| 15–24 | 2 |
| 5–14 | 1 |

Since the 2016 *Scorecard*, we have refined how we treat standards covering similar appliances. For example, while a country may have three independent requirements for gas, electric, and oil furnaces, we counted them as a single standard. This is to ensure that a country using multiple energy sources for a given end use is not receiving more points than a country relying on a single source. Due to this refinement, some countries have earned fewer points this year than in the past. See Appendix B for a table summarizing our appliance standard groupings.

### *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.[3] 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 one in the appropriate place along the continuum. An example of a categorical labeling system is the European Union's scheme, which awards a letter grade to a product. The EnergyGuide program in the United States is a continuous-scale labeling program (see figure 4).

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

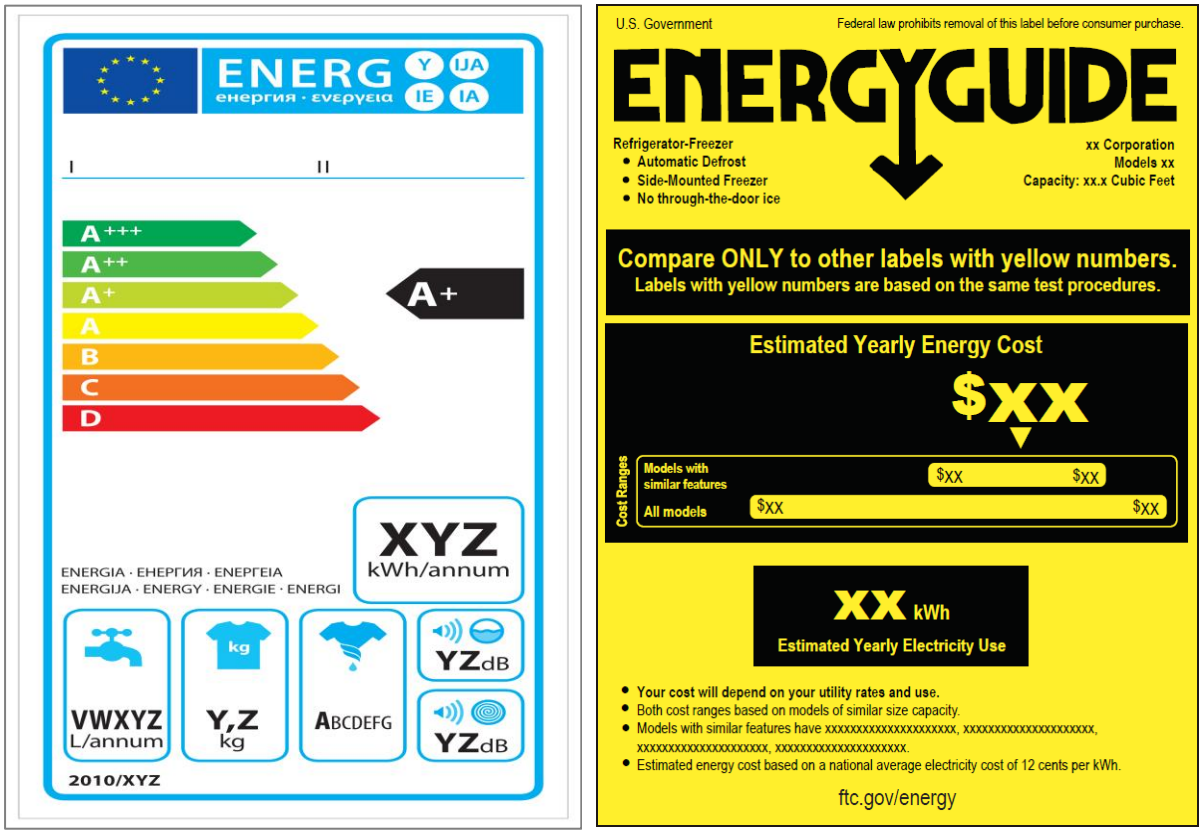


Figure 4. Categorical (left) and continuous (right) styles for appliance labeling

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; studies have shown that categorical labels are 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 5 appliance groups. Table 23 shows scores on this metric.

Table 23. Scores for standards (left) and labeling (right) of appliances and equipment

| Country | Number of appliance categories with minimum energy performance standards (MEPS) | Score | Mandatory or voluntary | Categorical or continuous | Score | Appliance groups | Score | Total score |
|---|---|---|---|---|---|---|---|---|
| US | 52 | 5 | Mandatory | Continuous | 0.5 | 18 | 1 | 1.5 |
| France | 41 | 4 | Mandatory | Categorical | 1 | 20 | 1 | 2 |
| Germany | 41 | 4 | Mandatory | Categorical | 1 | 20 | 1 | 2 |
| Italy | 41 | 4 | Mandatory | Categorical | 1 | 20 | 1 | 2 |
| Netherlands | 41 | 4 | Mandatory | Categorical | 1 | 20 | 1 | 2 |
| Poland | 41 | 4 | Mandatory | Categorical | 1 | 20 | 1 | 2 |
| Spain | 41 | 4 | Mandatory | Categorical | 1 | 20 | 1 | 2 |
| UK | 41 | 4 | Mandatory | Categorical | 1 | 20 | 1 | 2 |
| China | 41 | 4 | Mandatory | Categorical | 1 | 25 | 1 | 2 |
| Canada | 40 | 4 | Mandatory | Continuous | 0.5 | 12 | 0.5 | 1 |
| Turkey | 32 | 3 | Mandatory | Categorical | 1 | 20 | 1 | 2 |
| South Korea | 30 | 3 | Mandatory | Categorical | 1 | 19 | 1 | 2 |
| Mexico | 26 | 3 | Mandatory | Continuous | 1 | 9 | 0.5 | 1.5 |
| Australia | 21 | 2 | Mandatory | Categorical | 1 | 10 | 0.5 | 1.5 |
| Japan | 21 | 2 | Mandatory | Categorical | 1 | 1 | 0 | 1 |
| Taiwan | 13 | 1 | Mandatory | Categorical | 1 | 8 | 0.5 | 1.5 |
| Brazil | 11 | 1 | Mandatory | Categorical | 1 | 15 | 1 | 2 |
| South Africa | 11 | 1 | Mandatory | Categorical | 1 | 9 | 0.5 | 1.5 |
| India | 7 | 1 | Mandatory | Categorical | 1 | 4 | 0 | 1 |
| UAE | 7 | 1 | Mandatory | Categorical | 1 | 1 | 0 | 1 |
| Ukraine | 3 | 0 | Mandatory | Categorical | 1 | 10 | 0.5 | 1.5 |
| Thailand | 2 | 0 | Mandatory | Categorical | 1 | 0 | 0 | 1 |
| Indonesia | 1 | 0 | Mandatory | Categorical | 1 | 2 | 0 | 1 |
| Russia | 1 | 0 | Mandatory | Continuous | 0.5 | 18 | 1 | 1.5 |
| Saudi Arabia | 1 | 0 | Mandatory | Categorical | 0 | 0 | 0 | 0 |

*Source:* CLASP 2017.

### *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. All European countries in this edition of the *Scorecard* have mandatory building energy codes for existing buildings (IEA 2013).

For this edition of the *International Scorecard*, we awarded up to 4 points for countries with retrofit policies. We awarded 3 points to countries with codes that either require energy-efficient upgrades within a specific time frame; require the improvement of overall building energy performance 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 either residential or commercial buildings, but not both. We awarded 1 extra point to countries with federal incentives to encourage retrofits. Table 24 summarizes the presence or absence of retrofit policies in the evaluated countries, along with their corresponding scores.

**Table 24. Scores for building retrofit policies**

| Country | Building retrofit policies | Score | Incentives | Score | Total score |
|---|---|---|---|---|---|
| France | Codes requiring energy-efficient upgrades within a specific time frame | 3 | Loans and rebates | 1 | 4 |
| Australia | State or provincial codes that apply to two-thirds of the population | 2 | Loans and rebates | 1 | 3 |
| Canada | State or provincial codes that apply to two-thirds of the population | 2 | Loans and rebates | 1 | 3 |
| Germany | Mandatory national building energy codes for both commercial and residential buildings, applicable to the renovated area of the building | 2 | Loans and rebates | 1 | 3 |
| Italy | Mandatory national building energy codes for both commercial and residential buildings, applicable to the renovated area of the building | 2 | Loans and rebates | 1 | 3 |
| Japan | Mandatory renovation code; submission of energy efficiency plans | 2 | Loans and rebates | 1 | 3 |
| Netherlands | Mandatory national building energy codes for both commercial and residential buildings, applicable to the renovated area of the building | 2 | Loans and rebates | 1 | 3 |

| Country | Building retrofit policies | Score | Incentives | Score | Total score |
|---|---|---|---|---|---|
| Poland | Mandatory national building energy codes for both commercial and residential buildings, applicable to the renovated area of the building | 2 | Loans and rebates | 1 | 3 |
| Spain | Mandatory national building energy codes for both commercial and residential buildings, applicable to the renovated area of the building | 2 | Loans and rebates | 1 | 3 |
| Taiwan | Mandatory national building energy codes for both commercial and residential buildings, applicable to the renovated area of the building | 2 | Loans | 1 | 3 |
| UK | Mandatory national building energy codes for both commercial and residential buildings, applicable to the renovated area of the building | 2 | Loans and rebates | 1 | 3 |
| US | State or provincial codes that apply to two-thirds of the population | 2 | None | 0 | 2 |
| China | National codes that apply to renovation projects undertaken on all commercial buildings. | 1 | Loans and rebates | 1 | 2 |
| Turkey | Mandatory national building energy codes for both commercial and residential buildings, applicable to the renovated area of the building | 2 | None | 0 | 2 |
| Mexico | Mandatory national building energy codes for both commercial and residential buildings, applicable to the renovated area of the building | 2 | None | 0 | 2 |
| Russia | Mandatory national building energy codes that apply to renovation projects undertaken for residential buildings | 1 | Incentives | 1 | 2 |
| South Korea | Mandatory national building energy codes that apply to renovation projects undertaken for residential buildings | 1 | None | 0 | 1 |
| Thailand | No code | 0 | Incentives | 1 | 1 |
| Brazil | No code | 0 | None | 0 | 0 |
| India | No code | 0 | None | 0 | 0 |
| Indonesia | No code | 0 | None | 0 | 0 |
| Saudi Arabia | No code | 0 | None | 0 | 0 |
| South Africa | No code | 0 | None | 0 | 0 |
| UAE | No code | 0 | None | 0 | 0 |
| Ukraine | No code | 0 | None | 0 | 0 |

*Sources:* IPEEC 2017; IEA 2018a; DOE 2014 (China); BPIE 2015 (France, Germany, UK); ICC 2016 (Mexico); IPEEC 2016k (Spain); Republic of China 2018 (Taiwan); CCAP 2012 (Thailand); IPEEC 2016i (Turkey).

### *BUILDING RATING AND DISCLOSURE POLICIES (2 POINTS)*

We based scores for the next 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 costs associated with the 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 insight 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 25 lists the scores on this metric.

**Table 25. Scores for building rating and disclosure programs**

| Country | Building rating | Buildings covered | Score |
|---|---|---|---|
| France | Mandatory | All | 2 |
| Germany | Mandatory | All | 2 |
| Italy | Mandatory | All | 2 |
| Netherlands | Mandatory | All | 2 |
| Poland | Mandatory | All | 2 |
| Spain | Mandatory | All | 2 |
| Turkey | Mandatory | All | 2 |
| UK | Mandatory | All | 2 |
| Australia | Mandatory | Some | 1 |
| China | Mandatory | Some | 1 |
| India | Mandatory | Some | 1 |
| Russia | Mandatory | Some | 1 |
| Brazil* | Voluntary | All | 0.5 |
| Japan* | Voluntary | All | 0.5 |
| Canada* | Voluntary | All | 0.5 |
| US* | Voluntary | All | 0.5 |
| UAE** | Mandatory | Some | 0.5 |
| Taiwan | Voluntary | – | 0 |
| Mexico | Voluntary | – | 0 |
| South Korea | Voluntary | – | 0 |
| Thailand | Voluntary | – | 0 |
| Indonesia | None | – | 0 |

| Country | Building rating | Buildings covered | Score |
|---|---|---|---|
| Saudi Arabia | None | – | 0 |
| South Africa | None | – | 0 |
| Ukraine | None | – | 0 |

* We awarded partial points for voluntary programs in Canada, the United States, Brazil, and Japan because these programs have been used on a substantial number of buildings to date. **We awarded partial points to the UAE for mandatory codes in Dubai and Abu Dhabi as they cover a large proportion of the country's building stock, but not full points because the code is not mandatory at the national level. *Sources:* IMT 2018; IPEEC 2018.

### *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. A variety of factors affect a building's energy use, including its floor area, geographic location and climate, the number of occupants, and the level of economic activity (IPEEC 2015l). 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 among countries. We have included both in this report because no single metric is perfect. First, we looked at residential 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, 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. It should be noted that while some types of energy use in the home (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 2015l). This makes countries with large homes look more efficient than those with smaller living spaces.

We followed the same methodology for both energy use per floor area and energy use per capita. A number 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. In developing countries, energy use per capita continues to grow as people gain access to more building services and amenities (IPEEC 2015l).

We used final energy consumption of residential buildings because primary energy use by sector was not available for every country. We weighted energy intensity based on typical

heating and cooling degree days and the percentage of overall residential energy use that space heating and cooling account for in each country.[4] This adjustment allows a fairer comparison among countries with different heating and cooling needs and to normalize 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.

Adjusting building energy use for differences in climate between countries can be challenging. First, standards and expectations for indoor temperatures vary across countries. Not all buildings are heated and cooled to the same temperatures (or heated and cooled at all). Second, space heating and cooling account for varying proportions of overall building energy use from country to country. In some developed countries, such as the United States, space-conditioning accounts for less than half of overall residential energy consumption, while other end uses including lighting, appliances, and miscellaneous loads are increasing (IEA 2013). In other countries, such as Brazil and India, many households do not have heating and cooling systems (Young 2014).

### Commercial

We compared the energy intensity of commercial buildings among countries using two metrics to evaluate building energy use. We looked at commercial energy use per dollar of service-sector GDP in order to isolate energy-use trends from differences in overall GDP. Also, as we did for residential buildings, we looked at commercial building energy use by total floor area to reveal trends based on the size of the commercial buildings sector. 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 residential and commercial energy intensity metrics together. Table 26 and table 27 show the point allocation for residential and commercial buildings, respectively. Table 28 and table 29 list the energy intensity data and scores for the residential and commercial building sectors, respectively. Since we normalized residential-building energy intensity for heating and cooling to reflect variations in climate between countries, the results in table 28 should be interpreted as relative intensities.

Table 26. Scoring criteria for residential energy intensity

| Final energy use per floor area (MMBtus/m$^2$) | Score | Final energy use per capita (MMBtus/capita) | Score |
|---|---|---|---|
| ≤ 0.30 | 1.5 | ≤ 9 | 1.5 |
| ≤ 0.40 | 1 | ≤ 15 | 1 |
| ≤ 0.60 | 0.5 | ≤ 20 | 0.5 |
| > 0.60 | 0 | > 20 | 0 |

[4] 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).

Table 27. Scoring criteria for commercial energy intensity

| Final energy use per floor area (MMBtus/m²) | Score | Final energy use per service-sector GDP (MMBtus/$GDP) | Score |
|---|---|---|---|
| ≤ 0.69 | 1.5 | ≤ 400 | 1.5 |
| ≤ 1.30 | 1 | ≤ 600 | 1 |
| ≤ 2.00 | 0.5 | ≤ 800 | 0.5 |
| > 2.00 | 0 | > 800 | 0 |

Table 28. Scores for energy intensity in residential buildings

| Country | MMBtus/m² of space | Score | MMBtus/capita | Score | Total score |
|---|---|---|---|---|---|
| Mexico | 0.16 | 1.5 | 5.48 | 1.5 | 3 |
| China | 0.29 | 1.5 | 8.59 | 1.5 | 3 |
| Brazil | 0.31 | 1 | 4.64 | 1.5 | 2.5 |
| Taiwan | 0.38 | 1 | 8.48 | 1.5 | 2.5 |
| Turkey | 0.26 | 1.5 | 9.32 | 1 | 2.5 |
| Spain | 0.29 | 1.5 | 13.15 | 1 | 2.5 |
| Japan | 0.32 | 1 | 13.71 | 1 | 2 |
| India | 0.65 | 0 | 5.46 | 1.5 | 1.5 |
| Thailand | 1.14 | 0 | 6.51 | 1.5 | 1.5 |
| Indonesia | 0.67 | 0 | 8.44 | 1.5 | 1.5 |
| Ukraine | 0.52 | 0.5 | 12.70 | 1 | 1.5 |
| UAE | n/a | 0 | 8.54 | 1.5 | 1.5 |
| UK | 0.38 | 1 | 16.80 | 0.5 | 1.5 |
| Netherlands | 0.36 | 1 | 17.29 | 0.5 | 1.5 |
| Germany | 0.37 | 1 | 18.29 | 0.5 | 1.5 |
| South Africa | 0.70 | 0 | 12.17 | 1 | 1 |
| South Korea | 0.68 | 0 | 13.10 | 1 | 1 |
| Australia | 0.40 | 1 | 21.89 | 0 | 1 |
| Saudi Arabia | n/a | 0 | 11.07 | 1 | 1 |
| France | 0.46 | 0.5 | 19.07 | 0.5 | 1 |
| US | 0.35 | 1 | 24.24 | 0 | 1 |
| Poland | 0.80 | 0 | 15.64 | 0.5 | 0.5 |
| Italy | 0.52 | 0.5 | 21.58 | 0 | 0.5 |
| Canada | 0.50 | 0.5 | 29.06 | 0 | 0.5 |
| Russia | 0.86 | 0 | 20.01 | 0 | 0 |

*Source:* IEA 2018c

Table 29. Scores for energy intensity in commercial buildings

| Country | MMBtus/m$^2$ of commercial space | Score | MMBtus/$GDP | Score | Total score |
|---|---|---|---|---|---|
| Mexico | 0.14 | 1.5 | 201 | 1.5 | 3 |
| Brazil | 0.63 | 1.5 | 302 | 1.5 | 3 |
| Taiwan | 0.65 | 1.5 | 463 | 1.0 | 2.5 |
| Spain | 0.76 | 1 | 369 | 1.5 | 2.5 |
| Indonesia | 0.26 | 1.5 | 452 | 1.0 | 2.5 |
| UK | 0.89 | 1 | 298 | 1.5 | 2.5 |
| Netherlands | 1.25 | 1 | 375 | 1.5 | 2.5 |
| Australia | 0.93 | 1 | 317 | 1.5 | 2.5 |
| Italy | 0.96 | 1 | 397 | 1.5 | 2.5 |
| China | 0.32 | 1.5 | 653 | 0.5 | 2 |
| India | 0.32 | 1.5 | 676 | 0.5 | 2 |
| South Africa | 0.70 | 1 | 590 | 1.0 | 2 |
| France | 1.29 | 1 | 403 | 1.0 | 2 |
| Japan | 1.54 | 0.5 | 487 | 1.0 | 1.5 |
| Ukraine | 0.56 | 1.5 | 2,074 | 0.0 | 1.5 |
| Germany | 1.34 | 0.5 | 530 | 1.0 | 1.5 |
| Turkey | 1.58 | 0.5 | 708 | 0.5 | 1 |
| US | 1.46 | 0.5 | 622 | 0.5 | 1 |
| Canada | 1.86 | 0.5 | 764 | 0.5 | 1 |
| Poland | 1.68 | 0.5 | 853 | 0.0 | 0.5 |
| Russia | 1.71 | 0.5 | 1,401 | 0.0 | 0.5 |
| Thailand | 2.12 | 0 | 916 | 0.0 | 0 |
| South Korea | 3.35 | 0 | 1,084 | 0.0 | 0 |
| Saudi Arabia | – | 0 | 898 | 0.0 | 0 |
| UAE | – | 0 | – | – | 0 |

*Sources:* Energy consumption in buildings: IEA 2018c. Floor space: IPEEC 2015l; BPIE 2011 (Netherlands, Poland, Spain); ACEEE estimates based on Solidiance 2013 (Thailand); UNECE 2004 (Thailand).

### *BUILDINGS BEST PRACTICES*

**France.** Despite coming in second to Spain because its buildings have significantly higher energy intensities, France is leading the way in building energy efficiency policies. It has the most innovative retrofit programs in the world and is the only country to receive the full 4 points in our retrofit section. As part of the European Energy Performance Buildings Directive (EPBD), France requires that all buildings receive an energy rating (using an A–G scale) and that owners disclose this information when listing the building for sale. The country requires residential buildings scoring an F or G (approximately 15% of the stock) to complete renovations before 2025. Furthermore, in April 2018, the French government announced plans to renovate 500,000 homes a year (Felix 2018). France also encouraged commercial building renovation by requiring owners to develop, by 2017, a "plan for renovation" that reduces energy consumption by at least 25% (IPEEC 2017). Along with other EU countries, France has also introduced more than 20 new appliance standards since the last *Scorecard*.

**United States.** Like France, the United States is a longtime leader in energy efficiency policies for buildings. While US 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. US 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 United States. The 40 standards introduced during the Obama administration alone will save 43.8 quads of energy by 2030, according to the US Department of Energy's Appliance and Equipment Standards Program. The Trump administration has indefinitely deferred action on 20 standards, which may delay further energy savings from updated standards.

