The ACEEE 2012
International Energy Efficiency Scorecard

Sara Hayes, Rachel Young, and Michael Sciortino

Contributing Authors: Kate Farley, Ben Foster, Eric Mackres, and Shui Bin

Report Number E12A

529 14th Street N.W., Suite 600, Washington, D.C. 20045
(202) 507-4000 phone, (202) 429-2248 fax, http://aceee.org

CONTENTS

ACKNOWLEDGMENTS

The authors would like to acknowledge the assistance of several peer reviewers and expert advisors who assisted in the development of this report. Specifically, we would like to thank Lynn Price of Lawrence Berkeley National Laboratory, Elizabeth Sendich of the International Energy Agency, Gabrielle Kuiper of ANZ Bank, Drew Kodjak and Cristiano Facanha of the International Council on Clean Transportation, and staff from the Institute for Market Transformation including Carline Keicher, David Leipziger, and Cliff Majersik.

We also thank ACEEE staff including Renee Nida, Naomi Baum, Eric Schwass, Patrick Kiker, Glee Murray, Suzanne Watson and Tori Miller as well as our staff advisors: Harvey Sachs, Jennifer Amann, Maggie Molina, Harry Misuriello, Skip Laitner, and R. Neal Elliott. Special thanks go to Therese Langer for her immensely helpful assistance while halfway around the world and to Steven Nadel, who conceptualized and guided this analysis from start to finish.

COUNTRY EXPERTS

The experts listed here provided guidance and/or feedback for data and summaries of specific countries:

Gilberto Jannuzzi, University of Campinas, Brazil
Isabel Murray, International Energy Agency
Benjamin Boteler, Ecologic Institute
Max Gruenig, Ecologic Institute
Paolo Bertoldi, European Commission
Ken Elsey, Canadian Energy Efficiency Alliance
Meredydd Evans, Pacific Northwest National Laboratory
Igor Bashmakov, Russian Center for Energy Efficiency
Edouard Toulouse, European Environmental Citizens Organisation for Standardisation
Benoit Lebot, United Nations Development Programme
Sho Hirayama, Jyukankyo Research Institute
Katy Dean, Green Building Council of Australia

EXECUTIVE SUMMARY

A country that uses less energy to achieve the same or better results reduces costs and pollution, creating a stronger, more competitive economy. While energy efficiency has played a major role in the economies of developed nations for decades, cost-effective energy efficiency remains a massively underutilized energy resource.

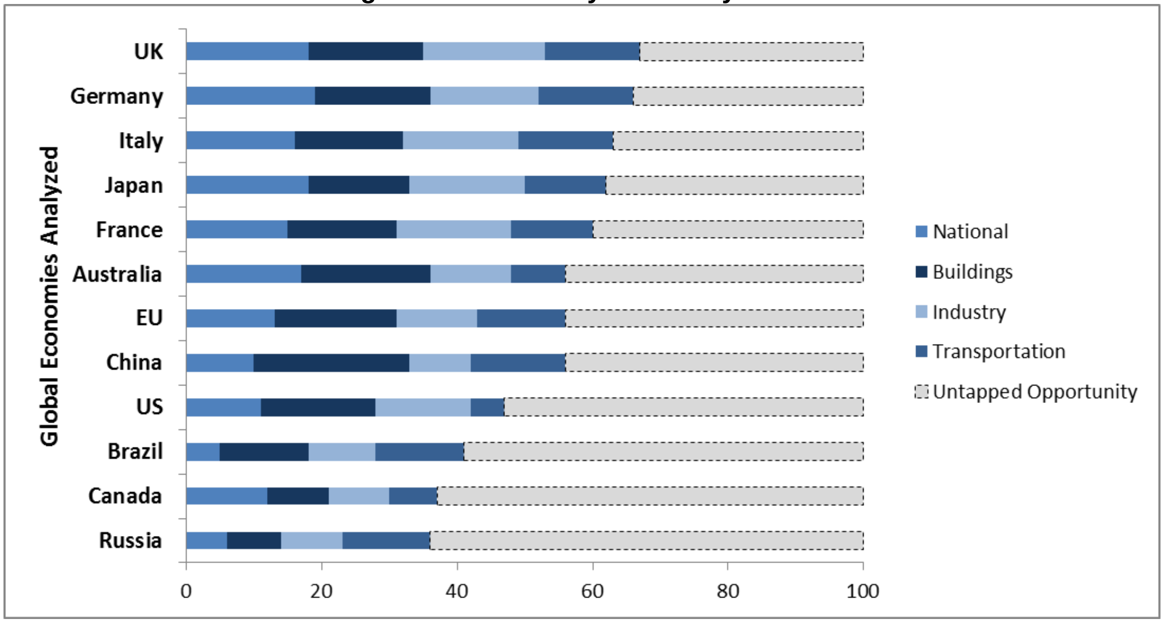
This report analyzes 12 of the world's largest economies representing over 78% of global gross domestic product, 63% of global energy consumption, and 62% of the global carbon-dioxide-equivalent emissions. We looked at 27 metrics to evaluate how efficiently these economies use energy. These metrics are divided roughly in half between evaluation of quantifiable results and policies. The "policy metrics" are evaluated based on the presence of a best practice policy. Examples of policy metrics include the presence of a national energy savings target, fuel economy standards for vehicles, and energy efficiency standards for appliances. The "performance metrics" measure energy use and provide quantifiable results. Examples of performance metrics include the amount of energy consumed by a country relative to its gross domestic product, average miles per gallon of on-road passenger vehicles, and energy consumed per square foot of floor space in residential buildings. We divided the metrics across the three primary sectors responsible for energy consumption in an economically developed country: buildings, industry, and transportation. We also included a number of metrics that cut across these sectors (such as efficiency of the electricity-generating sector) and that indicate a national commitment to energy efficiency. These metrics are included in a "national efforts" section. We selected "100" as the maximum possible score for a country and we allocated these points across these four sections, assigning a point value to each metric. We then scored and ranked all 12 economies based on the results of our research.

The top-scoring countries in each category are: Germany (National Efforts, 19 out of 25 points), China (Buildings, 23 out of 28 points), the United Kingdom (Industry, 18 out of 24 points), and a tie between Italy, China, Germany, and the United Kingdom (Transportation, each with 14 out of 23 points). The United Kingdom has the highest overall score, with 67 out of 100 possible points.

Our results indicate that some countries are outperforming others, but the more important finding is that there are substantial opportunities for improvement in all economies analyzed. The conditions required for a perfect score are currently achievable and in practice, somewhere on the globe. For every metric, at least one country (and often several) received full points. However, every country has serious weaknesses. The average score was just 54 points. Figure ES-1 shows the results divided by sector for each country.

Understanding exactly why countries scored and ranked where they did requires a detailed look at the metrics; however, generally, the top scoring countries scored solidly across all four sections. Interestingly, the top ranked countries in any one section are not necessarily the most highly ranked countries overall. For example, China outscored every other country in the buildings section and also has a very strong score in the transportation section; however, low scores in the national efforts and industrial sections bring down its overall ranking. The United States scored relatively well in the buildings and industrial sections, but very poorly in the transportation section, which helped to bring it down to the bottom tier of countries analyzed. In spite of ranking 6th overall (a tie), Australia is just 2 points away from the highest score in the national efforts section, perhaps reflecting a nation in transition to greater energy efficiency. In the lowest ranking tier, a country may stand out for strong performance in a particular section, but the overall ranking is brought down by the other three sections. This is true for Russia and Brazil, which each rank relatively high in the transportation section, but low in all others. Complete results and details are provided in the text of the report.

Figure ES-1. Country Scores by Sector



In the second part of the report, we focus specifically on the United States, examining historical trends for each metric, making observations about U.S. policies affecting energy efficiency, and offering recommendations for how the United States can reduce energy waste and improve its global competitiveness. The United States has made some progress toward greater energy efficiency over the last decade, particularly in areas such as building codes, appliance standards, voluntary partnerships between government and industry, and, recently, with improvements in vehicle fuel economy standards. However, the overall story is disappointing. The United States, long considered an innovative and competitive world leader, has progressed slowly, while countries including Germany, Japan, and China surge ahead. Countries that use energy more efficiently use fewer resources to achieve the same goals, thus reducing costs, preserving valuable natural resources, and gaining a competitive edge over other countries, such as the United States, where resources are wasted and costs have been allowed to remain unnecessarily high.

The inefficiency in the U.S. economy means a tremendous waste of energy resources and money. Across most metrics analyzed, in the past decade the United States has made limited or little progress toward greater efficiency at the national level. The overall U.S. score of 47 is less than half of the possible points and 20 points away from the top spot. Further, the United States falls behind Japan, the entire E.U., China, and even Australia. These scores suggest that this list of countries may have an economic advantage over the United States because using less energy to produce and transport the same economic output costs less. Their efforts toward efficiency likely make their economies more nimble and resilient. This raises a critical question: looking forward, how can the United States compete in a global economy if it continues to waste money and energy that other industrialized nations save and can reinvest? This report offers a number of recommendations for the United States such as:

- **A national energy savings target.** Congress should pass a national energy savings target to complement existing state policies and raise the bar for all states. Most countries analyzed in this Scorecard have such targets. In the interim, the 25 states without mandatory targets for utility energy savings should adopt them.
- **Efficiency in manufacturing.** Manufacturers should commit to continual improvement in energy efficiency by using Superior Energy Performance ISO 50001 (ISO 2011) and other voluntary platforms.
- **Financial incentives.** States and the federal government should implement improved financial incentives, such as tax credits, loans, and loan loss reserves, to spur private investment in energy efficiency.
- **Investment in research and development.** Greatly increased R&D investment is needed to develop new technologies and practices that support energy efficiency across all sectors of the economy.

- **Efficient power plants.** Government policies should be adopted that encourage utilities to retire old, inefficient power plants and ensure that any new power plants are highly efficient.
- **Output-based emissions standards.** These standards should be employed to encourage the use of the most efficient generation technologies.
- **Efficient power distribution.** Electric grid infrastructure should be modernized to reduce line losses. Utilities should deploy high efficiency distribution transformers, advanced "smart grid" techniques and increased utilization of distributed energy sources to reduce transmission and distribution losses.
- **Building codes.** All states should use the most recent and stringent building code standards.
- **Appliance standards.** Federal and state governments should implement and enforce existing appliance standards, regularly update these standards, and develop standards for additional products (e.g., pumps).
- **Combined heat and power.** Governments and regulators should adopt policies that allow combined heat and power (CHP) to obtain reasonable electricity buyback and backup power rates.
- **Vehicle miles traveled.** The United States should reconsider the pricing of transportation, and facilitate the adoption of policies such as "pay-as-you-drive" insurance, in which the cost is determined primarily by the number of miles traveled.
- **Public transit.** National funding should be increased for public transit, freight rail, and non-motorized modes of transportation.
- **Fuel economy for passenger vehicles.** The federal government should adopt the proposed increases in Corporate Average Fuel Economy (CAFE) standards, which would result in average fuel economy of 49.6 miles per gallon in 2025.
- **Fuel economy for heavy-duty vehicles.** The federal government should adopt substantially higher standards for heavy-duty vehicle fuel efficiency for 2025.

By taking these steps, the United States would increase its world ranking significantly. The opportunities for improvement in global competitiveness and economic resiliency in the United States and worldwide are considerable. Countries can preserve their resources, address global warming, stabilize their economies, and reduce the costs of their economic outputs by advancing one primary goal: use energy more efficiently.

INTRODUCTION

A country that uses less energy to achieve the same or better results reduces costs and pollution, creating a stronger, more competitive economy. While energy efficiency has played a major role in the economies of developed nations for decades, cost-effective energy efficiency remains a massively underutilized energy resource (Laitner et al. 2012).

This report has two primary goals. First, similar to our *State Energy Efficiency Scorecard* (Sciortino et al. 2011b), we analyze a wide range of variables indicative of the overall energy efficiency of economically developed nations. The results of this analysis provide insight into the best policies and practices across nations, and constitute a benchmark that nations can use to improve their energy efficiency. Secondly, we look more closely at these same variables in the United States, highlighting trends and identifying where this nation is improving and where more work is needed.

Because this is the first generation of the *International Scorecard*, we have covered just 12 countries. In this initial version of the report, we draw comparisons among economically developed nations, as the data from these countries are more closely comparable to those of the United States. These global economies represent over 78% of global gross domestic product, 63% of global energy consumption, and 62% of the global carbon dioxide equivalent emissions (World Bank 2011; CAIT 2011; IEA 2011a).

Some of the data come from global organizations and resources such as the International Energy Agency (IEA), Organisation for Economic Co-operation and Development (OECD), the European Commission, the World Bank, and others. Additional data were compiled by country-focused researchers at the American Council for an Energy-Efficient Economy. This report is unique in that in addition to compiling key information specifically addressing the energy efficiency of a country, it provides complementary resources and analysis so that comparisons can be made, highlighting best practices and providing a benchmark upon which a country's progress toward improving its energy efficiency can be compared. The report includes a list of the best practices that received the highest score within each metric, and graphics and discussions of each metric, as well as short summaries of results for each country.

This report identifies "best practices" across a range of 27 key metrics directly related to a country's overall energy efficiency. These metrics span three major economic sectors as well as take a cross-sector snapshot of national commitment to energy efficiency. These four categories are used to rank each country: national efforts, buildings, industry, and transportation. While no single metric can provide a complete picture of a nation's energy efficiency, the combined total of these metrics provides an indication of overall energy efficiency in a country compared to other countries.[1]

This Scorecard is unique in that it is comparative. In addition to compiling key information specifically addressing the energy efficiency of a single country, we provide complementary resources and analysis so that comparisons can be made. We highlight best practices and provide benchmarks upon which a country's progress can be compared with that of its economic peers.

This *International Scorecard* also includes a detailed discussion of the situation in the United States. We track historical trends for each metric, make observations about U.S. policies affecting energy efficiency, and offer recommendations for how the United States can reduce its energy waste, pollution, and greenhouse gas emissions, and strengthen its global competitiveness into the future.

[1] Any single metric is affected by factors, in addition to efficiency, that impact a result. For example, certain industrial processes consume more energy per dollar of gross domestic product (GDP) than others. Measuring the amount of energy consumed by a nation against its GDP does indicate something about how efficiently that energy is used, but it doesn't account for other differences such as the overall structure of the economy. A decomposition analysis attempting to separate out some of these effects is possible, but was beyond the scope of this report. The International Energy Agency has recently conducted such an analysis in its *IEA Scoreboard 2011* report (IEA 2011b). That report covers many, but not all, of the countries covered by the ACEEE Scorecard.

METHODOLOGY

We identified a list of indicators that, together, indicate the level of energy efficiency across a nation's economy and its commitment to energy efficiency. We then sought the advice of a group of expert advisors and revised the list according to their input. We reviewed the existing literature and research on the topics on the revised list and identified mechanisms to measure the indicators. The result was the conversion of the list of indicators into 27 metrics. These metrics are divided roughly in half between policies and quantifiable measures of performance. The policy metrics are evaluated by the presence of "best practice" policies, such as a national target for energy savings, fuel economy standards for vehicles, and energy efficiency standards for appliances. The performance metrics measure energy use and provide quantifiable data. Examples of performance metrics include the ratio of energy consumed by a country to its gross domestic product, the average miles per gallon of on-road passenger vehicles, and the energy consumed per square foot of floor space in residential buildings. To facilitate comparisons between countries, we normalize the results using variables such as population or gross domestic product.

The maximum possible score for a country is 100. We allocated 25 points to the national efforts section. The remaining 75 points are divided across the buildings, industry, and transportation sections based on the weighted average energy consumption for these sectors across all 12 economies analyzed.

Table 1. Maximum Possible Points by Sector

Sector	**Possible Points**
National Efforts	25
Buildings	28
Industry	24
Transportation	23
Total	**100**

The points available for the metrics in that section are allocated according to the recommendations of expert advisors (see Table 2). The highest score available for a given metric is always awarded to at least one country. Reduced points are awarded at regular intervals for countries with less comprehensive policies and/or quantifiable results that indicate lower efficiency based on the results of our research.

In this first generation of this *International Scorecard*, we limited the number of nations we covered to 12 (see Table 3). We wanted to focus on a comparison of economically developed nations, because the data from these countries are more closely comparable to those of the United States. We include the Group of Eight (G8) nations--Canada, France, Germany, Italy, Japan, Russia, the United Kingdom, and the United States—and the three countries with the next highest GDP--Australia, China, and Brazil—and the European Union.[2] It should be noted that while the European Union is not a country, as a whole it represents an economy comparable to that of the United States in many ways. Many of the metrics we collected were available for the European Union as a whole, although in some cases a metric representing the E.U. is actually based on fewer than the full 27 member nations, which we note when it occurs. We plan to expand the list of countries analyzed in future generations of this report to include India, Mexico, South Korea, and others.

[2] Based on GDP, India should also be in this group; however, it was excluded from this analysis due to limitations on the availability of comparable data.

Table 2. Metrics for all Sectors

Metrics	Possible Points
National Efforts	**25**
Energy Productivity	4
Change in Energy Intensity	4
Efficiency of Thermal Power Plants	4
Mandatory Energy Savings Goals	2
Tax Credits and Loan Programs	3
Energy Efficiency Spending	5
Energy Efficiency Research and Development Spending	3
Buildings	**28**
Energy Use In Residential Buildings	5
Energy Use in Commercial Buildings	5
Residential Building Codes	3
Commercial Building Codes	3
Building Labeling	3
Appliance and Equipment Standards	6
Appliance and Equipment Labeling	3
Industry	**24**
Energy Intensity of the Industrial Sector	8
Industrial Electricity Generated by Combined Heat and Power	6
Investment in Manufacturing Research and Development	3
Voluntary Energy Performance Agreements with Manufacturers	3
Mandate for Plant Energy Managers	2
Mandatory Energy Audits	2
Transportation	**23**
Vehicle Miles Traveled per Capita	3
Passenger Vehicle Fuel Economy	3
Fuel Economy Standards	3
Energy Intensity of Freight Transport	4
Freight Transport per Unit Economic Activity	3
Use of Public Transit	4
Investment in Rail Transit	3

Data for each country are obtained from centralized, internationally recognized sources when available, such as the International Energy Agency, the Organisation for Economic Co-operation and Development, and the World Bank. This information is supplemented with individual-country research by ACEEE staff. We sought the counsel of in-country and subject-matter experts to confirm that we accessed the best sources of information and to review our findings prior to publication.

Table 3. Gross Domestic Product and Energy Consumption by Country

	GDP (trillion current $)	Total Final Consumption (KTOE) (1,000 tonnes of oil equivalent)	Building Consumption (KTOE)	Industrial Consumption (KTOE)	Transport Consumption (KTOE)	Population
Australia	0.9	77,712	16,493	26,608	28,600	22,328,800
Brazil	2.1	190,786	33,101	71,135	62,588	194,946,470
Canada	1.6	194,171	63,298	52,071	55,227	34,108,752
China	5.9	1,432,986	405,950	679,940	160,799	1,338,299,512
European Union	16.2	1,154,792	435,391	294,874	322,267	502,087,670
France	2.6	160,257	65,195	27,599	44,400	64,876,618
Germany	3.3	223,918	95,049	47,908	53,923	81,702,329
Italy	2.1	125,576	45,432	28,922	39,088	60,483,521
Japan	5.5	313,580	111,419	82,125	76,091	127,450,459
Russia	1.5	422,834	147,420	124,357	89,614	141,750,000
United Kingdom	2.3	132,126	54,266	25,758	41,706	62,218,761
United States	14.6	1,462,524	468,645	258,912	577,759	309,050,816

Sources: IEA 2011a (energy consumption data); World Bank 2011 (GDP and population data).
KTOE = 1,000 tonnes of oil equivalent

Data and Analytical Limitations

The scoring framework used for this analysis is our best attempt to represent a wide range of factors that measure the energy efficiency of a nation. There are many complexities and national differences that we cannot factor in. For example, some industries are more energy intensive than others, thus energy use varies widely by type of industry. Climate is another variable that impacts energy use and that varies across the globe. We have made some adjustments for weather patterns in the metrics for energy consumption in buildings, though we cannot fully account for the impacts of climate and weather variations. Two variables that impact the results are a nation's geographical size and the distribution of its population. For example, countries with areas of high population density, such as those in the European Union, may be able to lower the energy intensity of their transportation sector through an increase in the use of public transit and by encouraging trips that cover shorter distances. We have made adjustments to mitigate the impact of some of these variables on our results, but the limitations remain, and this analysis should be considered in the context of these factors.

Although this analysis is focused on the national level, regulations and policies also emanate from regional, state, and city governments, and their relative importance varies across nations. Local policies and regulations can be just as effective, but are beyond the scope of this report.

To facilitate comparisons among countries, we have normalized the results using variables such as population and gross domestic product, among others. We want to call attention to the effect that this has on some countries' rankings. Tables 4 and 5 show the difference in results when comparing national energy consumption with either population or GDP. In both tables the countries are ranked starting with the least energy consumed, but the choice of normalizing variable changes the ranking order. The largest impact is on Brazil and China, which move seven and nine ranks, respectively. The variables used to normalize data were selected based on the recommendations of our expert advisors.

Table 4. Final Consumption per Capita

	Tonne of Oil Equivalent per Person
Brazil	0.99
China	1.07
Italy	2.08
U.K.	2.12
E.U.	2.30
Japan	2.46
France	2.47
Germany	2.74
Russia	2.98
Australia	3.48
United States	4.73
Canada	5.69

Table 5. Total Final Consumption per Dollar of Gross Domestic Product

	Tonne of Oil Equivalent per Billion Dollars
Japan	57.44
U.K.	58.75
Italy	61.21
France	62.60
Germany	68.26
E.U.	71.18
Australia	84.03
Brazil	91.38
United States	100.26
Canada	123.12
China	241.79
Russia	285.73

To collect comparable data across nations is challenging. In some cases, the data are simply not collected. In these cases, we have assigned reasonable scores, to the extent possible, based on data that are available. We have noted this in each instance.

It is our experience that the first generation of a research effort such as this is often the most challenging. The metrics will be refined over time. We look forward to discussions of the results among a variety of communities, and we await productive feedback including additional resources that will strengthen and diversify future generations of this *International Scorecard*.

RESULTS

Figure 1 shows the final total and ranking for each country, Table 6 lists the scores by country for each metric, and Table 7 provides the section totals and lists the countries in order of rank for each section.

Figure 1. Rankings for All Economies Analyzed

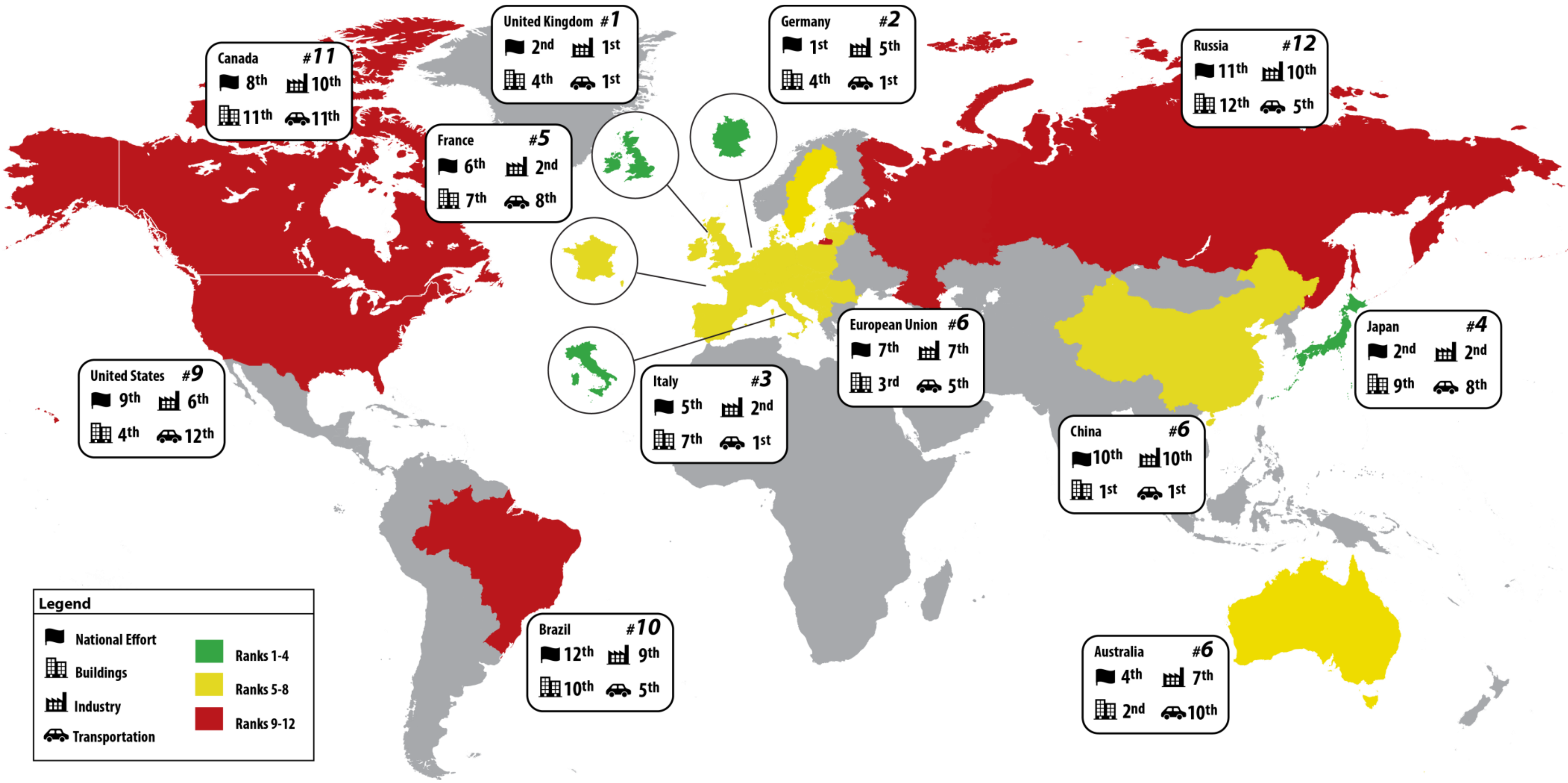


Table 6. Scores for All Metrics by Country

Metrics	Total	Australia	Brazil	Canada	China	EU	France	Germany	Italy	Japan	Russia	U.K.	U.S.
National Efforts Total	**25**	**17**	**5**	**12**	**10**	**13**	**15**	**19**	**16**	**18**	**6**	**18**	**11**
Energy Productivity	4	2	2	1	0	3	3	3	4	4	0	4	1
Change in Energy Intensity	4	2	0	2	3	3	4	4	3	2	0	2	1
Efficiency of Thermal Power Plants	4	2	1	2	1	2	1	3	3	4	0	4	2
Mandatory Energy Savings Goals	2	0	0	2	2	2	2	2	2	2	2	2	0
Tax Credits and Loan Programs	3	3	2	3	2	0	3	3	3	3	3	3	3
Energy Efficiency Spending	5	5	0	1	1	2	0	4	0	2	1	1	1
Energy Efficiency R&D Spending	3	3	0	1	1	1	2	0	1	1	0	2	3
Buildings Total	**28**	**19**	**13**	**9**	**23**	**18**	**16**	**17**	**16**	**15**	**8**	**17**	**17**
Energy Use in Residential Buildings	5	5	5	1	5	2	0	0	3	4	0	1	1
Energy Use in Commercial Buildings	5	1	2	1	5	3	3	4	0	0	2	3	2
Residential Building Codes	3	3	0	0	2	3	3	3	3	2	1	3	3
Commercial Building Codes	3	3	0	0	2	3	3	3	3	3	1	3	3
Building Labeling	3	2	1	1	2	3	3	3	3	1	3	3	1
Appliance and Equipment Standards	6	2	2	5	4	2	2	2	2	3	0	2	6
Appliance and Equipment Labeling	3	3	3	1	3	2	2	2	2	2	1	2	1
Industry Total	**24**	**12**	**10**	**9**	**9**	**12**	**17**	**16**	**17**	**17**	**9**	**18**	**14**
Industrial Energy Intensity	8	5	5	5	0	7	7	8	7	7	1	8	6
Industrial Electricity Generated by CHP	6	2	3	0	3	4	3	3	4	1	3	6	4
Investment in Manufacturing R&D	3	1	2	1	2	1	2	2	1	3	0	1	2
Voluntary Agreements	3	2	0	3	0	0	3	3	3	2	3	3	2
Mandate for Plant Energy Managers	2	0	0	0	2	0	0	0	2	2	0	0	0
Mandatory Energy Audits	2	2	0	0	2	0	2	0	0	2	2	0	0
Transportation Total	**23**	**8**	**13**	**7**	**14**	**13**	**12**	**14**	**14**	**12**	**13**	**14**	**5**
Vehicle Miles Traveled per Capita	3	2	3	1	3	2	1	2	2*	2	3	1	0
Passenger Vehicle Fuel Economy	3	0	1	0	1	2	2	2	3	0	1	3	0
Fuel Economy Standards	3	0	0	1	1	3	3	3	3	3	0	3	1
Energy Intensity of Freight Transport	4	4	3	3	4	2	1	3	0	1	4	0	3
Freight Transport per Dollar of GDP	3	1	1	2	0	2	3	2	3	3	0	3	1
Use of Public Transit	4	1	4	0	4	1	1	1	1	3	2	1	0
Investment in Rail Transit	3	0	1	0	1	1	1	1	2	0	3	3	0
TOTALS	**100**	**56**	**41**	**37**	**56**	**56**	**60**	**66**	**63**	**62**	**36**	**67**	**47**

**Score based on ACEEE estimate*

Table 7. Final Scores and Ranking by Country

Total (100 possible points)		
	Score	Rank
U.K.	67	1
Germany	66	2
Italy	63	3
Japan	62	4
France	60	5
E.U.	56	6
Australia	56	6
China	56	6
United States	47	9
Brazil	41	10
Canada	37	11
Russia	36	12

National Efforts (25 possible points)		
	Score	Rank
Germany	19	1
U.K.	18	2
Japan	18	2
Australia	17	4
Italy	16	5
France	15	6
E.U.	13	7
Canada	12	8
United States	11	9
China	10	10
Russia	6	11
Brazil	5	12

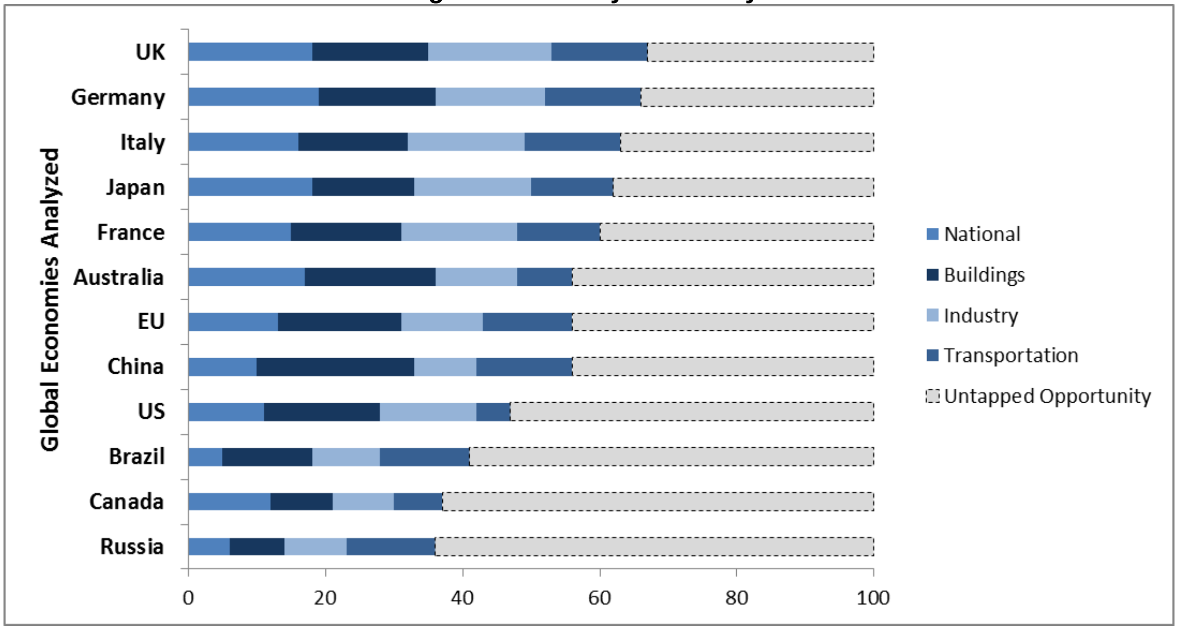
Buildings (28 possible points)		
	Score	Rank
China	23	1
Australia	19	2
E.U.	18	3
United States	17	4
U.K.	17	4
Germany	17	4
Italy	16	7
France	16	7
Japan	15	9
Brazil	13	10
Canada	9	11
Russia	8	12

Industry (24 possible points)		
	Score	Rank
U.K.	18	1
Italy	17	2
France	17	2
Japan	17	2
Germany	16	5
United States	14	6
Australia	12	7
E.U.	12	7
Brazil	10	9
Russia	9	10
China	9	10
Canada	9	10

Transportation (23 possible points)		
	Score	Rank
Italy	14	1
China	14	1
Germany	14	1
U.K.	14	1
E.U.	13	5
Brazil	13	5
Russia	13	5
Japan	12	8
France	12	8
Australia	8	10
Canada	7	11
United States	5	12

Figure 2 shows the results compounded by sector for each country. This view shows that there is a big overall difference between the top countries and lowest ranking countries. It is also evident that there is substantial room for improvement across all countries. In each metric a top score was awarded—this means that if a country emulates the top practices and results in each metric, a score of 100 could be achieved.