## Industry

The industrial sector is responsible for more than half of the total final energy consumed in the world, more than any other end-use sector (EIA 2017).[5] In this edition of the *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. 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 policies to support the integration of energy efficiency into management practices through the use of energy management systems (EnMS) and ISO 50001 (the global EnMS standard), and we took into account the presence of MEPS for motors.[6] Finally, we evaluated countries' overall agricultural energy intensity.

Japan received the highest score with 21.5 points, earning the top spot through a mix of regulatory measures, voluntary actions, and financial incentives to encourage energy efficiency in industry. Germany and Italy tied for second with 20.5 points each. The top-scoring countries generally had lower energy intensities, a high percentage of industrial CHP capacity or comprehensive policies in place to encourage CHP deployment, and voluntary government programs aimed at improving energy efficiency in partnership with businesses.

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 2016 *Scorecard*, the European countries did a consistently good job across all metrics, and they stand out for their voluntary agreements and mandatory energy audits for facilities. All countries have some room for improvement. Table 30 lists the section total and scores for each country on individual metrics.

5 The term *industrial sector* as used here follows the definition in the cited EIA source. It includes energy-intensive manufacturing, non-energy-intensive manufacturing, and non-manufacturing industries.

6 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 2018). 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 30. 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** | **3** | **2** | **2** | **2** | **2** | **2** | **2** | **2** | **2** |
| Japan | 21.5 | 6 | 3 | 2 | 2 | 1 | 0 | 2 | 2 | 2 | 1.5 |
| Germany | 20.5 | 5 | 3 | 0 | 2 | 2 | 1 | 2 | 2 | 1.5 | 2 |
| Italy | 20.5 | 5 | 3 | 2 | 2 | 2 | 1.5 | 1 | 2 | 0.5 | 1.5 |
| UK | 19.5 | 6 | 3 | 0 | 2 | 2 | 0.5 | 1 | 2 | 1.5 | 1.5 |
| France | 18 | 6 | 3 | 0 | 2 | 2 | 0 | 1 | 2 | 1.5 | 0.5 |
| Mexico | 17.5 | 5 | 3 | 2 | 2 | 1 | 0 | 1 | 2 | 0 | 1.5 |
| South Korea | 16.5 | 4 | 3 | 0 | 2 | 1 | 0.5 | 1 | 2 | 2 | 1 |
| Taiwan | 16.5 | 4 | 0 | 2 | 2 | 1 | 1.5 | 1 | 2 | 1.5 | 1.5 |
| Turkey | 15.5 | 4 | 3 | 0 | 2 | 1 | 0.5 | 2 | 1 | 0.5 | 1.5 |
| Spain | 15.5 | 5 | 3 | 0 | 2 | 1 | 0.5 | 0 | 2 | 0.5 | 1.5 |
| Indonesia | 15 | 5 | 3 | 2 | 2 | 1 | 0 | 0 | 0 | 0 | 2 |
| Netherlands | 15 | 5 | 2 | 0 | 2 | 0 | 1.5 | 1 | 2 | 1.5 | 0 |
| India | 14.5 | 1 | 3 | 2 | 2 | 2 | 0.5 | 1 | 1 | 0 | 2 |
| US | 13 | 3 | 2 | 0 | 0 | 1 | 0.5 | 2 | 2 | 2 | 0.5 |
| Ukraine | 13 | 0 | 3 | 2 | 2 | 1 | 1.5 | 1 | 0 | 0.5 | 2 |
| Thailand | 12.5 | 1 | 3 | 2 | 2 | 1 | 0.5 | 0 | 1 | 0.5 | 1.5 |
| China | 12 | 0 | 0 | 2 | 2 | 2 | 1 | 1 | 1 | 1 | 2 |
| Canada | 10.5 | 2 | 3 | 0 | 0 | 1 | 0.5 | 1 | 2 | 1 | 0 |
| Russia | 10 | 0 | 3 | 0 | 2 | 1 | 2 | 0 | 0 | 0.5 | 1.5 |
| Poland | 10 | 3 | 0 | 0 | 2 | 0 | 1.5 | 1 | 2 | 0.5 | 0 |
| Brazil | 7.5 | 1 | 2 | 0 | 0 | 1 | 0.5 | 1 | 1 | 0 | 1 |
| Australia | 6 | 2 | 0 | 0 | 0 | 0 | 0.5 | 0 | 1 | 1.5 | 1 |
| Saudi Arabia | 5.5 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0.5 | 2 |
| UAE | 4 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 |
| South Africa | 1.5 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0.5 | 0 |

### *ENERGY INTENSITY OF INDUSTRY (6 POINTS)*

Countries vary widely in the mix and structure of their industrial sectors. Depending on the size and type of predominant industries, energy consumption will also vary from one economy to another. Additionally, industrial processes can 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.

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.[7] First we calculated raw energy intensities using overall industrial energy consumption and overall industrial GDP (IEA 2018d; World Bank 2018e). 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 assumed that the energy mix of US industries is applicable to that of other countries (EIA 2013; EIA 2015). A complete description of these steps is available in Appendix A.

Devising a performance metric that allows a representative comparison of industrial energy intensity is inherently problematic. Several methodological approaches can be used, each with distinct advantages and disadvantages. 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 professional judgment, provides a more meaningful analysis than other options. However this approach is more complicated and requires us to make many assumptions, especially when data are limited.

To facilitate evaluation in a more meaningful way and to better inform energy policy, comparisons must be made between similar industry subsectors across the world. Countries should report both energy consumption data and value added by each type of industry. Additionally, international harmonization on the definitions of industrial subsectors would help ensure fairer comparisons.[8]

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[7] Industries are grouped into the following categories by our primary data source for this metric, the International Energy Agency: 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 (industry). These data do not include energy consumption in agriculture.

[8] 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.

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 31 shows the point allocation for industrial energy intensity. Table 32 lists the results by country.

**Table 31. 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 |

**Table 32. Scores for energy intensity of industrial sector**

| Country | Relative intensity factor | kBtus/$ | Joules/$ | Score |
|---|---|---|---|---|
| UK | 0.76 | 1.21 | 1,277 | 6 |
| Japan | 1.05 | 1.82 | 1,919 | 6 |
| France | 1.14 | 1.95 | 2,061 | 6 |
| Germany | 1.20 | 2.14 | 2,259 | 5 |
| Italy | 1.16 | 2.20 | 2,320 | 5 |
| Indonesia | 0.59 | 2.24 | 2,366 | 5 |
| Netherlands | 0.81 | 2.28 | 2,405 | 5 |
| Mexico | 0.70 | 2.28 | 2,410 | 5 |
| Spain | 1.28 | 2.52 | 2,654 | 4 |
| Turkey | 1.14 | 3.16 | 3,333 | 4 |
| Taiwan | 0.75 | 3.32 | 3,504 | 4 |
| South Korea | 0.92 | 3.38 | 3,561 | 4 |
| US | 1.28 | 3.68 | 3,878 | 3 |
| Poland | 1.49 | 4.04 | 4,265 | 3 |
| Canada | 1.82 | 5.26 | 5,545 | 2 |
| Australia | 2.02 | 5.33 | 5,621 | 2 |
| Saudi Arabia | 1.21 | 6.32 | 9,350 | 2 |
| UAE | 1.02 | 6.94 | 7,320 | 1 |
| Thailand | 0.89 | 6.96 | 7,340 | 1 |

| Country | Relative intensity factor | kBtus/$ | Joules/$ | Score |
|---|---|---|---|---|
| Brazil | 1.28 | 7.01 | 7,393 | 1 |
| India | 0.68 | 7.13 | 7,524 | 1 |
| South Africa | 1.12 | 9.28 | 9,791 | 0 |
| Russia | 1.20 | 10.15 | 10,711 | 0 |
| China | 1.15 | 11.15 | 11,760 | 0 |
| Ukraine | 1.18 | 22.85 | 24,111 | 0 |

*Sources:* IEA 2018d; World Bank 2018e

### *VOLUNTARY AGREEMENTS WITH MANUFACTURERS (3 POINTS)*

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

We gave the highest score of 3 points for the presence of a program that establishes voluntary agreements between government and manufacturers for reducing consumption and offers incentives or other financial support for achievements and/or participation. Countries with agreements that do not offer incentives received 2 points. Table 33 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 energy management expert on site. A dedicated on-site energy manager can improve processes, identify waste, and maximize the efficient use of energy resources (Russell 2013). However, in spite of the economic benefits of reduced energy waste and the increased economic productivity that can come from having an onsite expert, only a few of the countries analyzed had such a requirement.

Countries that had a plant energy manager mandate received 2 points. Table 33 displays 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 33 lists the findings for this indicator.

Table 33. 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 | 3 | Yes | 2 | Yes | 2 | 7 |
| Indonesia | Agreements and incentives | 3 | Yes | 2 | Yes | 2 | 7 |
| Italy | Agreements and incentives | 3 | Yes | 2 | Yes | 2 | 7 |
| Japan | Agreements and incentives | 3 | Yes | 2 | Yes | 2 | 7 |
| Mexico | Agreements and incentives | 3 | Yes | 2 | Yes | 2 | 7 |
| Thailand | Agreements and incentives | 3 | Yes | 2 | Yes | 2 | 7 |
| Ukraine | Agreements and incentives | 3 | Yes | 2 | No | 2 | 7 |
| France | Agreements and incentives | 3 | No | 0 | Yes | 2 | 5 |
| Germany | Agreements and incentives | 3 | No | 0 | Yes | 2 | 5 |
| Russia | Agreements and incentives | 3 | No | 0 | Yes | 2 | 5 |
| South Korea | Agreements and incentives | 3 | No | 0 | Yes | 2 | 5 |
| Spain | Agreements and incentives | 3 | No | 0 | Yes | 2 | 5 |
| Turkey | Agreements and incentives | 3 | No | 0 | Yes | 2 | 5 |
| UK | Agreements and incentives | 3 | No | 0 | Yes | 2 | 5 |
| China | No agreements | 0 | Yes | 2 | Yes | 2 | 4 |
| Netherlands | Agreements | 2 | No | 0 | Yes | 2 | 4 |
| Taiwan | No agreements | 0 | Yes | 2 | Yes | 2 | 4 |
| Canada | Agreements and incentives | 3 | No | 0 | No | 0 | 3 |
| Brazil | Agreements | 2 | No | 0 | No | 0 | 2 |
| Poland | No agreements | 0 | No | 0 | Yes | 2 | 2 |
| UAE | Agreements | 2 | No | 0 | No | 0 | 2 |
| US | Agreements | 2 | No | 0 | No | 0 | 2 |

| Country | Voluntary agreements with manufacturers | Score | Mandate for energy managers | Score | Mandatory energy audits | Score | Total score |
|---|---|---|---|---|---|---|---|
| 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 2018a; IIP 2017; ABB 2013a–h; ACEEE country research

### *POLICY TO ENCOURAGE ENERGY MANAGEMENT (2 POINTS)*

One way national governments can improve energy efficiency in industries is by encouraging the implementation of energy management systems (EnMS). The purpose of an EnMS standard is to provide guidance for industrial and commercial facilities to integrate energy efficiency into their management practices, including fine-tuning production processes and improving the energy efficiency of industrial systems (McKane et al. 2009). Some policies may also require companies to take into account relevant national or international standards. In 2011 the International Organization for Standardization (ISO) adopted the ISO 50001 energy management system standard, which provides a common framework for industrial facilities, commercial facilities, or entire organizations (ISO 20111). Energy planning, management, implementation, training, and auditing are all vital to the standard. More than 23,400 sites worldwide had achieved ISO 50001 certification as of 2016 (ISO 2011). Between 2015 and 2016, the number of ISO 50001-certified facilities increased from 11,985 to 20,216 (ISO 2017). The growth of ISO 50001 is expected to accelerate 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 like the Clean Energy Ministerial's Energy Management Leadership Awards.

The previous edition of the *Scorecard* awarded 2 points to countries with a national policy to encourage EnMS that referenced ISO 50001, and 1 point to those countries that had a non-ISO national policy in place. However the number of certified ISO 50001 facilities in a country is a better indication of how dedicated the national policy is to the ISO 50001 standard. Therefore this year we awarded 2 points to each country that had national policies to encourage EnMS *and* more than 500 ISO 50001–certified facilities. Countries with a national EnMS policy in place but fewer than 500 ISO 50001–certified facilities received 1 point. Countries without a national policy to encourage EnMS received no points. Table 34 lists the scores for this metric.

Table 34. Scores for policies to encourage EnMS

| Country | Energy management policy | Number of ISO 50001–certified facilities (2016) | Score |
|---|---|---|---|
| Germany | Yes | 9,024 | 2 |
| UK | Yes | 2,829 | 2 |
| Italy | Yes | 1,415 | 2 |
| China | Yes | 1,015 | 2 |
| France | Yes | 759 | 2 |
| India | Yes | 570 | 2 |
| Spain | Yes | 465 | 1 |
| Taiwan | Yes | 298 | 1 |
| Thailand | Yes | 255 | 1 |
| Russia | Yes | 174 | 1 |
| Turkey | Yes | 115 | 1 |
| South Korea | Yes | 99 | 1 |
| Indonesia | Yes | 54 | 1 |
| US | Yes | 47 | 1 |
| Japan | Yes | 40 | 1 |
| Brazil | Yes | 22 | 1 |
| Ukraine | Yes | 21 | 1 |
| Mexico | Yes | 18 | 1 |
| Canada | Yes | 8 | 1 |
| Poland | No | 112 | 0 |
| Australia | No | 86 | 0 |
| Netherlands | No | 64 | 0 |
| UAE | No | 48 | 0 |
| South Africa | No | 10 | 0 |
| Saudi Arabia | No | 2 | 0 |

*Sources:* IIP 2017; ISO 2017; ACEEE country research

### *CHP INSTALLED CAPACITY (2 POINTS)*

CHP systems generate electricity and useful thermal energy in a single integrated system. The use of 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.

For this metric we awarded points 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 use of CHP. For example, evaluating the share of electricity actually produced by CHP systems may be a better measure of whether a country utilizes 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.

We gave the full 2 points to countries where CHP makes up at least 35% of the installed power capacity. Countries that have at least 15% of installed power capacity from CHP earned 1.5 points, those with at least 10% from CHP earned 1 point, and those with at least 5% from CHP earned 0.5 point. Table 35 lists the results by country.

**Table 35. Scores for share of CHP in installed capacity**

| Country | % of CHP in installed capacity | Score |
|---|---|---|
| Russia | 57.79% | 2 |
| Netherlands | 38.42% | 2 |
| Italy | 22.85% | 1.5 |
| Poland | 19.51% | 1.5 |
| Taiwan | 16.79% | 1.5 |
| Ukraine | 15.71% | 1.5 |
| Germany | 14.18% | 1 |
| China | 13.00% | 1 |
| South Korea | 9.82% | 0.5 |
| India | 9.60% | 0.5 |
| Thailand | 8.87% | 0.5 |
| UK | 7.32% | 0.5 |
| Turkey | 7.16% | 0.5 |
| Canada | 6.70% | 0.5 |
| Brazil | 6.66% | 0.5 |
| US | 6.51% | 0.5 |
| Spain | 5.44% | 0.5 |
| Australia | 5.00% | 0.5 |
| France | 3.77% | 0 |
| Japan | 3.06% | 0 |
| Indonesia | <2% | 0 |
| Mexico | 0.78% | 0 |

| Country | % of CHP in installed capacity | Score |
|---|---|---|
| South Africa | <1% | 0 |
| Saudi Arabia | <1% | 0 |
| UAE | <1% | 0 |

*Sources:* World Energy Council 2016c; ACEEE country research

### *CHP POLICY (2 POINTS)*

Countries can encourage or discourage CHP deployment in many ways. This new metric recognizes countries for their adoption of policies and other regulations that promote the deployment of CHP systems. First we looked for the presence of a national goal or target for CHP. Then we looked for other supportive policies such as tax credits, financial incentives, or regulatory support for CHP production. Countries could earn up to 2 points for policies to encourage CHP.

We awarded the full 2 points 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 1 point. 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 a system size that is optimal 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 36 details the criteria and scores for CHP policy.

Table 36. Scores for CHP policy

| Country | CHP target | CHP incentives | Score |
|---|---|---|---|
| Germany | Yes | Yes | 2 |
| Japan | Yes | Yes | 2 |
| Turkey | Yes | Yes | 2 |
| US | Yes | Yes | 2 |
| Brazil | No | Yes | 1 |
| Canada | No | Yes | 1 |
| China | Yes | No | 1 |
| France | No | Yes | 1 |
| India | No | Yes | 1 |
| Italy | No | Yes | 1 |
| Mexico | No | Yes | 1 |
| Netherlands | No | Yes | 1 |
| Poland | No | Yes | 1 |
| South Africa | Yes | No | 1 |
| South Korea | No | Yes | 1 |

| Country | CHP target | CHP incentives | Score |
|---|---|---|---|
| Taiwan | No | Yes | 1 |
| UK | No | Yes | 1 |
| Ukraine | No | Yes | 1 |
| Australia | No | No | 0 |
| Indonesia | No | No | 0 |
| Russia | No | No | 0 |
| Saudi Arabia | No | No | 0 |
| Spain | No | No | 0 |
| Thailand | No | No | 0 |
| UAE | No | No | 0 |

*Source:* ACEEE country research

### *STANDARDS FOR MOTORS (2 POINTS)*

Electric motors (and the systems they drive) consume 70% of the electricity required by industry. (Bazurto, Quispe, and Mendoza 2016). In industrial applications, electric motors are used to drive pumps, fans, compressors, and other processing equipment. Many countries have established mandatory motor efficiency standards to limit the amount of energy that motors can consume. We scored this metric according to whether or not a country had MEPS in place for electric motors.

International standards classify motors on a scale of energy efficiency from lowest efficiency (IE1) to highest (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 37 includes the details and scoring for this metric.

**Table 37. MEPS for motors**

| Country | Mandatory MEPS for motors | Score |
|---|---|---|
| Canada | Yes, >IE3 | 2 |
| France | Yes, >IE3 | 2 |
| Germany | Yes, >IE3 | 2 |
| Italy | Yes, >IE3 | 2 |
| Japan | Yes, >IE3 | 2 |
| Mexico | 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 |
| UK | Yes, >IE3 | 2 |
| US | Yes, >IE3 | 2 |
| Australia | Yes | 1 |
| Brazil | Yes | 1 |
| China | Yes | 1 |
| India | Yes | 1 |
| Saudi Arabia | Yes | 1 |
| Thailand | Yes | 1 |
| Turkey | Yes | 1 |
| UAE | Yes | 1 |
| Indonesia | No | 0 |
| Russia | No | 0 |
| South Africa | No | 0 |
| Ukraine | No | 0 |

*Sources:* CLASP 2017; ACEEE country research

### *INVESTMENT IN R&D (2 POINTS)*

While industrial R&D spending is not invested exclusively in energy efficiency, energy efficiency is a major outcome of R&D investments, which reduce waste and improve productivity (Laitner et al. 2012). The spending included in this metric therefore represents R&D activities carried out in the business enterprise sector regardless of their particular application. We divided total R&D spending in the industrial sector by industrial GDP and report the results as a percent 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 equal to or greater than 5% of industrial GDP. Investment of 3% or more earned 1 point, and investment of 1% or more earned 0.5 point. Table 38 lists the results.

Table 38. Scores for investment in industrial R&D

| Country | 2015 investment in industrial R&D (% of industrial GDP) | Score |
|---|---|---|
| US | 10.19% | 2 |
| South Korea | 9.31% | 2 |
| Japan | 9.11% | 2 |
| France | 7.16% | 1.5 |
| Taiwan | 6.74% | 1.5 |
| Germany | 6.22% | 1.5 |
| UK | 5.79% | 1.5 |
| Australia | 5.78% | 1.5 |
| Netherlands | 5.50% | 1.5 |
| Canada | 4.48% | 1 |
| China | 3.97% | 1 |
| Italy | 2.85% | 0.5 |
| Spain | 2.63% | 0.5 |
| Ukraine | 1.53% | 0.5 |
| Russia | 1.42% | 0.5 |
| Poland | 1.27% | 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 |
| UAE | 0.94% | 0 |
| Brazil | 0.56% | 0 |
| Mexico | 0.48% | 0 |
| Indonesia | 0.16% | 0 |

*Sources:* UNESCO 2017; ACEEE country research

### *ENERGY INTENSITY OF AGRICULTURE (2 POINTS)*

The energy intensity of the agricultural sector 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 covered in this chapter, despite differences in crop mix and conditions across countries. Various crop

production practices require direct consumption of fuel and electricity, and the production of agricultural inputs, such as fertilizers and pesticides, requires an indirect use of energy. Sourcing and transporting water are additional factors affecting energy use and energy intensity in the agricultural sector.

Energy use can be particularly high in colder regions or in countries with heavily industrialized food production processes, while 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 39 outlines the scoring, and table 40 lists the results by country.

**Table 39. 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 |
| < 0.25 | 0 |

**Table 40. Scores for energy intensity of agriculture**

| Country | Energy intensity of agriculture (koe/$ agricultural GDP) | Score |
|---|---|---|
| Saudi Arabia | 0.0111 | 2 |
| Indonesia | 0.0121 | 2 |
| India | 0.0315 | 2 |
| China | 0.0400 | 2 |
| Germany | 0.0412 | 2 |
| Ukraine | 0.0473 | 2 |
| Taiwan | 0.0540 | 1.5 |
| Turkey | 0.0545 | 1.5 |
| Spain | 0.0800 | 1.5 |
| Japan | 0.0840 | 1.5 |
| Russia | 0.0850 | 1.5 |
| Thailand | 0.0873 | 1.5 |

| Country | Energy intensity of agriculture (koe/$ agricultural GDP) | Score |
|---|---|---|
| UK | 0.0909 | 1.5 |
| Italy | 0.0945 | 1.5 |
| Mexico | 0.0957 | 1.5 |
| Brazil | 0.1006 | 1 |
| South Korea | 0.1139 | 1 |
| Australia | 0.1406 | 1 |
| US | 0.1503 | 0.5 |
| France | 0.1721 | 0.5 |
| South Africa | 0.2036 | 0 |
| Poland | 0.2460 | 0 |
| Netherlands | 0.3430 | 0 |
| Canada | 0.3939 | 0 |
| UAE | No data available | 0 |

*Source:* WEC 2016b

### *INDUSTRY BEST PRACTICES*

**Japan.** Japan's 2015 industrial energy intensity was among the lowest of the 25 analyzed countries. It achieved this distinction through regulatory measures, voluntary actions, and financial incentives to encourage energy efficiency. The Act Concerning the Rational Use of Energy introduced mandatory energy efficiency requirements for designated industries in 1978 and continues to serve as the foundation of Japan's industrial energy efficiency policy. It requires companies to appoint an energy manager and report on the status of energy consumption every year. In 2008 a revision to the act introduced a benchmarking system obligating businesses to achieve specific medium-term (2015) and long-term (2020) energy efficiency targets (IIP 2018b). These requirements are supported by a tax incentive scheme, a special depreciation rate for all businesses investing in specified energy conservation and efficient equipment (ABB 2012). CHP does not contribute a significant share of Japan's total power capacity, but the government offers support to help encourage a greater contribution from it. The country's Energy and Environment Council defined a CHP road map that aims to more than double industrial and commercial CHP capacity, to 22 gigawatts (GW) in 2030 (Pales 2013).

**Germany.** The energy intensity of Germany's industrial sector is relatively low compared with that of other countries, with the majority of energy used in the chemical and iron and steel industries. 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 until 2022 (IIP 2018a). To encourage large companies to reach savings targets, these companies are eligible for a tax exemption when they achieve their goals. The federal government provides funding to small and medium-size companies to replace inefficient systems with energy-saving engines, pumps, and compressors. The country aims to generate 25% of its electricity from CHP by 2020. In 2017, Germany adopted an ordinance to auction funding for innovative CHP systems that produce heat based on renewable sources. The government has also encouraged energy-intensive companies to implement energy management systems to achieve emissions and energy savings targets. Germany has the largest number of facilities certified to the ISO 50001 standard among all the evaluated countries, progress that is encouraged by a number of incentives.

## Transportation

Globally the transportation sector accounts for approximately 20% of end-use energy consumption (EIA 2017). The scoring methodology in this section includes a combination of policy and performance metrics relating to energy efficiency in transportation. Countries could earn a total of 25 points across nine metrics that cover passenger and freight transport. We evaluated the efficiency of passenger transportation 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 policy by comparing light-duty fuel economy standards. We used national spending on rail versus road facilities as an indicator of investment in alternative 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 two performance metrics: energy consumed per ton-mile and ton-mile 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, and in keeping with our overall approach of presenting data in the simplest form that is meaningful, we largely avoided adjusting the data presented in this section to reflect other factors that may impact energy use in the transportation sector, 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. This can be partially attributed to the fact that cities and provinces typically have more jurisdiction over transportation efficiency policies than national governments.

France took first place, earning the top score of 17.5 points out of a possible 25. Italy and India were tied for second with scores of 17 points, and China took fourth place with a score of 15.5. The average score for this section was approximately 11 points. More than a third of the evaluated countries scored fewer than 10 points. These included Mexico, Russia, Ukraine, Australia, Turkey, South Africa, and Thailand. The United Arab Emirates earned the lowest score, 1.5 points, although as with Saudi Arabia, which earned the second-to-last spot with 4 points, this is 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 sustainable mobility options like public transit. Table 41 shows the total scores by country for the transportation section and scores for each metric.

Table 41. Transportation sector scores

| Country | Total score | Average light-duty (LD) on-road fuel economy | 2025 LD fuel economy standard | Heavy-duty (HD) fuel economy standard | VMT per capita | Ton-mile per $ of GDP | Energy per ton-mile traveled (kBtus/ ton-mile) | Smart freight programs | Ratio of rail to road investments | % of passenger travel by transit |
|---|---|---|---|---|---|---|---|---|---|---|
| **Max. score** | **25** | **3** | **4** | **3** | **3** | **2** | **3** | **1** | **3** | **3** |
| France | 17.5 | 3 | 4 | 0 | 2 | 2 | 1 | 1 | 3 | 1.5 |
| India | 17 | 3 | 3 | 1 | 3 | 0 | 2 | 0 | 2 | 3 |
| Italy | 17 | 3 | 4 | 0 | 2.5 | 2 | 0 | 1 | 3 | 1.5 |
| China | 15.5 | 1 | 3 | 2 | 2.5 | 0 | 2 | 1 | 1 | 3 |
| UK | 14 | 2 | 4 | 0 | 1 | 2 | 0 | 1 | 3 | 1 |
| Japan | 13.5 | 2 | 3 | 1 | 1.5 | 2 | 0 | 1 | 1 | 2 |
| South Korea | 13.5 | 1 | 4 | 0 | 1.5 | 2 | 0 | 1 | 2 | 2 |
| Spain | 13.5 | 2 | 4 | 0 | 1 | 1 | 2 | 0 | 2 | 1.5 |
| Canada | 13 | 1 | 3 | 3 | 0.5 | 1 | 2 | 1 | 1 | 0.5 |
| Germany | 13 | 2 | 4 | 0 | 0.5 | 2 | 1 | 1 | 1 | 1.5 |
| Netherlands | 12.5 | 2 | 4 | 0 | 1 | 2 | 1 | 1 | 0 | 1.5 |
| Brazil | 11 | 2 | 2 | 0 | 2 | 1 | 2 | 0 | 0 | 2 |
| Taiwan | 11 | 3 | 0 | 0 | 1.5 | 2 | 1 | 0 | 2 | 1.5 |
| US | 11 | 0 | 3 | 3 | 0 | 1 | 1 | 1 | 1 | 1 |
| Indonesia | 10 | 2 | 0 | 0 | 3 | 0 | 1 | 0 | 1 | 3 |
| Poland | 10 | 2 | 0 | 0 | 1 | 1 | 3 | 0 | 1 | 2 |
| Mexico | 9.5 | 1 | 1 | 0 | 2 | 1 | 0 | 1 | 1 | 2.5 |
| Russia | 9.5 | 1 | 0 | 0 | 1.5 | 0 | 3 | 0 | 2 | 2 |
| Ukraine | 8.5 | 2 | 0 | 0 | 2 | 0 | 0 | 0 | 2 | 2.5 |
| Australia | 6.5 | 0 | 0 | 0 | 0.5 | 1 | 3 | 0 | 1 | 1 |
| Turkey | 6.5 | 3 | 0 | 0 | 2.5 | 1 | 0 | 0 | 0 | 0 |
| South Africa | 6 | 2 | 0 | 0 | 2.5 | 0 | 0 | 0 | 0 | 1.5 |
| Thailand | 4.5 | 2 | 0 | 0 | 2.5 | 0 | 0 | 0 | 0 | 0 |
| Saudi Arabia | 4 | 0 | 2 | 0 | 2 | 0 | 0 | 0 | 0 | 0 |
| UAE | 1.5 | 0 | 0 | 0 | 1.5 | 0 | 0 | 0 | 0 | 0 |

### *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. A number of 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 and 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 by virtue of the prevalence of low-consuming vehicles there.

We used the International Council on Clean Transportation's (ICCT's) comparison of passenger-vehicle fuel economy standards to rate countries' efforts (ICCT 2017). ICCT adjusts standards levels in each country to reflect the relationship between that country's test cycle to estimate fuel economy and the US Corporate Average Fuel Economy (CAFE) test cycle in order to fairly compare standards. Countries with standards greater than 55 mpg by 2025 received the full score of 4 points, while countries with standards between 45 and 55 mpg by 2025 received 3 points. Countries with requirements between 40 and 45 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 35 mpg received the full 3 points for this metric, while countries with an average between 31 and 35 mpg received 2 points and countries with an average between 25 and 30 mpg received 1 point. The cut points used to score on-road passenger vehicle fuel economy are lower than the thresholds for the standards metric because real-world fuel economy is typically lower than test values. This difference exists because test cycles can capture only a limited range of driving behaviors and conditions. Table 42 lists results and scores for both metrics by country.

**Table 42. Scores for fuel economy standards and fuel economy for light-duty vehicles**

| Country | 2025 fuel economy standards (mpg) | Score |
|---|---|---|
| France | 56.9 | 4 |
| Germany | 56.9 | 4 |
| Netherlands | 56.9 | 4 |
| Spain | 56.9 | 4 |
| UK | 56.9 | 4 |
| Italy | 56.9 | 4 |
| South Korea | 56.7 | 4 |

| Country | Average fuel economy in 2015 (mpg) | Average fuel economy in 2015 (l/100 km) | Score |
|---|---|---|---|
| Turkey | 45.2 | 5.2 | 3 |
| Italy | 39.4 | 6.0 | 3 |
| India | 37.8 | 6.2 | 3 |
| France | 36.4 | 6.5 | 3 |
| Taiwan | 35.8 | 6.9 | 3 |
| Ukraine | 35.0 | 6.7 | 2 |
| Brazil | 33.6 | 7.0 | 2 |

| Country | 2025 fuel economy standards (mpg) | Score |
|---|---|---|
| Canada | 49.7 | 3 |
| US | 49.7 | 3 |
| India | 49.4 | 3 |
| China | 47.7 | 3 |
| Japan | 45.9 | 3 |
| Brazil* | 40.9 | 2 |
| Saudi Arabia | 40.0 | 2 |
| Mexico | 35.1 | 1 |
| Taiwan | 22.3 | 0 |
| Australia | None | 0 |
| Indonesia | None | 0 |
| Poland | None | 0 |
| Russia | None | 0 |
| South Africa | None | 0 |
| Thailand | None | 0 |
| Turkey | None | 0 |
| UAE | None | 0 |
| Ukraine | None | 0 |

| Country | Average fuel economy in 2015 (mpg) | Average fuel economy in 2015 (l/100 km) | Score |
|---|---|---|---|
| Spain | 33.6 | 7.0 | 2 |
| South Africa | 33.1 | 7.1 | 2 |
| UK | 32.4 | 7.3 | 2 |
| Germany | 32.3 | 7.3 | 2 |
| Indonesia | 32.2 | 7.3 | 2 |
| Netherlands | 31.7 | 7.4 | 2 |
| Poland | 31.6 | 7.4 | 2 |
| Thailand | 31.4 | 7.5 | 2 |
| Japan | 31.0 | 7.6 | 2 |
| China | 29.7 | 7.9 | 1 |
| Mexico | 29.4 | 8.0 | 1 |
| Canada | 29.3 | 8.0 | 1 |
| South Korea | 29.2 | 8.1 | 1 |
| Russia | 27.8 | 8.5 | 1 |
| Australia | 22.2 | 10.7 | 0 |
| US | 22.0 | 10.7 | 0 |
| Saudi Arabia | No data available | | |
| UAE | No data available | | |

* Brazil's fuel economy standard is voluntary, although there are numerous incentives for compliance in place. *Sources:* 2025 fuel economy standards: Yang and Bandivadekar 2017. Average fuel economy in 2015: Australia Bureau of Statistics 2017 (Australia); Odyssey-MURE 2017 (EU countries); DOT 2017 (US); ICCT 2017 (Brazil, Canada, China, India, Mexico, Russia, South Korea); Hill, Windisch, and Klimenko 2016 (Ukraine); MLIT 2016 (Japan); ACEEE data request (Taiwan); IEA 2017b (Indonesia, South Africa, Thailand, Turkey).

### *VEHICLE MILES TRAVELED PER CAPITA (3 POINTS)*

Improved vehicle fuel economy will not adequately address energy use over the long term in the transportation sector if growth in VMT goes unchecked. A VMT-per-capita metric measures the extent to which the demand for mobility is met by private vehicles in a country. 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 the use of personal cars per capita. A number of 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 the data in the simplest form that is meaningful across the 25 nations.

Countries with an average VMT per capita of no more than 500 received 3 points; with no more than 1,000, 2.5 points; no more than 2,000, 2 points; no more than 3,500, 1.5 points; no

more than 5,000, 1 point; and no more than 6,000, 0.5 point. Table 43 summarizes VMT per capita and all countries' 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 43. Scores for VMT and VKT per person**

| Country | VMT per capita (2015) | VKT per capita (2015) | Score |
|---|---|---|---|
| India | 153 | 247 | 3 |
| Indonesia | 287 | 462 | 3 |
| Thailand | 660 | 1,062 | 2.5 |
| South Africa | 704 | 1,133 | 2.5 |
| China | 739 | 1,189 | 2.5 |
| Italy | 814 | 1,309 | 2.5 |
| Turkey | 885 | 1,425 | 2.5 |
| Ukraine | 1,182 | 1,902 | 2 |
| Saudi Arabia | 1,396 | 2,247 | 2 |
| Brazil | 1,564 | 2,518 | 2 |
| Mexico | 1,635 | 2,631 | 2 |
| France | 1,866 | 3,003 | 2 |
| Russia | 2,209 | 3,555 | 1.5 |
| UAE | 2,210 | 3,556 | 1.5 |
| Taiwan | 2,236 | 3,598 | 1.5 |
| South Korea | 3,021 | 4,861 | 1.5 |
| Japan | 3,043 | 4,898 | 1.5 |
| Netherlands | 3,900 | 6,277 | 1 |
| Spain | 4,301 | 6,923 | 1 |
| Poland | 4,341 | 6,986 | 1 |
| UK | 4,842 | 7,793 | 1 |
| Germany | 5,383 | 8,663 | 0.5 |
| Australia | 5,501 | 8,853 | 0.5 |
| Canada | 5,508 | 8,864 | 0.5 |
| US | 9,149 | 14,724 | 0 |

*Sources*: ICCT 2017; ITF 2016 (France, Italy, Turkey, UK); NRCan 2017 (Canada); German Federal Motor Vehicle Office 2018 (Germany); ACEEE data request (Taiwan).

### *USE OF PUBLIC TRANSIT (3 POINTS)*

The use of public transit is an important factor in the efficiency of a country's overall transportation system. We measured public transit use in the 25 nations evaluated in this report 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 in the case of VMT per capita, this metric does not capture a number of 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.

Countries where at least 60% of passenger travel is completed by public transit received a full score of 3 points; at least 45% by public transit, 2.5 points; at least 20%, 2 points; at least 15%, 1.5 points; at least 10%, 1 point; and at least 5%, 0.5 point. Table 44 below lists the results for this metric.

**Table 44. Scores for use of public transit**

| Country | Distance traveled by public transit (% passenger km by public transit modes in 2015) | Score |
|---|---|---|
| China | 67.5% | 3 |
| India | 63.8% | 3 |
| Indonesia | 63.3% | 3 |
| Ukraine | 56.3% | 2.5 |
| Mexico | 49.7% | 2.5 |
| South Korea | 39.8% | 2 |
| Japan | 36.0% | 2 |
| Brazil | 34.5% | 2 |
| Russia | 28.5% | 2 |
| Poland | 21.5% | 2 |
| France | 19.9.0% | 1.5 |
| Netherlands | 18.7% | 1.5 |
| Italy | 18.6% | 1.5 |
| Spain | 18.6% | 1.5 |
| Taiwan | 17.7% | 1.5 |
| Germany | 15.8% | 1.5 |
| South Africa | 15.0% | 1.5 |
| UK | 13.5% | 1 |
| Australia | 11.8% | 1 |

| Country | Distance traveled by public transit (% passenger km by public transit modes in 2015) | Score |
|---|---|---|
| US | 10.5% | 1 |
| Canada | 8.7% | 0.5 |
| Turkey | 1.6% | 0 |
| Saudi Arabia | No data available | 0 |
| Thailand | No data available | 0 |
| UAE | No data available | 0 |

*Sources:* ITF 2017a; ICCT 2017 (Brazil, Canada, China, India, Mexico, Indonesia, Russia); ACEEE data request (Taiwan); European Union 2016 (Ukraine)

### *INVESTMENT IN RAIL TRANSIT VERSUS ROADS (3 POINTS)*

A nation's investment in public transit is a key indicator of its commitment to energy-efficient 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 45 shows the results and scores by country.

**Table 45. Scores for investment in rail transit versus roads**

| Country | 2015 investment in rail transit (ratio of $ in rail vs. roads) | Score |
|---|---|---|
| UK | 1.55 | 3 |
| Italy | 1.23 | 3 |
| France | 1.03 | 3 |
| Russia | 0.82 | 2 |
| India | 0.76 | 2 |
| Taiwan | 0.68 | 2 |
| South Korea | 0.65 | 2 |
| Spain | 0.63 | 2 |
| Ukraine | 0.62 | 2 |

| Country | 2015 investment in rail transit (ratio of $ in rail vs. roads) | Score |
|---|---|---|
| Germany | 0.41 | 1 |
| Japan | 0.30 | 1 |
| China | 0.27 | 1 |
| Australia | 0.26 | 1 |
| Indonesia | 0.22 | 1 |
| Canada | 0.19 | 1 |
| US | 0.18 | 1 |
| Mexico | 0.17 | 1 |
| Poland | 0.16 | 1 |
| Turkey | 0.14 | 0 |
| Brazil | 0.00 | 0 |
| Netherlands | 0.00 | 0 |
| Saudi Arabia | 0.00 | 0 |
| South Africa | 0.00 | 0 |
| Thailand | 0.00 | 0 |
| UAE | 0.00 | 0 |

Data for Italy are from 2014. Data for Mexico are from 2013. *Sources:* OECD 2018b; PwC 2016 (Indonesia); ACEEE data request (Japan, Taiwan, Ukraine).

### *ENERGY INTENSITY OF FREIGHT TRANSPORT (5 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 used two metrics. The first is the energy consumed per ton-mile of goods moved, which reflects the shares of goods moved by more and less energy-intensive modes as well as the energy efficiency of each mode. The second metric calculates the ton-miles of freight transported per dollar of GDP to evaluate freight energy use relative to economic activity, a proxy measure of the location efficiency of industrial and commercial activity.

As with the other performance-based metrics described in this section, the metrics we used to evaluate freight energy intensity also reflect differences in economic factors among the included countries, as well as demographic and geographic factors such as population density.

Table 46 shows the point allocation for both freight intensity metrics. Table 47 gives the scores.

Table 46. Point allocation for freight metrics

| Energy per ton-mile traveled (kBtus/ton-mile) in 2015 | Score | Ton-mile per dollar of GDP (2015) | Score |
|---|---|---|---|
| ≤ 0.75 | 3 | ≤ 0.2 | 2 |
| ≤ 1.2 | 2 | ≤ 1 | 1 |
| ≤ 2 | 1 | | |

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

| Country | Energy per ton-mile traveled (kBtus/ton-mile) in 2015 | Energy per tonne-km traveled (MJ/tonne-km) in 2015 | Score | Ton-mile per dollar of GDP (2015) | Tonne-km per dollar of GDP (2015) | Score | Total score |
|---|---|---|---|---|---|---|---|
| Australia | 0.42 | 0.65 | 3 | 0.69 | 0.47 | 1 | 4 |
| Poland | 0.68 | 1.05 | 3 | 0.91 | 0.63 | 1 | 4 |
| Russia | 0.48 | 0.74 | 3 | 3.46 | 2.37 | 0 | 3 |
| Canada | 0.79 | 1.22 | 2 | 0.80 | 0.55 | 1 | 3 |
| Brazil | 1.05 | 1.62 | 2 | 0.66 | 0.45 | 1 | 3 |
| Spain | 1.20 | 1.84 | 2 | 0.24 | 0.16 | 1 | 3 |
| Germany | 1.29 | 1.99 | 1 | 0.20 | 0.14 | 2 | 3 |
| Netherlands | 1.55 | 2.39 | 1 | 0.16 | 0.11 | 2 | 3 |
| Taiwan | 1.65 | 2.54 | 1 | 0.05 | 0.03 | 2 | 3 |
| France | 1.90 | 2.93 | 1 | 0.11 | 0.07 | 2 | 3 |
| India | 1.08 | 1.66 | 2 | 1.83 | 1.25 | 0 | 2 |
| China | 1.11 | 1.72 | 2 | 2.03 | 1.39 | 0 | 2 |
| US | 1.25 | 1.92 | 1 | 0.40 | 0.27 | 1 | 2 |
| UK | 2.15 | 3.31 | 0 | 0.10 | 0.07 | 2 | 2 |
| Italy | 2.83 | 4.35 | 0 | 0.10 | 0.07 | 2 | 2 |
| South Korea | 3.11 | 1.84 | 0 | 0.16 | 0.11 | 2 | 2 |
| Japan | 4.80 | 7.39 | 0 | 0.09 | 0.06 | 2 | 2 |
| Indonesia | 1.34 | 2.07 | 1 | 2.09 | 1.43 | 0 | 1 |
| Mexico | 2.36 | 3.64 | 0 | 0.40 | 0.27 | 1 | 1 |
| Turkey | No data available | | 0 | 0.41 | 0.28 | 1 | 1 |
| South Africa | No data available | | 0 | 1.26 | 0.87 | 0 | 0 |
| Ukraine | No data available | | 0 | 3.77 | 2.59 | 0 | 0 |

| Country | Energy per ton-mile traveled (kBtus/ton-mile) in 2015 | Energy per tonne-km traveled (MJ/tonne-km) in 2015 | Score | Ton-mile per dollar of GDP (2015) | Tonne-km per dollar of GDP (2015) | Score | Total score |
|---|---|---|---|---|---|---|---|
| Saudi Arabia | No data available | | 0 | No data available | | 0 | 0 |
| Thailand | No data available | | 0 | No data available | | 0 | 0 |
| UAE | No data available | | 0 | No data available | | 0 | 0 |

Freight intensity by GDP: Data for Canada are from 2014; data for South Africa are from 2013. *Sources:* ITF 2017b; ICCT 2017 (Brazil, US, Indonesia); University of Stellenbosch 2015 (South Africa); Eurostat 2018 (UK); NRCan 2017; ACEEE data request (Japan, Taiwan).
Freight intensity by energy use: Data for Australia are from 2013. *Sources:* ICCT 2017, Australian Office of the Chief Economist 2015 (Australia); NRCan 2017 (Canada); Odyssey-MURE 2017 (France, Italy, Netherlands, Poland, Spain, UK); ACEEE data request (Taiwan, Japan).