Figure 2. Country Scores by Sector



While section scores are informative, a look at countries' overall policies and performance is also revealing (see Table 8). Specifically, when countries are ranked according to just the policy-related metrics, the top-scoring countries include countries that scored high overall such as Germany, the U.K., Japan, France, and Italy. Australia, which tied for 6th place overall, is also 6th based on just policy metrics, however it is only 2 points away from the highest scoring nation when looking at just policy metrics, suggesting that Australia is doing well in its adoption of policies to promote energy efficiency. China is just 1 point ahead of the United States, with 27 points. Out of 47 possible points,[3] the E.U., Canada, and Russia all score less than half of the possible points while Brazil has just 11 out of 47 policy metric points.

Table 8. Countries Ranked by Total Score for Policy Metrics

Germany	31
Japan	31
France	31
U.K.	31
Italy	30
Australia	29
China	27
United States	26
E.U.	23
Russia	20
Canada	19
Brazil	11

[3] Policy metrics include: Mandatory Energy Savings Goals, Tax Credits and Loan Programs, Energy Efficiency Spending, Energy Efficiency Research and Development Spending, Residential Building Codes, Commercial Building Codes, Building Labeling, Appliance and Equipment Standards, Appliance and Equipment Labeling, Investment in Manufacturing Research and Development, Voluntary Energy Performance Agreements with Manufacturers, Mandate for Plant Energy Managers, Mandatory Energy Audits, Fuel Economy Standards, and Investment in Rail Transit.

In contrast, ranking countries according to only performance metrics reveals different leaders (see Table 9). Out of 53 possible points,[4] the U.K. scores 36 points followed by Germany, which scores 35. Italy and the E.U. tie for 3rd with 33 points each and Japan has 31 points. In this ranking, Japan, which tied for 1st in the policy metrics, is 5th. Australia, which ranked 6th in the policy metrics (just 2 points away from the lead), is 9 points below the top spot here, coming in 9th. The United States ranks even lower in this grouping, coming in 10th.

Table 9. Countries Ranked by Total Score for Performance Metrics

U.K.	36
Germany	35
E.U.	33
Italy	33
Japan	31
Brazil	30
France	29
China	29
Australia	27
United States	21
Canada	18
Russia	16

National Efforts

The national efforts section is intended to convey energy efficiency performance across all sectors of the economy as well as overall commitment and leadership of the national government. These metrics look at the performance of the electricity-generating fleet, the useful productivity of energy consumed, and the change in nations' energy intensity over time. Metrics in this section examine national commitment by evaluating financial investment in energy efficiency overall and in research and development in emerging technologies. The metrics also evaluate policy indicators such as the presence of national energy savings goals and programs to engage the private sector using tax credits and loans.

Out of 25 possible points (see Table 10), the highest scoring country across the National Efforts metrics is Germany, followed by Japan and the U.K. Germany's overall energy productivity is high, it has substantially improved its energy intensity over the last decade, and its overall financial investment in energy efficiency is strong. These factors help it to occupy 1st place in spite of receiving no points for spending on energy efficiency research and development. Japan and the U.K. have high energy productivities and score relatively well across all metrics except spending. Both Japan and the U.K. scored low for overall energy efficiency spending per capita, and both received only a partial score for investment in energy efficiency research and development.

Most countries have a national energy savings goal of at least 1% savings per year on average, as well as programs to encourage private investment in energy efficiency, such as loans and tax credits. National investment in energy efficiency varies widely across countries, but in some cases increases as part of a greenhouse gas mitigation strategy or economic stimulus effort. We found a great deal of room for improvement in the efficiency of thermal power plants across all countries due to low operational efficiency and high distribution losses. Table 10 shows the total score across national metrics as well as

[4] Performance metrics include: Energy Productivity, Change in Energy Intensity, Efficiency of Thermal Power Plants, Energy Use in Residential Buildings, Energy Use in Commercial Buildings, Energy Intensity of Industrial Sector, Industrial Electricity Generated by Combined Heat and Power, Vehicle Miles Traveled per Capita, Passenger Vehicle Fuel Economy, Energy Intensity of Freight Transport, Freight Transport per Unit Economic Activity, and Use of Public Transit.

the individual country scores for each national metric. Table 10 is followed by additional detail about each national metric.

Table 10. Scores for National Metrics

	Total National Efforts Score	Energy Produc-tivity	Change in Energy Intensity	Efficiency of Thermal Power Plants	Mandatory Energy Savings Goals	Tax Credits and Loan Programs	Energy Efficiency Spending	Energy Efficiency R&D Spending
Germany	19	3	4	3	2	3	4	0
Japan	18	4	2	4	2	3	2	1
United Kingdom	18	4	2	4	2	3	1	2
Australia	17	2	2	2	0	3	5	3
Italy	16	4	3	3	2	3	0	1
France	15	3	4	1	2	3	0	2
European Union	13	3	3	2	2	0	2	1
Canada	12	1	2	2	2	3	1	1
United States	11	1	1	2	0	3	1	3
China	10	0	3	1	2	2	1	1
Russia	6	0	0	0	2	3	1	0
Brazil	5	2	0	1	0	2	0	0

Energy Productivity *(4 possible points)*

We measure energy productivity by taking 2010 gross domestic product in U.S. dollars and dividing it by total energy consumption of primary energy measured in tonnes of oil equivalent (TOE) for the most recent year available (2009) (Word Bank 2011; IEA 2011a). This is a measure of the amount of economic output in a country per unit of energy consumed—i.e., higher levels indicate greater efficiency. The full 4 points are awarded to countries with greater than $16,000 per TOE, 3 points for greater than $13,000 per TOE, 2 points for greater than $10,000 per TOE, and 1 point for greater than $7000 per TOE (see Table 11). Japan and the United Kingdom score highest scores in this metric, followed by Italy, France, Germany, and the E.U. China and Russia round out the bottom with considerably lower productivity, and the middle tier is occupied by Australia, Brazil, United States, and Canada.

Table 11. Energy Productivity

	Gross Domestic Product to Energy Consumption ($/TOE)[5]	Score
Japan	17,408	4
United Kingdom	17,020	4
Italy	16,336	4
France	15,974	3
Germany	14,651	3
European Union	14,048	3
Australia	11,901	2
Brazil	10,944	2
United States	9,974	1
Canada	8,122	1
China	4,136	0
Russia	3,500	0

Sources: World Bank 2011 (GDP); IEA 2011a (energy consumption).

Change in Energy Intensity *(4 possible points)*

Energy intensity is the inverse of energy productivity, and equals the amount of energy consumed divided by national GDP. With this metric we examine change over time, from 2000 to 2009. GDP is adjusted to account for inflation over time, which significantly impacts the outcome. For example, in Russia, GDP has grown substantially over the last decade while energy consumption has remained relatively flat; however, inflation in Russia over this same period has been so high that Russia's energy intensity over time shows no change. Countries with a decline in energy intensity of at least 40% are awarded 4 points, at least a 30% decline receive 3 points, at least a 20% decline receive 2 points, and at least a 10% decline received 1 point (see Table 12).

The results are listed in Table 12, which makes clear that energy intensity in France has improved dramatically in the last decade. Germany has also made important improvements, followed closely by Italy and China. Brazil is the only country where energy intensity has increased. The United States, in spite of shifting to a less industry-intensive economy, shows the smallest improvement (excluding Russia and Brazil).

[5] Current U.S. dollars are used throughout this report unless otherwise noted.

Table 12. Percentage of Change in Historical Energy Intensity

	Percent Change in Energy Intensity 2000-2009	Score
France	-47	4
Germany	-41	4
Italy	-37	3
China	-36	3
European Union	-33	3
Australia	-29	2
Canada	-28	2
United Kingdom	-27	2
Japan	-25	2
United States	-17	1
Russia	0	0
Brazil	3	0

Sources: ACEEE calculation using IEA 2011a (for energy consumption); World Bank 2011 (for GDP and GDP deflators).

Efficiency of Thermal Power Plants *(4 possible points)*

This metric is based on the overall efficiency of the electric power system, accounting for both operational efficiency at power plants and losses that occur during the distribution of electricity. These data indicate how effectively or ineffectively the electric power sector converts fossil fuels into useable electricity. Full points are awarded for overall efficiency of at least 37%, and points were subtracted in increments of 4%. Countries with less than 25% overall thermal efficiency receive no points.

Distribution losses are a significant factor here (see Table 13). Japan scored highest according to this metric due to the high heat rate of its thermal power plants (44%) and its relatively low distribution losses of 5%. Brazil, in contrast, has relatively high efficiency thermal power plants with a 42% thermal efficiency, but its distribution losses of 17% result in a low overall score. The European countries generally have lower operational efficiency but also lower distribution losses (5-8%), causing them to rank above Brazil. Russia has both low operational efficiency and high distribution losses. The United States falls in the middle of the pack.

Table 13. Efficiency of Thermal Power Plants

	Operational Efficiency of Thermal Power Plants (%)	Distribution Losses (%)	Overall Efficiency of Thermal Power Plants (%)	Score
Japan	44	5	39	4
United Kingdom	44	7	37	4
Italy	41	7	34	3
Germany	37	4	33	3
European Union	38	6	32	2
Canada	39	8	31	2
United States	37	6	31	2
Australia	36	7	29	2
China	32	5	27	1
France	33	6	27	1
Brazil	42	17	25	1
Russia	32	11	21	0

Sources: WEC 2012 (thermal efficiency); IEA 2011a (distribution losses). Thermal efficiency for Russia is an ACEEE estimate.

Mandatory Energy Savings Goals *(2 possible points)*

This metric is scored according to whether a country has a policy outlining a mandatory national energy savings goal (see Table 14). National energy savings goals can send a message across all sectors of an economy, spur innovation, and articulate national priorities. These goals measure progress towards a goal, making energy efficiency more tangible and yielding quantifiable results. Full credit is awarded for policies that require a fixed amount of energy savings per year. An average annual energy savings target of at least 1% appears to be a fairly standard practice among industrialized countries. In some cases, a country received credit for an energy *intensity* target, such as China's goal to reduce energy intensity. In contrast, both Australia and Canada scored 0 points, because, even though both countries do have national commitments to reduce greenhouse gases, they don't have energy savings targets *per se*. The United States is the only country that has neither a national energy saving target nor a greenhouse gas reduction target. Table 14 identifies countries with goals in place.

Tax Credits and Loan Programs *(3 possible points)*

This metric reflects a government's policies that encourage private investment in energy efficiency. Energy efficiency investments often pay for themselves over time, but a common barrier to these investments is the upfront cost of the technology or upgrade. Government loan programs and tax credits can help to lower or spread out the upfront costs, thus enabling projects to move forward within the "payback" demands of the entity financing the improvement. In addition, government-backed loan programs and credits can make market conditions for energy efficiency more favorable, attracting additional private investment. The full 3 points are awarded for countries with *both* multi-sector loan programs and multi-sector tax credits. Two points were awarded for countries having one or the other. A country could earn 1 point if it had either tax credits or a loan program for a single sector, though no country fell into this category. Most countries scored the full 3 points, with the exception of Brazil, China, and the E.U. Our research indicated that China has national loan programs extending across multiple sectors but lacks multi-sector tax credits. In Brazil, utilities can obtain low-interest financing for major energy efficiency projects from a revolving loan fund, but the government offers no tax credits. Many countries in the E.U. have financing mechanisms, but there is not uniform adoption of a loan program or tax credits and there is no E.U. directive.

Table 14. Energy Savings Goals, Tax Credits and Loan Programs by Country

	Mandatory Energy Savings Goals	Score	Multi-Sector Tax Credits and Loan Programs	Score
France	Yes	2	Both	3
Germany	Yes	2	Both	3
Italy	Yes	2	Both	3
Japan	Yes	2	Both	3
Russia	Yes	2	Both	3
United Kingdom	Yes	2	Both	3
Canada	Yes	2	Both	3
China	Yes	2	Loans	2
Australia	No	0	Both	3
United States	No	0	Both	3
Brazil	No	0	Loans	2
European Union	Yes	2	Neither	0

Source: Wade et al. 2011 (energy savings targets for France, Germany, Italy, United Kingdom, and the European Union). Citations for all other energy savings goals, tax credits, and loan programs for each country are included in the country summaries in Appendix A.

Energy Efficiency Spending and Energy Efficiency Research and Development Spending *(5 possible points/3 possible points)*

The metric measuring energy efficiency spending is scored based on total investments in energy efficiency by the national government and the utility sector. In some countries the utility sector is controlled by the national government, whereas, in the United States the utility sector is primarily regulated by states. Therefore, to obtain parity between countries, we combined spending by utilities and national governments for each country. We divided the total annual investment (measured in U.S. dollars) by population.

The results for this metric are an approximation of the annual spending on energy efficiency in 2010 (or the year of most recently available data) per person in each country (see Table 15). The data for this metric were among the most challenging to collect. In some cases, information about national spending is publicly available through a budget process, while in other cases our calculation/number is based on an averaging of lump sum budgets for programs that span multiple years. In cases where multi-year budgets were used, we divided these budgets over the years of the program. While this metric does not examine where investments are made or measure how effectively the money is spent, it is an indication of overall commitment to energy efficiency. The awarding of points is as follows: 5 points are awarded for per capita spending of at least $200, 4 points for spending of at least $150 per person, 3 points for at least $100, 2 points for at least $50, and 1 point for at least $20.

Australia spends much more than any other country, in line with its commitments to reduce greenhouse gas emissions and recent economic stimulus spending. Australia is followed by Germany. Spending in the E.U. and Japan is similar, but at only about a third of Germany's level. The United States and China come next, followed by Russia, the U.K., and Canada. In some cases, such as for Australia and the

United States, the level of spending in 2010 is artificially high (compared to historical trends) because of one-time economic stimulus spending.

To complement this metric, we include a more narrowly defined metric measuring annual per-capita investment in energy efficiency research and development (R&D). These data are much more readily available, and results are in a tighter range. Australia had the highest spending in this metric as well, with 3 points awarded for exceeding $4.00 per person. Partial credit of 2 points is awarded to countries with spending between $3.00 and $4.00 per person. Most countries were awarded 1 point for spending between $2.00 and $3.00 per person. Table 15 lists the results by country for both metrics.

Table 15. Energy Efficiency Spending and Energy Efficiency R&D Spending[6]

	Energy Efficiency Spending ($/capita)	Score	Energy Efficiency R&D Spending ($/capita)	Score
Australia	208.76	5	5.42	3
Germany	155.91	4	1.76	0
Japan	60.81	2	2.43	1
European Union**	56.14	2	2.57	1
United States	33.94	0	4.50	3
United Kingdom	23.14	1	3.61	2
China	35.40	1	NA	1*
Canada	22.45	1	2.95	1
France	7.14	0	3.12	2
Russia	29.53	1	0.77	0
Italy	7.88	0	2.19	1
Brazil	1.93	0	0.00	0

*ACEEE estimate
**Energy efficiency spending for European Union is the average of France, Germany, Italy, and the United Kingdom. R&D spending is for the "European region."
Source: IEA 2011a (R&D spending). Sources for R&D spending in Brazil, China, and Russia are included in the country summaries in Appendix A. Overall efficiency spending is an ACEEE calculation based on research of individual country budgets and program spending.

BUILDINGS

In the buildings section countries could earn up to 28 points across 7 different metrics. This section quantifies and compares energy use in residential and commercial buildings as well as related policies, such as building energy codes and programs that require disclosure of building energy consumption. This section also scores policy treatment of appliances and equipment, looking at whether performance standards are in place and whether energy consumption of products is disclosed.

The top scorer in the buildings section is China, followed by Australia and the European Union. Tied for 4th place are Germany, the United Kingdom, and the United States, and France and Italy are just 1 point behind. China and Australia both scored well in the metric measuring energy use in residential buildings,

[6] It should be noted that due to the inconsistencies in the availability of national energy efficiency spending, it is possible that some of the results include energy efficiency R&D spending in the total efficiency spending. For instance, in the United States, there is likely some overlap because national spending is based, in part, on the budget of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, which is tasked with investing in clean energy technologies. It is worth noting, however, that there does not appear to be overlap between the spending used to calculate the scores for Australia, the top scorer for both metrics.

but China pulled away from the rest of the group with low energy use also in commercial buildings. China also has a high number of appliance and equipment standards, as do Canada and the United States.

Building codes and labels disclosing energy use by appliances and equipment seem to be fairly standard practices among industrialized countries. Building labeling and performance standards for appliances and equipment are also standard practices, though the comprehensiveness of the building labeling programs and the number of appliances covered by standards vary by country. Table 16 lists the total sector scores and scores for each metric for all 12 economies. The following section discusses the metrics in greater detail.

Table 16. Building Sector Scores by Country

	Total Buildings Score	Energy Use In Residential (RES) Buildings	Energy Use in Commercial (COM) Buildings	Residential Building Codes	Commercial Building Codes	Building Labeling	Appliance and Equipment Standards	Appliance and Equipment Labeling
China	23	5	5	2	2	2	4	3
Australia	19	5	1	3	3	2	2	3
European Union	18	2	3	3	3	3	2	2
Germany	17	0	4	3	3	3	2	2
United Kingdom	17	1	3	3	3	3	2	2
United States	17	1	2	3	3	1	6	1
France	16	0	3	3	3	3	2	2
Italy	16	3	0	3	3	3	2	2
Japan	15	4	0	2	3	1	3	2
Brazil	13	5	2	0	0	1	2	3
Canada	9	1	1	0	0	1	5	1
Russia	8	0	2	1	1	3	0	1

Energy Use in Residential and Commercial Buildings *(5 possible points each)*

These two metrics are calculated using the most recent data available for total energy consumption divided by the floor space of the building stock. To normalize these results, we factored in differences in seasonal temperatures. We took the average of the total heating and cooling degree days (the "H&C factor") in the three most populated cities in each country and the European Union, and divided energy consumption over floor area by the H&C factor for that country. The results are affected by a number of variables related to building use, including efficiency of buildings, size of buildings, and how heavily buildings are heated and cooled. China has the best score for this metric for both residential and commercial buildings, due in part to lower energy service levels than many of the other countries analyzed. Aside from China, the countries did not perform well in both residential and commercial buildings. For example, Italy scores 3 points in residential buildings, but has the highest energy consumption per floor area of any country in the commercial building sector. Similarly, Germany has the second highest performance for commercial buildings, and one of the lowest scores for residential buildings. Table 17 shows how the results were scored, and the results themselves are presented in Table 18.

Table 17. Scoring of Energy Use in Buildings Metrics

Points	Residential (Btu/f2)	Commercial (Btu/f2)
5	7	6
4	8	11
3	9	16
2	10	21
1	11	26

Table 18. Energy Use in Residential and Commercial Buildings*

	Energy Use in Residential Buildings			Energy Use In Commercial Buildings		
	(Btu/f2)	(kJ/m2)	Score	(Btu/f2)	(kJ/m2)	Score
China	6.1	69	5	5.0	57	5
Brazil	4.3	49	5	17.0	193	2
Australia	6.9	79	5	23.6	268	1
European Union	9.4	106	2	13.4	152	3
Germany	11.4	129	0	10.5	119	4
Japan	7.7	88	4	27.0	307	0
United Kingdom	10.6	121	1	11.2	127	3
Italy	8.8	100	3	31.3	356	0
France	11.7	133	0	15.6	177	3
United States	10.5	119	1	19.3	220	2
Russia	11.6	132	0	19.9	226	2
Canada	10.2	116	1	25.7	292	1

*Energy use is adjusted by a heating and cooling degree day adjustment factor to account for climatic differences.
Sources: IEA 2011a (energy use in buildings); Degree Days 2012 (heating and cooling adjustment factors); ACEEE country research (area of existing building stock). Country-specific sources are provided in the country summaries in Appendix A.

Residential and Commercial Building Codes *(3 possible points each)*

Scores for these metrics are based on the presence of national, mandatory building codes covering five major areas:

- *Insulation in Walls and Ceiling*. Insulating the "envelope" or "shell" of a house or commercial building includes adding insulation to prevent heat loss in the winter and heat gain in the summer.

- *Window U-Factor and Shading/Solar Heat Gain Coefficient.* The U-factor measures the rate of heat transfer through a window and rates how well the window insulates. The Solar Heat Gain Coefficient (SHGC) measures the fraction of solar energy transmitted and indicates how well the window blocks heat caused by sunlight.

- *Lighting Efficiency Requirements.* Minimum standards for high efficiency lighting and lamps and/or lighting controls are included in some building codes.

- *Heating and Cooling Requirements*. Heating and cooling requirements refer to the efficiency of a building's heating, ventilating, and air conditioning (HVAC) systems.

- *Air Sealing.* Sealing the "envelope" or "shell" includes getting rid of air leaks throughout a home, such as around windows and doors, and holes in attics, basements and crawlspaces. These leaks can be sealed using caulk, spray foam, weather stripping, and other sealants. *(Residential buildings only)*

Countries with mandatory requirements addressing all five of the major elements in the residential sectors receive 3 points. Countries with mandatory requirements in four of the elements score 2 points and countries with requirements in three of the major elements receive 1 point. In the commercial sector, countries with mandatory requirements addressing all four of the major elements receive 3 points. Countries with three elements receive 2 points and countries with two elements receive 1 point. We did not evaluate the effectiveness, stringency, or enforcement of requirements in each country, as finding a consistent way to compare and contrast these variables across the different countries would be particularly challenging and worthy of a report of its own. But we recognize that these are very important aspects of effective building codes, and we will seek to account for some of these additional variables in future editions of this report. Tables 19 and 20 list the major areas scored for residential and commercial buildings and the results for each country.

Table 19. Residential Building Code Scoring

	Insulation in Walls and Ceiling	Window U-Factor and Shading/Solar Heat Gain Coefficient	Lighting Efficiency	Heating and Cooling Requirements	Air Sealing	Score
Australia	Yes	Yes	Yes	Yes	Yes	3
European Union	Yes	Yes	Yes	Yes	Yes	3
France	Yes	Yes	Yes	Yes	Yes	3
Germany	Yes	Yes	Yes	Yes	Yes	3
Italy	Yes	Yes	Yes	Yes	Yes	3
United Kingdom	Yes	Yes	Yes	Yes	Yes	3
United States*	Yes	Yes	Yes	Yes	Yes	3
China**	Yes	Yes	Yes	Yes	No	2
Japan	Yes	Yes	Yes	Yes	No	2
Russia	Yes	Yes	No	No	Yes	1
Brazil	No	No	No	No	No	0
Canada	No	No	No	No	No	0

*The U.S. federal government does not have authority to pass mandatory building codes; however, the majority of U.S. states have adopted codes. The U.S. score is based on this progress. See the U.S. section of this report for additional detail.
**In China building codes do not apply to rural areas, which represent more than half of the building stock; however, building codes are in place for both commercial and residential buildings in urban areas. China has been awarded 2 points in recognition of this.
Source: Individual country research by ACEEE. Country building codes are referenced in the country summaries in Appendix A.

Table 20. Commercial Building Code Scoring

	Insulation in Walls and Ceiling	Window U-Factor and Shading/Solar Heat Gain Coefficient	Lighting Efficiency	Heating and Cooling Requirements	Score
Australia	Yes	Yes	Yes	Yes	3
European Union	Yes	Yes	Yes	Yes	3
France	Yes	Yes	Yes	Yes	3
Germany	Yes	Yes	Yes	Yes	3
Italy	Yes	Yes	Yes	Yes	3
Japan	Yes	Yes	Yes	Yes	3
United Kingdom	Yes	Yes	Yes	Yes	3
United States*	Yes	Yes	Yes	Yes	3
China**	Yes	Yes	Yes	Yes	2
Russia	Yes	Yes	No	No	1
Brazil	No	No	No	No	0
Canada	No	No	No	No	0

*The U.S. federal government does not have authority to pass mandatory building codes; however, the majority of U.S. states have adopted codes. The U.S. score is based on this progress. See the U.S. section of this report for additional detail.
**In China, building codes do not apply to rural areas, which represent more than half of the building stock; however, building codes are in place for both commercial and residential buildings in urban areas. China has been awarded 2 points in recognition of this.
Source: Individual country research by ACEEE. Country building codes are referenced in the country summaries in Appendix A.

Labeling and Disclosure of Building Energy Efficiency *(3 possible points)*

Scores for the next buildings-related metric are based on the presence of mandatory labeling (or rating) and mandatory disclosure of energy use. A building label creates transparency regarding the energy costs associated with a building, similar to the transparency provided by a miles-per-gallon rating for a vehicle. Disclosure of a building's energy use can assist in recognizing the value of energy efficiency benefits at the time of a purchase or lease. The full 3 points are given to countries with disclosure and labeling requirements applicable to all buildings (new and existing, commercial and residential). National policies that apply to new buildings and are triggered for existing buildings upon a sale, lease, or remodel are awarded full credit. National policies that apply only to new buildings or only to a subset of buildings (commercial but not residential) are awarded 2 points, and voluntary national policies are awarded 1 point. Table 21 below lists the findings for this metric.

Table 21. Scores for Building Energy Labeling and Disclosure Programs by Country

	Building Energy Labeling and Disclosure	Score
Germany	Mandatory for all buildings	3
European Union	Mandatory for all buildings	3
France	Mandatory for all buildings	3
Italy	Mandatory for all buildings	3
Russia	Mandatory for all buildings	3
United Kingdom	Mandatory for all buildings	3
China	Mandatory for new large commercial and governmental buildings	2
Australia	Mandatory for residential and office buildings. Triggered for existing buildings upon sale or lease	2
Brazil	Voluntary program for residential and commercial buildings	1
Canada	Voluntary program	1
Japan	Voluntary program	1
United States	Voluntary program at the national level, and mandatory programs in some jurisdictions	1

Sources: IMT 2012; Leipziger 2012.

Appliance and Equipment Standards *(6 possible points)*

Policies implementing minimum energy performance standards for appliances and equipment are eligible for up to 6 points. Points are awarded based on the number of appliances and types of equipment covered by standards. This metric does not measure stringency of standards, percentage of energy consumption covered by standards, or compliance with standards, all of which are important factors impacting the energy efficiency of appliances and equipment. Canada and the United States stand out in this category for having energy performance standards that cover the highest number of products, followed by China and Japan. Table 22 shows point thresholds and Table 23 shows the scores and ranks.

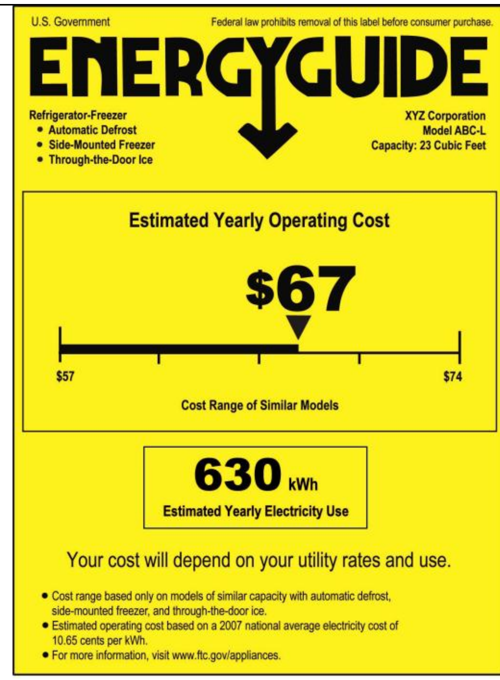
Table 22. Scoring of Appliance and Equipment Standards

Points Awarded	Number of Appliance and Equipment Standards
6	40 or more
5	At least 33
4	At least 26
3	At least 19
2	At least 12
1	At least 5

Labeling of Appliance and Equipment Energy Efficiency *(3 possible points)*

Labeling programs disclose to consumers information about how much energy an appliance or piece of equipment uses compared to similar products of the same type. The labels typically display the comparative information using a categorical rating or a continuous scale. Categorical labels divide the models into distinct groups based on energy use or efficiency, whereas continuous scales mark the high and low end of energy use or efficiency among models, and place each model in the appropriate place along the continuum. An example of a categorical label is the European Union scheme, which awards a letter grade to a product. The EnergyGuide program in the United States is a continuous labeling program. See Figure 3.

Figure 3. Sample Appliance Labels

Categorical	Continuous
	

Research on label design and effectiveness conducted in many countries repeatedly demonstrates that categorical labels are easier to understand and use, and are more motivating for consumers and manufacturers. Experience in countries with categorical and continuous labels bear out the research: categorical labels are more effective in driving manufacturers to offer and consumers to purchase higher efficiency products than continuous label designs. Policies that include mandatory disclosure of the energy consumption of appliances and equipment using a categorical format are awarded 2 points, countries with these requirements for ten or more products received 3 points and countries with requirements for fewer than ten products receive 2 points. Mandatory labeling using a continuous approach is awarded 1 point. Results for this metric are included in Table 23.

Table 23. Standards and Labeling for Appliances and Equipment

	Appliance and Equipment Standards	Score	Appliance and Equipment Labeling	Score
United States	43	6	Continuous	1
Canada	34	5	Continuous	1
China	26	4	Categorical	3
Japan	21	3	Categorical	2
Australia	17	2	Categorical	3
European Union	14	2	Categorical	2
France	14	2	Categorical	2
Germany	14	2	Categorical	2
Italy	14	2	Categorical	2
United Kingdom	14	2	Categorical	2
Brazil	13	2	Categorical	3
Russia	1	0	Continuous	1

Sources: CLASP 2011; Ecodesign 2012 (number of appliance standards for all European countries and E.U.); NRC 2012 (number of appliance standards for Canada). U.S. numbers are an ACEEE calculation based on a composite of DOE rulemakings.

INDUSTRY

In the industrial section of this report, countries are scored based on the energy intensity of the industrial sector as well as how much of the sector's electricity comes from combined heat and power (CHP). Investment in industrial research and development is also scored. The policy metrics evaluated look to government efforts to encourage energy efficiency in the industrial sector through incentives and the implementation of voluntary programs to set energy savings targets, as well as mandates for requiring periodic energy audits and on-site energy managers.

The United Kingdom is in the top spot with 18 points, followed closely by France, Italy, and Japan in a three-way tie. Germany comes in 5th with 16 out of 24 points. All five of the top-scoring countries have lower energy intensities and voluntary government programs aimed at improving the energy efficiency of partnering businesses.

The policies that countries adopt to address energy efficiency of the industrial sector vary quite a bit and no country received a perfect score across all three policy metrics (voluntary agreements, requirements for plant energy managers, and periodic energy audits). The European countries do a consistently good job across all metrics, and they stand out for their voluntary agreements and incentives available to manufacturers. All countries have significant room for improvement. Table 24 lists the sector total and scores by individual metrics for each country.

Table 24. Industry Scores

	Total Industry Score	Energy Intensity of Sector	Electricity Generated by CHP	Investment in R&D	Voluntary Agreements	Mandate for Plant Energy Manager	Mandatory Energy Audits
United Kingdom	18	8	6	1	3	0	0
France	17	7	3	2	3	0	2
Italy	17	7	4	1	3	2	0
Japan	17	7	1	3	2	2	2
Germany	16	8	3	2	3	0	0
United States	14	6	4	2	2	0	0
Australia	12	5	2	1	2	0	2
European Union	12	7	4	1	0	0	0
Brazil	10	5	3	2	0	0	0
Canada	9	5	0	1	3	0	0
China	9	0	3	2	0	2	2
Russia	9	1	3	0	3	0	2

Energy Intensity of Industrial Sector *(8 possible points)*

This metric is a measure of the total final consumption of energy in the industrial sector (measured in British thermal units (Btu)) divided by industrial GDP in U.S. dollars. Countries with the lowest energy consumption per dollar of output (Btu/$) in the industrial sector are awarded 8 points, with a cutoff of 2.10 Btu per dollar. Points are subtracted for each additional whole Btu per dollar, and countries exceeding 9.10 Btu per dollar received 0 points. Table 25 lists the results by country.