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

Fuel efficiency standards for heavy-duty vehicles are relatively new policies for most countries but 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). We evaluated the percentage improvement the standards achieved by the end of the policy period relative to a 2010 baseline. Only five countries have fuel economy standards in place for heavy-duty vehicles.

Evaluating the stringency of fuel efficiency standards using percentage improvement over a baseline year measures progress, not absolute efficiency levels. Countries received the full 3 points for future reduction of at least 20%, 2 points for reduction of at least 13%, 1 point for at least 5%, and no points if they did not have a standard in place. Table 48 shows the savings from the standards and scores for each country.

Table 48. Scores for fuel efficiency standards for tractor trucks

| Country | % reduction in fuel consumption or $CO_2$ emissions for tractor trucks | Score |
|---|---|---|
| Canada | 29% | 3 |
| US | 29% | 3 |
| China | 14% | 2 |
| India | 11% | 1 |
| Japan | 9% | 1 |
| Australia | None | 0 |
| Brazil | None | 0 |
| France | None | 0 |
| Germany | None | 0 |
| Indonesia | None | 0 |
| Italy | None | 0 |

| Country | % reduction in fuel consumption or $CO_2$ emissions for tractor trucks | Score |
|---|---|---|
| Mexico | None | 0 |
| Netherlands | None | 0 |
| Poland | None | 0 |
| Russia | None | 0 |
| Saudi Arabia | None | 0 |
| South Africa | None | 0 |
| South Korea | None | 0 |
| Spain | None | 0 |
| Taiwan | None | 0 |
| Thailand | None | 0 |
| Turkey | None | 0 |
| UAE | None | 0 |
| UK | None | 0 |
| Ukraine | None | 0 |

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

### *SMART FREIGHT INITIATIVES (1 POINT)*

National smart freight programs provide domestic and multinational corporations with a framework for streamlining freight operations and reducing their company's 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 number of 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 our 25 countries (Smart Freight Centre 2017). Countries that have either a voluntary or mandatory national smart freight program earned 1 point this year. Table 49 shows the results.

Table 49. 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 |
| UK | Yes | Logistics Carbon Reduction Scheme | 1 |
| US | Yes | EPA Smart Way | 1 |
| Australia | No | | 0 |
| Brazil | 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 |
| UAE | No | | 0 |
| Ukraine | No | | 0 |

*Source:* Smart Freight Centre 2017

### *TRANSPORTATION BEST PRACTICES*

**France.** France took first place this year in the transportation section with a score of 17.5 points. 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 has come up with a comprehensive approach that includes increasing the overall efficiency of vehicles by adhering to the EU passenger vehicle standards but also 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 2018 transportation rankings. France was among the top five countries for on-road fuel economy in 2015 with an average mpg of 36.4 (6.5 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 passenger and freight movement.

**Italy.** Italy was among the top five in the transportation section of the 2018 edition of the ACEEE *International Energy Efficiency Scorecard*, with a score of 17. The country participates in the European Union's mandatory emissions-reduction targets for new cars, which require cars registered within the EU to 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 Italy in 2015 was among the highest at 39.4 mpg (6.0 liters/100 km).

Italy also spent approximately 1.23 euros on rail transit facilities for every euro it spent on road maintenance and construction in 2015. Italy's passenger and freight railway systems are currently undergoing a period of transition, as the national government has opened up the market for services to competitors to the national railway company. Italy also participates in the European Lean and Green smart freight logistics program, which aims to encourage businesses and government agencies to increase the efficiency of freight movement and improve the overall sustainability of the freight sector through updated logistics methods and programs.

## Conclusion

*The 2018 International Energy Efficiency Scorecard* compares energy use and energy efficiency policies among 25 of the world's top energy-consuming countries. The rankings are dominated by European Union nations such as Germany, Italy, and France, in addition to Japan. As we mentioned in the Methodology section, we awarded full points to the top-performing country on each metric. Table 50 summarizes the best policies and outcomes for each.

**Table 50. Highest-scoring policies and performances for each metric**

| Metric | Results | Countries |
|---|---|---|
| National efforts | | |
| Change in energy intensity | –23.7% between 2010 and 2015 | Ukraine |
| Spending on energy efficiency | $31.30 per capita | Germany |
| Energy savings goals | Commitments to energy savings greater than 1% per year | France, Germany, India, Italy, Japan, Netherlands, Poland, Spain, United Arab Emirates, United Kingdom |
| Efficiency of thermal power plants | 84.1% | Brazil |
| Tax credits and loan programs | Federal tax credits and loan programs, both covering multiple sectors | Canada, France, Germany, India, Italy, Japan, Netherlands, Russia, South Korea, United Kingdom, United States |
| Spending on energy efficiency R&D | $3.94 per capita | United States |
| Size of the ESCOs market | 0.37% of total GDP | France |
| Water efficiency policy | A national water law with conservation principles, plus implementation of water efficiency programs | Australia, China, Germany, Indonesia, Mexico, Taiwan |
| Data availability | Widely available data | Australia, Canada, France, Germany, Italy, Japan, Mexico, Netherlands, United Kingdom, United States |

| Metric | Results | Countries |
|---|---|---|
| Buildings | | |
| Appliance and equipment standards | 52 mandatory appliance and equipment standards | United States |
| Residential building codes | Mandatory building codes covering all 6 technical-requirement categories | Australia, France, Germany, Italy, Netherlands, Poland, South Africa, South Korea, Spain, United Kingdom |
| Commercial building codes | Mandatory building codes covering 5 out of 6 technical-requirement categories | Australia, France, Germany, Italy, Mexico, Netherlands, Poland, South Africa, South Korea, Spain, United Kingdom |
| Building retrofit policies | Mandatory renovations when major work is done and loans and tax rebates available for assistance | France |
| Building rating and disclosure | Mandatory building energy rating and disclosure policy covering all buildings | France, Germany, Italy, Netherlands, Poland, Spain, Turkey, United Kingdom |
| Appliance and equipment labeling | Mandatory categorical program covering 15 or more product categories | Brazil, China, France, Germany, Italy, Netherlands, Poland, Russia, South Korea, Spain, Turkey, United Kingdom, United States |
| Energy intensity in residential buildings | 0.16 MMBtus per square meter of floor space, 5.48 MMBtus per capita | Mexico |
| Energy intensity in commercial buildings | 0.14 MMBtus per square meter of floor space, 201 MMBtus per million dollars of GDP | Mexico |
| Industry | | |
| Energy intensity of the industrial sector | 1.21 kBtus/$ GDP | United Kingdom |
| Voluntary energy performance agreements with manufacturers | Government agreements with manufacturers and incentives for a variety of business types | Canada, France, Germany, India, Indonesia, Italy, Japan, Mexico, Russia, South Korea, Spain, Thailand, Turkey, United Kingdom, Ukraine |
| Policy to encourage energy management | Energy management policy that references ISO 50001 with more than 500 facilities certified to the standard | China, France, Germany, India, Italy, United Kingdom |

| Metric | Results | Countries |
|---|---|---|
| Minimum efficiency standards for electric motors | Mandatory IE3 MEPS | Canada, France, Germany, Italy, Japan, Mexico, Netherlands, Poland, South Korea, Spain, Taiwan, United Kingdom, United States |
| Mandate for plant energy managers | Requirement for a dedicated onsite energy expert | China, India, Indonesia, Italy, Japan, Mexico, Taiwan, Thailand, Ukraine |
| 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 |
| Investment in manufacturing R&D | 10.19% of total industrial GDP | United States |
| 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 |
| Agriculture energy intensity | 0.010 koe per $ of agricultural GDP | Saudi Arabia |
| Transportation | | |
| Fuel economy standards for light-duty vehicles | 56.9 mpg by 2025 | France, Germany, Italy, Netherlands, Spain, United Kingdom |
| Fuel economy of light-duty vehicles | 45.2 mpg | Turkey |
| Vehicle miles traveled per capita | 247 vehicle miles traveled per capita | India |
| Fuel economy standards for heavy-duty tractor trucks | 29% improvement in fuel consumption/$CO_2$ emissions of tractor trucks | Canada, United States |
| Freight transport per unit of economic activity | 0.05 ton-miles per $ of GDP | Taiwan |
| Energy intensity of freight transport | 0.42 kBtus per ton-mile | Australia |
| Use of public transit | 67.5% of total passenger kilometers traveled | China |
| Investment in rail transit versus roads | $1.55 spent on transit per $1 spent on roads | United Kingdom |
| Smart freight initiatives | National smart freight program | Canada, China, France, Germany, Italy, Japan, Mexico, Netherlands, South Korea, United Kingdom, United States |

Although (as in 2016) no country achieved a perfect overall score in this year's *Scorecard*, 15 scored above 50 points. The average score was 50.5 points in in 2018, compared with 51 points in 2016. The highest score earned this year was 75.5 compared with 73.5 in 2016, showing that the leading countries did incrementally better in this edition of the rankings.

Two factors may have played a part in this improvement. Nationwide commitments stemming from the Paris Agreement have pushed a number of countries to implement countrywide energy-reduction and GHG-reduction targets as well as a suite of complementary policies to spur energy savings, technology deployment, and economic development. Additionally, many countries' scores, particularly the European ones, improved due to the availability of more recent data that reflected the impact of their ambitious energy efficiency policies across different sectors.

Despite an overall improvement in scores among the top scorers in 2018, the fact that the average score remained relatively constant between 2016 and 2018 indicates that there remains significant—and in some cases dramatic—room for improvement in every country analyzed in this edition, particularly in the transportation section. Countries must address energy use in this sector to meet aggressive reduction targets in line with their voluntary commitments to the Paris Agreement. The average score for countries on the transportation metrics was 11, and the highest-scoring country earned a total of 17.5 points out of the available 25.

Of note this year was the United States' fall to the 10th spot from 8th in 2016. The United States tied with Canada and ranked below China, and Taiwan this year with a score of 55.5 points compared with 61.5 in 2016. Some of this difference was due to the changes in scoring methodology we implemented, but the United States lost 1 point in the energy and GHG targets metrics as well as points on energy intensity. This decline is worrying, especially given that it is likely to continue if the current administration succeeds in rolling back critical energy efficiency policies and programs.

The countries with the most room for improvement include one new addition this year, the UAE, along with Thailand, South Africa, and Saudi Arabia. While many of this year's low-scoring countries have emerging economies with increasing demand for energy services or have highly energy-intensive economies, they still have plenty of opportunity to build energy efficiency into their continued economic growth by implementing policies in their industrial, buildings, and transportation sectors. Additionally, it is important to note that scores for the UAE and Saudi Arabia are not necessarily reflective of their progress on energy efficiency and may instead result from a lack of available data across sectors.

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. Countries that use energy more efficiently use fewer resources to achieve the same goals. This helps them to reduce overall costs, preserve valuable natural resources, and gain a competitive edge over countries where resources are wasted and costs are higher.

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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, including climate, economic composition, and population. As a result, isolating the impact of energy efficiency measures on energy use is difficult. For *The 2018 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 evaluated in the report 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 between countries. 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.

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

$$\begin{aligned} &Energy\ intensity\ of\ space\ cooling\ (E^{C}) \\ &= Energy\ intensity\ (E^{0}) * Share\ of\ space\ cooling\ in\ residential\ energy\ use \end{aligned}$$

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

Next we calculated the ratio of each country's heating and cooling degree days to the average number of heating and cooling degree days of all the countries analyzed.[9]

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

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

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 the countries had the same climate.

[9] 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). Heating and cooling degree day data were obtained from the Climate Analysis Indicators Tool (CAIT) developed by the World Resources Institute and from the European Environment Agency.

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

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

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 followed the same methodology for both residential intensity metrics: energy use per floor area and energy use per capita. The adjustment serves the sole purpose of allowing 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.

### *INDUSTRY*

We used energy intensity to compare the efficiency of the industrial sector across countries.[10] To begin, we calculated the raw energy intensity of industry using total energy consumed by industry and total industrial GDP (World Bank 2018c) 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 the energy intensity of industry 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, semi-finished goods, and services purchased from all sources) (BEA 2006). However this information is not available for all countries.

Using raw energy intensities alone does not offer a meaningful comparison among countries. Both the composition of the industrial sector and the energy use of individual industries vary significantly across the 25 countries analyzed. For example, in 2015 Australia's energy consumption was highest in nonferrous-metals manufacturing, while Brazil's energy consumption was highest in food and tobacco production. Figure A1 shows the mix of industries in the 25 countries and the energy consumption of the IEA's 13 industry groupings as a share of total energy consumed by the industrial sector overall.[11]

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[10] 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). The industry groupings used in this analysis 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.

[11] For certain countries, final energy consumption data reported by industry grouping did not appear consistent. For example, 98% of final energy consumption in Saudi Arabia was reported as nonspecified, which was inconsistent with the fact that hydrocarbon extraction is the country's most significant industry grouping. This

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 cement, pulp and paper, metal products, and chemicals, which have low market value and high energy consumption.

In order 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 we call the *relative intensity factor* to normalize raw energy intensities.

### Step 1. Energy Intensities of Industry Groupings

To calculate the relative intensity factors, we needed the energy intensities of industry groupings for each country. These would ideally be calculated using the energy consumption of and value added by each industry. While energy consumption data for industry groupings were available (IEA 2018d), value-added data were not available in a consistent manner across all countries for the year we evaluated. As a substitute, we used the energy intensities per value added of US industry groupings to calculate the energy intensities of the same industry groupings in other countries, assuming the pattern would be similar. It may be possible to improve this assumption in future editions of the *Scorecard* by approximating the intensities of individual countries' industries based on regional similarities where good data are available.

allocation distorted results for the country. To approximate a more representative picture of industrial energy consumption in Saudi Arabia, we moved half of its nonspecified energy consumption to the mining and quarrying industry group. We made no adjustments for other countries, but this issue warrants further investigation.

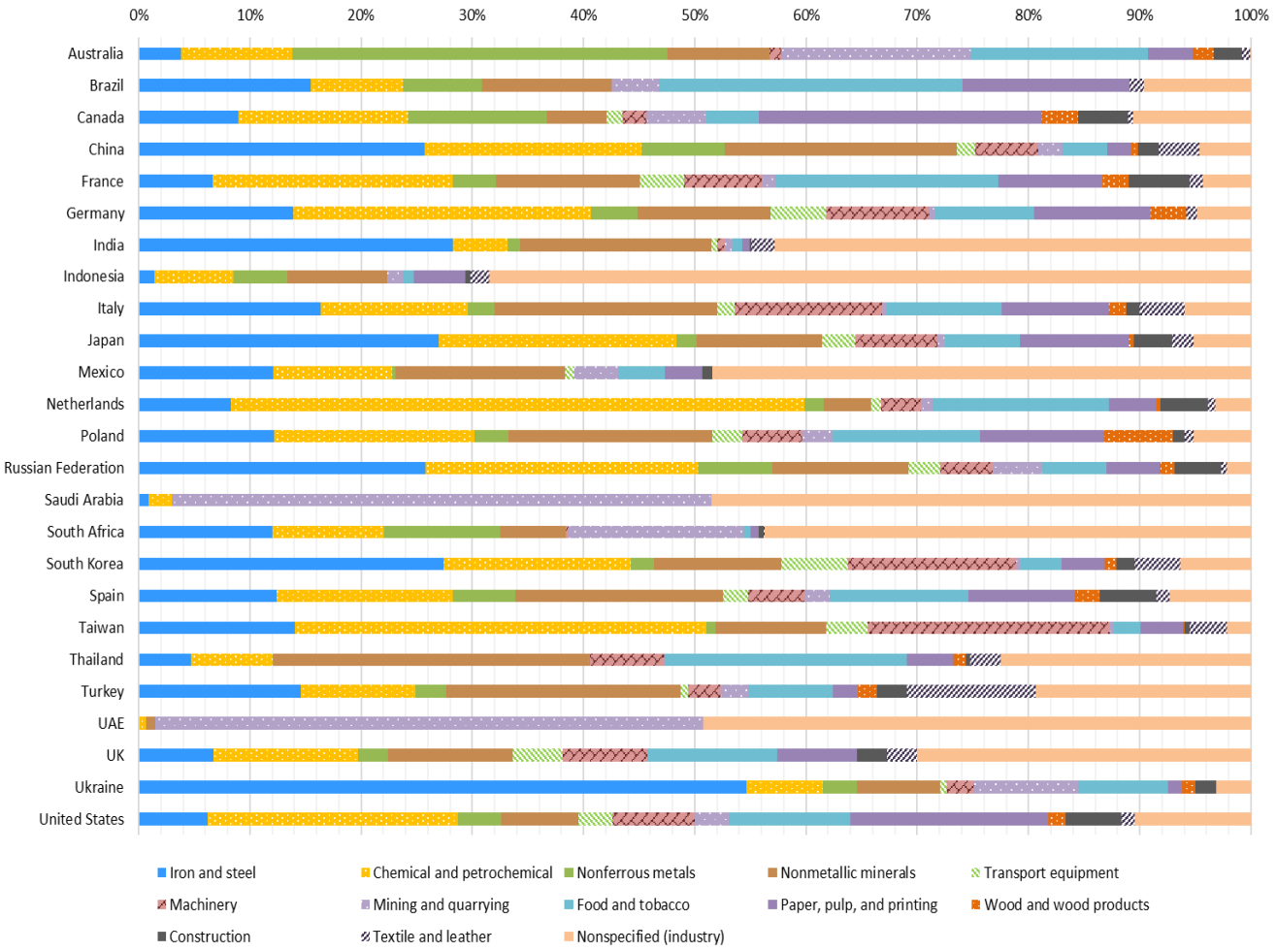



**Figure A1. Industry groupings and respective shares of energy consumption by industry in analyzed countries. Source: IEA 2018c.**

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 ($R^{ci}$).

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

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

Then we multiplied each grouping's share of energy consumption by the corresponding US industry intensity of that grouping. Thus we derived 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 US industry intensities on energy consumption and value of shipments reported in tables 25 to 35 of the *Annual Energy Outlook 2015* (EIA 2015). We chose to use value of shipments because recent data on value added were not available. For textile and leather manufacturing and the nonspecified sector, we used the average intensity of energy consumption per dollar of value of shipments reported in table 6.3 of the *2010 Manufacturing Energy Consumption Survey* (MECS) (EIA 2013). In future editions of the *International Scorecard*, it would be helpful to use value added by manufacturing instead of value of shipments, because value added data better capture the efficiency of transforming raw materials into finished goods, and new value added data will be available from MECS.

### 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 then 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 the raw energy intensities for each country 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 the raw energy intensity, relative intensity factor, and weighted energy intensity for each of the 25 countries.

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

| Country | Raw energy intensity (kBtus/2015$) | Relative intensity factor | Weighted energy intensity (kBtus/2015$) |
|---|---|---|---|
| Australia | 2.63 | 2.02 | 5.33 |
| Brazil | 5.46 | 1.28 | 7.01 |
| Canada | 2.89 | 1.82 | 5.26 |
| China | 9.66 | 1.15 | 11.15 |
| France | 1.71 | 1.14 | 1.95 |
| Germany | 1.78 | 1.20 | 2.14 |
| India | 10.43 | 0.68 | 7.13 |
| Indonesia | 3.82 | 0.59 | 2.24 |
| Italy | 1.90 | 1.16 | 2.20 |

| Country | Raw energy intensity (kBtus/2015$) | Relative intensity factor | Weighted energy intensity (kBtus/2015$) |
|---|---|---|---|
| Japan | 1.73 | 1.05 | 1.82 |
| Mexico | 3.26 | 0.70 | 2.28 |
| Netherlands | 2.81 | 0.81 | 2.28 |
| Poland | 2.70 | 1.49 | 4.04 |
| Russia | 8.45 | 1.20 | 10.15 |
| Saudi Arabia | 5.21 | 1.21 | 6.32 |
| South Africa | 8.32 | 1.12 | 9.28 |
| South Korea | 3.68 | 0.92 | 3.38 |
| Spain | 1.96 | 1.28 | 2.52 |
| Taiwan | 4.41 | 0.75 | 3.32 |
| Thailand | 7.78 | 0.89 | 6.96 |
| Turkey | 2.76 | 1.14 | 3.16 |
| UAE | 6.82 | 1.02 | 6.94 |
| UK | 1.59 | 0.76 | 1.21 |
| Ukraine | 19.32 | 1.18 | 22.85 |
| US | 2.87 | 1.28 | 3.68 |

*Sources:* IEA 2018d; World Bank 2018c.

### 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 approach is appealing in its simplicity but has clear drawbacks. High energy intensity does not necessarily correspond with wastefulness but depends on the structure of a country's industrial sector and the mix of individual industries within it. This approach does not account for structural differences, and it disadvantages countries with high-consuming, low-value industries.

A different approach could instead 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, 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 other 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 US patterns may not hold true for every country. We thus urge caution in interpreting the rankings resulting from this metric.

## Appendix B. Appliance Standards Scoring

We used the following point allocation for the appliance standards metric of the buildings section.

**Table B1. Point allocation for appliance standards**

| Product group | Appliance | Sector | Contribution to total standard count | Comments |
|---|---|---|---|---|
| Building materials | Envelope | | 0 | Typically covered in building codes |
| | Window | | 0 | |
| Compressors | Air compressor | Commercial | 1 | |
| | Refrigerant compressor | Commercial | 1 | |
| Computers & ICT | Computers & ICT | All | 1 | |
| | Computer | All | 1 | |
| | Hard drive | All | 1 | |
| | Networking equipment | All | 1 | |
| | Server | All | 1 | |
| Cooking & dishwashing | Coffee machine | Residential | 1 | |
| | Cooktop/hob | | 1 | |
| | Dish dryer | | 1 | |
| | Dishwasher | | 1 | |
| | Kettle | | 1 | |
| | Microwave | | 1 | |
| | Oven | Commercial | 1 | All fuel sources |
| | | Residential | 1 | |
| | Rice cooker | | 1 | |
| | Tortilla-making machine | | 1 | |
| Heating & air-conditioning | Boiler | Commercial | 1 | All fuel sources |
| | | Residential | 1 | |
| | Central AC | | 1 | |
| | Chiller | | 1 | |
| | Cooler tower | | 1 | |
| | Evaporative cooler | | 1 | |
| | Furnace | Commercial | 1 | All fuel sources |
| | | Residential | 1 | |

| Product group | Appliance | Sector | Contribution to total standard count | Comments |
|---|---|---|---|---|
| | Other | | X | Different for each country |
| | Packaged terminal | | 1 | All configurations |
| | Portable AC | | 1 | |
| | Room AC | | 1 | All fuel sources |
| | Space heater | | 1 | All fuel sources |
| Laundry | Clothes dryer | | 1 | All fuel sources |
| | Clothes washer | Commercial | 1 | |
| | | Residential | 1 | |
| | Combination washer/dryer | | 0 | Included with clothes washers |
| | Iron | | 1 | |
| Lighting | Ballast, fluorescent | | 1 | |
| | Ballast, high intensity discharge (HID) | | 1 | |
| | Fluorescent, CFL | | 1 | |
| | Fluorescent, general-service lamp | | 1 | |
| | Fluorescent, fixture | | 1 | |
| | Halogen | | 1 | |
| | HID lamp | | 1 | |
| | Incandescent, general-service lamp | | 1 | |
| | Incandescent, reflector lamp | | 1 | |
| | Low-pressure sodium | | 1 | |
| | Other | | X | Different for each country |
| | Signal lighting, traffic signals | | 1 | |
| | Signal lighting, exit signs | | 1 | |
| | Solid-state lighting/LEDs | | 1 | |
| Miscellaneous | Air cleaner | | 1 | |
| | Dehumidifier | | 1 | |
| | Toilet seat (electric) | | 1 | |
| | Vacuum cleaner | | 1 | |

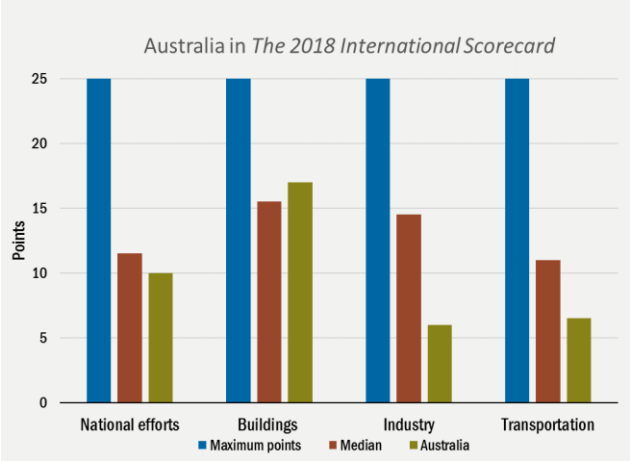
| Product group | Appliance | Sector | Contribution to total standard count | Comments |
|---|---|---|---|---|
| Motors | Medium 3-phase general purpose | | 1 | |
| | Small 1-phase general purpose | | 1 | |
| | Small 3-phase general purpose | Industrial and multi-sector | 1 | |
| Office equipment | Imaging machine | | 1 | |
| External power supplies | Power supply & power conversion | | 1 | |
| | Battery charger | | 1 | |
| | Contactor | | 1 | |
| | External power supply | | 1 | |
| | Transformer | | 1 | |
| Pumps | All other types | | X | Different for each country |
| | Building circulator | | 1 | |
| | Pump system | | 1 | |
| Refrigeration | Freezer | Commercial | 1 | |
| | | Residential | 1 | |
| | Ice machine | | 1 | |
| | Industrial process chiller | | 1 | |
| | Kim-chi refrigerator | | 1 | |
| | Refrigerated cabinet | | 1 | |
| | Refrigerated vending machine | | 1 | |
| | Refrigerator | Commercial | 1 | |
| | | Residential | 1 | |
| | Refrigerator-freezer | | 0 | Included with refrigerator |
| | Walk-in cooler & freezer | | 1 | |
| | Water cooler | | 1 | |
| | Wine chiller | | 1 | |
| Standby and off-mode electric consumption | All equipment types | | X | Different for each country |
| | Network | | 1 | |

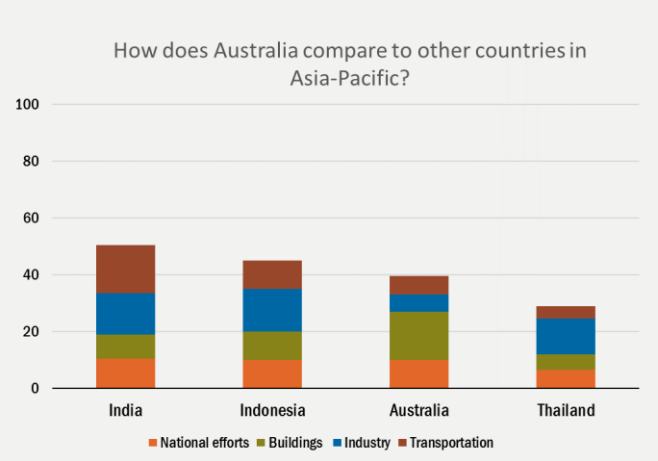
| Product group | Appliance | Sector | Contribution to total standard count | Comments |
|---|---|---|---|---|
| Televisions, displays, & audiovisual | Audiovisual | | X | Different for each country |
| | Display | | 1 | All screen types (CRT, flat screen) |
| | Set-top box (STB) | | 1 | |
| | Television | | 1 | All screen types (CRT, flat screen) |
| Ventilation, fans, & blowers | Ceiling fan | | 1 | |
| | Cooktop/cooker hood | | 1 | |
| | Exhaust fan | Commercial | 1 | |
| | | Residential | 1 | |
| | Furnace/duct fan | | 1 | |
| | Industrial blower | | 1 | |
| | Industrial fan | | 1 | |
| | Integrated fan | | 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 2018 International Energy Efficiency Scorecard.* These summaries highlight the area of strongest performance as well as areas that need improvement for each country. Appendix D presents a more detailed set of recommendations for the United States.

# COUNTRY SUMMARY: AUSTRALIA #18




Australia ranked 18th with a total score of 39.5 points.

## NATIONAL EFFORTS

Australia scored 10 points in the national efforts section, coming in in 15th place. The Australian government aims to increase energy productivity 40% by 2030 through the implementation of strategies in the National Energy Productivity Plan. These include improving the national construction code, reducing overall energy use in buildings, and promoting the procurement of energy-efficient equipment. However implementation of these strategies has been limited since the plan was drafted in 2015.

## BUILDINGS

Australia was strongest in building energy efficiency due to its building codes, commercial building labeling program, and appliance and equipment labeling. Starting in 2000, its strategy to reduce greenhouse gases has included mandatory minimum energy performance requirements for new buildings. Covering the residential and commercial sectors, these requirements include a wide-ranging set of technical elements.

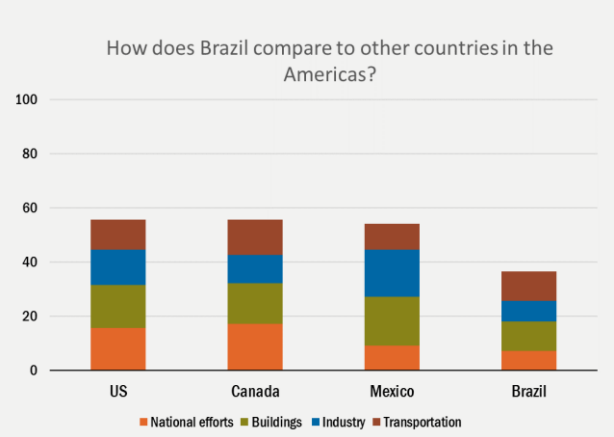
## INDUSTRY

Australia ranked 22nd in the industrial energy efficiency section. The national government has no agreements with the manufacturing sector to improve energy efficiency, nor does it require industrial facilities to incorporate an energy manager or conduct regular energy audits. These are areas of opportunity to explore as this country strives to reach 40% energy productivity by 2030.

## TRANSPORTATION

Australia was among the lowest-scoring countries in the transportation section. It is the only developed economy we assessed that does not have fuel economy standards in place for passenger vehicles; it also lacks standards for heavy-duty trucks. In addition, Australia has a low percentage of public transit use (approximately 12%) and invests only about 26 cents in rail facilities for every dollar spent on road construction and maintenance.

## COUNTRY SUMMARY: BRAZIL #20


Brazil ranked 20th with a total score of 36.5 points.

### 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 loan programs and 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

In 2013, Brazil enacted a mandatory building performance standard for new residential buildings. Currently, the country has no commercial building code. The country has limited appliance and equipment standards, applying to few products. Brazil has ample models from which to draw—including Australia, France, the United Kingdom, and the United States, which has saved large amounts of energy through robust appliance standards—to improve energy efficiency in buildings.

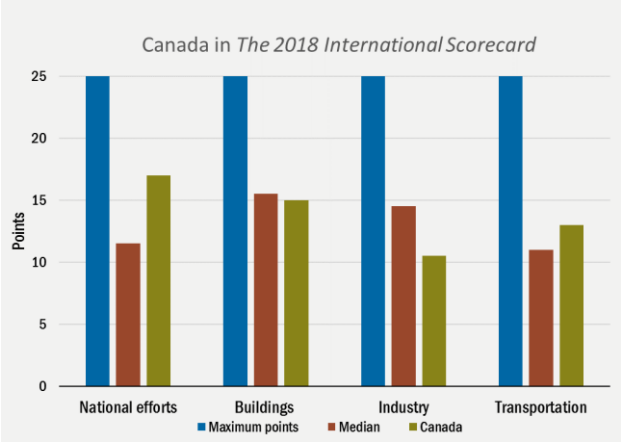
### INDUSTRY

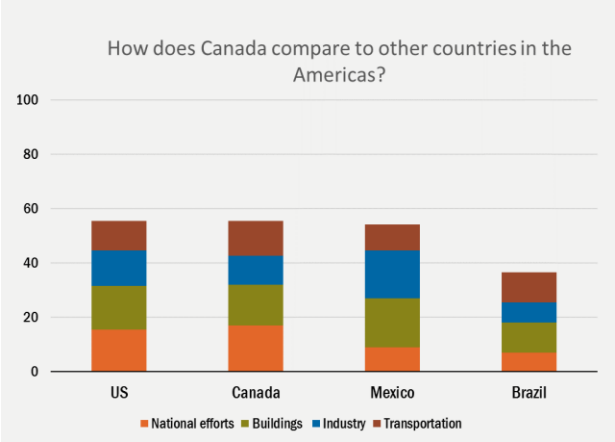
Brazil's standing improved slightly in the industrial section of the *2018 Scorecard*, scoring 7.5 points. However industrial efficiency remains a big area of opportunity for Brazil. A focus on implementing a policy on energy management could greatly benefit Brazil's energy efficiency efforts. In particular, the country could explore requiring energy audits and the hiring of energy managers for large industrial facilities. Moreover, Brazil's CHP potential remains highly unexplored and implementing CHP incentives and establishing goals could help revamp this technology in the country.

### TRANSPORTATION

Brazil performs best in the Transportation section. The country has good passenger-vehicle fuel economy standards in place but to date these standards are still voluntary. The Brazilian government has also shown commitment to financing more efficient transportation modes. Roads account for 61% of freight movement providing the country with the perfect opportunity to improve standards for heavy-duty vehicles and make an effort to shift some freight traffic to rail or water.

## COUNTRY SUMMARY: CANADA #10




Canada ranked 10th with a total score of 55.5 points.

### 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 30% below 2005 levels by 2030. Investments in energy efficiency are among the highest of the countries analyzed. Moreover, national tax incentives and loan programs exist in multiple sectors to help reach efficiency targets.

### 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 a large number of products, and to the adoption of its mandatory "EnergGuide" labeling for new and/or renovated homes by some municipalities. Canada has taken steps to improve benchmarking and labeling of energy use in buildings through a new benchmarking portfolio manager that marks building energy performance against similar buildings.

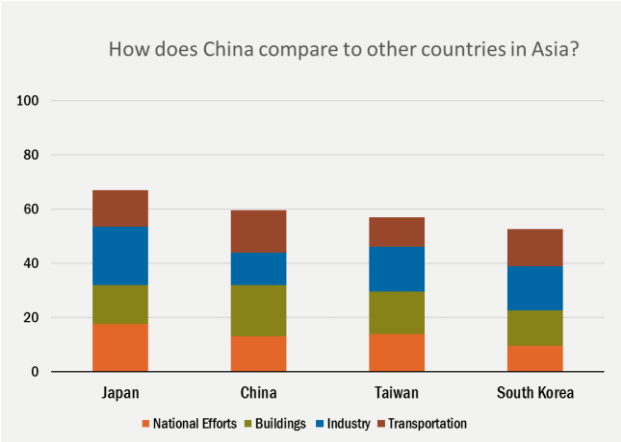
### INDUSTRY

Canada scored low in industrial efficiency. While the country has taken certain steps to address energy use in the industrial sector, such as the Canadian Industry Program for Energy Conservation (CIPEC), a government-industry partnership, there is still much that can be done. Canada could benefit from establishing a mandate for plant energy managers and mandatory energy audits. Additionally, CHP generation remains low in the country. Setting a CHP target could help set Canada on track to increase the amount of energy generated by combined heat and power in the country. The latter, coupled with robust incentives, could help revamp the use of this technology.

### TRANSPORTATION

Scoring only 13 out of 25 points, Canada could benefit from significant improvements to its transportation sector. Like the United States, Canada is a car-heavy economy, which means that very little daily travel occurs on more efficient forms of transport. Only 8.7% of travel occurs on public transport in Canada and as a result, the country has high vehicle miles traveled in personal vehicles per capita.

## COUNTRY SUMMARY: CHINA #8


China ranked eighth with a total score of 59.5 points.

### NATIONAL EFFORTS

China has room for improvement on the national efforts front, earning a score of just 13 out of 25 points in this section. The country's spending on energy efficiency R&D remained low in the 2018 *Scorecard*, as did the efficiency of its thermal power plant stock. Implementing multisector energy efficiency incentives, such as loan programs and tax credits that are similar to ones that recently expired, will help the country achieve economy-wide energy reductions.

### BUILDINGS

China has building codes that apply to residential and commercial buildings in urban areas. However these could be extended to rural areas to more fully capture efficiency potential in buildings. China has also adopted appliance and equipment standards for 41 products and requires energy efficiency labeling for some building types. China could improve its ranking by requiring building labeling and introducing a building retrofit policy, particularly with respect to its commercial buildings.

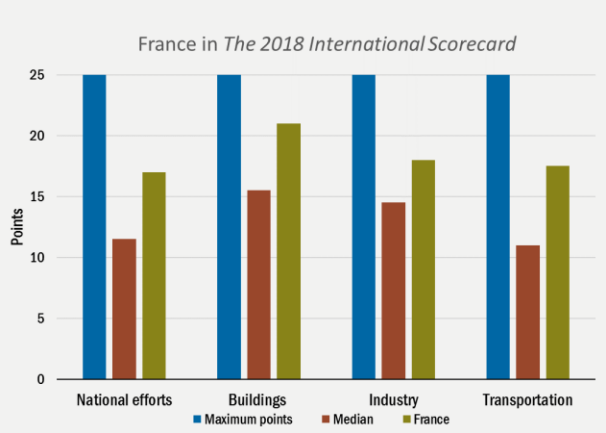
### INDUSTRY

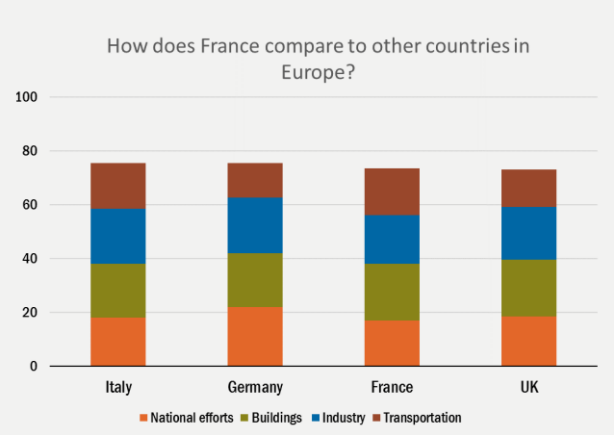
The energy intensity of China's industrial sector is the second highest of the 25 countries analyzed. China could improve in this regard by providing for agreements between the government and manufacturers aimed at improving energy efficiency in their operations. China's landmark industrial program, the Top 10,000 Energy-Consuming Enterprises program expired recently and if extended, will help China continue its progress toward energy reductions in the industrial sector.

### TRANSPORTATION

China scored well in transportation efficiency, taking second place. China has goals for mandatory fuel economy standards for passenger vehicles of 47.7 mpg by 2025. Standards for heavy-duty vehicles also exist and aim to achieve a 14% reduction in energy consumption over the lifetime of the standards. 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.

## COUNTRY SUMMARY: FRANCE #3




France ranked third with a total score of 73.5 points.

### NATIONAL EFFORTS

France did well in the national efforts section largely due to their participation in EU actions. France has made a commitment under the EU's Energy Efficiency Directive to reduce energy consumption 20% by 2030 relative to 2012. France's National Energy Efficiency Action Plan contains energy efficiency provisions that go beyond those implemented by other members of the EU. This includes the White Certificates Trading program, which requires suppliers of energy to meet government-mandated targets for energy savings.

### BUILDINGS

France came in second place in the buildings section with a score of 21 points. The country's Energy Efficiency Action Plan outlines aggressive policies to increase the number of low energy buildings and also commits to the deep renovation of 500,000 dwellings per year. France also has the most ambitious building retrofit program of the countries evaluated in this report but could still benefit from the creation of implementation regulations.

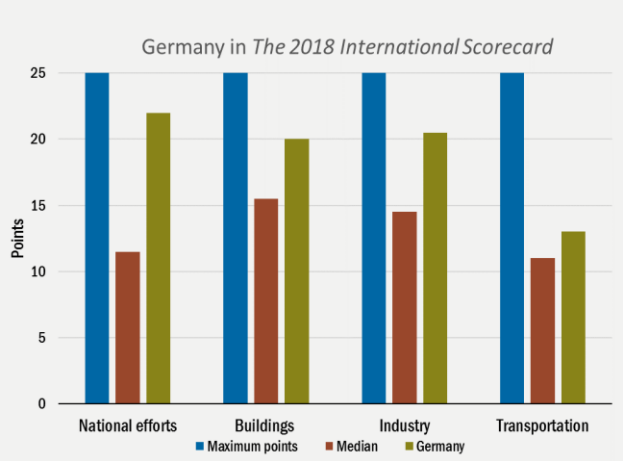
### INDUSTRY

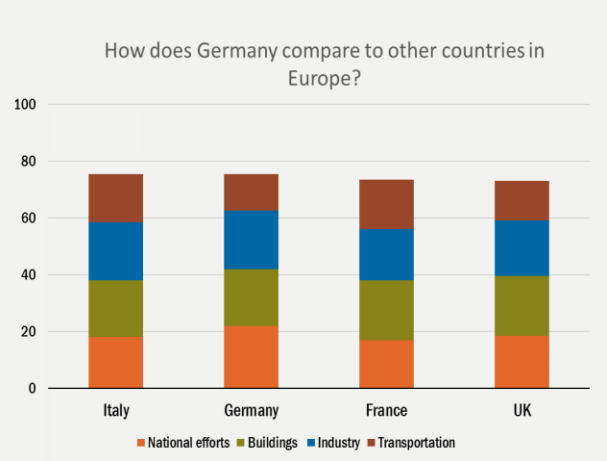
Although France took the fifth spot in the industrial rankings for the *2018 Scorecard*, there are still plenty of opportunities for improvement. France has a low percentage of installed capacity from CHP, which suggests that the country could benefit from establishing a CHP target and enacting strong 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 country follows the EU's stringent fuel economy standards, which call for a fleet-wide average of 56.9 mpg by 2025. However there is still room for improvement. The energy intensity of freight transport in France is high, as well as vehicle miles traveled. On the other hand, use of public transit in France remains low.

## COUNTRY SUMMARY: GERMANY #1




Germany ranked first, tying with Italy, with a total score of 75.5 points.