Table 25. Energy Intensity of the Industrial Sector

	Energy Intensity of Sector		Score
	(BTU/$)	Joules/$)	
Germany	2.08	2,199	8
United Kingdom	2.10	2,220	8
Italy	2.21	2,333	7
France	2.30	2,427	7
Japan	2.40	2,530	7
European Union	2.89	3,044	7
United States	3.19	3,363	6
Australia	4.48	4,724	5
Canada	4.98	5,256	5
Brazil	5.04	5,323	5
Russia	9.06	9,561	1
China	9.71	10,242	0

Sources: IEA 2011a (energy consumption of industrial sector); CIA 2012; and World Bank 2011. Industrial GDP is based on the percentage of total GDP (World Bank) attributable to the industrial sector (CIA).

Industrial Electricity Generated by Combined Heat and Power *(6 possible points)*

Combined heat and power systems (CHP) generate useful thermal energy and electricity or mechanical power in a single, integrated system. CHP systems are 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 existing thermal demands.

Scores are awarded according to the percentage of electricity consumed by the industrial sector that is produced by CHP. There is a wide range of results across countries. The U.K. has the highest percentage of industrial electricity consumption generated from CHP and has 8.3% more industrial electricity generated from CHP than the next highest score, that of the European Union overall. In contrast, Canada's industrial sector uses almost no CHP to produce electricity in the industrial sector.

Countries with at least 25% of their industrial electricity generated from CHP are awarded a full 6 points. Table 26 shows the scoring and Table 27 lists the results by country.

Table 26. Scoring Breakdown for Combined Heat and Power

Points	Percentage of Industrial Power from CHP
6	At least 25
5	At least 20
4	At least 15
3	At least 10
2	At least 5
1	At least 2.5

Table 27. Percentage of Industrial Electricity Generated by Combined Heat and Power

	Industrial Electricity Generated by Combined Heat and Power (%)	Score
United Kingdom	27.0	6
European Union	18.7	4
United States	17.5	4
Italy	15.0	4
Russia	14.8	3
Germany	12.9	3
France	10.6	3
Brazil	10.0	3
China	10.0	3
Australia	5.7	2
Japan	4.0	1
Canada	0.1	0

Sources: WEC 2012; CEN 2011 (China); IEA 2008 (Japan). The result for Brazil is an ACEEE estimate.

Investment in Manufacturing Research and Development *(3 possible points)*

While manufacturing R&D spending is not exclusively invested in energy efficiency, reducing waste and energy costs improves competitiveness, making energy efficiency a major focus of R&D investments in this sector. Spending included in this metric represents R&D activities carried out in the business enterprise sector, regardless of the origin of funding. We divide total R&D spending in the manufacturing sector by GDP and report the result in U.S. dollars. Japan has the highest relative spending with investments in manufacturing R&D equal to 2.30% of total GDP. Germany follows with 1.70%. The other countries with manufacturing R&D spending equal to at least 1% of GDP are Brazil, China, France, and the United States. Up to 3 points are awarded for countries with spending equal to at least 2.25% of GDP. Countries with spending equal to at least 1% of GDP received 2 points and countries with at least 0.50% received 1 point. Table 28 lists the results.

Table 28. Investment in Industrial Research and Development

	Percentage GDP Invested in Industrial Research and Development	Score
Japan	2.3%	3
Germany	1.7%	2
United States	1.3%	2
France	1.1%	2
Brazil	1.1%	2
China	1.0%	2
European Union*	0.8%	1
United Kingdom	0.7%	1
Australia	0.5%	1
Canada	0.5%	1
Italy	0.5%	1
Russia	0.1%	0

*Data for the European Union as a whole were not available. Result is based on 19 member countries
Sources: OECD 2012a; UNESCO 2011 (Brazil).

Voluntary Energy Performance Agreements between National Governments and Manufacturers *(3 possible points)*

The scoring for this metric is based on the presence of a national government program for entering into voluntary agreements with businesses in the manufacturing sector to improve energy efficiency. The highest score is awarded for a program that both impacts a diversity of manufacturers and offers incentives for achievements and/or participation. Countries with agreements that offer incentives *or* are available to a diversity of manufacturers are awarded 2 points. Several countries stand out in this area, including Russia, France, Italy, Canada, Germany, and the U.K. Table 29 lists the results of this metric by country.

Mandate for Plant Energy Managers *(2 possible points)*

This metric is scored according to whether or not a country has a national law or regulation requiring industrial facilities to employ an energy management expert on site (see Table 29). A dedicated, on-site energy manager can improve processes, identify waste, and maximize the efficient use of energy resources. However, in spite of the economic benefits of reduced energy waste and increased economic productivity that can come from having an on-site expert dedicated to improving energy efficiency, only three of the countries analyzed have such a requirement: Japan, China, and Italy. Countries that have a plant energy manager mandate receive 2 points.

Mandatory Energy Audits *(2 possible points)*

Periodic energy audits can help businesses identify opportunities to improve energy efficiency, benchmark improvements, and identify negative trends. Russia, Japan, China, France, and Australia have such a requirement (see Table 29). Countries are awarded 2 points if there is a national law or regulation requiring periodic energy audits of industrial facilities.

Table 29. Industrial Policies to Encourage Energy Efficiency: Voluntary Agreements, Energy Plant Managers, and Audits

	Voluntary Agreements with Manufacturers	Score	Mandate for Plant Energy Manager	Score	Mandatory Energy Audits	Score	Combined Score
Japan	Multi-sector manufacturers or incentives	2	Yes	2	Yes	2	6
Russia	Multi-sector manufacturers and incentives	3	No	0	Yes	2	5
France	Multi-sector manufacturers and incentives	3	No	0	Yes	2	5
Italy	Multi-sector manufacturers and incentives	3	Yes	2	No	0	5
Australia	Multi-sector manufacturers or incentives	2	No	0	Yes	2	4
China	No	0	Yes	2	Yes	2	4
Canada	Multi-sector manufacturers and incentives	3	No	0	No	0	3
Germany	Multi-sector manufacturers and incentives	3	No	0	No	0	3
United Kingdom	Multi-sector manufacturers and incentives	3	No	0	No	0	3
United States	Multi-sector manufacturers or incentives	2	No	0	No	0	2
Brazil	No	0	No	0	No	0	0
European Union	No	0	No	0	No	0	0

Sources: Price et al. 2010 (voluntary programs for Australia, Canada, France, Germany, Japan, and the United Kingdom); Vassiliouk 2011 and ABB 2012 (Russia); ABB 2011 and IEA 2011b (Italy). See the section below on the United States for additional detail on U.S. programs. Citations for data on plant energy manager and mandatory energy audits are cited in the country summaries in Appendix A.

TRANSPORTATION

In the transportation section, seven metrics are evaluated in the areas of passenger vehicles, public transit, and freight transport. The energy efficiency of passenger vehicles is evaluated using a comparison of fuel economy standards, the average fuel economy of on-road passenger vehicles, and the total vehicle miles traveled per person in a year. The metrics evaluating public transit look at both investment in and use of modes of public transport in a nation. Energy intensity of freight transport is evaluated based on the energy consumed per ton-mile. An additional measure of the efficiency of goods movement is provided by ton-mile per unit GDP, a measure of locational efficiency.

All countries scored low in the transportation sector. The highest scoring countries (Italy, the U.K., Germany, and China) received only partial credit in at least three of the seven metrics, and China, the U.K., and Italy all received 0 points in at least one category. Australia and Canada scored particularly low in this category, followed by the United States—all three having totals in the single digits. The United States received a score of 0 in four out of seven metrics. Most countries have a mandatory fuel economy standard in place, but a standard does not necessarily translate into better average fuel economy of on-road passenger vehicles due to differences in factors such as vehicle size and driving habits. Similarly, the countries investing the highest ratio of dollars in rail do not have the highest ridership in public transit. Table 30 shows the scores by country for the transportation section and each metric.

Table 30. Transportation Results

	Total Transportation Score	VMT Per Capita	Average Fuel Economy	Fuel Economy Standards	Efficiency of Freight Transport	Freight Transport in Relation to GDP	Use of Public Transit	Investment in Public Transit
China	14	3	1	1	4	0	4	1
Germany	14	2	2	3	3	2	1	1
Italy	14	2*	3	3	0	3	1	2
United Kingdom	14	1	3	3	0	3	1	3
Brazil	13	3	1	0	3	1	4	1
European Union	13	2	2	3	2	2	1	1
Russia	13	3	1	0	4	0	2	3
France	12	1	2	3	1	3	1	1
Japan	12	2	0	3	1	3	3	0
Australia	8	2	0	0	4	1	1	0
Canada	7	1	0	1	3	2	0	0
United States	5	0	0	1	3	1	0	0

**Score based on ACEEE estimate.

Vehicle Miles Traveled *(3 possible points)*

This metric is scored according to total miles traveled in a year by passenger vehicles divided by total population. This information provides some general insight into how much the population of a nation is using automobiles, an inefficient mode for personal transport. For Italy, this information was not readily available from a central source, so a score was extrapolated based on other information such as energy per passenger kilometer and older, related data. The United States stands out negatively in this category with an average vehicle miles traveled (VMT) per person that is more than twice that of most countries and more than 30% greater than the next lowest country, Canada. China has an exceptionally low VMT per capita, followed by Brazil and Russia. Countries with an average VMT per capita of no more than 3,000 receive 3 points; no more than 5,000, 2 points; and no more than 7,000, 1 point.

Table 31. Vehicle Miles Traveled per Person by Country

	VMT per capita	VKT per capita	Score
China	569	915	3
Brazil	1,393	2,242	3
Russia	1,788	2,878	3
European Union**	3,812	6,134	2
Japan	4,379	7,047	2
Germany	4,383	7,053	2
Australia	4,508	7,255	2
Italy*	NA	NA	2
United Kingdom	5,082	8,179	1
France	5,291	8,514	1
Canada	6,072	9,771	1
United States	9,557	15,380	0

*Score based on ACEEE estimate.
**Based on totals for 11 Member Countries.
Source: World Bank 2011 (population). Vehicle miles traveled are based on individual country research by ACEEE, which is cited in the country summaries in Appendix A.

Average Fuel Economy and Fuel Economy Standards *(3 possible points each)*

For purposes of this metric, fuel economy standards can include limitations on the amount of fuel consumed relative to distance traveled as well as emission limits on carbon dioxide (CO_2). Countries with requirements above 40 mpg by 2015 receive a full score of 3 points while countries with requirements above 35 mpg by 2015 received 2 points. Requirements over 30 mpg by 2015 earn 1 point.

In addition to standards, a separate score is awarded for average on-road fuel economy of passenger vehicles. Countries with fuel economies averaging greater than 35 mpg receive a full 3 points, while countries with an average greater than 30 mpg receive a partial score of 2 points, and countries with an average greater than 25 mpg received 1 point.

The good news is that the majority of countries have standards in place. However, many of these standards are relatively new, and the average fuel economy of on-road passenger vehicles could be dramatically improved in many of the nations analyzed. The U.S. has proposed standards that would yield an average fuel economy of 49.6 mpg in 2025, to be adopted in the summer of 2012. Table 32 lists results and scores for both metrics by country.

Table 32. Fuel Economy Standards and Average Fuel Economy

	Fuel Economy Standards*	Score	Average Fuel Economy (mpg)	Average Fuel Economy (l/100 km)	Score
Australia	None	0	21	11	0
Brazil	None	0	26	9	1
Canada	Approximately 34.5 mpg by 2015	1	22	11	0
China	Currently equivalent to approximately 34 mpg; increased standards are currently under consideration	1	27	9	1
European Union	Approximately 48.6 mpg by 2015	3	33	7	2
France	Same as for the E.U.	3	35	7	2
Germany	Same as for the E.U.	3	31	8	2
Italy	Same as for the E.U.	3	38	6	3
Japan	Approximately 47.0 mpg by 2015	3	23	10	0
Russia	None	0	29	8	1
United Kingdom	Same as for the E.U.	3	38	6	3
United States	Approximately 32.6 mpg by 2015; increased standards are currently under consideration	1	23	10	0

* Normalized to United States Corporate Average Fuel Economy Standards (CAFÉ) Test Cycle
Sources: ICCT 2011, 2012; Odyssee 2012 (average fuel economy of on-road vehicles for France, Germany, Italy, and the U.K.); Cuenot and Fulton 2011 (Russia). Average fuel economy for Brazil is calculated from Tsai, 2012. Standards levels cited for Canada and the U.S. include light commercial vehicles; the level cited for China is for gasoline vehicles only.

Public Transit Use and Investment in Rail Transit *(4 possible points/3 possible points)*

Public transit use is measured by looking at the distance traveled by passengers by rail, bus, and coach divided by total distance traveled by passengers across all motorized modes of inland travel (excluding motorcycles). Countries with greater than 50% of travel completed by public transit receive a full score of 4 points; greater than 35% receive 3 points, greater than 20% receive 2 points, and greater than 5% receive 1 point. There is a wide disparity among countries. China, Brazil, and Japan, followed by Russia, stand out positively, with considerably higher percentages of travel completed by public transit.

Investment in public transit is measured as the ratio of government investment in rail versus roads. Investment in all transit modes would have been a superior metric, but these data were not readily available. Interestingly, in the countries analyzed, high government investment in rail as compared to roads does not appear to be correlated with high use of public transit. This seems to support the view that countries must not only make public transit available, but must also address other factors that affect ridership. Further, more spending on rail alone is an imperfect measure of commitment to public transit. For example, public transit consists of many other modes that are not captured in this metric. Also in many countries, transit may be primarily funded by local governments.

The United Kingdom and Russia are the only countries analyzed that invest more money in rail than roads. Countries with spending in a ratio of 0.75 or greater of rail to roads receive a full score of 3 points. Spending in a ratio of 0.50 is awarded 2 points, and spending of 0.25 is awarded 1 point. Table 33 provides the results and scores for both metrics by country.

Table 33. Public Transit Use and Investment

	Distance Traveled by Public Transit (% passenger km by public transit modes)	Score	Investment in Public Transit (ratio of $ in rail versus roads)	Score
China	85	4	0.30	1
Brazil	65	4	NA	1*
Russia	29	2	1.05	3
Japan	37	3	0.20	0
Italy	17	1	0.54	2
United Kingdom	11	1	1.20	3
European Union	17	1	0.45	1
France	16	1	0.40	1
Germany	14	1	0.36	1
Australia	12	1	0.19	0
Canada	4	0	0.05	0
United States	4	0	0.04	0

*Score is based on ACEEE estimate.
Sources: OECD 2012b; ANTP 2010 (distance traveled by public transit for Brazil); EU 2011 (distance traveled by public transit for the United States); ICCT 2012 (distance traveled by public transit for Russia and China).

Energy Efficiency of Freight Transport and Freight Transport per Unit Economic Activity *(4 possible points/3 possible points)*

To assess the energy intensity of freight transport in a nation we used a metric measuring energy consumed per ton-mile traveled. The amount of freight transport per unit of economic activity, which can be considered a measure of location-efficiency of industrial and commercial activity, is measured by looking at ton-miles per dollar of GDP. Russia, Australia, and China scored well in this metric. The European countries, with the exception of Germany, scored low as a whole, as freight rail is not widely used there. Table 34 below lists how each metric is scored, and Table 35 provides the results for both freight metrics by country.

Table 34. Scoring for Freight Metrics

Energy per Ton-Mile Travelled (kBtu/ton-mile)	Score	Ton-Mile per Dollar of GDP (Ton-mile per $)	Score
1.4	4	0.07	3
2.1	3	0.24	2
2.8	2	0.41	1
3.5	1		

Table 35. Energy Efficiency of Freight Transport; Ton-Miles in Relation to GDP

	Energy per Ton-Mile Travelled (kBtu/ton-mile)	Energy per Tonne-Kilometer Travelled (MJ/tonne-km)	Score	Ton-Mile per Dollar of GDP (Ton mile per $)	Tonne-Kilometer per Dollar of GDP (Tonne-km per $)	Score
Germany	1.03	1.42	3	0.10	0.14	2
Canada	1.20	1.66	3	0.20	0.29	2
Australia	0.85	1.18	4	0.30	0.44	1
Russia	0.32	0.44	4	1.49	2.18	0
China	0.81	1.11	4	0.95	1.39	0
Japan	2.35	3.25	1	0.04	0.06	3
Brazil	1.08	1.49	3	0.37	0.54	1
United States	1.35	1.87	3	0.27	0.40	1
European Union	1.60*	2.22*	2	0.16	0.23	2
France	2.45	3.39	1	0.06	0.09	3
United Kingdom	2.80	3.87	0	0.05	0.08	3
Italy	2.60	3.60	0	0.06	0.09	3

*Based on average of France, Germany, Italy, and the United Kingdom weighted by ton-mile.
Sources: IEA 2011b (energy per ton-mile); Odyssee 2012 (ton-mile of freight); World Bank 2011 (GDP); Jiang and Zhu 2012 (China); ICCT 2012 (Russia). Results for Brazil are calculated from Ministerio 2012.

RECOMMENDATIONS AND BEST PRACTICES

As we mentioned above, in every metric, at least one country received full points. This means that it is possible for countries to receive a perfect score. However, no country even approached a perfect score, and most countries receive roughly half of all possible points. This indicates that there is significant room for improvement across all countries analyzed. Moreover, there are great opportunities for nations to learn from one another by emulating best policies, practices, and performance. Table 36 summarizes some of the best outcomes and policies that countries can look to as models for improving their energy efficiency. Our metrics evaluate either policies or performance. The highest scores in the performance metrics include, logically, the top performing nation in each metric. The best practices in the policy metrics, in contrast, are scored according to the *presence* of best practice policies currently in use, but we have not assessed the state of implementation or the success of those policies.

Appendix A summarizes the efficiency policies for each country, highlighting best practices and providing references to further information.

Table 36. Highest Scoring Policies and Performances for Each Metric

Metrics	Results	Country
National Efforts		
Energy Productivity	17,408 dollars per tonne of oil equivalent	Japan
Change in Energy Intensity	A reduction of energy intensity of 47% over the last decade	France
Efficiency of Thermal Power Plants	39%	Japan
Mandatory Energy Savings Goals	All 13 provincial and territorial governments have committed to an average of 1.67% improvement in energy efficiency per year.	Canada
Tax Credits and Loan Programs	Federal tax credits and loan programs, both covering multiple sectors	Australia, Canada, France Germany, Italy, Japan, Russia, U.S., and U.K.
Energy Efficiency Spending	$209 per person	Australia
Energy Efficiency R&D Spending	$5.42 per person	Australia
Buildings		
Energy Use In Residential Buildings	4.3 Btu per square foot	Brazil
Energy Use in Commercial Buildings	5.0 Btu per square foot	China
Residential Building Codes	Mandatory building codes covering all five categories	Australia, France, Germany, E.U., Italy, U.K., and U.S.
Commercial Building Codes	Mandatory building codes covering all four categories	Australia, China, France, Germany, E.U., Italy, Japan, U.K., and U.S.
Building Labeling	All buildings subject to energy labeling and rating disclosure	E.U., France, Germany, Italy, Russia, and U.K.
Appliance and Equipment Standards	43	U.S.
Appliance and Equipment Labeling	Categorical program	Australia, Brazil, China, the E.U., France, Germany, Italy, Japan, and U.K.
Industry		
Energy Intensity of Industrial Sector	2.08 Btu per dollar GDP	Germany
Industrial Electricity Generated by CHP	27%	UK
Investment in Industrial R&D	2.30% of GDP	Japan
Voluntary Energy Performance Agreements with Manufacturers	Government partnerships with energy saving agreements and incentives for a variety of business types	Canada, France, Germany, Italy, Russia, and U.K.
Mandate for Plant Energy Managers	Requirement for a dedicated, on-site energy expert	China, Italy, Japan
Mandatory Energy Audits Required	Requirement for periodic energy audits of facilities	Australia, China, France, Japan, and Russia
Transportation		
Vehicle Miles Traveled per Capita	569 vehicle miles traveled per person	China
Passenger Vehicle Fuel Economy	38 miles per gallon for an average on-road passenger vehicle	Italy and U.K.
Fuel Economy Standards	Fleet average of 49 miles per gallon	E.U.
Energy Intensity of Freight Transport	1.11 kBtu per ton-mile	China
Freight Transport in Relation to GDP	0.04 ton-miles per dollar GDP	Japan
Use of Public Transit	65% of motorized passenger kilometers are by rail, bus, or coach	Brazil
Investment in Passenger Rail	$1.20 invested in rail for each dollar invested in roads	U.K.

UNITED STATES HISTORICAL ENERGY EFFICIENCY AND RECOMMENDATIONS

This section focuses specifically on the United States, looking more closely at each metric and the historical trends in U.S. energy efficiency. The section concludes with recommendations for improving U.S. energy efficiency in order to strengthen the economic competitiveness of the United States.

National Efforts

The U.S. commitment to energy efficiency policy and programs at the national level has room to improve. This section describes the U.S. trends over 10 years across each of the metrics in the National Effort section. Some highlights include:

- **Investment in efficiency programs and R&D.** Per person investments in energy efficiency programs and efficiency R&D in support of energy efficiency technologies lag behind those of other industrialized nations, but the United States has recently increased investment through federal stimulus spending as well as ratepayer-funded utility demand-side management programs.

- **National energy efficiency target.** The United States lacks a national energy efficiency energy savings target, which could spur investment and implementation of energy efficiency technologies and practices. Much of U.S. energy policy is formulated at the state level, and a number of states have advanced aggressive energy efficiency policies to spur investment in energy-efficient technologies and practices.

- **Electric generation.** The U.S. electricity system could improve its efficiency dramatically. The relatively low efficiency of the thermal power plant fleet has remained fairly steady in the United States in spite of significant opportunities to reduce waste through the use of combined heat and power and combined-cycle power plants. Losses due to inefficient distribution of electricity resulted in $25.7 billion of wasted electricity in 2010 alone.

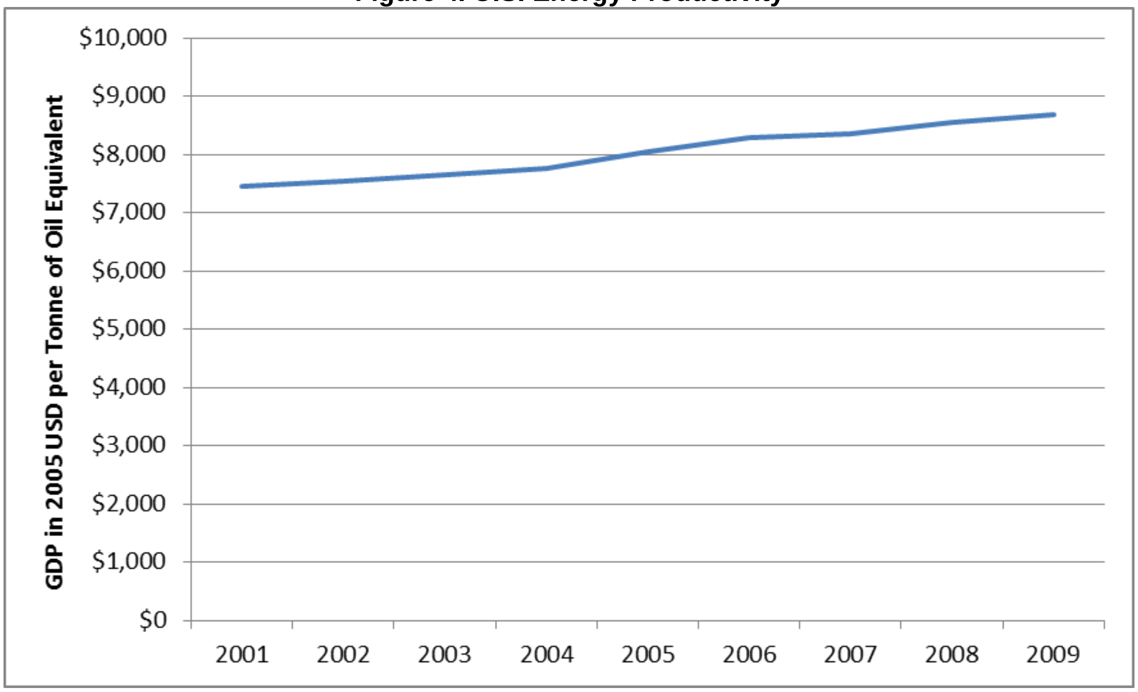
- **Economic output per unit of energy consumed.** Energy productivity in the United States improved modestly over the past decade, likely due to modest energy efficiency improvements in vehicles, buildings, and industry plus structural shifts in the economy away from energy-intensive industries.

- **Financial incentives to encourage investment.** The United States has some creative loan programs and tax credits for encouraging energy efficiency; however, as of the end of 2011, many important tax credits have expired and an important federal loan program has come under congressional scrutiny. Further, the focus of many of these programs is on renewable and emerging technologies, rather than proven, cost-effective energy efficiency improvements.

Energy Productivity

Energy productivity, the economic output per unit of energy consumed, continued to improve in the United States over the past decade. While we have not attempted to extricate the exact causes of the improvements in energy productivity, it is fair to assert that the United States is using energy more productively because of structural shifts in the economy as well as improvements in energy efficiency in a variety of sectors. Specifically growth in the services sector and a decline in manufacturing and industrial output have driven energy productivity improvements over the past decade. In addition, new standards for vehicles, appliances, and buildings have contributed to greater energy productivity. Nevertheless, the United States trails behind several other economically developed countries and would achieve even greater reductions in energy costs from a range of policies and programs to improve energy efficiency in all sectors of the economy. Figure 4 shows the change in U.S. energy productivity over the last decade, in 2005 dollars.

Figure 4. U.S. Energy Productivity



Sources: Real GDP data were accessed from the Bureau of Economic Analysis, and energy consumption data were accessed from the International Energy Agency. Because we use real GDP figures in 2005 dollars, the data we present here do not match data presented in the full report, which uses current GDP figures in 2009 dollars.

National Energy Savings Goal

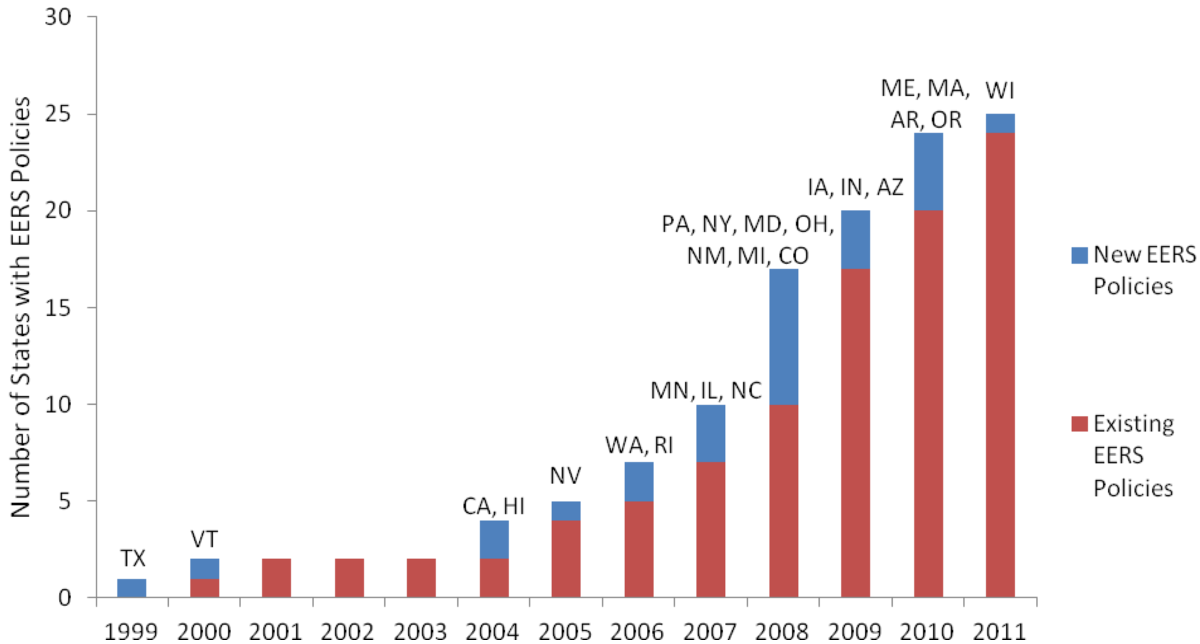
The United States does not have a national energy savings goal. Nearly every other country surveyed has a national energy savings goal in place (the exceptions are Australia and Brazil). In this vacuum, a patchwork of energy efficiency savings targets, also known as Energy Efficiency Resource Standards (EERS), have emerged at the state level.[7] An EERS requires a state's utilities to run programs that achieve a prescribed amount of energy savings over a multi-year period. Twenty-five states have put a policy in place. Together, the current suite of state EERS policies will achieve savings of around 5-6% of total U.S. electricity sales by 2020 (Sciortino et al. 2011a).

A number of states have adopted energy efficiency targets rivaling the most aggressive international energy efficiency targets. Massachusetts, Vermont, and Arizona, for instance, call for over 2% savings annually. A recent report shows that among states with some experience with an EERS policy, almost all are meeting or exceeding the savings targets (Sciortino et al. 2011a). A national EERS policy need not override current state policies, but it would set a minimum energy savings, ensuring that electricity customers (residential and commercial) in all states would have the option to participate in the same types of energy efficiency programs for homes and businesses. Further, a national EERS policy can produce greater energy savings at a lower cost than the current mix of state policies, by transforming markets for energy-efficient products and services faster and helping to identify the lowest-cost savings. The United States would also lessen the need for each state to reinvent the wheel, thus lowering operational and administrative costs. Figure 5 shows the adoption of state Energy Efficiency Resource Standards over time.

[7] For more information on state EERS policies in the U.S., see http://aceee.org/sector/state-policy/toolkit.

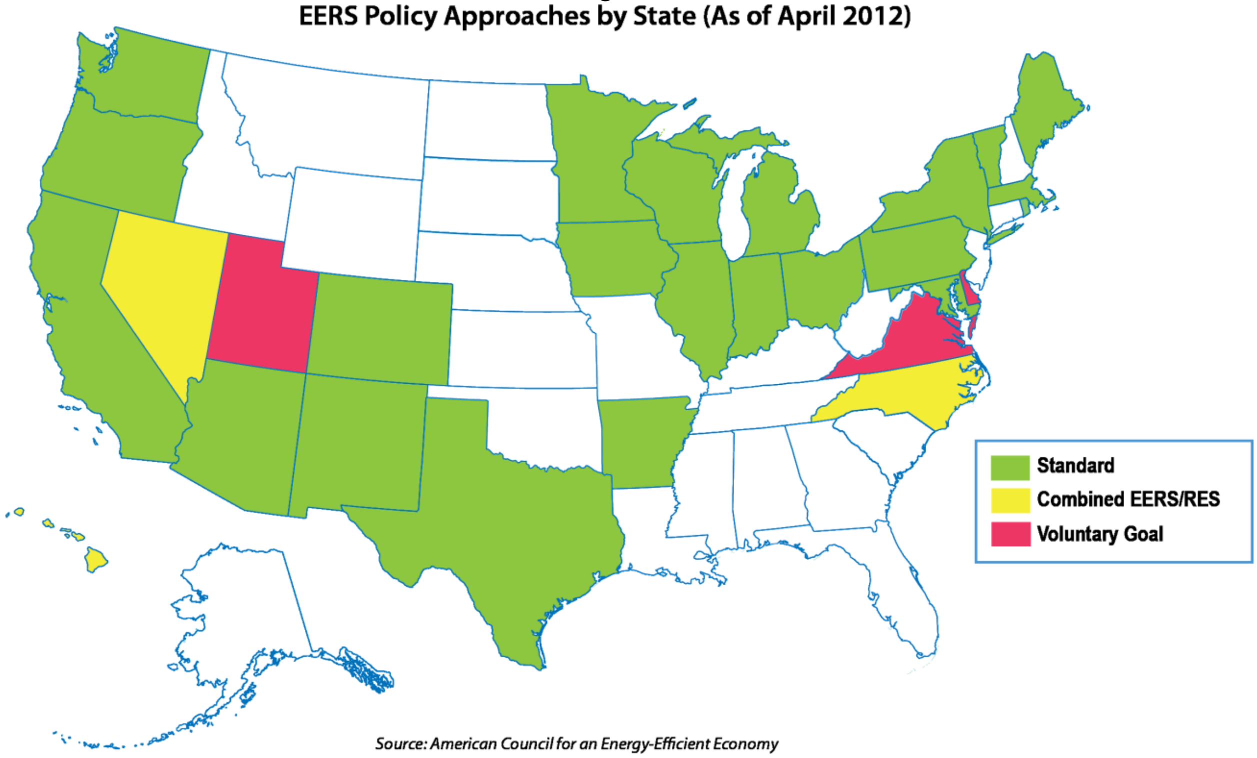
Recently, the President and Congress have begun to consider a "Clean Energy Standard," which requires utilities to generate a certain amount of electricity from "clean" energy sources. Some of the proposed policies have included energy efficiency as an option for compliance with the standard. Figure 5 shows the adoption of state EERSs over time. Figure 6 is a map of states with current EERSs in place.

Figure 5. States' Adoption of Energy Efficiency Resource Standards Policies by Year



Source: ACEEE compilation

Figure 6.
EERS Policy Approaches by State (As of April 2012)



Source: American Council for an Energy-Efficient Economy

Tax Credits and Loan Programs Supporting Energy Efficiency

The United States offers personal and corporate tax incentives supporting energy efficiency in buildings, vehicles, and businesses. The Residential Energy Efficiency Tax Credit is based on energy efficiency improvements in the building envelope of existing homes and for the purchase of high-efficiency heating, cooling, and water-heating equipment. These tax credits expired at the end of 2011 along with energy efficiency tax credits for new homes and appliances. While no action has been taken in 2012, Congress has discussed re-establishing the credits. Business tax incentives for energy improvements in commercial buildings and equipment remain in place (see 26 USCS § 179D). The United States offers tax credits for plug-in electric vehicles, as well as for idle-reduction equipment, fuel cell–powered motor vehicles, and the manufacture of advanced-technology vehicles (AFDC 2012).

The United States also supports energy efficiency through a number of different loan programs aimed at consumers, businesses, and state and local governments. Consumers can take advantage of energy efficiency mortgages, which are insured by the Federal Housing Authority or Veterans Affairs. These allow borrowers to stretch debt-to-income ratios in order to pursue energy efficiency, and secure lenders against loan default. The federal government also supports energy efficiency through grant and loan programs such as the Rural Energy Assistance Program, administered by the U.S. Department of Agriculture. The Rural Energy Assistance Program provides agricultural producers and rural small business owners with grants and loan guarantees for energy efficiency and renewable energy improvements.

The U.S. Department of Energy Loan Programs Office administers three separate loan programs for businesses. Two of these programs are the Loan Guarantee Programs (authorized in Sections 1703 and 1705 of the 2005 Energy Policy Act), which finance innovative technologies that are typically unable to secure conventional private financing due to high technology risks. The American Recovery and Reinvestment Act (ARRA) significantly bolstered funding for the Loan Guarantee Program, which has primarily financed technologies in the renewable energy sector; however, energy efficiency technologies are also eligible for funds. The third program, the Alternative Technology Vehicle Manufacture (ATVM) Loan Program, supports the development of advanced vehicle technologies and components.

Government and Utility Spending on Energy Efficiency

Much of the investment in energy efficiency in the United States comes from the utility sector, where programs are paid for by utility ratepayers. In addition, ARRA invested a tremendous amount of funding, about $30 billion between 2009 and 2012, in federal programs supporting energy efficiency; however, it seems unlikely that this funding will continue. Even at its highest level in decades, energy efficiency spending per capita is far less than in many other economically developed nations or regions, including Australia, Germany, Japan, and the European Union as a whole. Per capita spending in China, a country with a massive population, is more than twice the spending in the United States.

Public sector investments in energy efficiency in the United States are typically aimed at providing incentives for businesses and consumers to purchase energy efficiency technologies or services that they might otherwise not purchase due to high upfront cost or other market barriers. The U.S. public sector also invests in the R&D of new energy efficiency technologies, as well as in the energy efficiency of institutional buildings. Total government spending on energy efficiency is diffuse and difficult to accurately estimate, as there are hundreds of state and local governments investing in energy efficiency, not to mention an array of federal agencies, such as the Department of Defense, that invest in energy efficiency technologies for their own operations. It is clear, however, that the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy (EERE) makes the most significant investments in energy efficiency at the federal level, while ratepayer-funded programs administered by utilities and third-parties comprise the largest segment of spending at the state and local level.

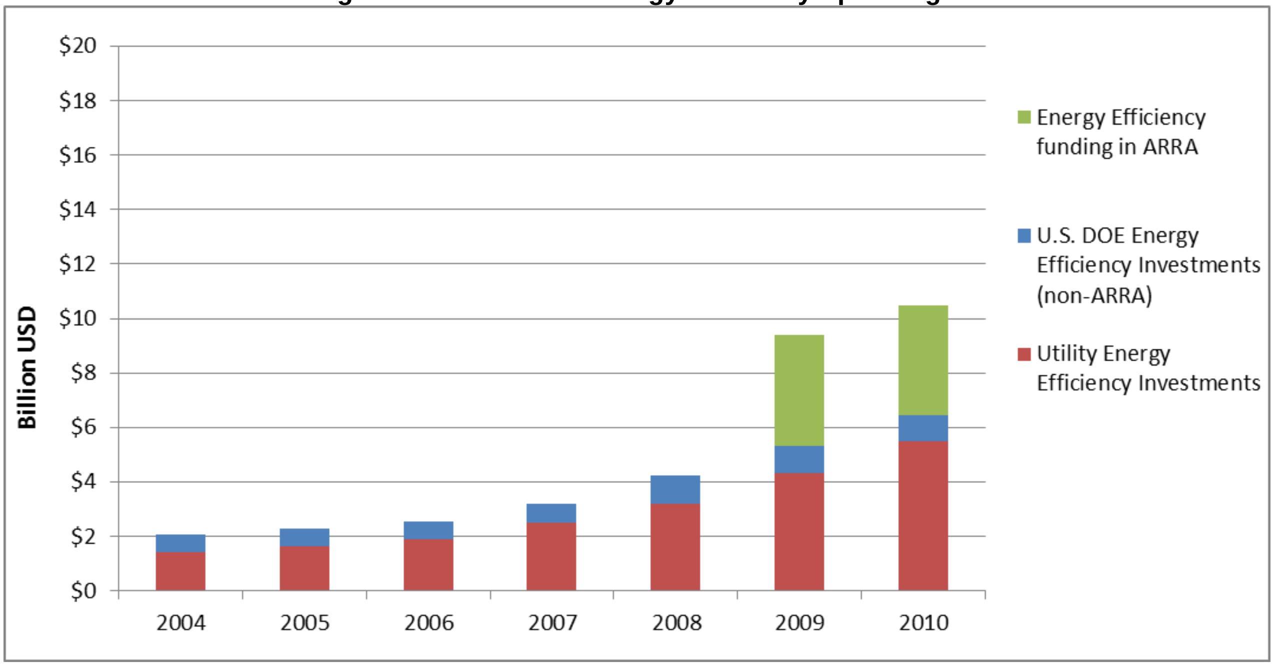
EERE administers a range of programs focusing on building technologies, manufacturing and industrial technologies and processes, vehicle technologies, energy management in federal buildings, and intergovernmental and weatherization programs. Aside from its set of intergovernmental and weatherization programs, most of EERE's work is devoted to improving technologies and processes, as well as promoting energy efficiency standards and codes. The building technologies program, for instance, focuses on improving residential and commercial building components, energy modeling tools, building energy codes, and appliance standards. The Weatherization and Intergovernmental Program at EERE funds energy efficiency programs at state and local governments through the State Energy Program, Weatherization Assistance Program, and Energy Efficiency and Conservation Block Grant Program. ARRA invested heavily in energy efficiency through EERE's programs.

The other major source of funding for energy efficiency comes from utility ratepayers, who fund energy efficiency programs that are administered by utilities and third parties such as Efficiency Vermont, the Energy Trust of Oregon, and Wisconsin's Focus on Energy. These programs focus on incentives for energy efficiency improvements in residential, commercial, and industrial buildings and facilities.

Energy efficiency investments by utilities are driven by a combination of regulatory and economic factors. As discussed above, numerous states have an energy efficiency resource standard (EERS) in place, which require utilities to run programs that will save a certain percentage of electricity and/or natural gas each year. The outlook for utility-sector spending on energy efficiency is promising, as more states ramp up EERS and look for alternatives to meeting electricity demand through new generation. An analysis of state-level energy efficiency policies estimates that ratepayer funding for electric and natural gas programs could rise to $10.8 billion by 2025 (Goldman et al. 2012).

Figure 7 lists annual energy efficiency spending by utilities and the U.S. Department of Energy (DOE). While rising DOE funding in 2009 is prominent, an equally, if not more, important trend is the steadily increasing investment by the utility sector. This sector has historically been the greatest source of energy efficiency spending, and that spending has more than doubled between 2006 and 2009.

Figure 7. Annual U.S. Energy Efficiency Spending



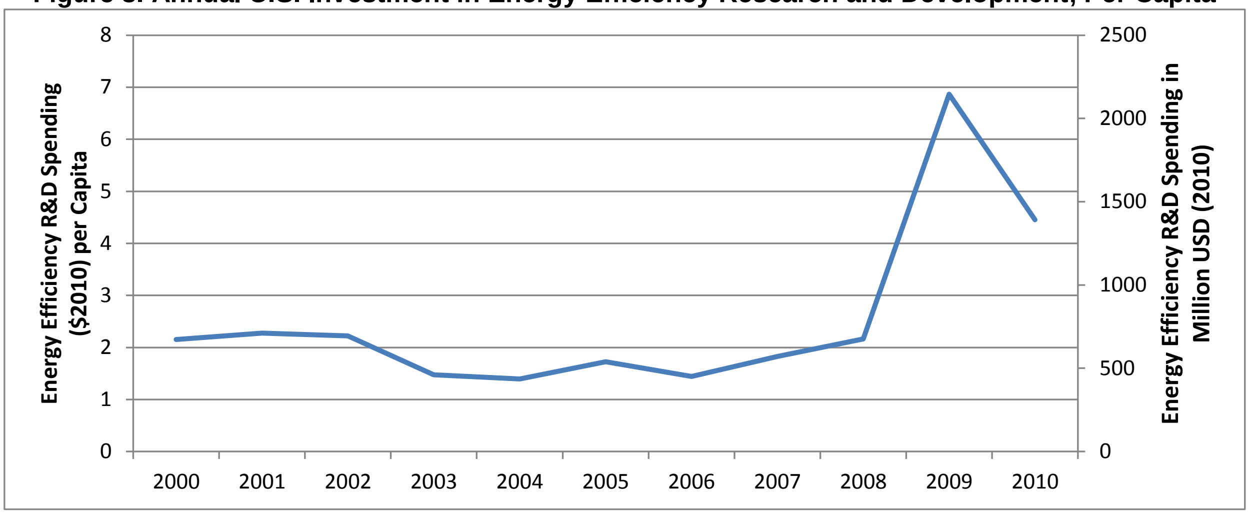
Note: DOE spending is funding for energy efficiency-related programs run by the Office of Energy Efficiency and Renewable Energy. Utility investments are actual spending on electric and gas demand side management programs in 2004, 2006, 2007, and 2008, while figures for 2005 (CEE 2006), 2009, and 2010 are budgets (CEE 2011; Sciortino et al. 2011b).

National Spending on Energy Efficiency Research and Development

For many years, the U.S. Department of Energy has carried out research and development (R&D) for energy efficiency technologies and practices.[8] Over the past two decades, R&D budgets have typically been between $300 and $600 million, and have funded R&D in building, industrial, and vehicle technologies. In particular, DOE focused much of its efforts on lighting technologies, heating and cooling systems, motors, and efficient practices and standards. In 2001, a National Research Council study quantified the economic benefits of just six DOE-funded technologies at $30 billion, based on R&D investment of around $400 million (National Research Council 2001).

Energy efficiency R&D budgets remained fairly flat until the passage of the American Recovery and Reinvestment Act (ARRA), which invested heavily in R&D efforts in energy. ARRA helped to fund a new federal initiative, the Advanced Research Projects Agency–Energy (ARPA-E), an agency recommended in a National Academy of Sciences report. Modeled after the successful Defense Advanced Research Projects Agency (DARPA), ARPA-E invests in “high-risk/high-reward” technologies, a number of which improve device and system efficiency. The agency has a particularly strong focus on batteries, building technologies, and electricity transmission and delivery. Figure 8 plots the historical investment in energy efficiency R&D per capita.

Figure 8. Annual U.S. Investment in Energy Efficiency Research and Development, Per Capita



Note: In the graphic above, investment appears to increase significantly between 2008 and 2009, which likely reflects federal stimulus funding (such as the American Recovery and Reinvestment Act). Please note that stimulus funding was actually *spent* over a longer period, from 2009 through 2011.
Source: IEA 2011a.

A report by the American Energy Innovation Council contrasts this spending on energy efficiency R&D to other sectors, noting that the U.S. government spends around $30 billion annually in medical research and over $80 billion for defense R&D (AEIC 2011).

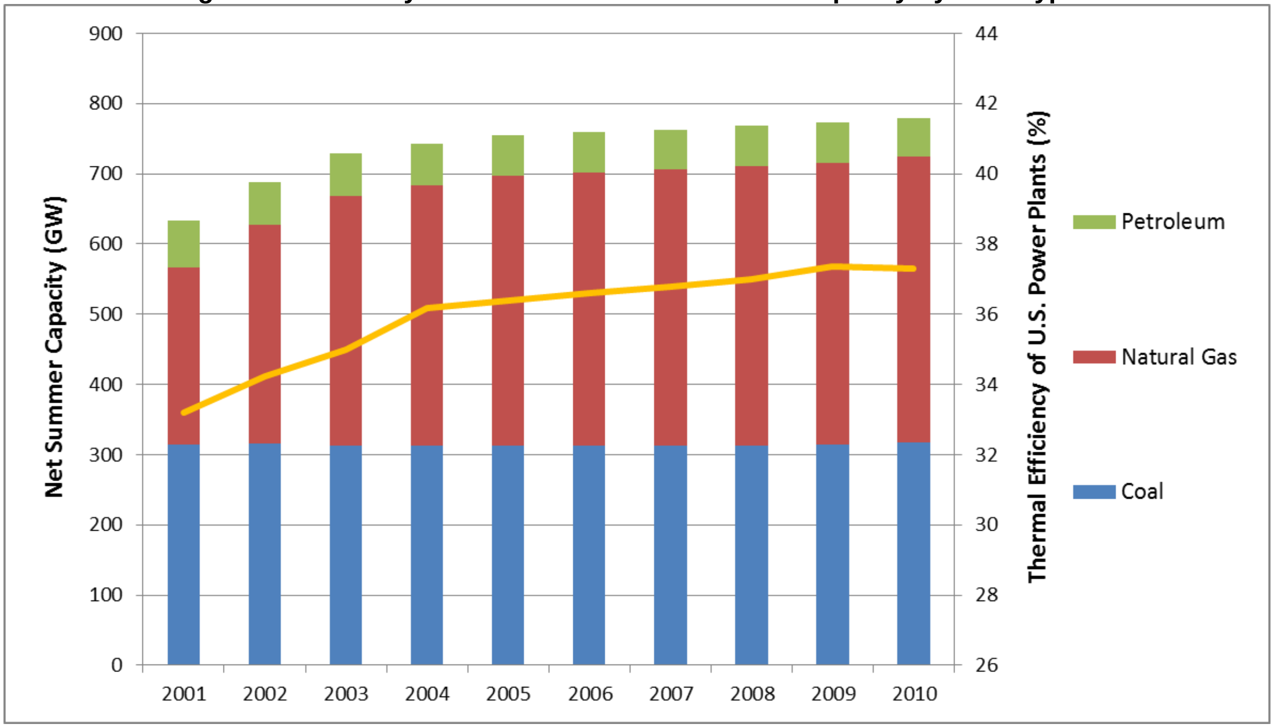
Efficiency of Thermal Power Plants

To measure the efficiency of thermal power plant fleets, two variables are used. First, thermal efficiency of fossil-fueled power plants in the form of a percentage of energy from fossil fuel that is converted into useable electricity. On average in the United States, natural gas plants operate at around 41% thermal efficiency, while coal plants operate at around 33% efficiency. Over the past ten years, U.S. power generation has increasingly shifted from coal to natural gas. Low natural gas prices and uncertainty regarding environmental controls on coal plants has driven a major increase in the construction and use

[8] States also conduct R&D through universities, but we focus on federal R&D for the purposes of this discussion.

of natural gas-fired power plants, and this increase in natural gas plants has led to improved overall efficiency of thermal power plants. Figure 9 shows the operational efficiency of U.S. thermal power plants over the last decade by fuel type.

Figure 9. Efficiency of Thermal Power Plants and Capacity by Fuel Type



Source: EIA 2011b

While the United States has seen an increase in the thermal efficiency of its fossil fueled power plant fleet, a very large portion of electric generation continues to come from highly inefficient, outdated coal-fired power plants. Even with these new developments, the U.S. average falls short of several other nations including Brazil, Italy, Japan, and the United Kingdom.

The second variable we used to calculate overall efficiency of the fossil fuel–powered power plant fleet is distribution losses. In the United States, electricity is “lost” in the transmission and distribution (T&D) system because of the resistance of the wires and equipment that the electricity passes through. Over the past two decades, T&D losses have averaged between 6-7% of total net electricity generation, or 261,421 MWh in 2010. At 2010 average retail electricity prices, T&D losses cost the U.S. economy $25.7 billion.

Buildings

The United States tied for 4th overall in the buildings section. This is due largely to a very high score for appliance and equipment standards, an area in which the United States is a global leader. The United States was given full credit for residential and commercial building codes in spite of having no national mandate, because a large number of states have standards in place.

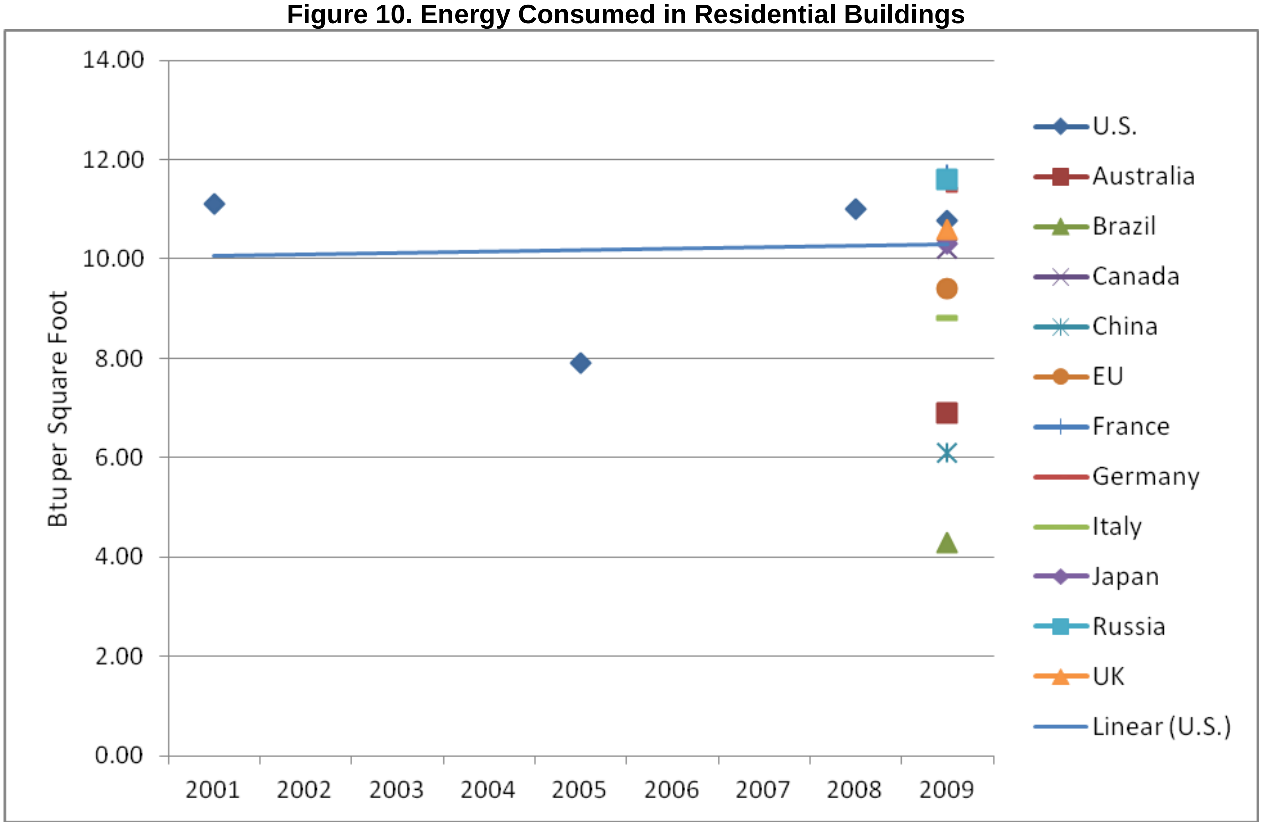
The area in which the United States could improve the most is in the energy consumed per square foot of floor area for both residential and commercial buildings. In spite of dramatic improvements in model building codes implemented by states, the energy consumption of buildings throughout the country has improved little, if at all, over the last decade. Further, the United States could implement low-cost policies to improve information transparency to consumers by implementing a national building labeling and energy disclosure program as well as improving labeling and energy disclosure for appliances and equipment.

Energy Use in Buildings

The United States received low scores for the metrics measuring residential and commercial energy use. These metrics were based on energy consumed by the sector per square foot of floor area and adjusted for weather by taking the average of the sum of annual heating and cooling degree days in the three most populated cities in the country: Chicago, Los Angeles, and New York.

In the residential sector, the United States scored just 1 out of 5 possible points. Among economically developed countries, only France, Germany, and Russia have higher intensities than the United States (while slightly higher, the U.K. calculation is virtually the same). Figure 10 illustrates the energy intensity of the U.S. residential building sector over the last ten years. Data from the U.S. Energy Information Administration Residential Energy Consumption Survey are available only periodically, and having additional data on the U.S. residential building stock and energy consumption in this sector would make it easier to determine whether and how U.S. policies, such as building codes, are impacting energy efficiency. While the actual data points available show quite a bit of variation over time, the best-fit trend line is virtually flat from 2001 to 2009.

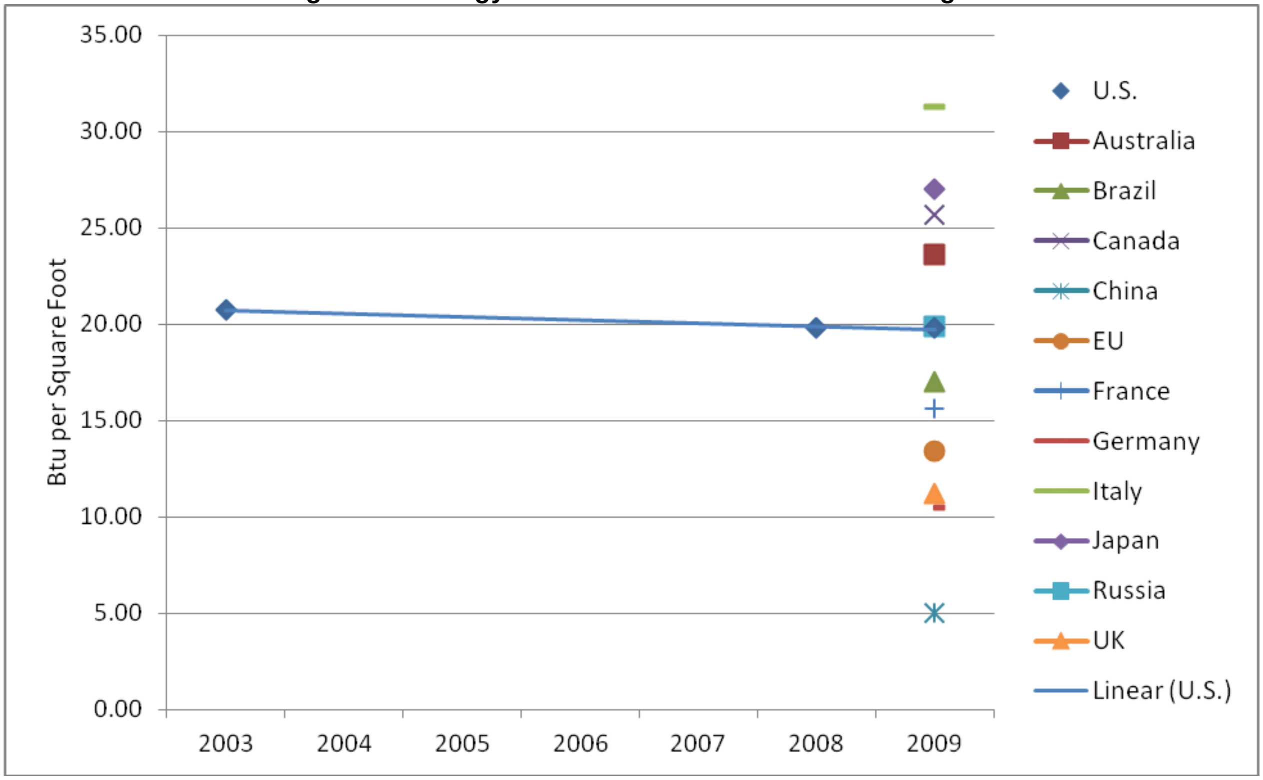
Figure 10. Energy Consumed in Residential Buildings



Sources: IEA 2011 (energy use in buildings); DegreeDay 2012 (heating and cooling adjustment factors); EIA 2009 (floor space).

The United States scored 2 out of 5 possible points in the metric measuring energy use in commercial buildings. Figure 11 shows the energy consumed per square foot of commercial building space in the United States. While there has been an increase in new building stock, the rate of energy consumption per square foot for all buildings seems to have improved only slightly.

Figure 11. Energy Consumed in Commercial Buildings



Sources: IEA 2011 (energy use in buildings); DegreeDay 2012 (heating and cooling adjustment factors); EIA 2003 (floor space).

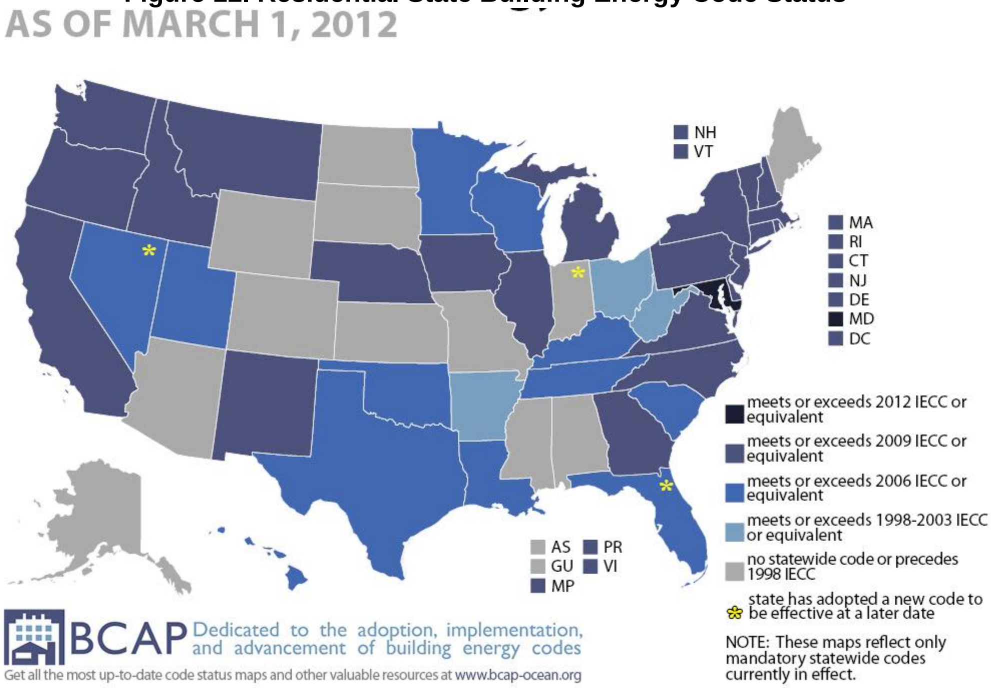
Building Codes

In the United States, national model building codes are set according to a national standard developed by leading non-governmental organizations, which are adopted by states and localities. The majority of states have building codes in place, many since 1975. Federal law requires states to adopt the national model commercial code and to consider the national model residential code (EIA 1992). When the national model codes are updated, the Department of Energy reviews these updates and certifies them for state adoption. This *International Scorecard's* scoring for the metrics for residential and commercial building codes is based on the presence of mandatory national standards across five categories for the residential sector and four categories for the commercial sector. While in most cases we have not awarded credit where countries have regional or state policies, in the case of the United States we have awarded credit for building codes because a large majority of building stock is covered by codes at the state and local levels.

The International Energy Conservation Code (IECC) is a building code created by the International Code Council in 2000 and is a model by which countries, states, and municipal governments can design their requirements for energy efficiency in residential buildings. This standard is generally revised every three years, with the current standard dated 2012. As seen in Figure 12, one state has adopted the 2012 IECC, 22 states have adopted the 2009 IECC or equivalent, 12 have adopted 2006 IECC or equivalent, and four meet 1998-2003 IECC or equivalent. Only ten states do not have any code in place, a number that has remained fairly constant over the last ten years.[9] In these states lacking statewide codes, the largest municipalities sometimes do have codes.

[9] Sciortino et al. (2012) discusses in greater detail these states and the barriers to energy efficiency policies, including building codes.

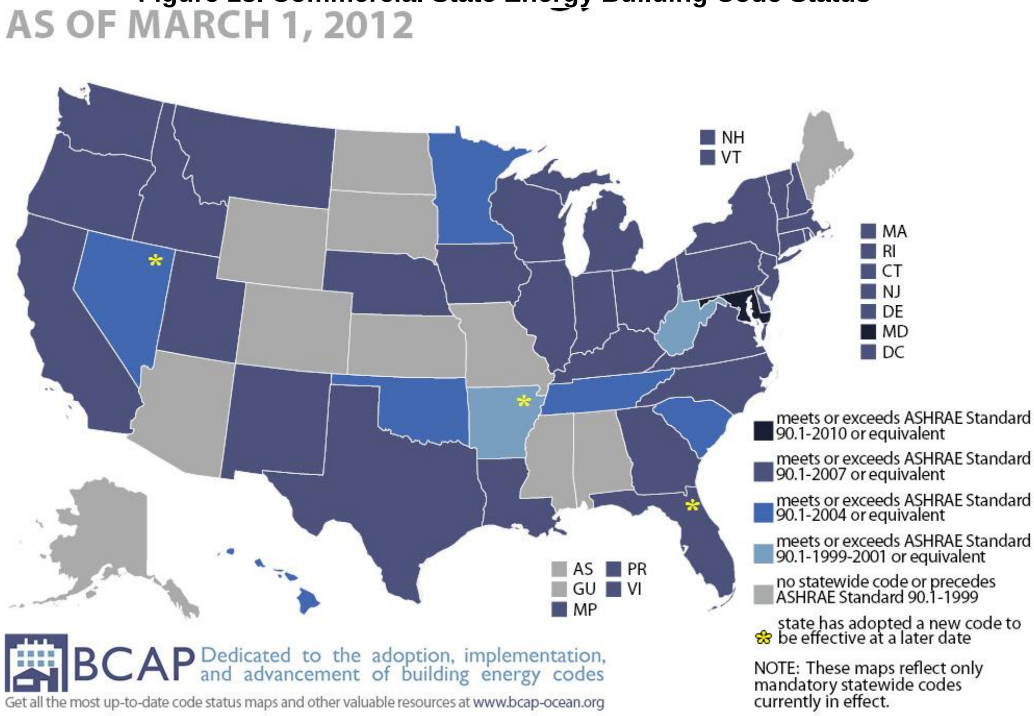
Figure 12. Residential State Building Energy Code Status



Source: BCAP 2012.

Building codes for energy efficiency in the commercial sector follow the same trends as in the residential sector. The American Society of Heating, Refrigerating and Air Conditioning Engineers (ASHRAE) has published a series of standards and guidelines for heating, ventilation, and air conditioning (HVAC) systems that are adopted by states or municipalities. As seen in Figure 13, one state has adopted 2010 standards, 28 states have adopted ASHRAE 90.1-2007 or equivalent, nine have adopted 90.1-2004, and two have ASHRAE 90.1-1999-2001 or equivalent in place. The number of states that have not adopted commercial building energy codes has remained relatively constant over the last ten years. In 2005, the ten states with no commercial energy codes in place were the same ten states that have none in place today.