### NATIONAL EFFORTS

Germany took first place in national efforts. German policymakers have implemented a comprehensive energy strategy, known as *Energiewende*. The country has set a 20% reduction target in primary energy consumption by 2020 and 50% by 2050, relative to 2008. The German government has continued to increase its expenditure in energy efficiency and efficiency-related R&D. Moreover, Germany has implemented multisector loan programs and tax credits aimed at increasing the deployment of energy-efficient technologies.

### BUILDINGS

Germany is a leader in buildings efficiency largely due to the National Energy Saving Ordinance for buildings. Adopted in 2002, the ordinance sets energy performance requirements for new and existing buildings undergoing major renovations. Germany could improve its score by setting compliance dates for its retrofit policies.

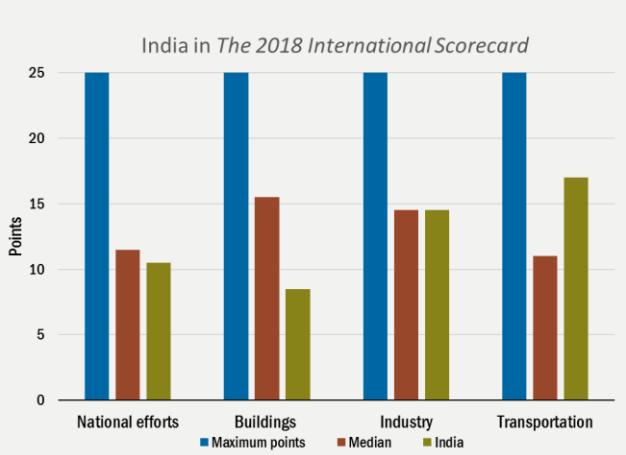
### INDUSTRY

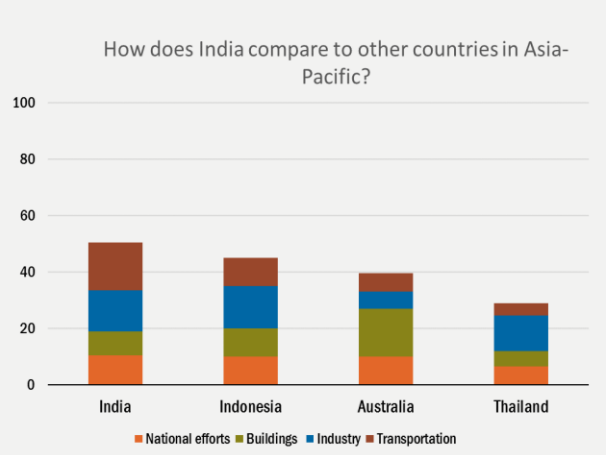
Germany tied for second place with Italy in the industrial section of the *Scorecard*. The energy intensity of Germany's industrial sector is low compared to the other countries analyzed. A voluntary agreement between German industry and the federal government to reduce $CO_2$ emissions has been in place since 1995. Updates in 2012 set targets for annual reductions in energy intensity in industry until 2022. Germany also has a target of obtaining 25% of electricity generation from combined heat and power (CHP) by 2020.

### TRANSPORTATION

The transportation sector provides energy efficiency opportunities for Germany, where this country only scored 13 out of a possible 25 points. 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.

## COUNTRY SUMMARY: INDIA #15




India ranked 15th with a total score of 50.5 points.

### NATIONAL EFFORTS

India ranked 14th in the national efforts section. The country has an energy reduction goal of 10% by 2019 relative to 2015. However the country needs to ramp up its energy efficiency efforts in order to be able to achieve this goal. India's operational efficiency of thermal power plants is the second lowest of the 25 countries analyzed, largely due to an aging power plant fleet. Moreover, expenditure in energy efficiency programs and R&D by the government remains very low.

### BUILDINGS

There is room to improve in India's buildings sector. EIA predicts that building energy consumption in India will grow 2.7% between 2015 and 2040, the fastest growth of any country in the world. In 2017, India launched a commercial building code that states are encouraged to adopt. The country is in the process of developing a residential code. India has appliance and equipment standards for just seven products. The country launched the Unnat Jyoti by Affordable LEDs for All initiative that sold more than 230 million LED bulbs to Indian households between 2013 and 2017.

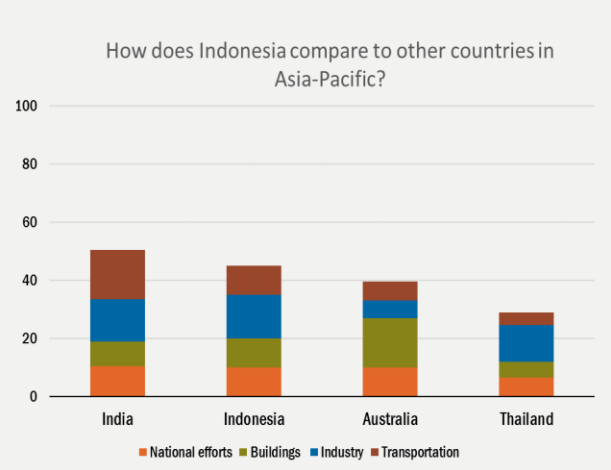
### INDUSTRY

The industrial sector offers opportunities for improvement. Industrial energy intensity in India remains high. India's Performance, Action, Trade (PAT) scheme for trading energy efficiency certificates in energy-intensive sectors is a step in the right direction for addressing industrial energy consumption. The program could be further improved by expanding it to include small and medium enterprises and by further tightening requirements.

### TRANSPORTATION

India is strongest in transportation energy efficiency. It has far fewer passenger miles traveled per capita than any other country analyzed. Even with no fuel economy standards for passenger vehicles, India ranks third in terms of passenger-vehicle fuel economy. More than 60% of passenger trips made in India utilize public transit, with only a moderate level of government investment in rail versus road. However it is important to note that India's successes in the transportation sector are likely due to the status of their economy.

# COUNTRY SUMMARY: INDONESIA #17


Indonesia ranked 17th with a total score of 45 points.

## NATIONAL EFFORTS

Overall, Indonesia's scores were low in the national efforts section, with the country ranking 15th. With few incentives available for private investment in energy efficiency, its ESCO market has seen negligible improvement since the first state-owned ESCO was established in 1986. 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 South East Asia.

## 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. There are no policies for energy performance of existing buildings and retrofits in Indonesia. Indonesia could also benefit by putting in place a national policy for building energy information disclosure, since it currently does not have one.

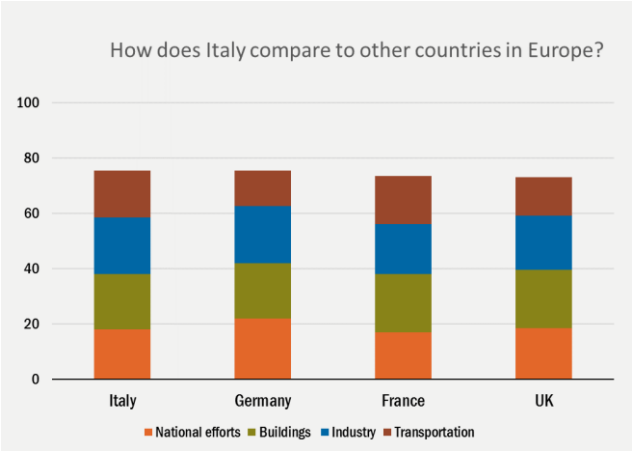
## INDUSTRY

Indonesia ranked 11th in the industrial energy efficiency category. The country has energy management policies in place, mandates for energy managers, and energy audit requirements. The country can further improve its industrial energy efficiency by implementing performance standards for motors, and enacting policies to encourage the deployment of CHP technologies.

## TRANSPORTATION

Indonesia was second best in the category of vehicle miles traveled per capita for passenger vehicles; however, as with India, this has more to do with the state of the economy than actual effort to improving mobility choices. There is still considerable room for improvement in the transportation sector. Indonesia does not have fuel economy standards for light-duty vehicles in place. Moreover, investment in rail transit remains low while energy intensity of freight transport remains high. With increase in demand for mobility, the country must plan ahead for meeting the demand by improving public transportation service and infrastructure.

## COUNTRY SUMMARY: ITALY #1


Italy ranked first, tying with Germany, with a total score of 75.5 points.

### NATIONAL EFFORTS

Italy has a very strong energy efficiency profile. The country is committed to a national energy-savings target under the EU's Energy Efficiency Directive (2012/27/EU) to reduce energy consumption by 15 megatonnes of oil equivalent by 2020. 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.

### BUILDINGS

Italy ranked fifth in the buildings sector. Several initiatives exist at the national level to support an increased rate of renovation, including a new incentive program, Conto Termico, which provides incentives for retrofits and energy efficiency improvements in residential and public buildings. Certain provincial codes also have mandatory requirements for renovations that must be met by a certain end date. Italy could receive full points for retrofit policies by extending these policies nationwide.

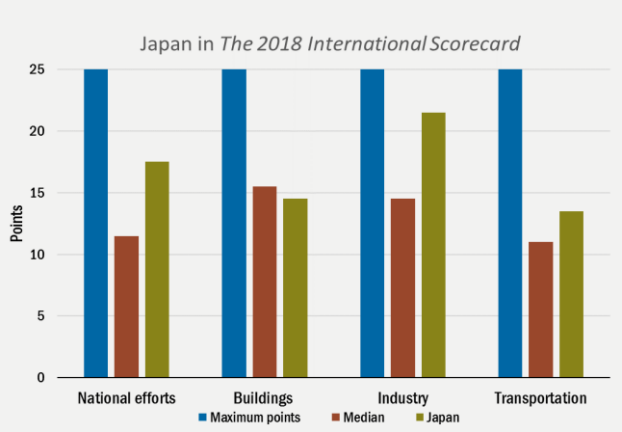
### INDUSTRY

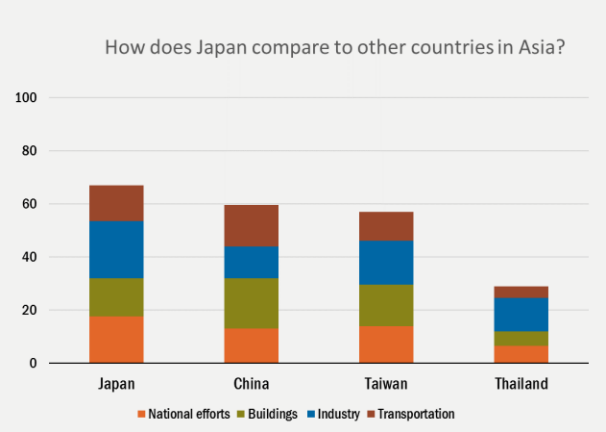
Italy tied for second place with Germany in industrial energy efficiency. The country has shown a strong commitment to energy efficiency by establishing energy savings targets and requiring plant energy managers to meet them. Italy mandates periodic energy audits in industrial facilities. A market-based energy efficiency certificate-trading scheme has been implemented 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.

### TRANSPORTATION

Italy ranked second in the transportation sector. The country participates in the EU's vehicle standards and will aim to achieve a fleet-wide average of 56.9 mpg by 2025. Italy's average on-road fuel economy for passenger vehicles is impressive at 39.4 mpg. Vehicle miles traveled per capita is lower in Italy than any other European country, and Italy has a high ratio of investment in rail transit to investment in roads. There is still some room for improvement in transportation efficiency, particularly since the use of public transit remains low and the energy intensity of freight transport in Italy is high.

# COUNTRY SUMMARY: JAPAN #5




Japan ranked fifth with a total score of 67 points.

## NATIONAL EFFORTS

Japan has strong national energy efficiency policies in place. The country's investment in energy efficiency programs and 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.

## BUILDINGS

The greatest area for improvement in Japan is in the buildings sector. Japan has uneven residential and commercial building codes and a complete lack of any sort of building energy labeling initiatives. 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 and implementing mandatory building labeling programs for all buildings.

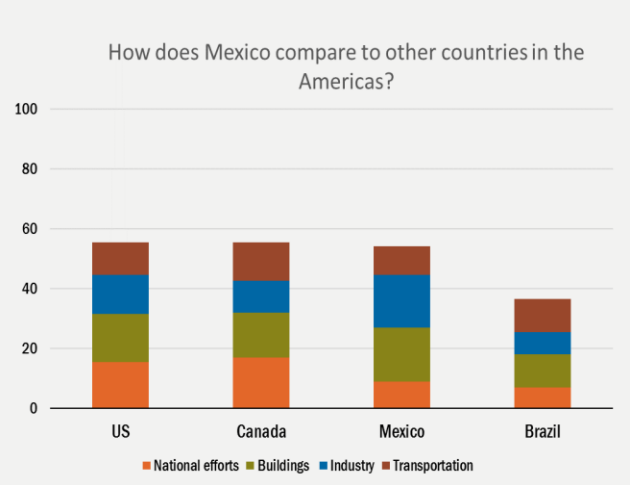
## INDUSTRY

Japan ranked first in the industrial energy efficiency section. 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 to achieve the lowest industrial energy intensity 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 also includes a benchmarking system that obligates businesses to achieve specific energy efficiency targets.

## TRANSPORTATION

Japan has set ambitious fuel economy standards for passenger vehicles of 45.9 mpg by 2025; current average on-road fuel economy is relatively high at 31 mpg. Japan established the first fuel economy program for heavy-duty vehicles in 2005 and is one of only four countries to have done so to date. The country has also invested heavily in high-speed passenger rail in creating its bullet train network. However vehicle miles traveled in Japan remains high, as does the intensity of freight transport.

## COUNTRY SUMMARY: MEXICO #12


Mexico ranked 12th with a total score of 54 points.

### NATIONAL EFFORTS

Mexico was one of the most improved countries in the national efforts section of this edition of the *Scorecard*. However this country still has many opportunities to enhance its efforts in this section to continue advancing in the rankings. Mexico could benefit from an increase in energy efficiency programs and R&D expenditures. Moreover, Mexico can consider taking advantage of the tax code as a powerful tool to motivate investment in energy efficiency technologies.

### BUILDINGS

Mexico was strong on energy efficiency in buildings, ranking in eighth place. Mexico has also established appliance and equipment standards for approximately 30 products and has mandatory labeling for 13 products. With regard to building codes, Mexico has mandatory requirements in place for commercial buildings, but does very little to regulate construction in residential or existing buildings.

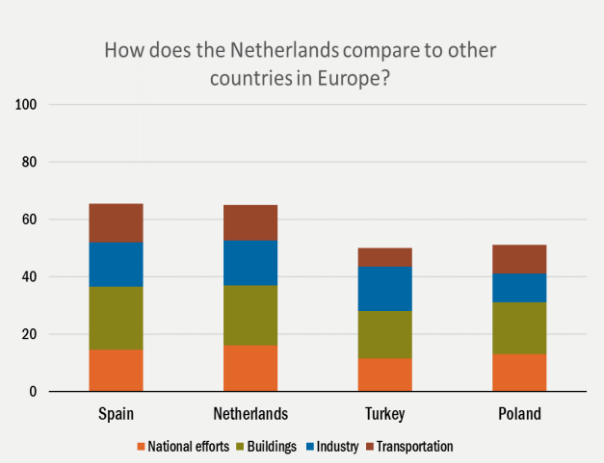
### INDUSTRY

Mexico has greatly improved in the industrial section due to the reduction of its industrial energy intensity and the policymaking efforts that have taken place since 2013. Mexico now requires large industrial facilities to employ energy managers and perform periodic audits. It also has an energy management policy in place that references ISO 500001. CHP amounts to less than 1% of the installed capacity in the country. Hence, enacting a CHP target with accompanying incentives should be explored.

### TRANSPORTATION

Mexico has passenger vehicle fuel economy standards in place but could benefit from increasing the stringency of the program and adding a heavy-duty component. The country also could benefit from increasing its investment in rail transit. Freight system efficiency is also a potential area of improvement as Mexico has high energy use per ton-mile traveled.

## COUNTRY SUMMARY: NETHERLANDS #7


Netherlands ranked seventh with a total score of 65.5 points.

### NATIONAL EFFORTS

Under the EU Energy Efficiency Directive, Netherlands is obliged to revise and submit its National Energy Efficiency Action Plan every three years. The Energy Agreement for Sustainable Growth aims to achieve 1.5% annual savings in final energy consumption and expects to meet the target comfortably. This country also has strong investment in energy efficiency programs.

### BUILDINGS

Netherlands tied with France for second place in the building section. It has strong residential and commercial building codes that are mandatory nationwide. Netherlands currently has 41 appliance groups covered by energy performance standards (MEPS) and 20 appliance groups covered by mandatory labels. The country could improve its score by introducing retrofit policies to drive savings in existing buildings.

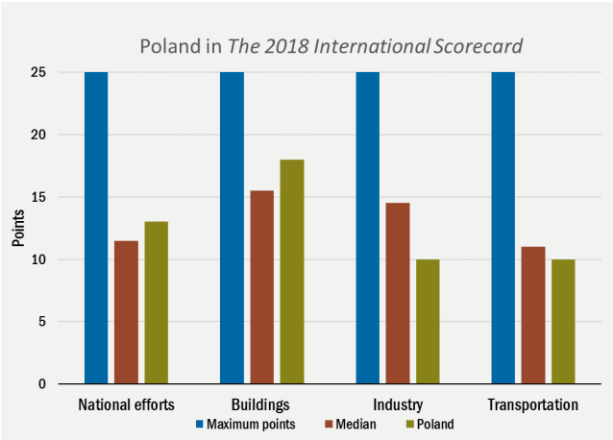
### INDUSTRY

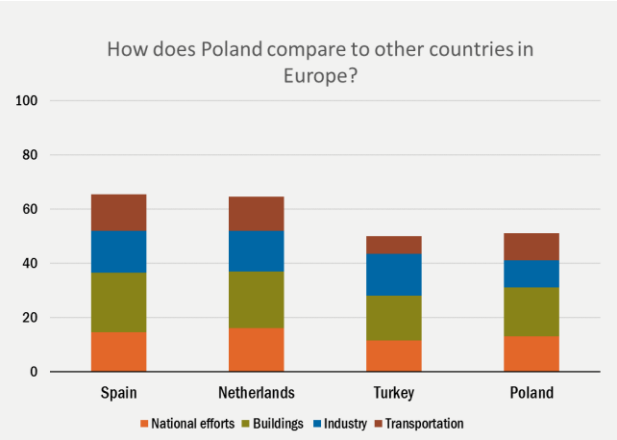
Netherlands performed well in the industrial section. Energy intensity of industry is relatively low. Netherlands has demonstrated leadership with its Long Term Agreements (LTAs) between government and industry groups. The LTAs direct industries consuming 80% of energy in the sector to draw up energy efficiency plans every four years, report on measures, and submit energy audits. All large enterprises not covered by the LTAs also are mandated to undergo energy audits. Netherlands could further improve by implementing energy management policies.

### TRANSPORTATION

Netherlands earned only 12.5 of the possible 25 points in the transportation sector. The country could gain energy savings by improving its investment in rail versus road transit, adopting fuel economy standards for freight trucks, and taking steps to lower the number of vehicle miles traveled in the country.

## COUNTRY SUMMARY: POLAND #14




Poland ranked 14th with a total score of 51 points.

### NATIONAL EFFORTS

Poland scored well in the national efforts section. The country aims to achieve primary energy savings of 13.6 Mtoe by 2020, compared to its forecasted energy consumption in 2020. Poland provides energy efficiency loans for multiple sectors of the economy. It could benefit from increasing the efficiency of its thermal power plants and providing tax incentives for energy-efficient technology.

### BUILDINGS

Poland scored 18 points in our building section. It received a full 6 points for its residential and commercial building codes, and also earned a full 2 points for requiring all building owners to receive Energy Performance Certificates. However Poland does not enforce these requirements as strictly as other European countries. Poland has taken steps to improve its compliance with the EU Energy Efficiency Directive by passing the Energy Efficiency Law (EEL) in 2016. However there is still no codified retrofit policy for residential and commercial buildings and there is more room for improvement on the number of appliances covered by standards.

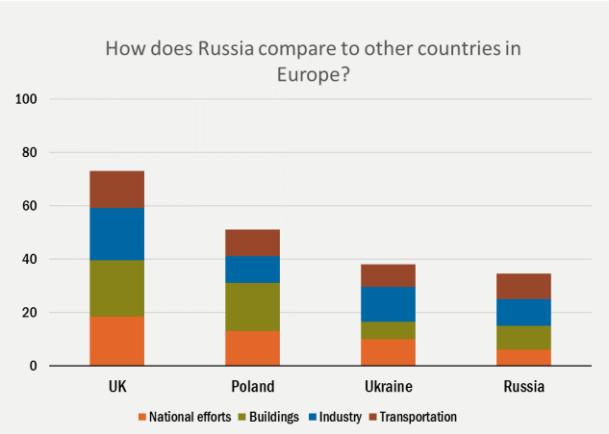
### INDUSTRY

Poland had the lowest score in industrial efficiency of any European country. The Polish government can initiate voluntary agreements with manufacturers to improve energy efficiency. Implementing a mandate for energy managers and mandatory audits in enterprises with high energy consumption would also improve Poland's standing in the industrial sector. Poland would also benefit from the implementation of the ISO 50001 standard in more facilities.

### TRANSPORTATION

Poland scored just below average in the transportation section. The country has no fuel economy standards for light-duty vehicles, and its use of passenger cars for personal transport is high, with 4,341 vehicle miles traveled per capita every year. The country's ratio of investment in rail versus road transportation is among the lowest. Poland can capture greater energy savings by implementing the plans outlined in the National Energy Efficiency Action Plan to improve rail transport and adopt intelligent transport systems.