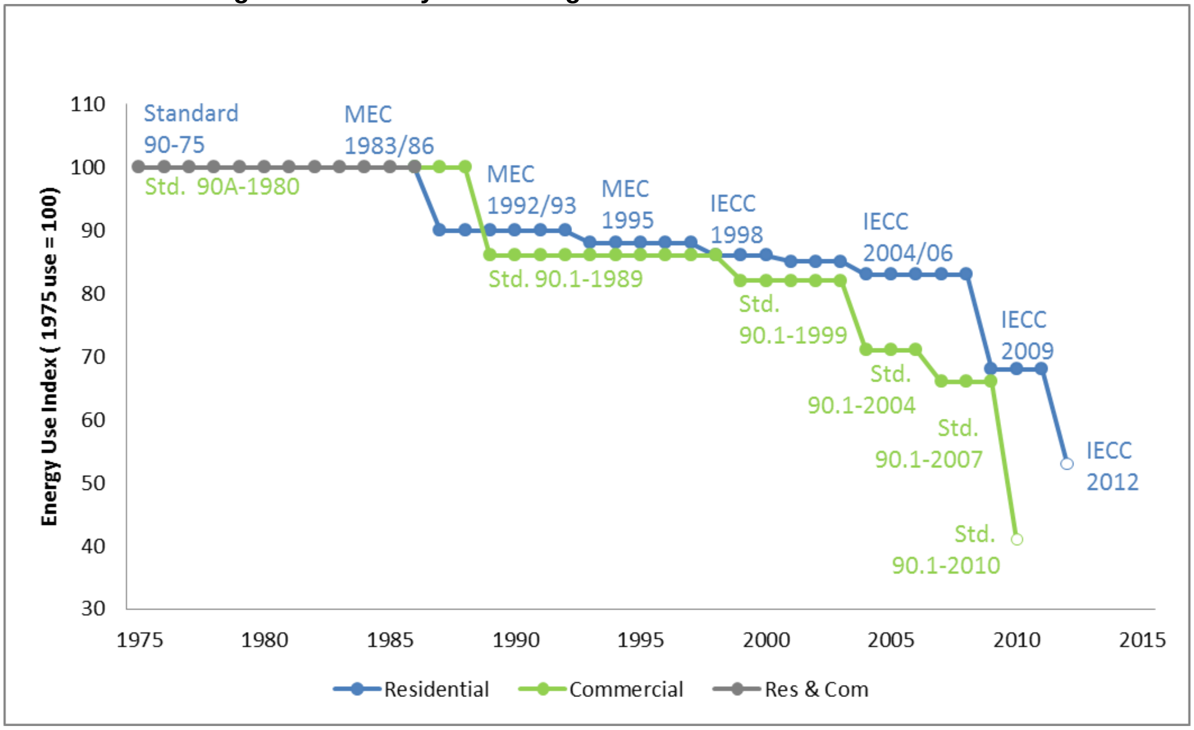
Figure 13. Commercial State Energy Building Code Status



Source: BCAP 2012.

Overall, the majority of states have had residential and commercial building codes for energy efficiency in place since the 1970s that have included all the criteria; however, the stringency of these codes has increased over time. The *International Scorecard's* metric does not reflect stringency. There was a dramatic increase in efficiency in the 2009 IECC standards and the 2010 ASHRAE standards. Wide adoption of the latest codes would significantly improve the United States' residential and commercial energy intensity score. Figure 14 shows the increased energy savings potential in the new building code standards.

Figure 14. History of Building Code Revisions in the United States



Source: ACEEE compilation

Building Energy Rating and Labeling

Currently, no federal law mandates building rating or building labeling; however, the federal government has taken steps recently to encourage the practice. ENERGY STAR labels are available for new homes and commercial buildings, and the Department of Energy and the Environmental Protection Agency are formulating a methodology for labeling energy ratings under a new voluntary national standard for homes and commercial buildings.

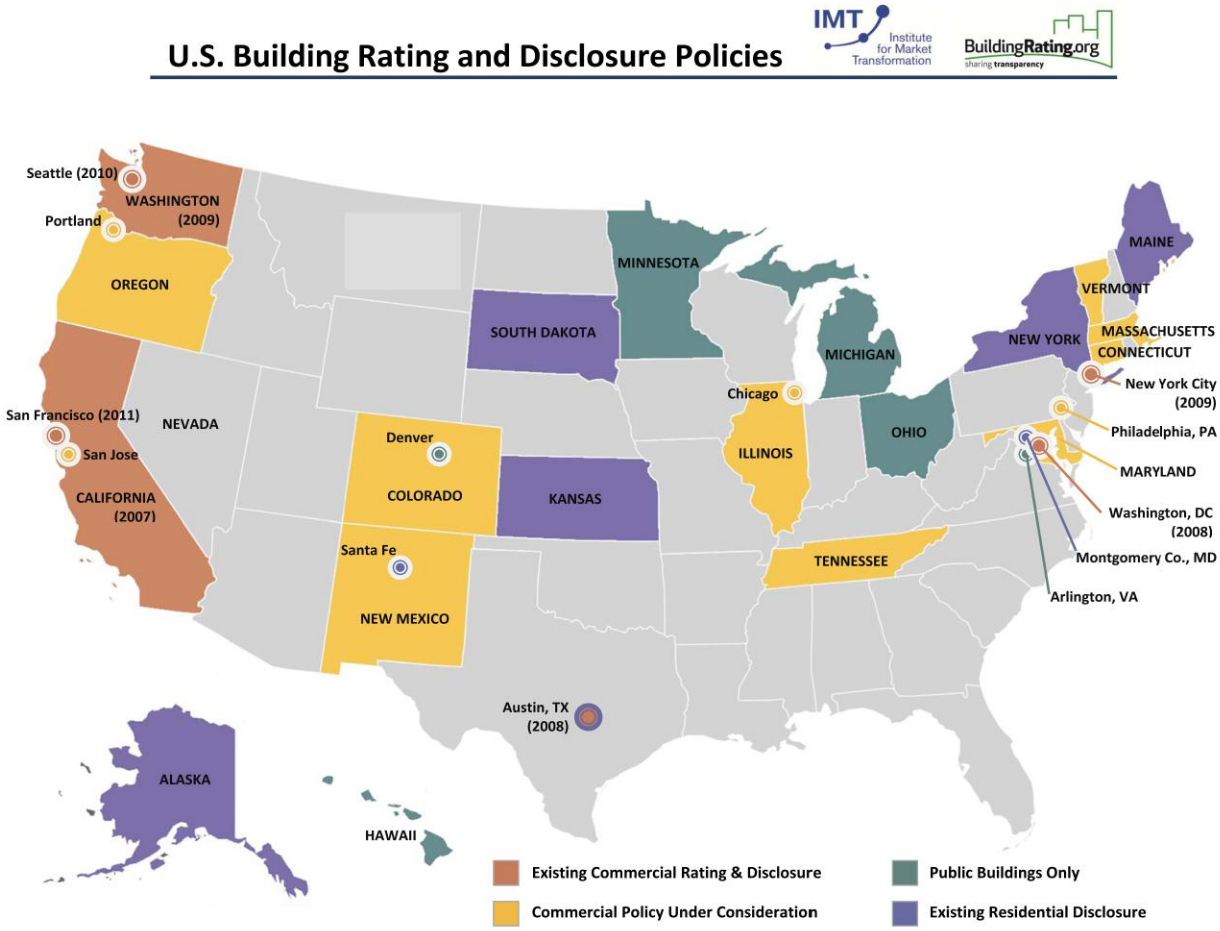
The United States currently has a patchwork of well-established voluntary programs for building rating and building labeling. The major rating programs in use in 2012 include:

- Home Energy Rating System (HERS) index, developed by the Residential Energy Services Network (RESNET)
- The Leadership in Energy and Environmental Design (LEED) Rating Systems, developed by the U.S. Green Building Council
- The Green Globes system, developed by the Green Building Initiative
- ENERGY STAR labels for commercial buildings and new homes

The ENERGY STAR Portfolio Manager rating methodology is a well-developed and widely used voluntary approach for existing commercial buildings. More than 25% of U.S. commercial floor space has been benchmarked using the tool, and the tool forms the basis for building energy rating in the six jurisdictions with mandatory energy rating policies for the commercial arena (ENERGY STAR 2012). Of the 200,000 buildings benchmarked, around 6% have earned the ENERGY STAR Buildings label.

Four cities (New York, Washington, D.C., Seattle, and Austin) and two states (Washington and California) require energy ratings for commercial buildings. The policies differ somewhat—for example, in New York, all commercial buildings must receive an energy rating, whereas in California, a building must have a rating at the time it is sold, leased, or financed. Figure 15 gives an overview of the building rating and disclosure policies in the United States.

Figure 15.



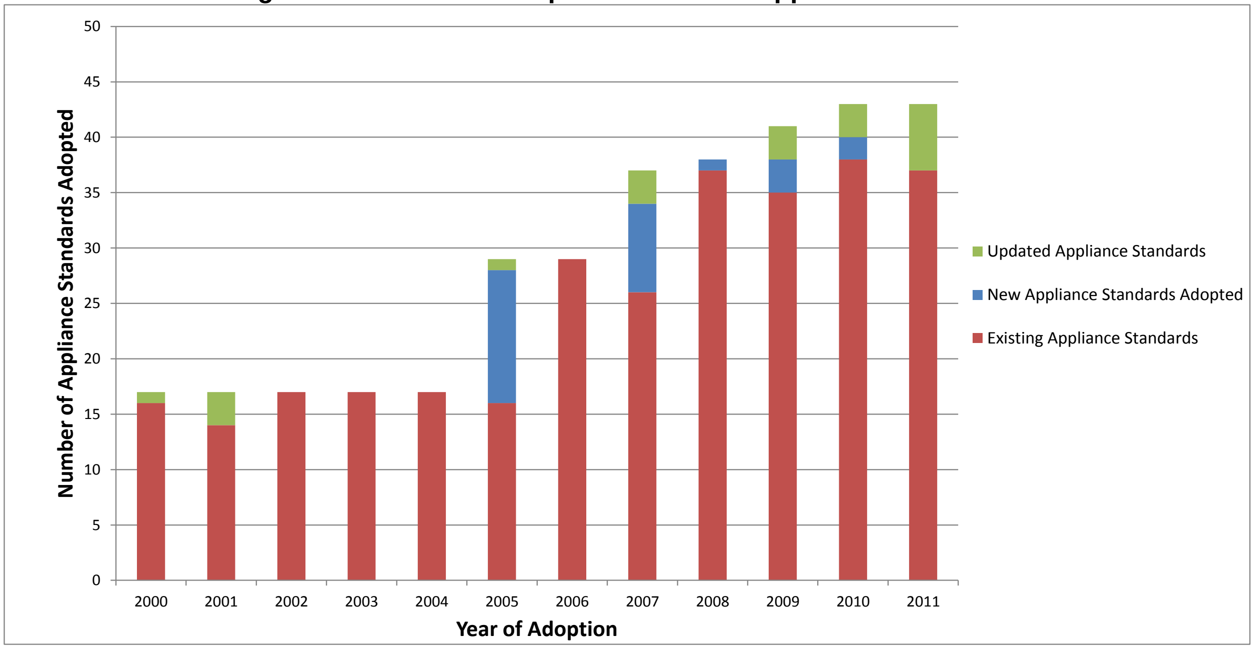
Source: Institute for Market Transformation, www.imt.org

Appliance Standards

Appliance standards have served as one of the nation's most effective policies for improving energy efficiency. The first standards were enacted at the state level in California in 1974. Over the next decade, states continued to lead on appliance standard adoption. To address concerns over differing state standards, manufacturers negotiated with energy efficiency advocates and states, reaching a consensus on national efficiency standards covering many major household appliances that would preempt the individual state standards. The resulting agreement formed the basis for a new federal law, the National Appliance Energy Conservation Act of 1987 (NAECA). States continued developing new standards for products not covered by NAECA, and in 1992 Congress enacted another round of standards. The 1992 Energy Policy Act (EPAct 1992) added standards for many of the most common types of commercial light bulbs, electric motors, commercial heating and cooling equipment, and plumbing fittings. All of these laws were based on consensus agreements between product manufacturers and efficiency advocates (Nadel and Pye 1996).

Since 2001, 13 states and the District of Columbia have adopted new state-level standards. As in the past, states' initiatives have continued to elicit a federal response. In 2005, the Energy Policy Act (EPAct 2005) set new standards for 16 products and directed the Department of Energy to set standards via rulemaking for another five. In 2007, Congress passed the Energy Independence and Security Act (EISA 2007), enacting new or updated standards for 13 products, several of which had been first regulated at the state level. EISA created the first-ever U.S. standards for general service light bulbs, which began to phase out conventional incandescent light bulbs in 2012. Figure 16 shows the number of appliance standards adopted in the United States over the last decade.

Figure 16. Historical Adoption of Federal Appliance Standards



Source: Appliance Standards Awareness Project, http://www.appliance-standards.org/

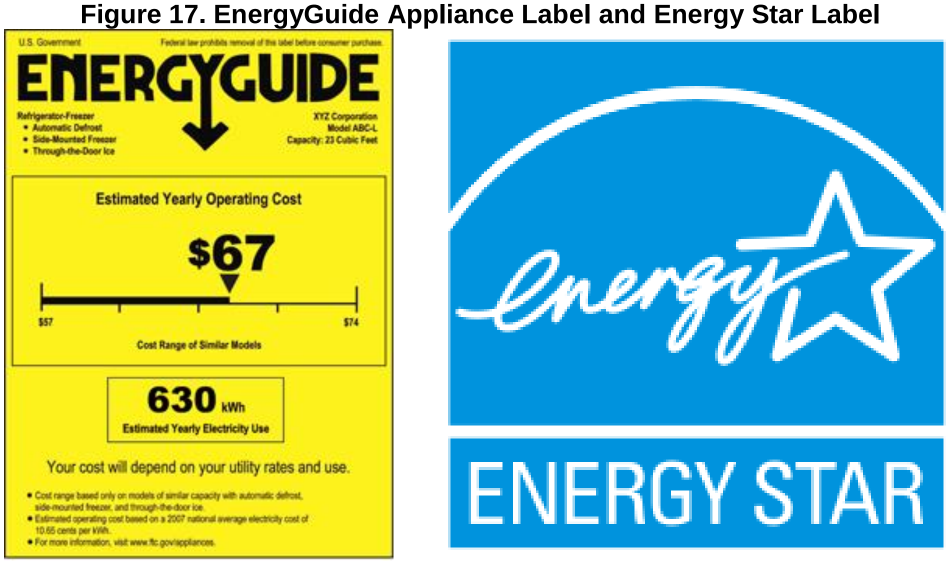
In general, these laws set initial standards in statute and direct DOE to conduct scheduled reviews to update standards to determine if improved standards make sense. Despite various updates, by 2004 DOE had missed legal deadlines for the review of 22 different standards. Part of this lapse could be traced to a congressional moratorium on standards and the resulting focus on process redevelopment at DOE in the mid-1990s. In response to concerns about whether the DOE had sufficient resources to meet all the statutory deadlines, the agency instituted a prioritization approach whereby would first tackle those overdue rulemakings with the biggest savings. However, DOE's pace of work on new rulemakings slowed to a crawl during President George W. Bush's first term. Many of DOE's efforts early in this period were focused on rolling back the air conditioner standards set at the end of the Clinton Administration—a rollback that was ultimately declared illegal by the federal courts (NRDC 2004).

Legislation enacted in August 2005 required DOE to report on its missed deadlines, provide explanation, and develop a plan for catching up (EIA 2005, Section 141). The law also requires DOE to provide status reports to Congress every six months. DOE submitted its first report to Congress in January 2006, which included its plan for catching up on all missed deadlines (DOE 2006). In November 2006, DOE signed a consent decree in the suit over the missed deadlines (State of New York 2006). In the wake of the congressional report and consent decree, the pace of work at DOE increased noticeably and remains elevated to this day. Congress increased the program budget from $10.1 million in FY2005 to $35 million by FY2010. However, in 2011 DOE began again to fall behind on deadlines for new standards, missing a final rule deadline for battery charger standards in July. DOE missed several more legal deadlines at the end of the year due to protracted administrative reviews at the Office of Management and Budget. However, DOE published proposed rules for three products in March and final new standards in May 2012 for clothes washers and dishwashers. Altogether, another eight new standards are due by the end of 2012, covering a range of products including motors, distribution transformers, walk-in coolers, and microwave oven standby power.

Appliance Labels

The Federal Trade Commission (FTC) has administered the EnergyGuide labeling program since 1980 to assist consumers in making informed decisions when purchasing certain home appliances and other energy-using equipment. This comparison label, mandatory for numerous appliances, gives information on the operating cost and energy use of the appliance. In 2005, the Energy Policy Act called on the FTC to explore more effective designs for the EnergyGuide label. In 2007, the FTC introduced a redesigned label that emphasizes the annual operating cost compared to that of similar products, using a continuous-scale graphic design. In 2010, the FTC proposed extending labeling requirements to some consumer electronics, starting with televisions.

Figure 17. EnergyGuide Appliance Label and Energy Star Label



The ENERGY STAR labeling program is a worldwide model for voluntary appliance and equipment labeling. Jointly administered by the Environmental Protection Agency and the Department of Energy, ENERGY STAR labels have identified and endorsed energy-efficient products since 1992. Through its partnerships with more than 20,000 private and public sector organizations, ENERGY STAR delivers technical information and tools for organizations and consumers seeking energy-efficient solutions and best management practices. ENERGY STAR labels cover 60 product categories and thousands of models for the home and office (ENERGY STAR 2012).

Industry

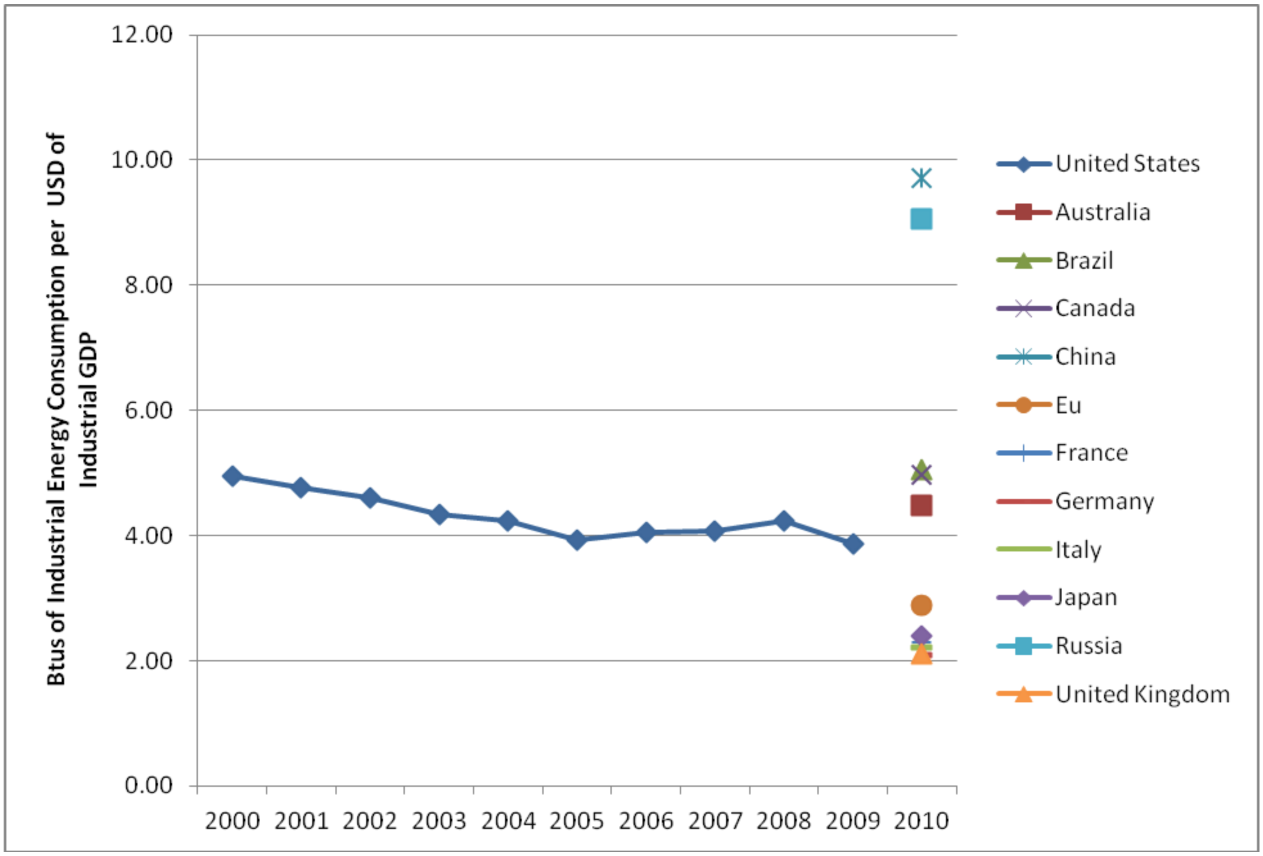
The United States ranks 6th overall in the industrial section, scoring 14 out of 28 possible points. There is significant room for improvement in both the policy and performance metrics in this section. While the United States does target energy efficiency improvements through the use of voluntary partnerships between the federal government and a diverse group of industrial participants, it has not employed mandatory energy audits, and there is no national requirement for on-site experts at manufacturing plants. In the performance metrics, the United States scored somewhat higher. For example, the United States has the 3rd highest percentage of industrial electricity consumption generated from combined heat and power.

Energy Intensity of Industrial Sector

The metric evaluating the energy intensity of the industrial sector measures total energy consumption by the industrial sector in relation to its share of the U.S. gross domestic product. The historical trend is promising, as it shows a decline in energy intensity of the industrial sector over the last decade from 5.68

Btu per dollar in 2000 to 3.65 Btu per dollar in 2009.[10] Compared to other nations, the United States scores relatively high in this metric. Australia, Brazil, and Canada all have higher energy intensities than the United States, and China and Russia have energy intensities more than twice that of the United States. As we previously noted, some types of industrial processes are more energy intensive than others, and these differences are not accounted for in this metric. However, the moderately high score of the United States compared to other nations and a declining energy intensity over time suggest that improvements are being made in the energy efficiency of the U.S. industrial sector as a whole. Figure 18 shows the historical energy consumption per dollar of GDP attributable to the U.S. industrial sector.

Figure 18. Historical Energy Consumed in the United States by the Industrial Sector per Dollar Industrial Gross Domestic Product*



*Adjusted to 2005 dollars.

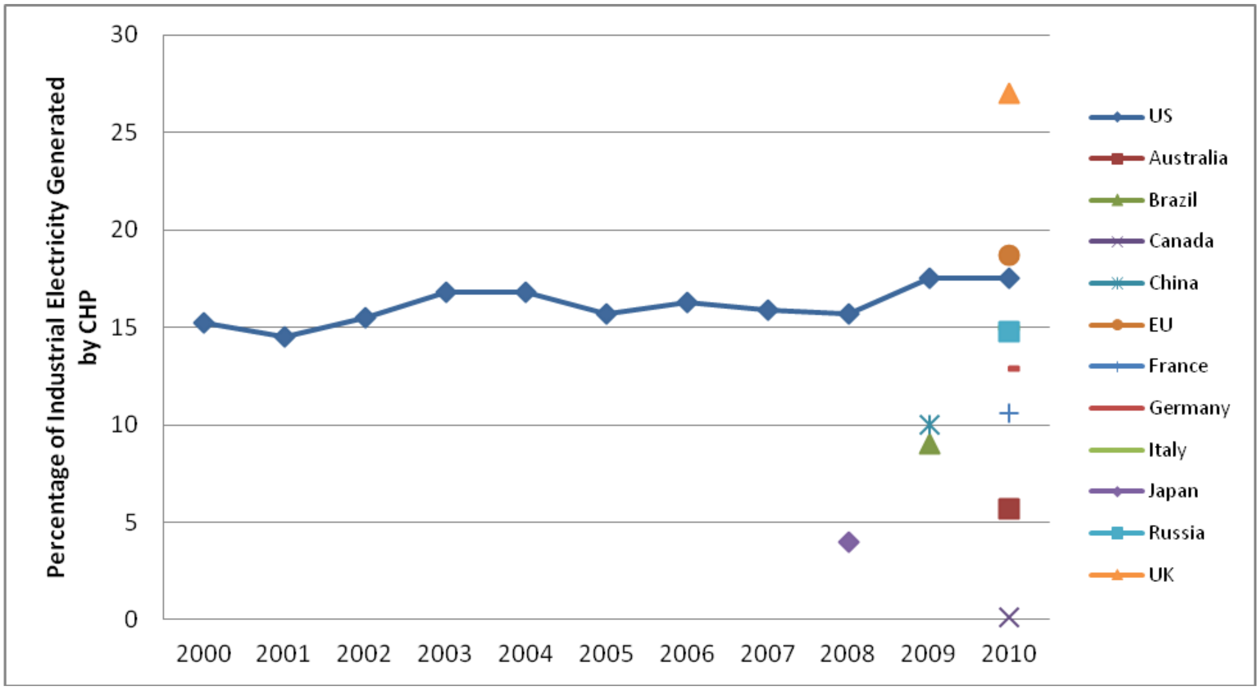
Sources: IEA 2011 (total final energy consumption); World Bank 2011 (percentage of industrial GDP); EIA 2011a (total GDP).

Combined Heat and Power

This metric looked at the percentage of industrial electricity used that was generated by combined heat and power. Combined heat and power (CHP), also known as waste heat recovery or cogeneration, is a method of simultaneously generating thermal energy (heat) and electricity in a single, integrated system that substantially improves efficiency. CHP is a significant resource in the United States, and the total capacity of CHP has been rising (ICF 2009). Figure 19 demonstrates that the United States is far behind the U.K., but leads most other countries we examined. In addition, the percentage of electricity generated by CHP in industry over the last 10 years has increased only slightly.

[10] The difference between this result and the result scored in the earlier, international portion of the report is due to a variation in estimates of the share of total GDP represented by the industrial sector. The CIA World Book (CIA 2012) was used for scoring for all countries. In this historical analysis, we used World Bank data (World Bank 2011) because it is available for past years. The difference between these sources would not change the U.S. score for this metric.

Figure 19. Percentage of Electricity Consumed by Industrial Sector that Is Generated by Combined Heat and Power



Source: WEC 2012

A recent ACEEE report found that one of the biggest hurdles facing new CHP projects is difficult negotiations between project owners and electric utilities. Utilities are, understandably, hesitant to support projects that will reduce electric demand, and therefore revenues, or otherwise threaten their business models (Chittum and Kaufman 2011).

There are several ways utilities can work to frustrate, stall, or even kill CHP projects. These include:

- Creating onerous and opaque interconnection requirements, and failing to adhere to the spirit of laws governing utility behaviors by causing unnecessary project delays or roadblocks;
- Offering special discounted electric rates to facilities considering CHP and thus artificially lengthening the project's payback period; and
- Requiring that any CHP projects be owned by the utility and thus reducing the economic benefit to the CHP owner.

CHP faces constraints from the power industry that limit when, where, and how CHP developers can sell their excess power to the grid. Many CHP developers cannot sell back their excess power at retail price; rather, developers are constrained by franchise agreements, private wires laws, and high fees for sending excess power over privately owned distribution lines.

In many states, standby power chargers can be exorbitant for CHP systems. Standby rates are the rates an electric utility charges a CHP system's host firm for additional or backup power and backup system capacity a CHP system buys to supplement a system, when a system unexpectedly goes down, and when a system is taken offline for scheduled maintenance.

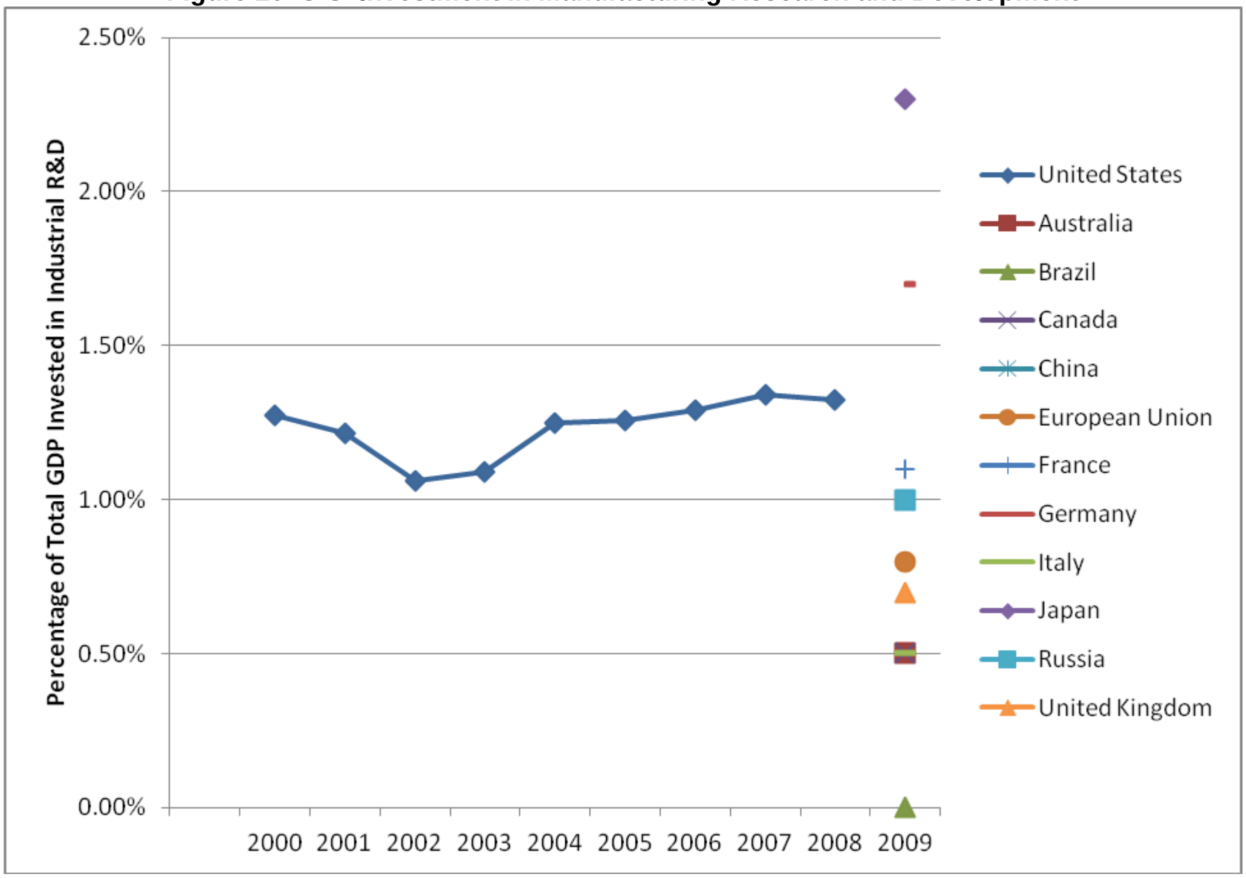
In addition, new CHP systems face permit and regulation processes in which the costs of compliance are extremely high or the permitting process is unusually demanding. Regulations for CHP systems can include air emissions regulations, fire department permits (for natural gas lines), buildings permits (for construction), and noise regulations. Certain regulations, such as building codes, do not explicitly speak to CHP systems, so a developer working for the first time in a certain municipality or state may not know what to expect. Interestingly, satisfying air emissions regulations is not a significant barrier since many

CHP developers will "steer clear" of particular technologies or project designs that they know will not satisfy local air regulations.

Investment in Manufacturing Research and Development

After an initial decline in U.S. investment in research and development in the manufacturing sector, between 2000 and 2002, there was a steady increase in per capita spending through 2007. U.S. investment, relative to overall GDP, is higher than most countries, but is substantially less than Japan and Germany. Figure 20 shows the change in U.S. investment in industrial GDP over the last decade and compares it in recent years to the other countries analyzed.

Figure 20. U.S. Investment in Manufacturing Research and Development



Sources: OECD 2012b; DOC 2011

Voluntary Partnerships and Incentives, Mandatory Energy Audits, and On-Site Plant Energy Managers

The United States has a number of voluntary programs that partner federal resources with manufacturers to improve energy efficiency, and in the past decade, these programs were the primary tool used to encourage the private sector to adopt best energy management practices. The EPA Climate Leaders program was at the forefront of private sector engagement, although this program was ended in 2009. Climate Leaders was an industry-government partnership encouraging individual companies to develop long-term, comprehensive climate change strategies. Under this program, partners agreed to set corporate-wide greenhouse gas reduction goals to be achieved in 5 to 10 years and to inventory their emissions to measure progress. EPA provided guidance and recognition, and developed several tools and services for developing companies' greenhouse gas inventories, reporting emissions reductions, setting and tracking reduction goals, and promoting their successes. EPA also offered Climate Leaders Partners national recognition and resources to communicate their program participation and achievements.

Since the Climate Leaders program ended, the Department of Energy has ramped up its portfolio of voluntary programs with manufacturers through the Advanced Manufacturing Office (AMO) (known formerly as the Industrial Technologies Program) within the Office of Energy Efficiency and Renewable Energy. The Advanced Manufacturing Office offers a host of technology deployment resources, including energy assessments, software tools, publications, trainings, and efficiency implementation resources. Similar to Climate Leaders, the Advanced Manufacturing Office runs a Better Plants program which recognizes manufacturers that sign a pledge to reduce energy intensity, in this case by 25% over ten years.

DOE's Advanced Manufacturing Office also runs the Superior Energy Performance program, which partners its Office of Energy Efficiency and Renewable Energy and the U.S. Council for Energy-Efficient Manufacturing, and focuses on developing and implementing system assessment standards, developing a transparent system to validate energy intensity improvements and management practices, and creating a verified record of energy savings and carbon reductions. This voluntary, industry-designed certification program gives companies a framework for managing and improving energy performance. A central element of the Superior Energy Performance program is the implementation of the global energy management standard, ISO 50001, with additional requirements to achieve and document energy performance improvements. The program also conducts energy management demonstration projects.

The Environmental Protection Agency established the Combined Heat and Power (CHP) Partnership in 2001 to encourage cost-effective CHP projects in the United States. The CHP Partnership is a voluntary program that promotes high-efficiency CHP technology by fostering cooperative relationships between the CHP industry, state and local governments, and other relevant stakeholders. As of January 2012, the CHP Partnership had more than 400 participants dedicated to promoting and installing combined heat and power.

Lastly, it is fairly common practice for utilities to provide incentives to industrial customers for energy efficiency programs such as incentives, technical assistance, rebates, and other services. For more detail, see the recent ACEEE report *Money Well Spent: 2010 Industrial Energy Efficiency Program Spending* (Chittum and Nowak 2012).

The United States encourages energy efficiency in its industrial sector through voluntary programs and incentives rather than through mandates (see DOE 2012; EPA 2012). An international leader in the promotion of energy efficiency in the manufacturing sector through its partnerships with private industry; the United States could ramp up investments in these successful programs to reach an even greater number of companies. In the field of training and workforce development, the United States has a foundation to build upon with its Industrial Assessment Centers, which train graduate students in energy audits at industrial facilities. The United States could also replicate other economically developed nations by moving beyond voluntary approaches. U.S. manufacturers could benefit from laws requiring plants to have an energy manager or to receive periodic energy audits.

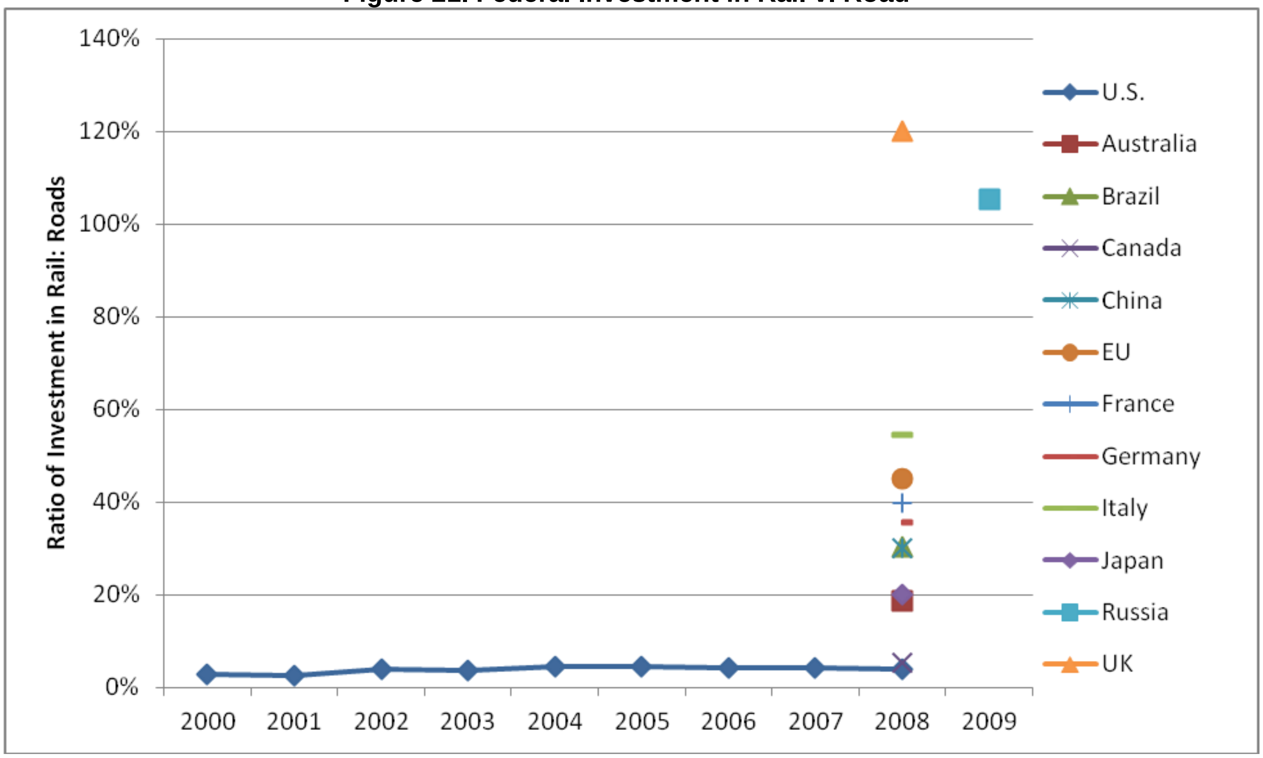
Transportation

The United States is the lowest scoring country in the transportation section. It scored 5 points out of 23, less than half the score of most other countries analyzed. The United States has made important improvements in transportation energy efficiency recently, but, when compared to other economically developed countries, the United States still lags far behind. The United States has had historically low levels of investment in rail, and current investment in rail compared to roads is lower than all other countries studied in this *International Scorecard*. The United States has a low level of public transit use, and passenger vehicle miles traveled (VMT) per capita is higher than in any other country. Despite its low score, the United States has had some modest improvements in transportation efficiency over the last ten years. Between 2004 and 2007 there was only a small rise in vehicle miles traveled per capita, and we are now seeing a decline. New passenger vehicles have become more fuel-efficient due to increasingly stringent fuel economy standards sparked by inter-governmental agency collaboration and high prices for oil. Over the last decade, there has been a slight increase in the use of public transit. Likewise, there has been a small decrease in the energy intensity of freight transport, and with the recent adoption of fuel efficiency standards for trucks, the energy intensity of freight transport may continue to improve. Overall, the United States still must improve in all categories if it is to compete with the rest of the world, but the trends we see show that the United States is on some of the right tracks.

Investment in Rail versus Investment in Roads

The U.S. national spending on roads is far higher than national spending on rail, and this is a long-standing pattern that hinders any rise in energy efficiency. Between 2000 and 2007, the United States spent an average of 4% of the amount spent on highways on rail infrastructure. This is lower than any other country analyzed in this first generation of the *International Scorecard*. While most countries spend more on roads, only Canada is close to the United States in terms of its extremely low ratio of spending. Figure 21 compares the ratio of U.S. investment in rail versus roads over time to that of other economically developed countries.

Figure 21. Federal Investment in Rail v. Road

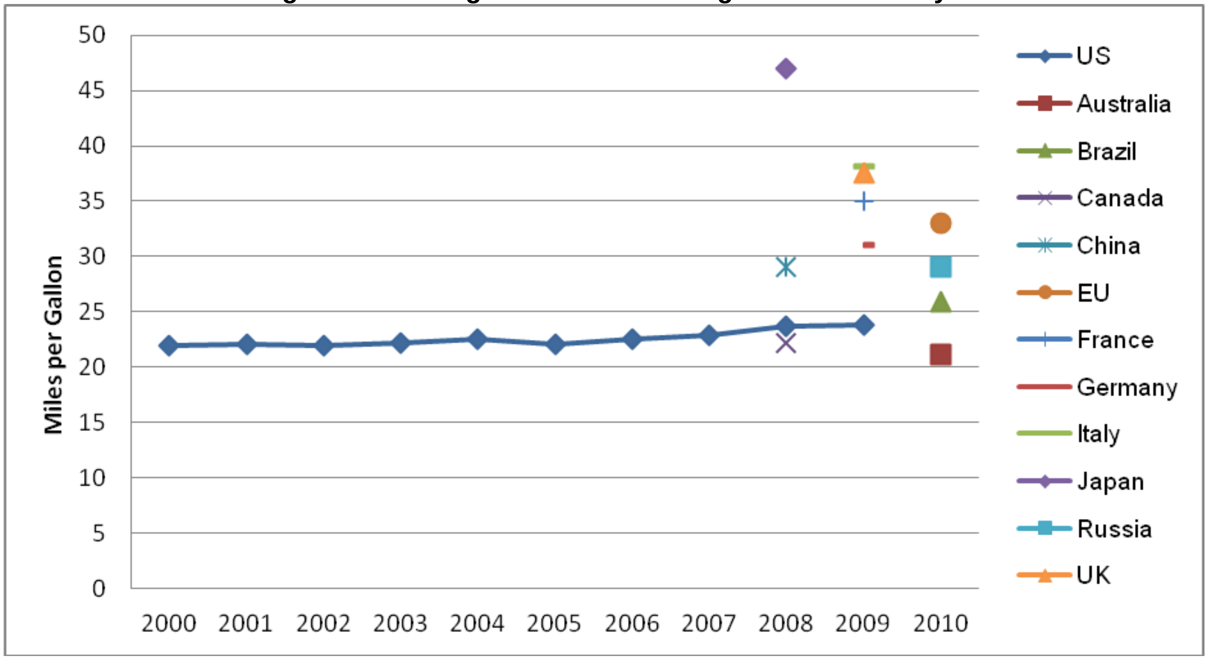


Source: RITA 2009b

Personal Transportation—Fuel Economy and Vehicle Miles Traveled

The United States was the first country to establish fuel economy standards for passenger vehicles. In 1975, the United States put in place the Corporate Average Fuel Economy (CAFE) program, and as a result fuel efficiency increased dramatically between 1980 and 1988 (DOE 2011). Fuel economy standards did not improve between the mid-1980s and the early 2000s. However, in 2004, the state of California adopted tailpipe greenhouse gas standards that pushed the nation toward higher fuel economy standards. The Energy Independence and Security Act of 2007 mandated fuel-efficiency for passenger vehicles of 35 miles per gallon by 2020. In 2010, the Environmental Protection Agency and the National Highway Traffic Safety Administration together issued standards for fuel economy and greenhouse gas emissions for cars and light trucks that are projected to achieve an average of 34.1 miles per gallon by 2016. This is a 30% increase from the 2008 average of 26.3 miles per gallon. These agencies have since proposed an increase in fuel economy standards to 49.6 mpg in 2025. As seen in Figure 22, the average on-road passenger vehicle fuel economy was flat for many years, but has increased slightly over the last five years.

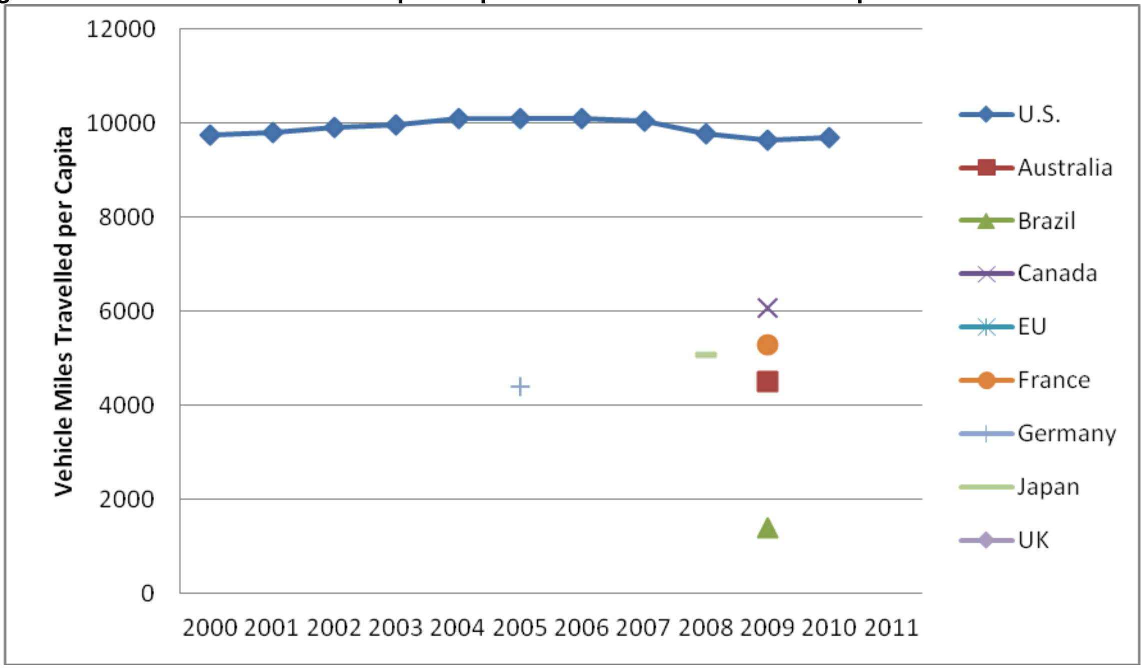
Figure 22. Average On-Road Passenger Fuel Economy



Source: FHA 2011

A more rounded picture of the energy efficiency of personal transportation in the United States can be seen by looking at how much travel individuals are doing by passenger vehicle. Figure 23 shows that the United States has the highest vehicle miles traveled per person of all countries surveyed, more than twice that of many countries and 50% more than Canada, the country with the second highest vehicle miles traveled per capita. Historically, vehicle miles traveled have grown every decade, but the rate of growth has been decreasing. Over the last ten years, this number grew at a steady rate of 1.4% and peaked in 2004 and 2005. In 2007–2009, we see an unexpected and slight decline, likely due at least in part to the economic recession and relatively higher gas prices in the United States in those years. The U.S. Energy Information Administration projects that travel activity will continue to rise over the next 15 years (EIA 2011a).

Figure 23. Vehicle Miles Traveled per Capita: Historical U.S. Data Compared to Other Countries



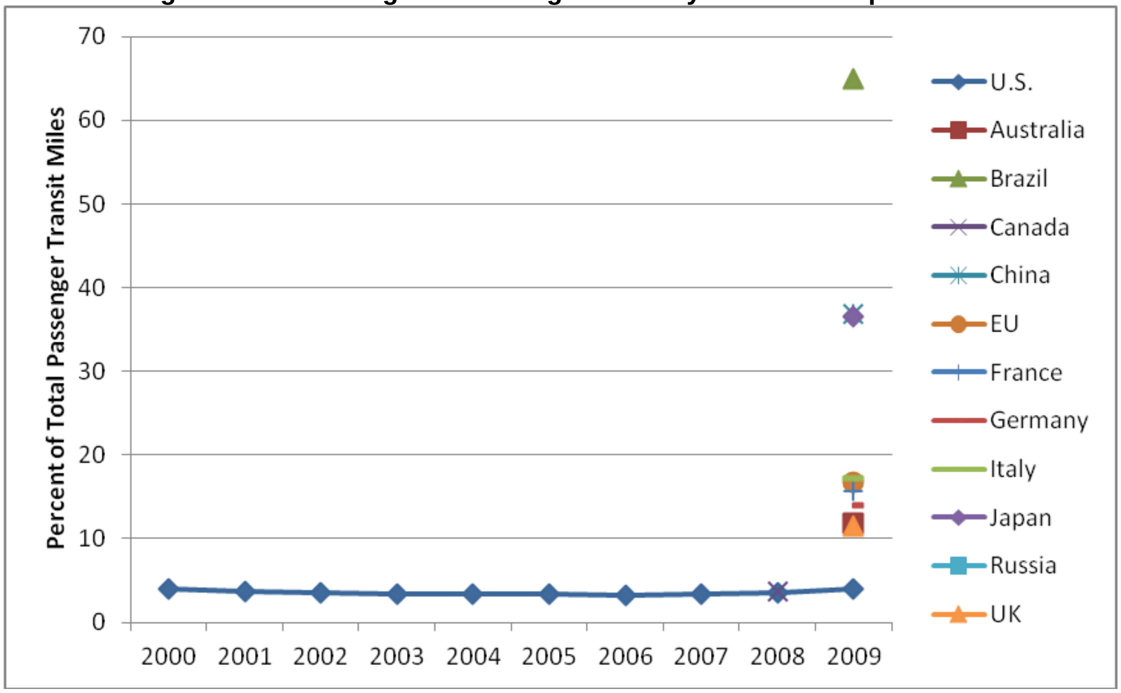
Sources: FHA 2011; DOC 2011.

Public Transit

The percentage of motorized miles traveled in the United States by public transit is just 4%, equal to that of Canada and lower than in all other countries analyzed in this *International Scorecard*. Brazil was by far the highest-scoring country at 65%, followed by China and Japan with greater than 35% of passenger miles traveled by public transportation.

Over the last ten years, the percentage of passenger miles traveled in the United States by rail, bus, and coach has remained at slightly below 4%, according to data collected by the U.S. Department of Transportation. Figure 24 shows the historical percentage of miles completed by public transit in the United States as compared to other economically developed nations.

Figure 24. Percentage of Passenger Miles by Public Transportation

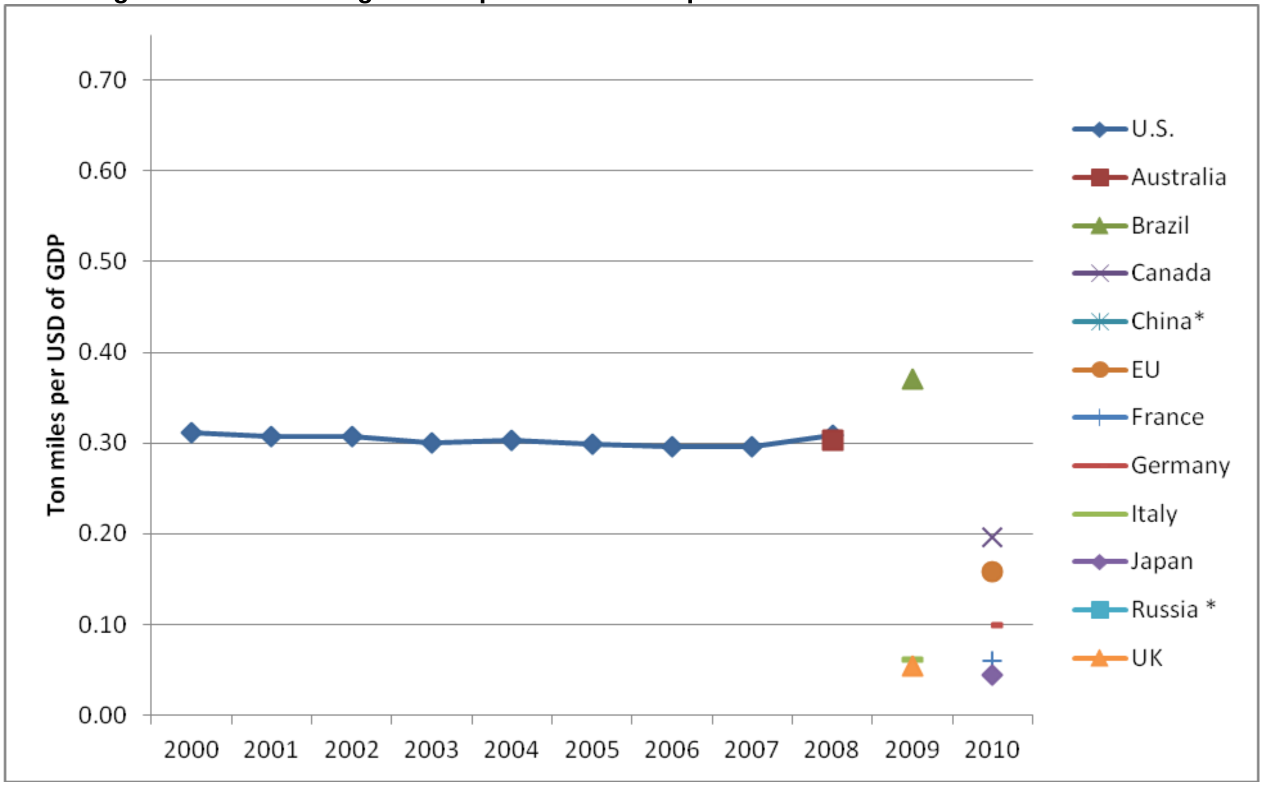


Source: EU 2011

Freight Transportation

The United States ranked in the middle of the pack for ton-miles of cargo transported per unit GDP (tm/GDP), scoring 1 out of 3 points. Japan and the U.K. scored the highest in this category with 0.04 and 0.05 tm/GDP, respectively. Historically, the United States saw a slight decrease in tm/GDP from 2000 through 2007 and a slight uptick in 2008 shifting from 0.312 tm/GDP in 2000 to 0.309 tm/GDP in 2008.

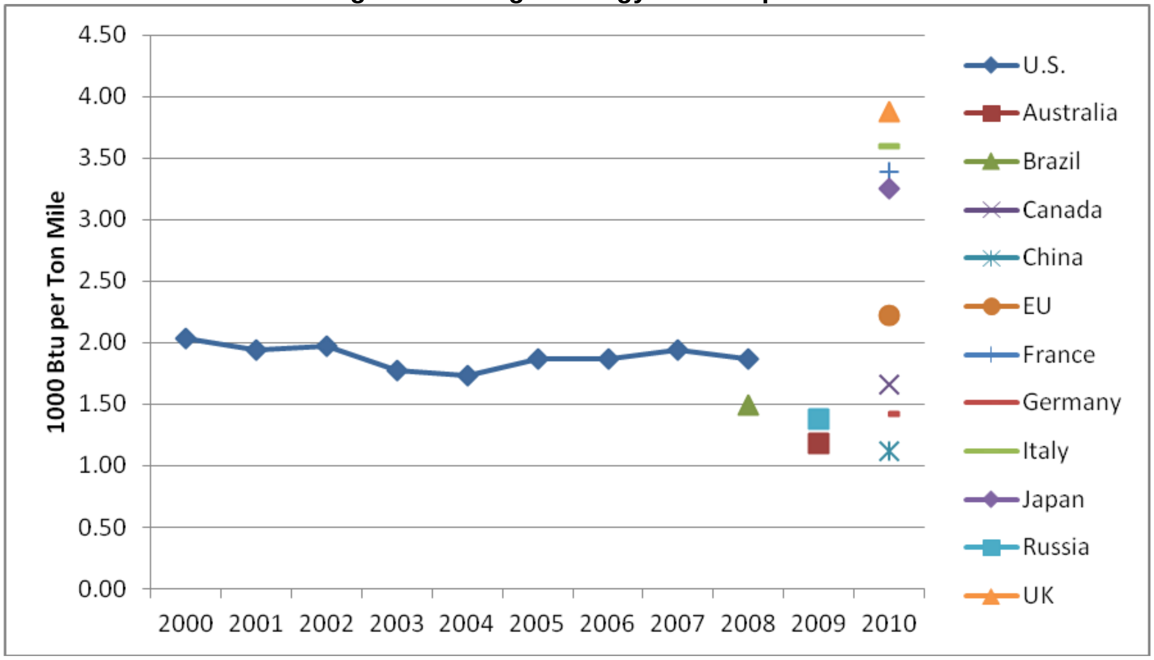
Figure 25. Inland Freight Transport in Ton-Mile per Dollar of Gross Domestic Product



Notes: *China and Russia each scored 0 points with 0.95 and 1.49 tm/GDP, respectively. These countries are not included in the figure because the results are so divergent that including these makes it difficult to see the distinctions among the other countries.
**U.S. GDP is in 2005 dollars while the GDP of other countries are in current dollars. See the transportation section of this report for a current-year comparison of all countries.
Sources: OECD 2012b; EIA 2011a (GDP).

In terms of the energy intensity of freight transport (energy consumed per ton-mile of freight transported), the United States received a moderate score. Over the last ten years, energy consumption per ton-mile of freight transport has fluctuated, but overall it declined slightly to 1.73 KBtu per ton-mile by 2008. Figure 26 shows there is significant room for improvement.

Figure 26. Freight Energy Consumption



Note: All country data are from country-specific research.
Sources: DOE 2010 (energy consumption); RITA 2009a (ton-miles).

In 2011, the Environmental Protection Agency and the National Highway Traffic Safety Administration, together, adopted standards for fuel economy and greenhouse gas emissions for heavy-duty vehicles (those over 8,500 lbs.) for model years 2014 through 2019. Trucks are by far the most energy-intensive form of freight transportation. Based on data from the U.S. Federal Highway Administration, the energy intensity of trucking is twice that of the energy intensity of rail, water, and pipeline transport combined. An ACEEE report describes some key ways to advance this standard in its second, 2025, phase (Khan and Langer 2011). Top priorities to improve the energy efficiency of heavy-duty vehicles in the United States include ensuring that advanced efficiency technologies will be recognized and incentivized, further tailoring data collection and use to reflect the real-world behavior of trucks and buses, and providing meaningful fuel efficiency information to buyers and the public (Khan and Langer 2011).

Recommendations to Improve Energy Efficiency in the United States

The United States has made some progress improving energy efficiency over the last decade, particularly in areas such as building codes, appliance standards, voluntary partnerships with industry and, recently, with improvements in fuel economy standards for passenger vehicles. But while these achievements are commendable, the overall story is disappointing. The United States wastes a tremendous amount of energy and money through its inefficient use of energy. Across most metrics analyzed, the United States has made limited or little progress toward the goal of using energy more efficiently over the last decade. The overall U.S. score of 47 is less than half of the possible points and 20 points away from the top position. Further, the United States falls behind Japan, the entire European Union, China, and even Australia. The low U.S. scores suggest that these other economically developed countries may have an economic advantage over the United States in that using less energy to produce and transport the same economic output costs less. This raises a critical question: how can the United States compete in a global economy if it continues to waste more money and energy than other developed economies?

The United States must turn the ship around and move in a direction that ensures that it retains a leadership role in the global economy. Here are key components of such a sea change.

National Efforts

- **National energy savings target.** Congress should pass a national energy savings target to complement existing state policies and raise the bar for all states. Most of the countries analyzed in this *International Scorecard* have such targets. In the interim, the states without mandatory targets for utility energy savings should adopt such targets.
- **Energy efficiency programs.** Overall investment should be increased by utilities and governments (federal, state, and local) in energy efficiency programs to lower consumers' energy bills and speed the transformation of markets for energy-efficiency technologies and services.
- **R&D investment.** An increase is needed in investment in research and development in energy efficiency to develop new technologies and practices.
- **State financial incentives.** States should implement financial incentives such as tax credits, loans, and loan guarantees.
- **Efficiency of electricity generation.** Government policies should be adopted that encourage utilities to retire old, inefficient power plants and ensure that any new power plants will be highly efficient.
- **Output-based emissions standards.** Output-based emissions standards should be employed to encourage use of the most efficient technologies.
- **Efficient power distribution.** Electric grid infrastructure should be modernized to reduce line losses. Utilities should deploy high efficiency distribution transformers, advanced "smart grid" techniques and increased utilization of distributed energy sources to reduce transmission and distribution losses.

Buildings

- **Building codes.** All states should adopt the most recent and stringent building code standards. The federal government should provide continued technical assistance to states for code adoption and the implementation of energy efficiency building codes for both residential and commercial sectors.
- **Appliance standards.** Governments and regulators should follow through on the implementation and enforcement of existing appliance standards, should regularly update standards, and should consider standards on additional products (e.g., pumps).
- **Appliance labels.** The current EnergyGuide appliance label should be switched from a continuous to a categorical, five-star label.
- **Disclosure of energy use before sale of buildings.** State and local requirements should be implemented that require the disclosure of energy use and costs of residential and commercial buildings before the sale or lease of the property.
- **Federal assistance for building owners.** The federal government should provide assistance for building owners that upgrade their buildings and participate in programs such as ENERGY STAR.

Industry

- **Energy management systems.** Manufacturers should commit to continual improvement using Superior Energy Performance ISO 50001 (ISO 2011) and other voluntary platforms.
- **Electricity buy-back rates for combined heat and power.** Governments and regulators should adopt policies that allow combined heat and power to obtain reasonable electricity buy-back rates.
- **On-site, expert energy managers.** Industrial and manufacturing facilities should employ energy managers to find cost-effective ways of reducing energy use and intensity.

- **Regular energy audits.** Industrial and manufacturing facilities should undergo periodic energy audits.
- **Partnerships between industry and government.** Voluntary energy saving partnerships between the government and industrial sectors should be expanded.
- **Industrial Assessment Centers.** Industrial Assessment Centers should be continued and supported.

Transportation

- **Fuel economy for passenger and heavy-duty vehicles.** The federal government should adopt the proposed increases in Corporate Average Fuel Economy (CAFE) standards, which would result in average fuel economy of 49.6 mpg in 2025. It should also adopt substantially higher standards for heavy-duty vehicle fuel efficiency for 2018 and beyond.
- **Innovative technologies.** Advances in fuel-efficient technologies should be continued, and investment in research and development for motor vehicles should be increased.
- **Vehicle miles traveled.** To slow the growth in vehicle miles traveled, the United States should reconsider the pricing of transportation, and facilitate the adoption of policies such as Pay-As-You-Drive insurance, in which the price of insurance is determined to a large extent by the number of miles traveled.
- **Urban development.** Incentives should be created to encourage more compact, transit-oriented development of cities and suburbs.
- **Public transportation, rail, and non-motorized transport.** National funding should be increased for public transit and freight rail, as well as for non-motorized modes of transportation.
- **More efficient modes of freight transport.** Policies should be adopted that increase intermodal freight transport, and shift freight from heavy-duty trucks to rail and waterway transit wherever possible.

CONCLUSION

The second part of this report has provided a summary of energy efficiency in the United States over the last decade. The results are disappointing. The United States, once considered an innovative and competitive world leader, has progressed slowly while countries such as the United Kingdom, Germany, Japan, and China surge ahead. Fortunately, there are many opportunities to improve energy efficiency and our comparison of 12 of the world's largest economies provides examples of how the United States can do better. This analysis also revealed that while some countries are clearly outperforming others, the biggest story is how poorly all these economies are doing overall. A highly efficient economy is well within reach of every country analyzed. The highest score in each of the 27 metrics was obtained by at least one, and in most cases more than one, top-performing country. The conditions required for a perfect score of 100 points are thus all currently achievable and are in practice, yet the highest score obtained by a single country was 67 points, and the average score was just 54 points.

Countries that use energy more efficiently use fewer resources to achieve the same goals, thus reducing costs, preserving valuable natural resources, and gaining a competitive edge over countries where resources are wasted and costs are higher. While there are some exceptions, in many cases the United States has failed to improve its efficiency significantly over the last decade. More work is needed.
The opportunities for improvement in the United States and worldwide are significant, and the need to rise to the challenge is serious. Countries can preserve their resources, address global warming, stabilize their economies, and reduce the costs of their economic outputs by advancing one achievable goal: use energy more efficiently.

REFERENCES

ABB. 2011. Italy Country Report. http://www.abb.com/cawp/db0003db002698/6cc1f7ff2eff1660c12579ba004b64ef.aspx. Zurich: ABB.

———. 2012. "Russia Energy Efficiency Report." Trends in global energy efficiency. http://www05.abb.com/global/scot/scot316.nsf/veritydisplay/9549bd5f263fc6b6c12579d0004f36b9/$file/Russia%20Energy%20efficiency%20Report.pdf. Zurich: ABB.

[AEIC] American Energy Innovation Council. 2011. *Catalyzing American Ingenuity: The Role of Government in Energy Innovation*. Washington, DC: American Energy Innovation Council

[AFDC] U.S. Department of Energy Alternative Fuels Data Center. 2012. Accessed online 3/30/2012 at http://www.afdc.energy.gov/afdc/.

[ANTP] National Association of Public Transport. 2010. General Report of 2010 Urban Mobility. http://portal1.antp.net/site/simob/Lists/rltgrl10/rltgrlc.aspx?AspXPage=g_14BE83073639449F9062D13003765899:%2540%255Fx0069%255Fd1%3D1Center Sao Paulo, Brazil: National Association of Public Transport.