# COUNTRY SUMMARY: RUSSIA #21


Russia ranked 21st with a total score of 34.5 points.

## NATIONAL EFFORTS

Russia was among the lowest ranked countries in the national efforts section. Although the country has multisector loan programs and tax incentives to promote the deployment of energy-efficient technologies, energy intensity remains high. 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 points. Even though building energy codes are mandatory for both residential and commercial buildings, these policies are too weak to stimulate large savings and there are no policies in place for the retrofit of existing buildings. 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.

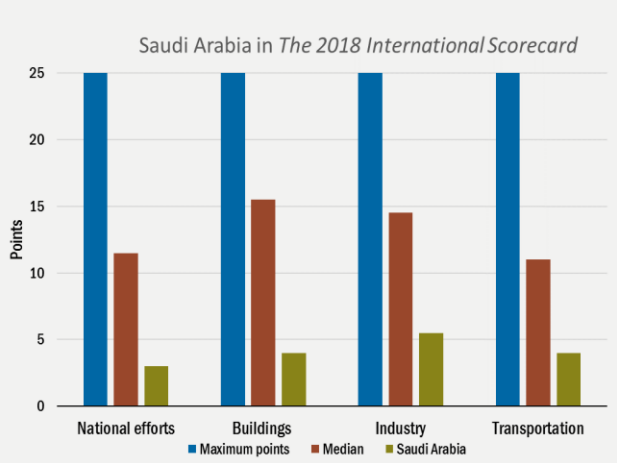
## INDUSTRY

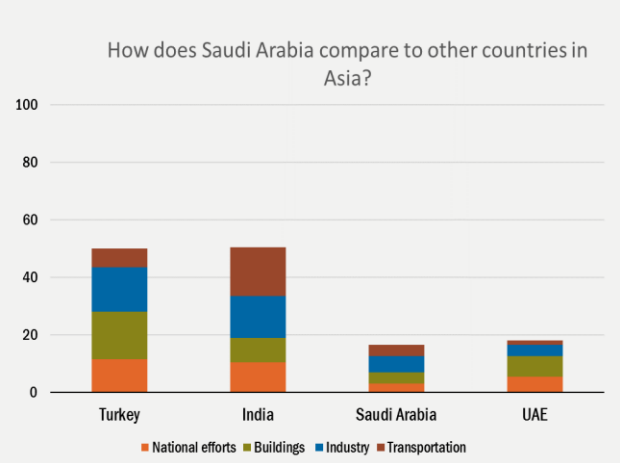
The energy intensity of Russia's industrial sector is high, but a significant portion of the electricity consumed by the industrial sector is generated by combined heat and power, which improves overall efficiency. Russia does require periodic energy audits of its manufacturing facilities and has agreements and incentives in place between governments and businesses to encourage energy efficiency. However the country has yet to implement mandates to employ energy managers in large industrial facilities and minimum energy performance standards for motors.

## TRANSPORTATION

Of the four categories, Russia was strongest in transportation efficiency. The country has low vehicle miles traveled per capita and strong investment in rail transit. Russia also has relatively low energy intensity of freight transport. Russia can benefit from establishing fuel economy standards for light- and heavy-duty vehicles.

## COUNTRY SUMMARY: SAUDI ARABIA #25




Saudi Arabia ranked 25th, with the lowest total score of 16.5 points (due, in part, to a lack of available data).

### NATIONAL EFFORTS

Saudi Arabia's energy intensity remains high. Its expenditures in energy efficiency R&D are marginal, and we were not able to find information regarding investments in energy efficiency programs. Saudi Arabia has no tax incentives or loan programs to promote the deployment of energy-efficient technologies.

### BUILDINGS

Saudi Arabia received the lowest score in our building section. The country received points for having mandatory residential and commercial building codes. However it only has a single technical requirement regarding efficiency and could improve its score by including additional requirements. Saudi Arabia only has one appliance requirement for air conditioners, and no mandatory appliance-labeling program.

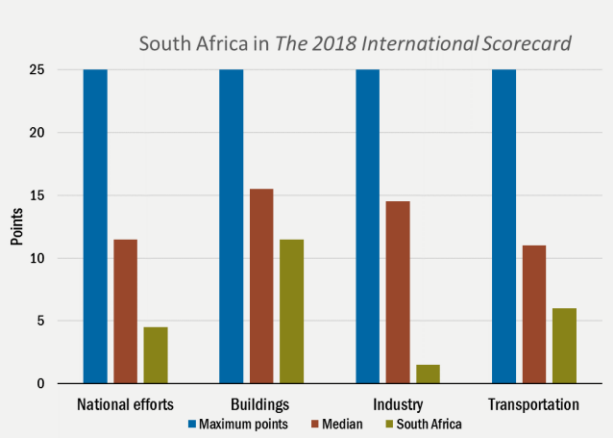
### INDUSTRY

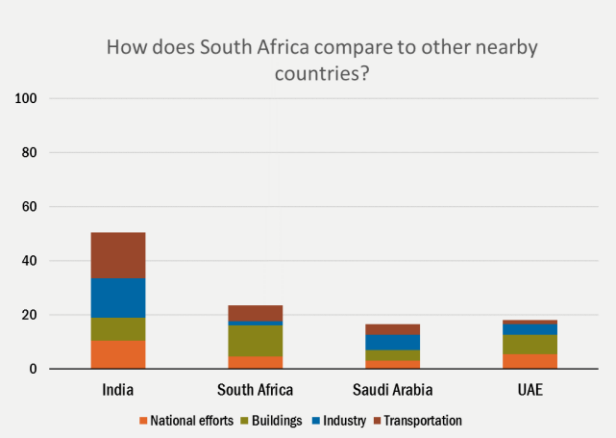
Opportunities to improve efficiency in the industrial sector currently exist. Saudi Arabia has minimum energy performance standards for motors in place and its agricultural intensity is among the lowest. However the country has yet to enact mandates for energy managers and audits and policies related 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. Information was not available for a number of metrics in the transportation section, including the average fuel economy of light-duty vehicles, freight transport per unit economic activity, energy intensity of freight transport, and investment in rail transit versus roads.

## COUNTRY SUMMARY: SOUTH AFRICA #23




South Africa ranked 23rd with a total score of 23.5 points.

### NATIONAL EFFORTS

The South African government has made a "peak, plateau, decline" commitment for emissions of greenhouse gases through its Intended Nationally Determined Contribution plan, which was submitted to the UNFCCC in 2015. However there are no formal reduction targets for energy use or emissions in the country. 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 could build on its existing policies by adopting performance standards and categorical labels for appliances. The country could adopt labeling and disclosure policies for buildings. South Africa would also benefit from applying its building energy codes to existing buildings and retrofits. South Africa scored the full 6 points in building energy codes for both new residential and non-residential buildings. The country also scored relatively high on energy intensity in residential and non-residential buildings.

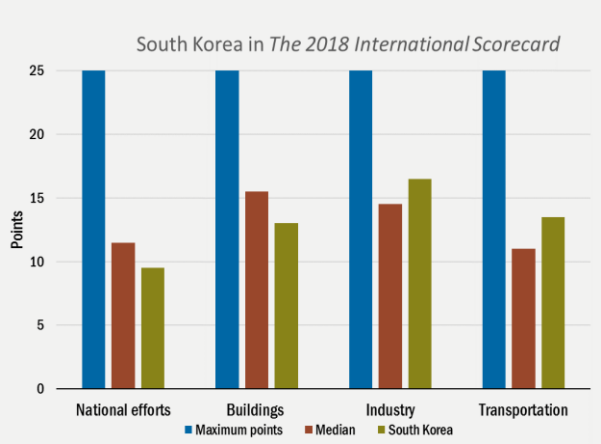
### INDUSTRY

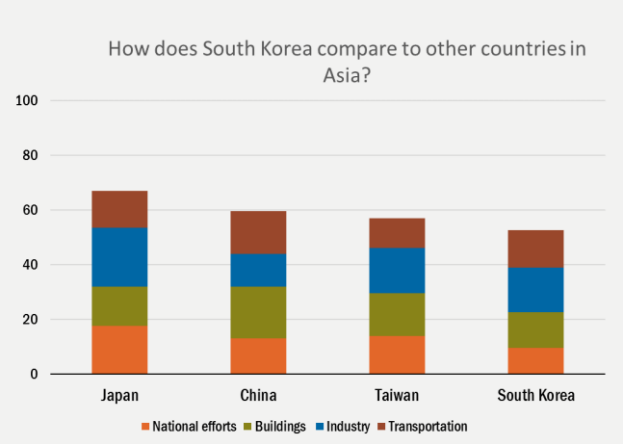
There is great potential for energy savings in the country's industrial sector. South Africa scored just 1.5 points in this category. The energy intensity of South Africa's industry was among the highest of all countries analyzed. There is a national tax incentive called "Section 12L" for energy efficiency savings; 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, performance standards for motors and pumps, or investment in manufacturing research and development.

### TRANSPORTATION

South Africa was among the lowest scoring countries in the transportation section. The country could benefit greatly from enacting fuel economy standards for light- and heavy-duty vehicles, increasing investment in rail transit, and implementing strategies to lower the intensity of freight transport.

# COUNTRY SUMMARY: SOUTH KOREA #13




South Korea ranked 13th with a total score of 52.5 points.

## NATIONAL EFFORTS

South Korea's second National Energy Master Plan established a 13% reduction goal below business-as-usual levels by 2035. The efficiency of its thermal power plants was among the highest of the countries analyzed. Nevertheless, energy intensity in the country remains high. South Korea should pursue the implementation of additional policies aimed at reaching the 2035 goal. Increasing expenditures in energy efficiency programs and R&D could be a step in the right direction.

## BUILDINGS

Building energy intensity was particularly low in South Korea for both commercial and residential buildings; however building efficiency in South Korea also showed a need for improvement. The country has in place mandatory residential and commercial building codes covering a broad range of technical components. However South Korea could benefit from stronger building retrofit policies. Additionally, the country has no building energy labeling system.

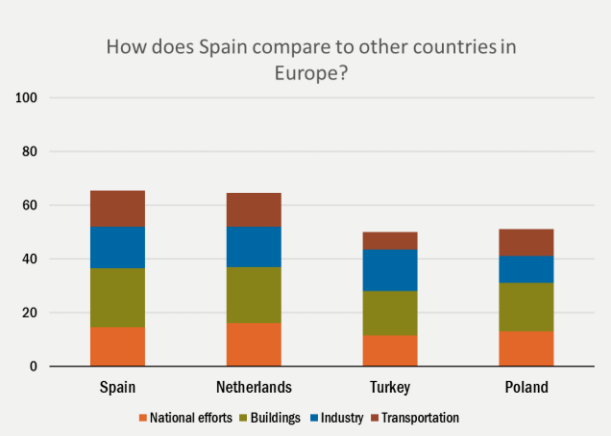
## INDUSTRY

South Korea scored well in the industrial category. The Korean Energy Management Corporation provides financial support and tax credits for businesses that enter into voluntary agreements or invest in energy-saving technologies. In addition, the country requires mandatory energy audits at large manufacturing facilities every five years. Facilities in South Korea generate a fair amount of industrial electricity from combined heat and power.

## TRANSPORTATION

South Korea scored well in the transportation section. The country has high fuel economy standards of 56.7 mpg by 2025. It also makes significant investments in rail transit. Although the country has a smart freight initiative in place, the energy intensity of its freight transport remains high. To improve the efficiency of the freight sector, South Korea could seek to implement heavy-duty fuel economy standards and improve freight intensity by switching a portion of freight movement to more efficient modes.

## COUNTRY SUMMARY: SPAIN #6


Spain ranked sixth with a total score of 65.5 points.

### NATIONAL EFFORTS

Spain's mandatory energy savings goal under the EU Energy Efficiency Directive has a target of 20% energy savings by 2020. The country's Institute for the Diversification and Saving of Energy is implementing this objective with a focus on improving final energy intensity by 2% each year until 2020. Spain 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 of its economy.

### BUILDINGS

Spain earned first place in the buildings section, largely because its buildings have low energy intensity. Spain has strong mandatory building codes for both residential and commercial buildings, which cover a broad range of technical elements. Furthermore, Spain has renovation requirements in place for all buildings as part of its construction code. Spain is also one of just a handful of countries with a mandatory program for building labeling and building energy disclosure.

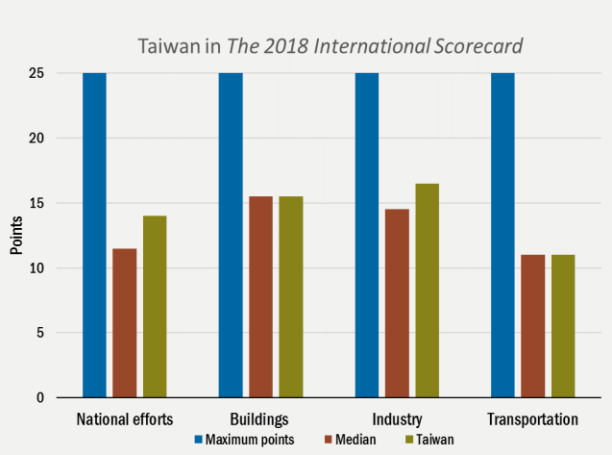
### INDUSTRY

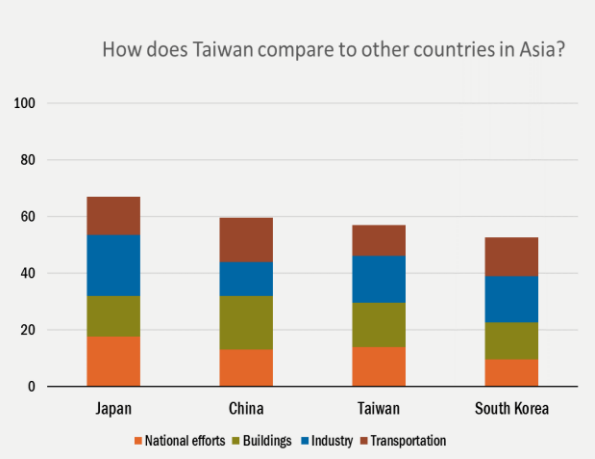
Spain's industrial energy intensity was among the lowest of the countries analyzed, but the country has considerable room for improvement in the industrial efficiency section of the *Scorecard*. Spain generates very low amounts of electricity from CHP and has no CHP targets or incentives in place. Moreover, it could benefit by encouraging more facilities to certify to ISO 50001.

### TRANSPORTATION

Although Spain ranked among the top 10 countries in the transportation section, it still has room for improvement. In particular, Spain's freight transport has a high energy intensity and the country lacks fuel economy standards for heavy-duty vehicles. Use of public transit remains low; consequently vehicle miles traveled is high in the country

## COUNTRY SUMMARY: TAIWAN #9




Taiwan ranked ninth with a total score of 57 points.

### NATIONAL EFFORTS

Taiwan performed well in its national efforts toward energy efficiency. Taiwan has low economy-wide energy intensity. The country has a national goal to improve energy efficiency by 2% per year. Taiwan's $760 million ESCO market as a share of its gross domestic product is among the largest of all countries analyzed. The country can further improve by implementing tax credits to promote the deployment of energy-efficient technologies.

### BUILDINGS

Buildings in Taiwan have very low energy-use intensity. Taiwan could benefit from expanding its appliance standards program. Currently, 13 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.

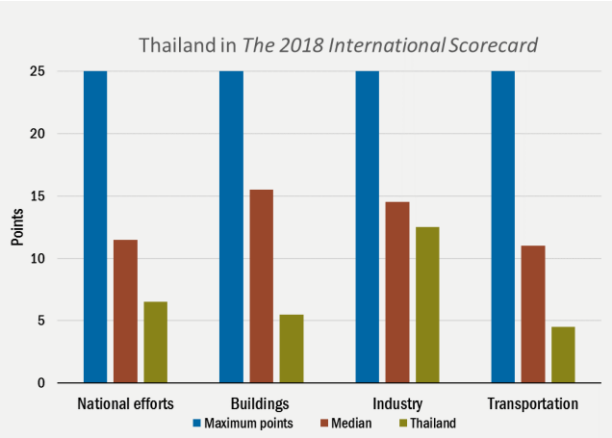
### INDUSTRY

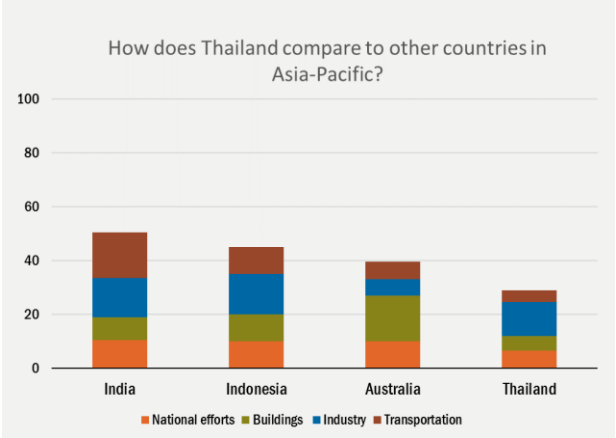
Taiwan has a low industrial energy intensity and a strong catalogue of policies aimed at improving the efficiency of its industrial sector. Nevertheless, Taiwan's industrial sector could further benefit by providing for voluntary agreements between the government and the manufacturing sector aimed at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

### TRANSPORTATION

Taiwan has significant room for improvement in the transportation section. This country could greatly benefit from enacting fuel economy standards for light- and heavy-duty vehicles. We could not find information regarding the intensity of freight transport in Taiwan.

## COUNTRY SUMMARY: THAILAND #22




Thailand ranked 22nd with a total score of 29 points.

### NATIONAL EFFORTS

Thailand's energy intensity remains high. The country has an energy efficiency goal to reduce energy intensity by 30% in 2036 relative to 2010, and highly efficient thermal power plants. However Thailand spends marginal amounts on energy efficiency programs and R&D.

### BUILDINGS

Thailand earned the second lowest score in the buildings section. Thailand has just two appliance groups covered by mandatory minimum energy performance standards and no appliances covered by mandatory labeling. Furthermore, Thailand could adopt mandatory building energy codes for residential buildings because none currently exist. The country provides federal incentives 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.

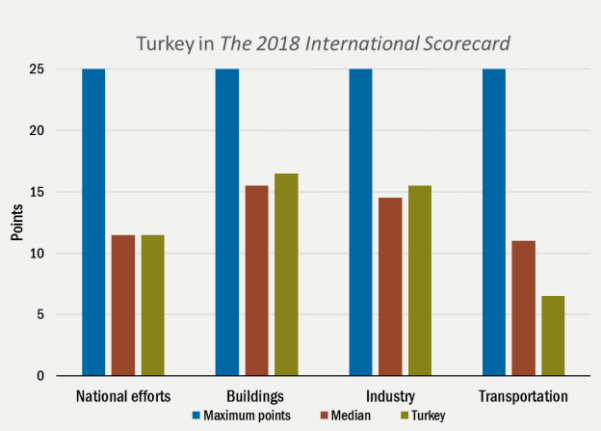
### INDUSTRY

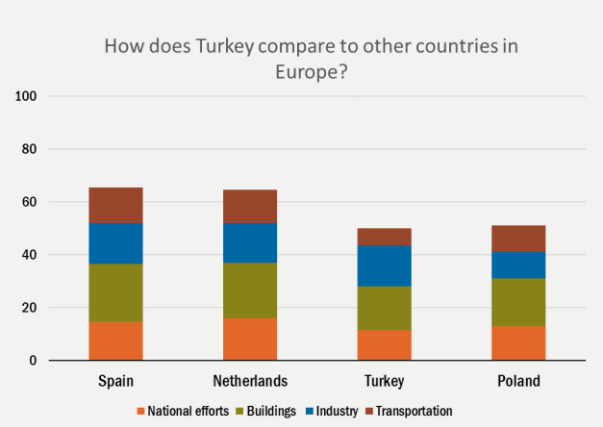
Thailand is one of the few countries with mandates for energy managers, energy audits, and energy management systems. However the energy intensity of its industry remains high. Thailand could improve its standing by ramping up the number of facilities certified to ISO 50001.

### TRANSPORTATION

Thailand was among the lowest-scoring countries in the transportation section. The country earned full scores 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 has a relatively high 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 energy intensity of freight transport.

# COUNTRY SUMMARY: TURKEY #16




Turkey ranked 16th with a total score of 50 points.

## NATIONAL EFFORTS

Turkey ranked 13th in the national efforts section. There is still significant room for improvement. The country lacks a national energy efficiency goal and its spending in energy efficiency R&D remains low. Turkey could benefit from enacting tax incentives aimed at promoting the deployment of energy-efficient technologies.

## BUILDINGS

Turkey ranked 11th in the buildings section. The country has mandatory labeling standards for appliance groups. Turkey could improve its score by adopting some of the recent EU equipment efficiency standards. Turkey also has mandatory building labeling policies for all buildings. The country has building energy codes in place for both new construction and existing buildings, but could improve its score by introducing additional technical requirements to increase the efficiency of newly constructed buildings and also develop building retrofit policies.