[BCAP] Building Codes Assistance Project. 2012. Code Status Maps. http://energycodesocean.org/code-status. Accessed March 1, 2012.

[CAIT] Climate Analysis Indicators Tool. 2011. http://cait.wri.org/. Washington, DC: World Resource Institute.

[CEE] Consortium for Energy Efficiency. 2006. *US Energy-Efficiency Programs A $2.6 Billion Industry.* http://www.cee1.org/ee-pe/cee_budget_report.pdf. Boston, MA: Consortium for Energy Efficiency.

———. 2011. *Annual Industry Reports.* http://www.cee1.org/ee-pe/AIRindex.php3. Boston, MA: Consortium for Energy Efficiency.

[CEN] China Energy News. January 27, 2011. Cogeneration will become the “second five” key. Beijing, China: China Energy News. http://www.chinaero.com.cn/rdzt/sewnygh/ghdt/01/89294.shtml

Chittum, Anna and Nate Kaufman. 2011. *Challenges Facing Combined Heat and Power Today: A State-by-State Assessment.* Washington, DC: American Council for an Energy-Efficient Economy.

Chittum, Anna and S. Nowak. 2012. *Money Well Spent: 2010 Industrial Energy Efficiency Program Spending.* Washington, DC: American Council for an Energy-Efficient Economy.

[CIA] Central Intelligence Agency. 2012. *World Fact Book.* https://www.cia.gov/library/publications/the-world-factbook/geos/xx.html . Washington, DC: Central Intelligence Agency.

[CLASP] Collaborative Labeling & Appliance Standards Program. 2011. Global S&L database. http://www.clasponline.org/en/ResourcesTools/Tools/SL_Search Washington, DC: Collaborative Labeling & Appliance Standards Program.

Cuenot, François and Lew Fulton. 2011. International comparison of light-duty vehicle fuel economy and related characteristics. http://www.globalfueleconomy.org/Documents/Publications/wp5_iea_fuel_Economy_report.pdf. Paris: International Energy Agency, Global Fuel Economy Initiative.

Degree Days. 2012. Custom Degree Day Data. http://www.degreedays.net/. Santa Barbara, Calif.: Degree Days

[DOC] U.S. Department of Commerce. 2011. Bureau of Economic Analysis, National Income and Product Accounts (March 25, 2011).

[DOE] U.S. Department of Energy. 2011. *Transportation Energy Data Book, Edition 30,* June 25. Washington DC: U.S. Department of Energy, Energy Efficiency and Renewable Energy.

———.http://www1.eere.energy.gov/manufacturing/ accessed March 15, 2012. Washington, DC: U.S. Department of Energy, Advanced Manufacturing Office

———. 2006. Energy Conservation Standards Activities Submitted Pursuant to Section 141 of the Energy Policy Act of 2005 and to the Conference Report (109-275) to the FY 2006 Energy and Water Development Appropriations Act. Washington DC: U.S. Department of Energy.

[Ecodesign] The EU Ecodesign and Energy Labelling Policies. 2012. Accessed May 15, 2012. http://env-ngo.eup-network.de/product-groups/draft-adopted-measures/

[EIA] Energy Information Administration. 1992. *Energy Policy Act, Public Law 102-486*. October 24. Washington, DC: U.S. Government Printing Office

———. 2003. Office of Energy Markets and End Use, Form EIA-871A of the 2003 Commercial Buildings Energy Consumption Survey. Washington, DC: U.S. Department of Energy.

———. 2005. *Energy Policy Act, Public Law 109-58*. August 8. Washington, DC: U.S. Government Printing Office.

_____. 2009. Office of Energy Consumption and Efficiency Statistics, Forms EIA-457 A and C of the 2009 Residential Energy Consumption Survey. Washington, DC: U.S. Department of Energy.

———. 2011a. *Annual Energy Outlook 2011 with Projections to 2035.* DOE/EIA-0383(2011). Washington, DC: U.S. Department of Energy.

———. 2011b. Form EIA-860 Annual Electric Generator Report. Washington, DC: U.S. Department of Energy.

[ENERGY STAR] ENERGY STAR. 2012. *History of Energy Star.* http://www.energystar.gov/index.cfm?c=about.ab_history. Accessed May 16.

[EPA] U.S. Environmental Protection Agency. 2012. "Combined Heat and Power Partnership." http://www.epa.gov/chp/. Accessed March 15. Washington, DC: U.S. Environmental Protection Agency.

[EU] European Commission. 2011. Statistical Pocketbook 2011: EU Transport in Figures. Luxembourg: European Commission. http://ec.europa.eu/transport/publications/statistics/doc/2011/pocketbook2011.pdf

[FHA] U.S. Department of Transportation, Federal Highway Administration Highway Statistics. 2011. (Washington, DC: Annual Issues), Table VM-1. http://www.fhwa.dot.gov/policyinformation/statistics.cfm as of Oct. 6, 2011.

Goldman, C., G. Barbose, I.M. Hoffman, and M. Billingsley. 2012. *A Rising Tide for Utility Customer-Funded Energy Efficiency.* Berkeley, CA: Lawrence Berkeley National Laboratory.

[ICCT] International Council on Clean Transportation. 2011. *Global Comparison of Light-Duty Vehicle Fuel Economy/GHG Emissions Standards*. Washington, DC: International Council on Clean Transportation.

———. 2012. *ICCT's Global Transportation Roadmap model v1-39.* Washington, DC: International Council on Clean Transportation.

[ICF] ICF International. 2009. "CHP: The State of the Market. October 1, 2009." Presentation of Bruce Hedman for the U.S. EPA Combined Heat and Power Partnership 2009 Partners Meeting & NYSERDA CHP Roundtable. ICF International. http://www.epa.gov/chp/documents/meeting_100209_hedman.pdf

[IEA] International Energy Agency. 2008 Combined Heat and Power: Evaluating the Benefits of Greater Global Investment. Paris, France: IEA.

———. 2011a. Data Services (2011 edition). Paris, France: International Energy Agency.

———. 2011b. *IEA Scoreboard 2011*. http://www.iea.org/w/bookshop/add.aspx?id=416. Paris, France: International Energy Agency.

[IMT] Institute for Market Transformation. 2012. *Building Energy Performance Benchmarking and Disclosure*. Washington, DC: Institute for Market Transformation.

[ISO] International Organization for Standardization. 2011. *Win the Energy Challenge with ISO 50000.* Switzerland: ISO. http://www1.eere.energy.gov/energymanagement/pdfs/iso_50001_energy.pdf. International Organization for Standardization

Jiang, K.J. & S.L. Zhu. 2012. *Analysis of Transportation Energy Consumption Intensity and Forecast.* Beijing, China: Energy Research Institute.

Khan, Siddiq and Therese Langer. 2011. *Heavy-Duty Vehicle Fuel Efficiency and Greenhouse Gas Emissions: The 2014-2019 Standards and a Pathway to the Next Phase*. Report T113. Washington, DC: American Council for and Energy-Efficient Economy.

Laitner, John A. "Skip," Steven Nadel, R. Neal Elliott, Harvey Sachs, and A. Siddiq Khan. 2012. *The Long-Term Energy Efficiency Potential: What the Evidence Suggests.* Report E121. Washington, DC: American Council for and Energy-Efficiency Economy.

Leipziger, David (Institute for Market Transformation). 2012. Personal communication with David Leipziger, May 7.

[Ministerio] Ministerio de Minas e Energia. 2012. Estudo Associado ao Plano Decenal de Energia PDE 2021: Consolidacao De Bases De Dados Do Sector Transporte: 1970-2010. Rio de Janeiro, Brazil: Ministerio de Minas e Energia.

Nadel, S., and M. Pye. 1996. *Appliance and Equipment Efficiency Standards: Impacts by State.* Washington, DC: American Council for an Energy-Efficient Economy.

National Research Council. 2001. *Energy Research at DOE: Was It Worth It?* Washington, DC: National Academy Press.

[NRC] Natural Resources Canada. 2012. Guide to Regulations. Accessed May 14, 2012. http://oee.nrcan.gc.ca/regulations/16802#products

[NRDC] Natural Resources Defense Council, et al., v. Abraham. 2004. 355 F.3d 179 (2d Circuit 2004).

Odyssee. 2012. Online indicators. http://www.odyssee-indicators.org/online-indicators/.

[OECD] Organisation for Economic Co-operation and Development. 2012a. *The OECD Analytical BERD (ANBERD) Database.* http://www.oecd.org/dataoecd/52/23/49546361.pdf. Paris, France: Organisation for Economic Co-operation and Development.

———. 2012b. *Statistics from A to Z.* http://www.oecd.org/document/0,3746,en_2649_201185_46462759_1_1_1_1,00.html. Paris, France: Organisation for Economic Co-operation and Development.

Price, Lynn, Stephane de la Rue du Can, and Hongyou Lu. 2010. *Evaluation of Efficiency Activities in the Industrial Sector Undertaken in Response to Greenhouse Gas Emission Reduction Targets*. http://china.lbl.gov/sites/china.lbl.gov/files/LBNL-3551E.pdf. Berkeley, CA: Lawrence Berkeley National Laboratory.

[RITA] U.S. Department of Transportation Research and Innovative Technology Administration, Bureau of Transportation Statistics. 2009a. *National Transportation Statistics,* Table 1-46a: US Ton-Miles of Freight. Accessed May 24. http://www.bts.gov/publications/national_transportation_statistics/. U.S. Department of Transportation Research and Innovative Technology Administration.

———. 2009b. Government Transportation Financial Statistics 2009. U.S. Department of Transportation Research and Innovative Technology Administration.

Sciortino M., M. Neubauer, S. Vaidyanathan, A. Chittum, S. Hayes, S. Nowak, and M. Molina. 2011. *The 2011 State Energy Efficiency Scorecard.* Washington, DC: American Council for an Energy-Efficient Economy.

Sciortino, M., S. Nowak, P. Witte, D. York, and M. Kushler. 2011. *Energy Efficiency Resource Standards: A Progress Report on State Experience.* ACEEE Report U112. Washington, DC: American Council for an Energy-Efficient Economy.

Sciortino, M., R. Young, and Steven Nadel. 2012. *Opportunity Knocks: Examining Low-Ranking States in Energy Efficiency.* ACEEE Report E126. Washington, DC: American Council for an Energy-Efficient Economy.

State of New York, et al. v. Samuel W. Bodman. 2006. (2nd District of New York, 2006). http://www.ag.ca.gov/globalwarming/pdf/2-27-08consent_decree_NYvBodman.pdf.

[UNESCO] United Nations Educational, Scientific and Cultural Organization. 2011. UIS Statistics in Brief: Science Profile–Brazil. http://stats.uis.unesco.org/unesco/TableViewer/document.aspx?ReportId=3587&IF_Language=eng&BR_Country=760&BR_Region=40520.

U.S. Congress. 1987. *National Appliance Energy Conservation Act, Public Law 100-12.* March 17. Washington, DC: U.S. Government Printing Office

Vassiliouk, Svetlana. 2011. “Russian Federation.” Compendium of Energy Efficiency Policies of APEC Economies. http://eneken.ieej.or.jp/data/4064.pdf. Tokyo, Japan: Asia Pacific Energy Research Centre.

Wade, Joanne, Pedro Guertler, Darryl Croft, and Louise Sunderland. 2011. *National Energy Efficiency and Energy Saving Targets.* Stockholm, Sweden: European Council for and Energy Efficient Economy.

[WEC] World Energy Council. 2012. Efficiency of thermal power plants. http://www.wec-indicators.enerdata.eu/#/power-plants-thermals.html. London, U.K.: World Energy Council.

World Bank. 2011. World Development Indicators: GDP (current US$). World databank edition 2011. Washington DC: The World Bank.

APPENDIX A: COUNTRY SUMMARIES

Country Summary: AUSTRALIA

	TOTAL	National Efforts	Buildings	Industry	Transportation
Score	56/100	17/25	19/28	12/24	8/23
Rank	6	4	2	7	10

Australia ranks in the middle of the pack of nations analyzed, though it scores significantly higher than both the United States and Canada. This could be a reflection of a nation in transition.

The Australian government has recently invested significantly in energy efficiency and has made a major commitment through the Climate Change Action Fund to assist the industrial sector and community organizations in the pursuit of improved energy efficiency. The government also has programs to encourage private investment in energy efficiency including a national Low Carbon Australia loan program. While there are regional programs that include commitments to energy efficiency savings goals, there is no national energy savings goal. In spite of these recent efforts, energy productivity and efficiency of thermal power plants in Australia are relatively low compared to those of other nations analyzed.

Residential buildings in Australia consume less energy per square meter than those of most other nations analyzed, but commercial buildings consume more energy per meter of floor area than most other countries included in the analysis. Both residential and commercial buildings in Australia are subject to mandatory building codes that cover a range of practices as well as mandatory disclosure of building energy consumption. The Nationwide House Energy Rating Scheme (NatHERS) rates the thermal performance of housing on a scale from 1-10 and mandatory disclosure of building energy efficiency at the time of a sale or lease is being phased in. Furthermore, Australia has adopted appliance and equipment standards for a relatively high number of products and requires mandatory categorical labeling of a number of products.

Commitment to energy efficiency in Australia's industrial sector is not as strong as in its buildings sector. Australia ranked near the bottom for investments in research and development in the manufacturing sector relative to total GDP. The percentage of electricity generated by combined heat and power is also low compared to that of other countries. Australia is making efforts to improve energy efficiency in its manufacturing sector by requiring periodic energy audits and through its Greenhouse Challenge Plus program, in which the national government enters into voluntary agreements with manufacturers to improve energy efficiency. There is no requirement for industrial facilities to employ energy managers. Overall, the total energy consumed by the manufacturing sector in relation to industrial GDP is moderate as compared to other countries.

In the transportation sector Australia has great room for improvement. Average on-road passenger vehicle fuel economy is lower than that of every other nation analyzed, and there is no mandatory fuel economy standard. The total vehicles miles traveled per person is moderate, but the percentage of trips taken by public transit is low. Freight transport is a somewhat different story and is more encouraging, with energy used per ton-mile being the second lowest among the twelve economies analyzed. Australia has a relatively low reliance on roads for freight transport, and depends more heavily on rail and waterways. In spite of this, however, Australia's investment in rail versus roads is one of the lowest among the countries surveyed.

Best Practices

Australia has invested significantly in improving energy efficiency through government spending, and its commitment to reducing energy consumption in the building sector appears to be producing positive results.

As part of a climate change action plan and economic stimulus, Australia has dramatically increased national investment in energy efficiency in the last two to three years. Australia has invested funds that rapidly expand energy efficiency grants, incentives, loans, and other programs. This effort will reduce the costs of achieving greenhouse gas reduction goals, improve Australia's infrastructure, make Australia a more competitive nation internationally, and create in-country jobs. For example, the Climate Change Action Fund was allocated over $2.8 billion to pay for, among other things, grants and incentives for businesses and community service organizations to invest in energy efficiency projects. More information about Australia's budget and programs is at http://www.ret.gov.au/energy/efficiency/Pages/EnergyEfficiency.aspx.

Australia has implemented the Nation-wide House Energy Rating Scheme (NatHERS) to standardize computer modeling programs and improve the quality of design of new buildings. NatHERS provides a framework that allows various computer software tools to rate the potential energy efficiency of Australian homes, and shapes national standards and software used by professionals offering assessment services. Through this program home buyers are able to assess houses' energy efficiency and make more informed choices about housing purchases and renovation. More information about the program is available at http://www.nathers.gov.au/about/index.html.

Area for Improvement: A national energy savings goal could be useful for improving energy efficiency in Australia. There are also many opportunities for Australia to learn from other countries' efforts in the industrial sector by offering incentives for improvements in energy efficiency, requiring facilities to employ energy managers, and increasing the use of combined heat and power. Finally, there is major potential for Australia to save energy by improving the fuel economy of its passenger vehicles, notably, by adopting mandatory fuel economy standards.

Table Notes

Table 14—Low Carbon Australia. Accessed May 17, 2012. http://www.lowcarbonaustralia.com.au/

Table 18—Langham, E., Dunstan, C., Walgenwitz, G., Denvir, P., Lederwasch, A., and Landler, J. 2010, Reduced Infrastructure Costs from Improving Building Energy Efficiency. Prepared for the Department of Climate Change and Energy Efficiency by the Institute for Sustainable Futures, University of Technology Sydney and Energetics.

Tables 19 and 20—Shui B., M. Evans, S. Somasundaram. April 2009. Country Report on Building Energy Codes in Australia. Richland, WA: Pacific Northwest National Laboratory. http://www.energycodes.gov/publications/research/documents/countryReports/CountryReport_Australia.pdf

Table 29—____. 2010. Continuing Opportunities: Energy Efficiency Opportunities Program—2010 Report. Canberra, ACT: Australian Government, Department of Resources, Energy and Tourism. http://www.ret.gov.au/energy/Documents/energyefficiencyopps/res-material/ContinuingOpportunitiesEEO2010Report_Web.pdf

Table 31—___. 2011. Road Vehicle-Kilometres Travelled: Estimation From State and Territory Fuel Sales (Research Report 124). http://www.bitre.gov.au/publications/2011/report_124.aspx. Canberra, Australia: Department of Infrastructure and Transport.

Country Summary: BRAZIL

	TOTAL	National Efforts	Buildings	Industry	Transportation
Score	41/100	5/25	13/28	10/24	13/23
Rank	10	12	10	9	5

Overall, Brazil scored 41 out of 100 points, putting it third from last and ahead of only Russia and Canada. Though Brazil scored the lowest of any country in the national efforts section, it is important to note that Brazil relies heavily on renewable energy and results should be considered in this context.

Energy productivity in Brazil is moderately low compared to that of other nations, and Brazil is the only country we analyzed where energy intensity has increased over the last decade. Brazil has the second lowest thermal power plant efficiency of all countries surveyed, and there is a low level of spending (per capita) by the government and utilities for energy efficiency. However, Brazil adopted a utility energy efficiency program in 2000 and requires the utilities to spend a minimum of 0.5% of revenues on energy efficiency programs. In addition, Brazil has an energy-efficiency loan program funded by the Brazilian Development Bank (BNDES). The program is called PROESCO and provides credit or loans to energy service companies, energy end-users, and utilities. These loans and credits cover technical installation and services, new equipment, information, monitoring and controls, and energy audits (BNDS 2012). Brazil has a national program for efficiency called the National Electrical Energy Conservation Program, or PROCEL, which is a mandatory policy to improve the efficiency of production and use of electricity throughout the country. A wide range of activities fall under PROCEL, including funding for research and development, consumer labeling information, energy efficient lighting initiatives, and outreach and education initiatives including trainings for industrial and commercial consumers and staff.

In the buildings category Brazil scored low, primarily because Brazil currently has no mandatory residential or commercial building codes at the national level and has only a small number of appliance standards. Brazil has the lowest residential energy intensity per square foot, but a relatively high commercial energy intensity. A voluntary commercial building code based on ASHRAE 90.1 is in place, and may become mandatory in the future, and several municipalities have building codes in place. Brazil has a voluntary building-labeling program, and a categorical appliance-labeling program. In addition, Brazil has minimum energy performance standards for 14 consumer products, and requires energy labels for 13 consumer products.

There is significant room for improvement in Brazil's industrial sector, as Brazil scored fourth from the lowest in this category. There are no public-private voluntary agreements for energy efficiency, and there is no requirement for plants to have energy managers or undergo energy audits. However, Brazil scored in the middle of the pack on the industrial energy consumption per industrial GDP dollars. Combined heat and power is used to generate 10% of the electricity consumed by the industrial sector. Investment in industrial R&D as a percentage of GDP is relatively high at 1.1% of GDP.

Brazil scored in the middle of the pack for the transportation metrics and had a substantially higher score than the United States, Canada, and Australia. Brazil does not have national fuel economy standards in place; however, vehicle miles traveled per person is low. Sixty-five percent of miles traveled by passengers in Brazil are in the form of public transportation (bus, coach, or rail), which is higher than that of every other country analyzed. The passenger cars used are not highly fuel efficient; however, they have higher miles per gallon performance than the United States. Brazil's infrastructure spending is low and its energy consumption per ton-mile of freight transported is better (lower) than most other countries analyzed.

Best Practices

Brazil has several national and multi-sector energy efficiency policies. Brazil's national electrical energy conservation program (PROCEL) was established in 1985 as a multi-sector policy that funds a range of electricity efficiency programs, labeling, demand side management through education, and efficiency standards. The goal of the program is to reduce electricity consumption and supply side energy lost. The program has a core budget of about $5 million per year and an additional 25–30 million USD in project financing. The program has created several market transformation activities including a product testing and labeling program called selo PROCEL. Selo PROCEL started in 1995, and in 2010 over 50 million selo-PROCEL-labeled products were sold. For more information, see http://www.eletrobras.com/elb/procel/main.asp and http://www.iea.org/textbase/pm/?mode=pm&id=3412&action=detail and http://www.aceee.org/research-report/i992.

In December 2008, Brazil's president signed the National Climate Change Plan (PNMC) into effect. The Plan focuses on reducing greenhouse gas emissions from deforestation and contains targets for limiting deforestation. The Plan also contains energy-efficiency and renewable-energy provisions, and it seeks to increase energy efficiency across various sectors of the economy. The Program seeks to maintain a high renewable energy mix in Brazil's transport and electricity sectors. The Program establishes a national energy efficiency action plan that aims to reduce electricity consumption by 10% by 2030. The Program also includes supply side goals and aims to improve energy efficiency in industry, and buildings on the demand side. For more information, see http://www.mma.gov.br/estruturas/smcq_climaticas/_publicacao/141_publicacao07122009030757.pdf.

Brazil adopted a utility energy efficiency program in 2000 and requires the utilities to spend a minimum of 0.5% of revenues on energy efficiency programs. All programs must be approved by the Brazilian Electricity Regulatory Agency (ANEEL). Another portion of this program requires at least 60% of energy efficiency funding to go to low-income households. These programs include distributing compact fluorescent light bulbs, replacing old refrigerators, and upgrading electricity service quality. For more information, see http://www.iea.org/textbase/pm/?mode=pm&id=4396&action=detail.

Area for Improvement: Brazil is growing rapidly economically, and there are many areas where Brazil can pull ahead of other nations by including energy efficiency policies in its economic development efforts. Brazil would benefit greatly from some national standards and plans to advance energy efficiency, including national residential and commercial building codes, fuel economy standards, mandatory manufacturing energy audits, and energy agreements with manufacturers. Brazil also has no procedures for evaluation, measurement, and verification (EM&V).

References:

[BNDS] O Banco Nacional do Desenvolvimento. 2012 (March). *Support for energy efficiency projects—PROESCO*.
http://www.bndes.gov.br/SiteBNDES/bndes/bndes_pt/Areas_de_Atuacao/Meio_Ambiente/proesco.html
Rio de Janeiro, Brazil: O Banco Nacional do Desenvolvimento.

[WRI] World Resource Institute. 2011. *National Electrical Energy Conservation Program (PROCEL).*
http://projects.wri.org/sd-pams-database/brazil/national-electrical-energy-conservation-program-procel
Washington, DC: World Resource Institute.

[Ministério do Desenvolvimento] Ministry of Development, Industry and Trade. 2009 (February 27). National Institute of Metrology, Industrial-Qualit. Order no. No. 53. http://www.scribd.com/doc/46922468/Regulamento-Tecnico-da-Qualidade-para-Eficiencia-Energetica-de-Edificios. Rio de Janeiro, Brazil: Ministério do Desenvolvimento.

[IMT] Institute for Market Transformation. 2011 (April). *International Building Energy Rating & Disclosure Policy Fact Sheet*. http://www.imt.org/files/FileUpload/files/International%20Rating%20Policy%20FACTSHEET%2041.pdf . Washington, DC: Institute for Market Transformation.

Table Notes

Table 14—Carbon Disclosure Project. 2010. *Corporate Clean Energy Investment Trends in Brazil, China, India and South Africa.* Carbon Disclosure Project and Renewable *Energy & Energy Efficiency Partnership.* http://www.reeep.org/file_upload/7217_tmpphpv4p5GZ.pdf. (Accessed April 30, 2012).

Table 14—International Energy Agency. 2012. *IEA/IRENA Global Renewable Energy Policies and Measures Database.* International Energy Agency, http://www.iea.org/textbase/pm/?mode=re&action=view&country=Brazil (Accessed April 30, 2012).

Table 15—___. 2011. Revista Pesquisa e Desenvolvimento da ANEEL. Avancos Tecnologicos No Setor Electrico. Produced by the Journal of R&D, ANEEL—the National Agency of Electric Energy. http://www.aneel.gov.br/arquivos/PDF/revista_P&D_04_web.pdf

Table 18—Grimme, Friedrich Wilhelm, Michael Laar, and Christopher Moore. 2006. *Man & Climate—Are We Losing Our Climate Adaptation?* San Jose, Costa Rica: Institute for Tropical Architecture.

Tables 19 and 20—Instituto Nacional de Metrologia, Qualidade, e Tecnologia. Ministério do Desenvolvimento, Indústria, e Comércio Exterior. 2009. *Regulamento Técnico da Qualidade para Eficiência Energética de Edifícios.* Portaria n.º 53. Sao Paolo, Brazil. http://www.scribd.com/doc/46922468/Regulamento-Tecnico-da-Qualidade-para-Eficiencia-Energetica-de-Edificios (Accessed April 30, 2012).

Table 31—David Tsai, 2012. Instituto de Energia e Meio Ambiente (IEMA), calculation based on background data for the transport emissions inventory: http://energiaeambiente.org.br/index.php/bibliotecas/exibir/3?arq=ProjetoIEMA.pdf.

Country Summary: CANADA

	TOTAL	National Efforts	Buildings	Industry	Transportation
Score	37/100	12/25	9/28	9/24	7/23
Rank	11	8	11	10	11

Canada ranked second from the bottom of the list, scoring 10 points below the United States and 30 points below the top spot. In Canada, energy productivity is low, and efficiency of thermal power plants is moderate.

Many energy efficiency initiatives occur at the provincial level rather than nationally, and thus cannot contribute to the national efforts score, however, commitments by all provincial governments to a 20% reduction in energy consumption by 2020 was included in the metric for national commitment to energy savings. There are national tax incentives to encourage energy efficiency in multiple sectors, and additional incentive and loan programs at the provincial level. Investment in energy efficiency by the national government is lower per capita than in most other countries, and investment in energy efficiency research and development per capital is moderate.

Canada ranked second to last in the buildings sector. In Canada a high amount of energy is consumed per square meter of building floor space, there are no mandatory national building codes, and there is no mandatory building-labeling program. Mandatory equipment standards do exist for a large number of products. There are also mandatory, continuous-scale labeling requirements for appliances, with Canada's "EnerGuide" label modeled after the EnergyGuide label in the United States.

Canada tied for the lowest score in the industrial sector. Our research indicated that effectively 0% of electricity consumed by the industrial sector is generated by combined heat and power. Further, only about 0.5% of GDP is spent on manufacturing research and development, which is among the lowest of the countries considered in this *Scorecard*. In addition, there is no mandate for energy audits or plant energy managers. However, there is a fairly robust partnership between Canadian industry and the government, called the Canadian Industry Program for Energy Conservation (CIPEC) (see Best Practices below). Over 5,000 companies are involved in CIPEC, and there are financial incentives for participation.

Canada has adopted the United States' fuel economy standards for passenger vehicles, thus, average on-road passenger vehicle fuel economy in Canada is equal to that in the United States and low compared to other countries analyzed. More positively, energy per ton-mile of goods shipped is moderate to low compared to other countries, which may be a reflection of the fact that most freight in Canada is shipped by rail. The proportion of trips taken by public transportation is tied for the lowest of any country, and national investment in rail transit as compared to roads is lower in Canada than any other country analyzed except the United States.

Best Practices
The Canadian Industry Program for Energy Conservation (CIPEC) has been successful in reducing the energy intensity of its member companies. In operation since 1975, CIPEC offers its members the advantage of cost-share assistance to improve energy efficiency as well as technical assistance and training. Over 5,000 companies are part of CIPEC. More information about CIPEC can be found here: http://oee.nrcan.gc.ca/industrial/cipec/13673.

Area for Improvement: Canada tied for the second lowest score in the industrial category. There are a number of policies that could improve this score including, notably, the adoption of mandatory energy audits and mandatory on-site energy managers in manufacturing plants. Producing electricity through the capture of waste heat (combined heat and power) would also dramatically improve Canada's industrial energy efficiency.

There is also room for improvement in Canada's energy used in buildings. Government programs addressing this issue exist, but energy use per square meter is still high. To improve buildings' energy efficiency, Canada needs to prioritize robust programs that emphasize insulation, efficient heating equipment, and retrofits.

Energy use in the transportation sector could be improved by increasing the use of public transit and reducing the vehicle miles traveled by Canadians.

Table Notes

Table 14—Council of the Federation. 2008. Climate Change: Fulfilling Council of the Federation Commitments. Québec City, Québec: Council of the Federation. http://www.councilofthefederation.ca/pdfs/COMMUNIQUE_EN_climate_changeJuly13%5b1%5dclean.pdf (Accessed May 2, 2012).

Table 14—International Energy Agency. 2012. IEA/IRENA Global Renewable Energy Policies and Measures Database. http://www.iea.org/textbase/pm/?mode=pm&action=view&country=Canada (Accessed April 30, 2012).

Table 18—Natural Resources Canada. 2010. Energy Use Data Handbook. Ottawa, Ontario: Office of Energy Efficiency, Natural Resources Canada.

Tables 19 and 20—Canadian Commission on Building and Fire Codes. 1999. Performance Compliance for Houses. Ottawa, Ontario: Canadian Commission on Building codes for all countries—every country and Fire Codes, Natural Resources Canada.

Tables 19 and 20—EcoENERGY. MNECB Mandatory Requirement Checklist. Ottawa, Ontario: ecoENERGY, Natural Resources Canada.

Tables 19 and 20—Shui, B. and M. Evans. 2009. Country Report on Building Energy Codes in Canada. Richland, Wash.: Pacific Northwest National Laboratory, U.S. Department of Energy.

Table 31—Statistics Canada. No date. "Table 4-1: Estimates of Vehicle-Kilometres for Canada — by Type of Vehicle and Jurisdiction." Canadian Vehicle Survey: Annual. Last updated July 7, 2010. http://www.statcan.gc.ca/pub/53-223-x/2009000/t071-eng.htm (Accessed May 4, 2012).

Country Summary: CHINA

	TOTAL	National Efforts	Buildings	Industry	Transportation
Score	56/100	10/25	23/28	9/24	14/23
Rank	6	10	1	10	1

China ranks sixth overall, tied with Australia and the European Union. While it's just one rank ahead of the United States, there is a gap of 9 points. China has the world's largest population, has the second largest economy in terms of GDP, and is the largest exporter of merchandise. Energy productivity in China is lower than in every other country scored except Russia. In order to improve China's energy efficiency, the Chinese government has reduced energy consumption per unit of GDP by 36% between 2000 and 2009 and set a new goal of further reduction of 16% between 2011 and 2015 (Price 2011). Key administrative divisions (e.g., provinces, autonomous regions, and municipalities) and end-use sectors (e.g., construction, transportation, industry, and agriculture sectors) are required to set their own goals for energy efficiency improvement and carbon reduction, and report the progress to their upper management. The national government not only developed an array of energy efficiency policies but also employed various financial means to promote energy efficiency. For example, China issued a consumption tax to encourage the purchase of energy efficient cars and room air conditioners. Every year, China's top five national banks release special loans which provide billions of dollars to support projects related to energy efficiency and carbon mitigation. In spite of these efforts, however, efficiency of thermal power plants is low, and per capita investment in energy efficiency by the national government is in the middle of the range of countries analyzed.

Commercial buildings in China consume less energy per square foot than those in any other country scored, and residential buildings have the second lowest energy consumption per square foot. This may be a result of (1) a larger stock of rural buildings that have lower energy intensity (excluding biomass), and (2) lower energy services overall, although China has witnessed an increasing stock of higher energy intensity residential and commercial buildings in large cities. The building sector has been a key sector targeted by the Chinese government for energy efficiency improvement since the late 1980s. In recent years, China has been adding 1.6 to 2.0 billion square meters of building floor space annually; as of 2009, the existing stock in China totaled 48.6 billion square meters. The Chinese government has promoted an array of policies and projects to promote energy efficiency in new and existing buildings. For example, both residential and commercial buildings in urban areas are subject to mandatory building codes. Medium and large construction projects are required to employ third-party companies for drawing and construction inspection (Shui 2012). In 2006, China also began to establish its administrative and technical systems for building energy efficiency labeling and evaluation. Since 2009, China has pursued the promotion of energy efficiency labeling in newly-built government office buildings and large public buildings through pilot projects in selected provinces and cities. The Chinese government began promoting green buildings in 2004, and will make compliance with green building rules mandatory in selected regions and cities between 2011 and 2015. In addition, China completed the residential retrofit of 182 million square meters of existing buildings between 2006 and 2010, and aims to retrofit a further 400 million square meters between 2011 and 2015 (Shui and Li 2012). Furthermore, China has adopted appliance and equipment standards for a relatively high number of products and has made energy efficiency labeling mandatory.