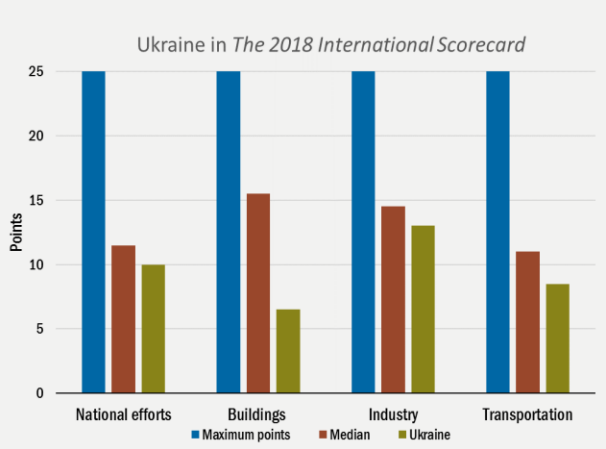
## INDUSTRY

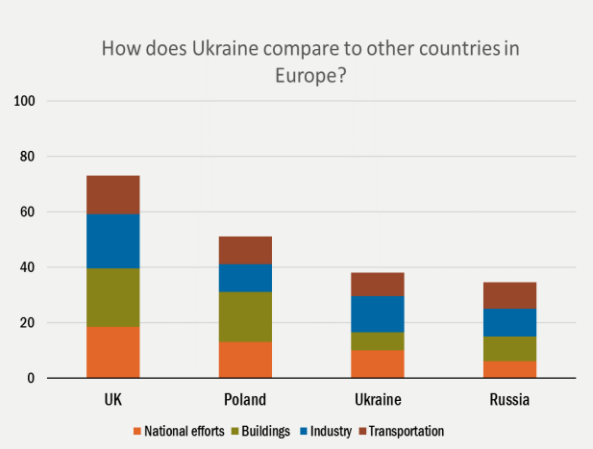
Turkey has attractive incentives for energy efficiency in the industrial sector. The 2007 Energy Efficiency Law was adopted to support energy efficiency projects and voluntary agreements in industry. If industries are committed to reducing their energy intensity by an average of 10% over a three-year 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 provides for mandatory energy audits. Turkey could benefit from enacting mandates to employ energy managers in large industrial facilities.

## TRANSPORTATION

Although Turkey's light-duty vehicles have a high average fuel economy (45.23 mpg), the country earned one of the lowest scores in the transportation section. This is largely due to the lack of fuel economy standards, low use of public transit, marginal investments in rail transit, and high intensity of freight transport.

# COUNTRY SUMMARY: UKRAINE #19




Ukraine ranked 19th with a total score of 38 points.

## NATIONAL EFFORTS

Ukraine's energy intensity fell the most between 2010 and 2015, primarily due to its political situation rather than to actual efforts to reduce energy use. There is significant room for improvement with regard to the country's national efforts. Ukraine has yet to enact an energy efficiency goal. Moreover, its expenditure in energy efficiency programs and R&D remains low. The country's thermal power plants are among the least efficient of all the countries analyzed.

## BUILDINGS

Ukraine scored 6.5 points for its building efficiency policies and performance. The country has mandatory building codes for both residential and commercial buildings. However these codes only address thermal efficiency and could be improved by adding technical requirements for lighting, mechanical equipment, and air sealing. Ukraine also has equipment standards for only three appliance groups, leaving room for significant improvement. The country could improve the efficiency of existing buildings by introducing financial incentives and policies that encourage retrofits.

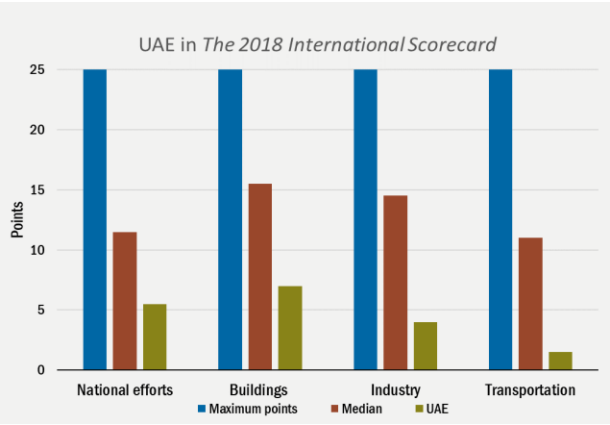
## INDUSTRY

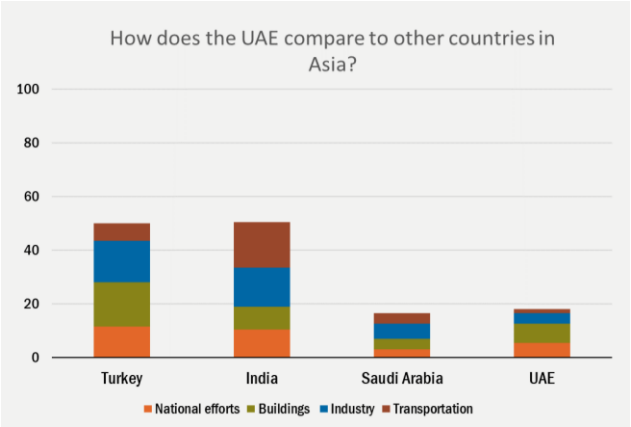
The energy intensity of Ukraine's industry is among the highest of the countries analyzed. Nevertheless, the country has a catalogue of strong energy efficiency policies aimed at increasing the efficiency of its industry. These policies include mandates for energy managers and energy audits, voluntary energy efficiency agreements for the manufacturing sector, and incentives for the deployment of combined heat and power technologies.

## TRANSPORTATION

Ukraine scored low in the transportation section. The country has no fuel economy standards for light- or heavy-duty vehicles in place. Moreover, the country's freight transportation is highly energy intensive. Nevertheless, use of public transit is high in Ukraine, amounting to 56% overall. The country also makes significant investments in rail transit.

# COUNTRY SUMMARY: UNITED ARAB EMIRATES #24




The United Arab Emirates ranked 24th with a total score of 18 points (due in part to a lack of available data), placing it at the bottom of the rankings.

## 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 7 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 country could also improve building efficiency by mandating efficiency requirements and labeling for appliances for additional products.

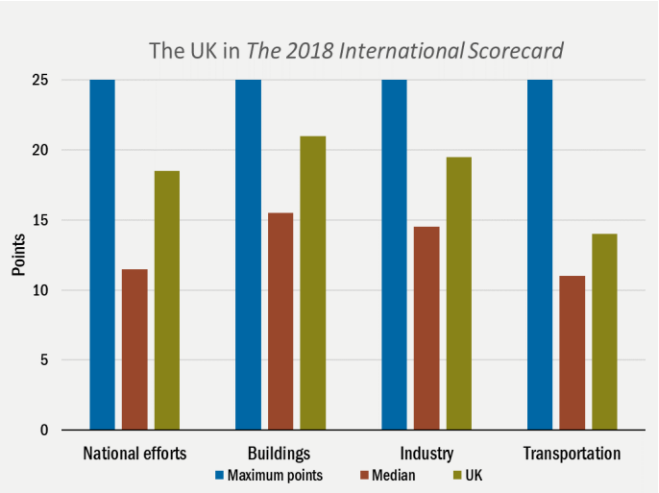
## INDUSTRY

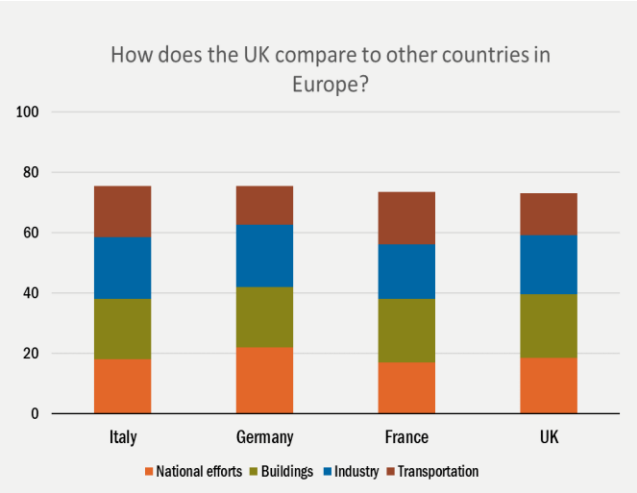
Efforts to improve efficiency in the industrial sector currently exist. The government provides for voluntary agreements with manufacturers to improve energy efficiency. Nevertheless, the energy intensity of the country's industrial sector remains high. This country could greatly benefit from establishing 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 for only one: vehicle miles traveled. The country has a relatively low VMT per capita of 2,210; however this is likely due to its size.

## COUNTRY SUMMARY: UNITED KINGDOM #4




The United Kingdom ranked fourth with a total score of 73 points.

### NATIONAL EFFORTS

The United Kingdom (UK) has made significant commitments to energy reduction through its national policies. The country has set its energy efficiency target under the EU Energy Efficiency Directive, which amounts to an 18% reduction from the UK's 2007 business-as-usual projection for 2020. The country has highly efficient thermal power plants having built many new, more-efficient plants recently. The United Kingdom also makes significant investments in energy efficiency programs and R&D activities. The United Kingdom could further improve by promoting the market expansion of its ESCOs.

### BUILDINGS

The United Kingdom tied for second place in the buildings section of our analysis with a score of 21 points. Comprehensive residential and commercial building codes that have a number of technical requirements are in place, as is a building energy labeling program. Additionally, there are stringent retrofit requirements in place for existing building stock. The UK also has mandatory appliance and equipment standards for 41 products, as well as mandatory labeling requirements for 20 appliance groups.

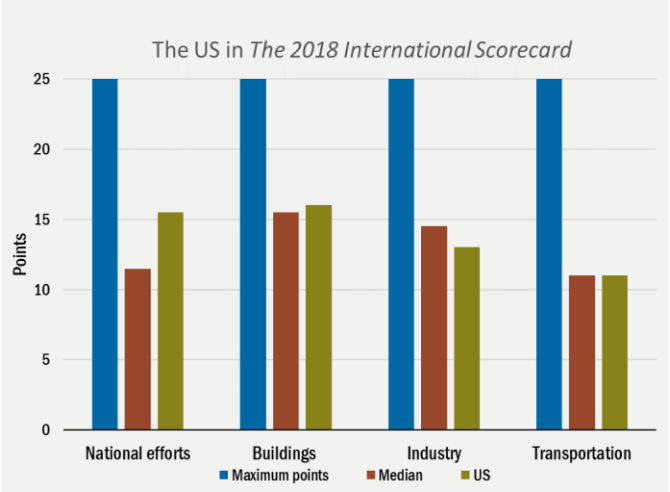
### INDUSTRY

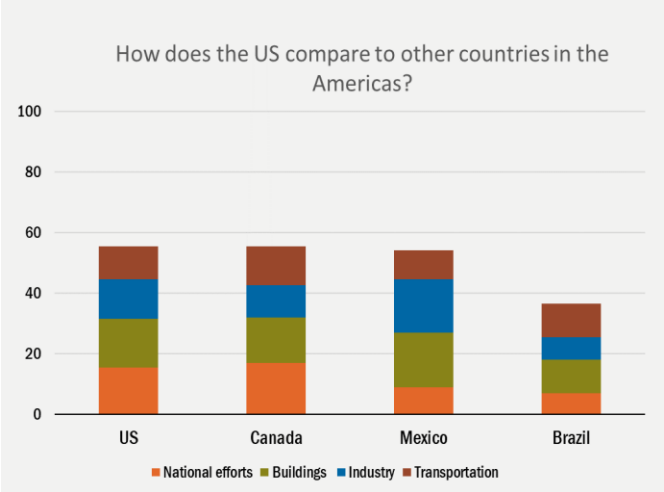
The United Kingdom ranked in the top five of the industrial section of the 2018 *Scorecard*. The industrial energy of this country was among the lowest of all the countries analyzed. Moreover, the UK has a strong catalogue of policies aimed at improving the efficiency of its industry. These policies include voluntary agreements with manufacturers to improve energy efficiency, mandates for energy managers and audits, and incentives for the deployment of CHP technologies and the implementation of energy management systems.

### TRANSPORTATION

The UK scored among the top five countries in the transportation section. The country has high fuel economy standards set at 56.9 by 2025 and comparatively high average fuel economy for light-duty vehicles (32.4 mpg). 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.

## COUNTRY SUMMARY: UNITED STATES #10




The United States ranked 10th with a total score of 55.5 points.

### NATIONAL EFFORTS

The United States is one of very few large energy-consuming economies that does not have national energy reduction targets in place. Additionally, the United States has ceased participating in and announced its intention to withdraw from the Paris Agreement. Nevertheless, the country makes significant investments in energy efficiency programs and R&D and has tax incentives and loan programs that apply to a multitude of sectors in its economy. The United States makes energy data easily accessible to both citizens and international audiences through the Energy Information Administration (EIA), which publishes periodic energy data on its website and provides a number of other tools and services.

### BUILDINGS

The United States claimed the 12th spot in the buildings section. Of the 25 nations evaluated in this report, the United States has the most mandatory appliance and equipment standards, covering more than 52 product categories. Most US states provide tools, training, and resources to support the adoption and maintenance of building codes. The United States also has state energy-use policies for retrofitting buildings covering two-thirds of the country's population.

### INDUSTRY

The United States' performance in the industrial section of the *2018 Scorecard* was marginally above average. The country makes strong investments in manufacturing R&D and has some of the highest minimum energy performance standards for motors. However the United States could focus on expanding the scope of voluntary partnerships between the government and large manufacturers. The federal government could also do more to encourage the adoption of a globally recognized manufacturing standard such as ISO 50001.

### TRANSPORTATION

The lowest-scoring section for the United States was the transportation sector, where it scored 11 points out of 25. Annual vehicle miles traveled per capita in personal vehicles was the highest among the countries on our list at 9,149 miles per capita. 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. 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 (EPA SmartWay).

## Appendix D. US Performance and Recommendations for Increased Energy Efficiency

In *The 2016 International Energy Efficiency Scorecard*, the United States ranked 8th out of 23 countries evaluated with a score of 61.5 points, improving significantly from 13th place in 2014. In 2018, the United States slips back down the ladder again, landing in 10th place with a total score of 55.5 points out of 100. This was due in part to some updates to our methodology and in part to policy changes.

In the national efforts section, the United States ranks eighth. Despite being one of the world's largest energy consumers, the United States has no binding national energy reduction plan in place and has gone so far as to announce its intention to formally withdraw from UNFCCC's Paris Agreement on Climate Change.

In the buildings sector, the United States dropped from 2nd place in 2016 with a score of 18.5 to the 12th spot in 2018 with a score of 16. Much of this change is due to adjustments in the methodology in this section, particularly with regard to scoring of residential and commercial building codes. The United States still earns the highest number of points in the appliance and equipment standards category for having the most mandatory standards among all the evaluated countries in the report. However some important programs have expired and have yet to be extended. This includes the residential tax incentive program for energy efficiency improvements, which expired at the end of 2017.

The United States earned 14th place in the industrial section of the analysis. The United States scored well on policies encouraging investment in CHP, which is a new metric in this edition. The United States also has one of the highest levels of investment in industrial R&D, second only to Japan. However the absence of mandates for energy auditing and installing energy managers in facilities brought the country's score down.

The United States earned its lowest score in the transportation sector, where it received only 11 points out of a possible 25, tying with Taiwan and Brazil for 12th place. The country relies heavily on personal vehicle travel. Its annual VMT per capita in personal vehicles is higher than in any of the other 24 countries, indicating a serious need for efficient vehicles as well as better mobility options to effectively reduce transportation-sector energy use.

The current administration's focus on energy production rather than efficiency has meant that progress on federal energy efficiency policies has largely stalled and, in some cases, is threatened by policy rollbacks. In the buildings sector, the Trump administration has pulled back plans for new appliance standards and has not scheduled any potential improvements to existing standards. Thus, there may be little progress for the next few years. This approach threatens the United States' position as a leader in building-sector energy efficiency standards.

In the transportation sector, regulators have proposed undoing light-duty fuel economy standards scheduled to apply to model years 2021 to 2025. This suggests that the United States' score could take an even greater hit in the 2020 edition of the *Scorecard*. A potential fight over heavy-duty standards is also looming. Proposed legislation on this front includes

eliminating efficiency requirements for trailers as well as a proposal to exempt vehicles with rebuilt engines from the heavy-duty standards.

The United States could take advantage of untapped energy efficiency potential if it stopped the roll back of important policies and adopted or maintained a number of key measures. The following sections outline these measures by sector.

## *NATIONAL EFFORTS*

### Establish National Goals

The United States has ceased participating in and has announced its intention to withdraw from the Paris Agreement, which, although voluntary, aims to reduce global GHG emissions. The United States is one of few large energy-consuming economies that do not have national energy reduction targets in place. Many of the 24 other countries evaluated in this report have energy savings targets. France adopted a transition bill in 2015 calling for a 20% reduction in final energy consumption by 2020 and a 50% reduction by 2050. Similarly, Germany has a plan to cut GHG emissions by 40% by 2020 and up to 95% by 2050. A US national target would help align energy efficiency goals across sectors and coordinate efficiency and GHG emissions reduction actions. It would also encourage energy efficiency efforts at the state and local levels. For national targets to be effective, they need to be accompanied by a comprehensive implementation plan. The United States would benefit from a multisector road map or action plan that incorporates checkpoints and performance metrics to gauge progress.

### Maintain or Increase Energy Efficiency Spending

Investment in energy efficiency programs and R&D is critical to achieving economy-wide energy reductions. The president's budgets for 2018 and 2019 proposed substantial cuts for energy efficiency. While Congress has thus far rejected these reductions for 2018, some cuts to efficiency programs and offices are possible across a range of federal agencies for 2019. Potentially at risk are all the R&D, commercialization, and codes and standards programs at the DOE Energy Efficiency and Renewable Energy Office, as well as EPA's ENERGY STAR®, SmartWay, and vehicle emissions programs. All of these have demonstrated impacts on energy use. In order to remain competitive on a global scale and promote investments in the economy that lead to jobs, the federal government should maintain funding to programs that encourage research in and deployment of energy efficiency technologies and methods.

## *BUILDINGS*

### Strengthen and Add to Existing Appliance and Equipment Standards

The United States is a leader in appliance and equipment standards, with requirements that cover 52 different categories on the books. However these standards have to be constantly improved and amended in order to ensure that they continue to have an impact on energy use in the buildings sector. The administration's current freeze on appliance standards activity threatens not only future energy savings but also US global leadership on this front. The freeze indefinitely delays almost 20 energy efficiency standards with a potential to save American residents and businesses billions of dollars on energy bills. Efficiency standards completed through 2016 and future update requirements could save consumers and businesses $43 billion annually by 2035 (ACEEE 2017). The United States will have to

maintain and update existing standards and enact new ones to have an impact on buildings sector energy use.

#### Improve Energy-Use Transparency

One of the biggest barriers to energy efficiency investments is a lack of information (Vaidyanathan et al. 2013). As a complement to comprehensive building codes and retrofit policies, state and local governments can make building owners and renters aware of their energy footprint by implementing requirements that make the energy use and costs of both residential and commercial buildings transparent at the point of sale or lease. This goal could be achieved through a mandatory disclosure policy or rating system that compares buildings on their energy use. States and cities in the United States could look to the EU's Energy Performance Certificate (EPC) scheme for both residential and commercial buildings. The EU and Australia are leaders on this front, with ambitious policies that require EPCs to be displayed when buildings are sold or rented or when construction is completed (Arcipowska et al. 2014). The cities of Berkeley, California, and Portland, Oregon, have adopted similar policies for residential buildings that could serve as examples to other US cities and states. An additional six cities and two states have mandatory policies that cover commercial buildings disclosure (IMT 2013).

### *INDUSTRY*

#### Expand Scope of Voluntary Agreements

US performance in the industrial section of the 2018 *Scorecard* was average. The United States would realize greater energy savings in the industrial sector by expanding the scope of voluntary partnerships between the government and large manufacturers. The federal government could step up encouragement of a globally recognized manufacturing standard such as ISO 50001 or implementation of less-demanding processes such as strategic energy management or the new DOE 50001 Ready program.

#### Increase Workforce Development

Greater federal investment in workforce development and training programs such as DOE's Industrial Assessment Center (IAC) program will increase energy savings. IACs are located at universities across the country and train young engineers to conduct energy audits for small- and medium-size manufacturers to help improve efficiency, reduce waste, and increase productivity. Students are a major focus of the IAC program, which has increased the number of students who pursue energy efficiency careers and has taught them skills that are highly valued by the private sector (Stephen et al. 2015). IACs have conducted more than 18,000 free audits since 1976, resulting in approximately 800 million kWh annually in electricity savings and more than 0.5 million metric tons of avoided $CO_2$ emissions per year (ACEEE 2018b). The IAC program underwent a major update in the fall of 2017, expanding the number of centers and incorporating important new elements including training and assistance on smart manufacturing.

### *TRANSPORTATION*

#### Maintain Light-Duty Vehicle Fuel Economy Standards

The United States has already taken significant strides to reduce fuel consumption in the transportation sector by implementing fuel economy and GHG emission standards for light-

duty vehicles out to 2025. To fully realize the savings potential of these standards, the United States will need to stop the proposed rollback of standards for model years 2021 to 2025. If the United States elects to keep the standards in place, fuel savings for new vehicles sold between model years 2022 and 2025 will average out to an impressive 4% per year.

### Maintain Heavy-Duty Vehicle Fuel Economy Standards

Heavy-duty vehicles are similarly subject to fuel efficiency and GHG standards in the United States. Phase 1 of the standards was adopted in 2011 and impacts medium- and heavy-duty trucks from model year 2014 onward. Phase 2 was adopted in the summer of 2016. Phase 1 and Phase 2 standards together would reduce the average fuel consumption of new trucks to 35% below 2010 levels by model year 2027. Protecting these standards from rollbacks is critical to drawing advanced vehicle efficiency technologies into the market to reduce energy consumption in heavy-duty vehicles.

The policies discussed in this appendix are just a few examples of actions the United States can take to maintain and heighten its standing on the global stage for energy efficiency, ensure economic competitiveness, and provide health and economic benefits for its residents.