China scored low in the industrial section. China has been making great efforts to improve energy efficiency in its industrial sector by requiring key manufacturers to pledge their reduction goals, by conducting periodic energy audits, and by employing energy managers. For example, China's Top 1000 Energy-Consuming Enterprises Program mandated a series of energy conservation procedures for the heavy energy users in nine industrial sectors. Though China has made great strides in industrial energy efficiency compared to other countries, the total energy consumed in relation to industrial GDP is still very high. Investment in research and development in the manufacturing sector relative to total GDP is in the middle of the range of countries analyzed.

With the rapidly growing volume of residential and commercial vehicles, transportation was identified by Chinese leaders as a key sector for energy efficiency improvement in the mid-2000s. Average on-road passenger vehicle fuel economy is fairly low, although China has mandatory fuel economy standards. The number of vehicle miles traveled per person is very low, and the percentage of trips taken by public transit (rail, bus, and coach) is higher than any other country. China's freight energy intensity is lower than that of any other country in our analysis except Russia. The ratio of government investment in rail versus roads is in the middle of the range of countries analyzed.

Best Practices
The enforcement of building energy codes and the "Top-1000 Energy-Consuming Enterprises Program" (Top-1000 Program) are two best practices that should be implemented for building and industrial energy efficiency, respectively. China has dramatically improved its compliance rate with building energy codes in only five years. The impressive improvements have been rooted in strong governmental regulatory support, with the establishment of clear rules outlining the responsibilities of key stakeholders and penalties for non-compliance, plus an effective national program of inspection. In the case of the "Top 1000 Program," energy consumption targets were determined for each enterprise, followed by a strong program of monitoring and information dissemination. For more information see: http://ies.lbl.gov/iespubs/LBNL-519E.pdf.

Areas for Improvement: Since the total floor space located in China's rural areas accounts for more than half of the total building area, energy efficiency in buildings in rural areas should be a strong focus. There are opportunities for China to further improve its energy efficiency in the transportation sector by learning from other countries' development and implementation of transportation management systems and practices. Continued focus on industrial efficiency is also needed to bring energy use per unit of product to global norms.

Table Notes

Table 14—Price, L. 2011. "China FAQs: China's Energy Conservation Accomplishments of the 11th Five Year Plan." http://www.chinafaqs.org/library/chinafaqs/chinas-energy-conservation-accomplishments-11th-five-year-plan. Washington, DC: World Resource Institute.

Table 14—International Energy Agency. 2012. IEA/IRENA Global Renewable Energy Policies and Measures Database. International Energy Agency, http://www.iea.org/textbase/pm/?mode=re&action=view&country=Brazil (Accessed April 30, 2012).

Table 18—Center of Science and Technology of Construction. 2011. "China Building Energy Efficiency Development Report". Beijing, China: Construction Industry Publisher.

Tables 19 and 20—Evans, M., B. Shui, M. Halverson and A. Delgado. 2010. "Enforcing Building Energy Codes in China: Progress and Comparative Lessons." Richland, WA: Pacific Northwest National Laboratory.

Tables 19 and 20—Shui, B. 2012. "Third Parties in the Implementation of Building Energy Codes in China. http://imt.org/files/GBPNChina3rdPartyFinal.pdf. Washington, DC: Institute for Market Transformation, and American Council for an Energy-Efficient Economy.

Tables 19 and 20—Shui, B. & J. Li. 2012. "Status Report of Building Energy Efficiency in China, 2011." Paris, France: Global Building Performance Network; Washington, DC: American Council of Energy-Efficiency Economy.

Table 31—Personal communication with Jianmin Zhang, Energy Research Institute, Beijing, China. April 2012.

Table 32—ICCT 2012

Country Summary: EUROPEAN UNION

	TOTAL	National Efforts	Buildings	Industry	Transportation
Score	56/100	13/25	18/28	12/24	13/23
Rank	6	7	3	7	5

The European Union (E.U.) is made up of 27 member countries, but we treat it in our analysis in the same way we treat individual countries because its economy is similar in size to other major world economies and because important energy-related policies apply to the E.U. as a whole. In some cases, the data used to score the metrics were not available for all 27 countries, and in those cases the data reflect the best information available, often a subset of E.U. countries. In addition, several of our metrics are scored according to the adoption of a policy. This approach to scoring in the E.U. at the country level doesn't work because, with rare exceptions, most of the countries are in various stages of adoption of somewhat different policies. Instead, we looked at whether the E.U. Commission had adopted a policy via a directive. E.U. directives are law, but generally must be implemented independently by each country. This process can result in a significant delay between the adoption of an E.U. directive and the implementation of a policy at the country level.

The E.U. falls in the middle of the rankings of economically developed nations in the National Effort section. The energy productivity metric is an average of all 27 nations and is lower than that for France, Germany, Italy, and the U.K. The E.U. has made a mandatory energy savings commitment through Directive 2006/32/EC, which requires member states to adopt energy efficiency action plans that achieve an overall national energy savings target by 2016. However, it has not adopted a policy requiring national loan programs or tax credits to encourage private investment in energy efficiency. Energy efficiency spending data are an average of France, Germany, Italy, and the U.K., but investment in energy efficiency research and development represents spending for the entire European region. The spending on energy efficiency research and development is moderate within the range of countries analyzed. Efficiency of thermal power plants is also in the middle of the range of countries analyzed.

The E.U. scored high in the buildings section. Both residential and commercial buildings in the E.U. consume less energy per square foot than in most other countries analyzed. In addition, the E.U. has mandatory performance codes for residential and commercial buildings, which also require mandatory disclosure of energy consumption in buildings, though this requirement has not yet been implemented by all countries. The E.U. requires the adoption of performance standards for a relatively high number of appliances and equipment, and has a strong appliance-labeling and energy consumption disclosure program.

The E.U. industrial sector did not rank as high as its buildings sector. The E.U. has not adopted policies requiring periodic energy audits or energy plant managers, and has not put in place a requirement for voluntary agreements or incentives between governments and manufacturers. The percentage of electricity consumed by the industrial sector that is generated by combined heat and power is the second highest of any of the nations surveyed; however, the energy consumed by the industrial sector relative to industrial GDP is moderate. Data for investment in manufacturing research and development as a share of GDP are an average of 19 E.U. countries, and the European Union's score falls in the middle of the pack.

In the transportation sector the E.U. has had some impressive accomplishments. The average fuel economy of on-road passenger vehicles in Europe is 33 miles per gallon, and vehicle miles traveled per person (averaged across 11 E.U. countries) is low. The E.U. has also adopted aggressive fuel economy standards. The use of public transit in the E.U. is moderate compared to other economically developed nations, and investment in rail as compared to roads is moderately high. Ton-miles of freight compared to GDP is higher across the E.U. than in France, Germany, Italy, and the U.K. The energy per ton-mile reported is an average of those four countries.

Best Practices

E.U. Directive 2006/32/EC is intended to be a comprehensive energy efficiency policy, tackling many of the areas where countries can improve. It established targets, incentives, and legal frameworks to eliminate barriers to, and encourage the adoption of, energy efficiency in the end-use sector. The Directive applies to the distribution and retail sale of energy, the delivery of measures to improve end-use energy efficiency, and the armed forces. It targets the retail sale, supply, and distribution of electricity and natural gas, as well as other types of energy such as district heating, heating oil, coal and lignite, forestry and agricultural energy products, and transport fuels. The Directive also addresses financing of energy efficiency. While this Directive doesn't address all barriers to energy efficiency, it is a great example of leadership at the level of a centralized government, which leads to implementation by regions, states, and localities. Additional information about this E.U. Directive can be found here: http://europa.eu/legislation_summaries/energy/energy_efficiency/l27057_en.htm

The E.U. has also adopted Directive 2002/91/EC, which requires the member states to:

- use a common methodology for calculating the integrated energy performance of buildings
- apply minimum standards on the energy performance of new and existing buildings subject to major renovation
- implement systems for the energy certification of new and existing buildings and, for public buildings, prominent display of this certification and other relevant information
- require regular inspection of boilers and central air-conditioning systems in buildings

More information about this Directive can be found at http://ec.europa.eu/energy/efficiency/buildings/buildings_en.htm and at http://europa.eu /legislation_summaries/other/l27042_en.htm.

Area for Improvement: While the level of adoption of combined heat and power in the E.U. is impressive, there are a number of policies that could further improve energy efficiency in the industrial sector. These include mandatory periodic energy audits, a requirement for manufacturing plants to employ on-site energy managers, and a program that offers incentives and voluntary agreements between the government and manufacturers.

Table Notes

Table 18—Economidou, M. 2011. Europe's Buildings Under the Microscope. Brussels, Belgium: Buildings Performance Institute Europe (BPIE).

Tables 19 and 20—European Commission. Energy Performance of Buildings Directive (EPBD, 2002/91/EC.

Table 31—United Nations Economic Commission for Europe (UNECE), Transport Division. Transportation Statistics/Road Traffic/ Motor Vehicle Movements on National Territory by Country, Vehicle-kilometres (millions) and Time. Last updated May 15, 2012.

Country Summary: FRANCE

	TOTAL	National Efforts	Buildings	Industry	Transportation
Score	60/100	15/25	16/28	17/24	12/23
Rank	5	6	7	2	8

France scored in the middle of the range of total scores with a score of 60 points. Dollars of gross domestic product (GDP) produced as compared to primary energy consumption is moderately high, but efficiency of thermal power plants is relatively low. The French government's energy efficiency investment per person is low, and its investment in energy efficiency research and development is moderate. France has made a major commitment in their Directive on Energy End-Use Efficiency and Energy Services to save 9% of their energy by 2016 through energy efficiency, which is part of their broader objective of a 20% improvement in energy efficiency by 2020. The government also has programs to encourage private investment in energy efficiency including tax incentives and loan programs targeting the industrial, agricultural, transportation, and buildings sectors.

Residential buildings in France consume a relatively high amount of energy per square foot compared to other economically developed nations, even though both types of buildings are subject to mandatory building codes that cover a range of practices as well as mandatory disclosure of building energy consumption. France has created innovative financing products such as tax incentives and zero-interest loans for the purchase of new homes that meet building code requirements. France also requires labeling of some products, and standards for appliances and equipment adopted by the European Commission are directly applicable.

France is a leader in the energy efficiency policies and practices of its industrial sector. The total energy consumed by the industrial sector in relation to industrial GDP is low compared to that of other countries, and investment in research and development in the manufacturing sector relative to total GDP is relatively high. France has a moderately high percentage of electricity consumed by the industrial sector that is produced by combined heat and power. Further, France is making efforts to improve energy efficiency in its manufacturing sector by requiring periodic energy audits and a mandatory biannual boiler inspection. However, there is no requirement for industrial facilities to employ energy managers.

Many of France's transportation policies are linked to its commitments to reduce greenhouse gases. Average on-road passenger vehicle fuel economy is high, and France has a fairly aggressive mandatory fuel economy standard. The total vehicles miles traveled per person and the percentage of trips taken by public transit (rail, bus and coach) are in the mid-range compared to other countries. Energy per ton-mile of freight transport is on the high end compared to other countries. In addition, France's investment in rail versus roads is low compared to the U.K. but moderate in comparison to the rest of the countries surveyed.

Best Practices

One way that France has promoted energy efficiency is through its tradable white certificate scheme. White certificates are issued by independent certifying bodies to confirm that market actors are saving energy by using efficiency measures. France's white certificate scheme was set up by the 2005 Energy Law and implemented in 2006. Under the scheme, suppliers of energy (electricity, gas, heating oil, liquid petroleum gas, heat, and refrigeration) must meet government-mandated targets for energy savings achieved through the suppliers' residential and tertiary customers. The scheme aims to stimulate improvements in energy efficiency through the use of market-based instruments. It was initially targeted toward energy savings in the residential sector, but now energy suppliers are free to use other actions to fulfill their obligations. More details are at http://www.ea-energianalyse.dk/reports/710_White_certificates_report_19_Nov_07.pdf and http://www.iea.org/textbase/pm/?mode=pm&id=2613&action=detail)

As part of France's 2009 Finance Law there were several provisions to increase financing for energy efficiency investments. The law established zero-interest loans for purchasing houses. The loan is increased by 20,000 Euros if the building meets efficiency standards beyond those required under current building regulations. The Finance Law also introduced a 0% loan for energy-efficiency renovations in which the strategy is that the energy savings will provide the money for repayment of the loan. Projects covered under the loan include thermal insulation for roofs, exterior walls, and exterior glass surfaces; installation, regulation or replacement of heating or hot water systems; and installation of heating or hot water systems that use renewable energy. The loan amount is limited to EUR 30,000. Lastly, the law modified provisions allowing tax credits for the interest paid on loans used to buy or construct a new home as long as it meets current building code efficiency requirements. The provision also extended the repayment period from five to seven years if the home exceeds current thermal efficiency standards. More detail is available at http://www.iea.org/textbase/pm/?mode=pm&id=4298&action=detail and http://www.assemblee-nationale.fr/13/dossiers/loi_finances_2009.asp)

France has also defined performance levels for buildings to qualify for high energy performance labels. According to the provisions of the 2002 E.U. Directive on the Energy Performance of Buildings, as of January 2006, member states must apply minimum requirements regarding the energy performance of new and existing buildings and must ensure the certification of their energy performance. These labels are awarded to buildings with appreciably lower consumption than the regulatory reference consumptions. In France every house or apartment for rent or sale receives an energy audit and rating, which is made public. The French government has also put in place several financial incentives to support the construction of certified buildings including tax credits and low interest bank loans. For more details: http://eea.eionet.europa.eu/Public/irc/eionet-circle/etc_waste/library?l=/eionet_workshop/eionet_workshop_2009/exchange_information/showcases_consumptionpdf_3/_EN_1.0_&a=d)

In France new cars are labeled with the same energy rating scheme as is used in buildings. The government also introduced a “feebates” scheme to transform the market toward low emission cars. Purchasers of a car that is rated as having higher energy use pay a penalty of up to 2600 Euros. The penalty is collected in a fund. Purchasers of more efficient vehicles receive a rebate of 500 Euros or more.

Area for Improvement: While the French government has made clear commitments to energy savings, overall investment in energy efficiency by France’s national government is low compared to that of other countries.

Table Notes

Table 14—International Energy Agency. 2010. Energy Policies of IEA Countries: France 2009 Review. http://www.iea.org/textbase/nppdf/free/2009/france2009.pdf. Paris, France: International Energy Agency.

Table 14—International Energy Agency. 2011. “Policies and Measures Databases.” http://www.iea.org/textbase/pm/?mode=pm. Paris, France: International Energy Agency.

Tables 18, 19, and 20—Buildings Performance Institute Europe. 2011. Europe’s buildings under the microscope: A country-by-country review of the energy performance of buildings. http://dl.dropbox.com/u/4399528/BPIE/HR_%20CbC_study.pdf. Brussel, Belgium: Buildings Performance Institute Europe.

Table 29—International Energy Agency. 2011. Policies and Measures Databases. http://www.iea.org/textbase/pm/?mode=pm. Paris, France: International Energy Agency.

Table 31—European Commission. 2012. Eurostat Transport: Road Traffic. http://epp.eurostat.ec.europa.eu/portal/page/portal/transport/data/database. Brussels, Belgium: European Commission.

Country Summary: GERMANY

	TOTAL	National Efforts	Buildings	Industry	Transportation
Score	66/100	19/25	17/28	16/24	14/23
Rank	2	1	4	5	1

Germany is ranked 2nd overall, behind the U.K. and ahead of Japan. Energy productivity in Germany is higher than the E.U. average and ranks in the middle among the countries analyzed in this report, and energy efficiency of thermal power plants is also moderate. In 2010, Germany released the "Energy Concept for an Environmentally Sound, Reliable, and Affordable Energy Supply" that set a national energy strategy to reduce energy demand and cover the remaining demand with renewable energy (BMWi 2010). The Concept included an economy-wide energy savings target of 20% by 2020 and 50% by 2050 compared to a 2008 baseline. The Concept also set targets for reducing electricity consumption by 10% by 2010 and 25% by 2050. On the supply side, the government has vowed to shut down all of its nuclear plants, which currently account for about a quarter of the country's electricity generation, by 2022 (BMU 2011).

The German government invests significantly in energy efficiency through government programs and has made a commitment of 1.5 billion Euros to a program supporting residential building modernization. The government also has programs to encourage private investment in energy efficiency, including a special fund to support the implementation of energy efficiency in small and medium-sized enterprises (BMU 2011).

The energy consumption per square foot of residential buildings in Germany is high compared to that of the other countries we examined, while commercial buildings in Germany are relatively more efficient. Both residential and commercial buildings in Germany are subject to mandatory building codes that cover a range of practices. Energy certification of buildings at the time of a sale or lease is also required. Germany requires mandatory labeling of some products, and standards for appliances and equipment adopted by the European Commission are directly applicable.

Germany has shown a strong commitment to energy efficiency in its industrial sector. Numerous laws and incentives support the use of combined heat and power in industry. Investment in research and development in the manufacturing sector relative to total GDP is the second highest of all countries analyzed, while the total energy consumed by the manufacturing sector in relation to industrial GDP is lowest among the countries we examined. Although Germany does not require periodic energy audits or on-site energy managers in manufacturing plants, it does offer voluntary agreements with incentives to multiple industries.

The average fuel economy of on-road passenger vehicles in Germany is moderately high, and there is a fairly aggressive mandatory fuel economy standard in place. The total vehicle miles traveled per person is moderate compared to other nations. Germany is slightly below the E.U. average for trips taken by public transit (rail, bus and coach), and government investment in rail as compared to roads is moderate. We found that energy per ton-mile for freight transport in Germany is relatively low among the countries analyzed.

Best Practices

Germany's "Energy Concept for an Environmentally Sound, Reliable, and Affordable Energy Supply" and its energy savings target of 20% savings by 2020 provides a solid commitment in all sectors to pursue energy efficiency. Germany has supported this goal with numerous initiatives to promote energy efficiency investments in residential and commercial buildings, industry, and transportation. Investments in programs such as the CO_2 Building Modernization Program have assisted the residential building sector in implementing energy efficiency projects (BMU 2011). An energy efficiency fund administered by the Federal Ministry of Economics and Technology supports the market introduction of highly efficient cross-application technologies as well as the optimization of energy management systems and manufacturing processes. The fund also supports energy efficiency incentives and educational programs for consumers and local authorities (BMWi 2010).

Germany adheres to the E.U. Energy Performance Buildings Directive, a comprehensive program that ensures that new and existing residential and commercial buildings are designed to be energy-efficient. Despite Germany's relatively low ranking in energy performance of residential buildings, this country is a leader in building energy policies. The existing standards were recently raised by 30% and will likely be raised again in 2012 by another 30%. Germany also has policies supporting passive and other highly efficient new buildings, which are taking a growing share of the market.

Germany's industrial sector also presents a number of best practices, including a number of incentives for the deployment of combined heat and power systems. The Co-generation Act of 2002 gives incentives for the operation and modernization of existing co-generation units. The law allows operators of combined heat and power plants that feed electricity into the grid to receive bonus payments on top of the revenue at market price (IEA measures database 2012).

Area for Improvement: While Germany is a leader in R&D investments in the manufacturing sector, the country lags behind in energy efficiency R&D. The country might benefit from greater focus on R&D in technologies and practices to improve energy efficiency in its buildings and vehicles. In the industrial sector, Germany should adopt minimum performance standards for electric motors. Germany would also benefit from implementing the "Partnership for Climate Protection, Energy Efficiency, and Innovation", an interagency collaborative that would encourage energy audits and energy efficiency benchmarking.

References

[BMWi] Federal Ministry of Economics and Technology. 2010. Energy Concept for an Environmentally Sound, Reliable, and Affordable Energy Supply. Berlin, Germany: Federal Ministry of Economics and Technology.

[BMU] Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety. 2011. Climate Protection and Growth: Germany's Path into the Renewable Energy Age. Berlin, Germany: Federal Ministry for the Environment, Nature Conservation, and Nuclear Safety.

Table Notes

Table 14—BMWi 2010

Tables 18, 19, and 20—Buildings Performance Institute Europe. 2011.

Tables 18, 19, and 20—Europe's Buildings Under the Microscope. Brussels, Belgium: Buildings Performance Institute Europe.

Table 31—Bodeck, K. and Heywood, J. 2008. Europe's Evolving Passenger Vehicle Fleet: Fuel Use and GHG Emissions Scenarios through 2035. Cambridge, MA: Laboratory for Energy and Environment, Massachusetts Institute of Technology.

Country Summary: ITALY

	TOTAL	National Efforts	Buildings	Industry	Transportation
Score	63/100	16/25	16/28	17/24	14/23
Rank	3	5	7	2	1

Overall, Italy ranked 3rd, just 4 points away from the top spot. The dollars of gross domestic product (GDP) produced in relation to total energy consumed and the efficiency of thermal power plants are both high compared to the other economically developed nations analyzed. In 2007, Italy released a National Energy Efficiency Action Plan (Directive 2006/32/CE) that set a national energy savings target of 9.6% between 2008-2016 in buildings, transport, and small industries. Energy distributors must achieve end-use savings of 6 Million tonnes of oil equivalent by 2012. Each energy distributor has an energy saving quota determined by its market share. Distributors receive “White Certificates” issued by the Gestore Mercato Elettrico (GME) for the savings they achieve. Certificates may then be sold through a dedicated marketplace or through bilateral contracts. Distributors with energy savings below their quota could purchase certificates to make up for the shortfall.

The government’s energy efficiency spending per person is low, although the government has made a major commitment through its Industria 2015 program to assist the industrial and transport sectors in the pursuit of improved energy efficiency. The government also has programs to encourage private investment in energy efficiency including a special fund to support the implementation of energy efficiency targets and loan funds targeting the public sector.

Residential buildings in Italy consume less energy per square foot than their European counterparts that we analyzed; however, commercial buildings consume the most energy per square meter seen in our study. Both residential and commercial buildings in Italy are subject to mandatory building codes set forth in the E.U. Energy Performance of Buildings Directive that cover a range of practices. This Directive also requires energy certification of buildings at the time of a sale or lease. Italy also requires mandatory labeling of some products, and standards for appliances and equipment adopted by the European Commission are directly applicable.

Italy’s has shown strong commitment to energy efficiency in its industrial sector. Numerous laws and incentives support the use of high-efficiency cogeneration of electricity in industry, and the percentage of electricity generated by combined heat and power sectors is relatively high compared to that of other countries. Italian industrial plants are required to have a plant energy manager. The total energy consumed by the industrial sector is low in relation to industrial GDP; however, *investment* in research and development in the manufacturing sector relative to total gross domestic product is also relatively low.

Italy’s score in the transportation section is fairly high. Average on-road passenger vehicle fuel economy is high compared to that of other nations, and a mandatory fuel economy standard is in place. Though current data on vehicle miles traveled are not available, the percentage of trips taken by public transit (rail, bus and coach) is moderate, and government investment in rail as compared to roads is relatively high. While the energy consumed per ton-mile of freight transport is among the highest in the countries we analyzed, the ratio of ton-miles GDP is among the lowest.

Best Practices

Italy’s National Action Plan for Energy Efficiency and its energy savings target of 9.6% savings by 2016 provide a solid commitment in all sectors to pursue energy efficiency. Italy has supported this goal with numerous initiatives to promote energy efficiency investments in residential and commercial buildings, industry, and transportation. The White Certificate Program, in particular, has simultaneously required energy distributors to pursue aggressive energy efficiency goals and given them flexibility in how they accomplish this. Italy also supports energy efficiency through a revolving loan fund of 200 million Euros per year (2007-2009) established in the country’s 2007 Budget Law and a number of other funds supporting energy efficiency in industrial, residential, and institutional sectors. The 2007 Budget Law also included provisions for the establishment of a Sustainable Mobility Fund of 90 million Euros per year for three years (2007-2009) to provide incentives for energy efficiency and sustainability improvements in motor vehicles.

Investments in programs such as Industria 2015 have assisted industry and the transportation sector to carry out energy efficiency projects. Industria 2015 provides a strategic plan for the development and competitiveness of Italian industry, a plan that focuses on innovation. The strategy also uses business networks and financing tools to drive innovation, improve energy efficiency, and re-position Italian industry to lead in sustainable mobility, and the development of new technologies. For additional information see: http://www.sviluppoeconomico.gov.it/index.php?option=com_content&view=article&viewType=1&idarea1=593&idarea2=0&idarea3=0&idarea4=0&andor=AND&sectionid=0&andorcat=AND&partebassaType=0&idareaCalendario1=0&MvediT=1&showMenu=1&showCat=1&showArchiveNewsBotton=0&idmenu=2263&id=2012714.

Italy has one of the highest on-road vehicle fuel economy levels among the countries we analyzed. The high price of gasoline in the country has pushed the market towards smaller, more efficient vehicles, and the Italian government has also put in place policies such as incentives for car-buyers and a long-term National Transportation Plan setting out national objectives that are then taken up by Regional Urban Mobility Plans.

Area for Improvement: Italy is at risk of overlapping incentives, particularly in the building sector, as seen in the recent implementation of a revolving loan fund for efficiency, as well as a number of other government funding initiatives. Italy should consider establishing a robust monitoring mechanism to prevent access to multiple subsidies for the same measure.

Despite the success of the White Certificates program and recent funding activity, overall energy efficiency investments by the Italian government and utilities is very low compared to that of other countries analyzed. The country would benefit from cost-effective programs complementary to the White Certificates program that provide incentives for efficiency improvements to consumers and businesses.

Table Notes

Table 14—International Energy Agency. 2011. Policies and Measures Databases. http://www.iea.org/textbase/pm/?mode=pm. Paris, France: International Energy Agency.

Tables 18, 19, and 20—Buildings Performance Institute Europe. 2011.

Tables 18, 19, and 20—Europe's Buildings Under the Microscope. Brussels, Belgium: Buildings Performance Institute Europe.

Table 29—Personal Communication with Paolo Bertoldi. December 7, 2011

Country Summary: JAPAN

	TOTAL	National Efforts	Buildings	Industry	Transportation
Score	62/100	18/25	15/28	17/24	12/23
Rank	4	2	9	2	8

NOTE: The New National Energy Strategy—published by the Ministry of Economy, Trade, and Industry (METI) in 2006 and updated in 2010—set a goal of doubling the country's self-sufficiency from its then-current 18% by 2030. Much of this was to be accomplished by increasing the proportion of nuclear power in the electricity supply mix to as much as 50%, as well as improving energy efficiency by 30% (METI 2006, 2010a). The high reliance on nuclear power in this plan has been fundamentally called into question in the wake of the nuclear disaster at the Fukushima Daiichi Nuclear Power Station following a massive earthquake and tsunami in northeastern Japan on March 11, 2011. This section describes Japan's energy efficiency policies and investments as they stood prior to the Fukushima accident. Therefore, this analysis likely underestimates the role that energy efficiency will play as a resource in the country's future energy mix.

Overall, Japan is in 4th place in this first generation of the *International Scorecard*. Energy productivity—dollars of gross domestic product (GDP) produced in comparison to energy consumption—is higher in Japan than any other country analyzed and has been improving steadily since the country first began investing in energy efficiency after the oil shocks of the 1970s (METI 2011a). The efficiency of thermal power plants is the highest among the countries we scored, at 39% (after T&D losses). National investment in energy efficiency per capita is moderate, and as part of the New National Energy Strategy METI anticipated combined public and private investments for efficiency of over $1 trillion. The strategy also set a target of improving energy intensity (energy consumption as a function of GDP) across the economy by 30% by 2030 (from 2003 levels), with specific targets for each sector (METI 2010a).

Investments in research and development on energy efficiency are only moderate compared to those of other countries. As part of the Cool Earth—Innovative Energy Technology Program, the national government in 2009 allocated $995 million for research and development in 21 selected technologies, including technologies for high-efficiency homes and buildings, next-generation high-efficiency lighting, ultra high-efficiency heat pumps, and high-efficiency information technologies. The government also has programs to encourage private investment in energy efficiency, including tax benefits for home retrofits and the purchase of more efficient vehicles, a low-interest loan program for small and medium businesses making efficiency investments, and subsidies for the promotion of new high-efficiency technologies in the commercial, industrial, residential, and transport sectors.

Residential buildings in Japan consume less energy per square foot than most nations analyzed in this *International Scorecard*, but commercial buildings consume much more energy per square meter than all other countries analyzed. All commercial buildings and residential buildings in Japan over a certain size are subject to mandatory building energy codes that include both performance-based and prescriptive elements. Japan's three codes focus mainly on insulation and heating, ventilation, and air conditioning, with some provisions related to water heating and lighting equipment. As of 2010, code compliance was reported to be relatively high (88%) for new commercial buildings—at least in the design stage—but new residential building compliance was lagging at 39% (METI 2011). Recent changes to Japan's codes stipulate that owners of small and medium-sized buildings (300-2000 m^2) must submit energy savings plans with any proposed new construction or renovation, and that construction companies building more than 150 units annually must submit a similar energy savings plan (METI 2011). Japan's Top Runner program takes an innovative approach to appliance and equipment standards, defining standards for 21 products and requiring mandatory labeling for a subset of them (see below).

Commitment to energy efficiency in Japan's industrial sector is quite strong. Investment in research and development in the manufacturing sector is equal to 2.3% of GDP, higher than in every other country analyzed. Currently, the total energy consumed by the industrial sector is relatively low in relation to industrial GDP, though the percentage of industrial electricity generated by combined heat and power systems is also low. Japan requires industrial and commercial facilities over a certain size to employ energy managers, to submit annual reports justifying their energy use, and to provide long-term plans describing their planned energy efficiency investments. In addition, the Japanese government administers a successful voluntary partnership with the industrial sector (see best practices below).

Japan tied for 8th in the rankings of the transportation sector, though it was just 2 points away from the top spot. The total vehicles miles traveled per person is moderate, but average fuel efficiency of on-road passenger vehicles is relatively low. Although Japan pioneered the development of high-speed rail, government investment in rail as a mode of transport as compared to roads is somewhat lower than such investment in most of the countries surveyed. Japan was also the first country to adopt (in 2006) fuel economy standards for heavy-duty vehicles, which will go into effect in 2015. Unlike other nations surveyed, the bulk of freight in Japan—94%—is transported by road, which may contribute to the country's energy use per ton-mile being relatively high.

Best Practices
Japan's Top Runner Program takes an innovative approach to setting mandatory efficiency standards for appliances and other equipment. As of 2009, the program covered 21 products (23 if light- and heavy-duty vehicles are included) that were chosen according to three criteria: products that involve large domestic shipments, that consume a large amount of energy when in use, or that have considerable potential for efficiency improvements. The products covered under the program account for 70% of residential electricity consumption (Kimura 2010). The Top Runner Program defines standard values based on the energy consumption of the highest-efficiency product on the market at the time of the standard setting, taking into account the potential for further technological improvements. A particular manufacturer's compliance with the standard is evaluated based on the energy consumption of all of its products in a particular category, weighted by shipment volume (i.e., sales). The Top Runner program has resulted in the average efficiency of all covered products meeting or exceeding the initial standard targets (METI 2010b). For example, average annual electricity consumption of air conditioners on the market fell by approximately 76% from 1995 to 2009 (METI 2011).

Keidanren, a nationwide business association, established its Voluntary Action Plan on the Environment in 1996 to promote energy efficiency improvements and to set voluntary reduction targets for carbon dioxide (CO_2) emissions. As of 2009, participants included 34 associations in the industrial or energy sectors, 14 associations and companies in the commercial sector, and 13 associations and companies in the transportation sector. The Action Plan led to an almost 15% reduction in CO_2 emissions intensity in the industrial sector by 2008, compared to a 1990 baseline (Keidanren 2010).

Areas for Improvement: In the short term, Japan continues to face severe electricity supply shortages, estimated at up to 10% in some places in the summer of 2012 (NPU 2011a). Therefore, current efforts to reduce energy use will more likely focus on conservation and changing short-term behaviors than on encouraging broad efficiency investments or long-term change in habits. For example, in the summer of 2011 a national energy-saving effort utilized a multi-channel marketing campaign to raise consumer awareness about residential electricity use, leading to peak electricity savings in Tokyo by more than 15%, exceeding the government's goal (Hirayama 2011). In light of these electricity supply constraints and continued uncertainty about the future of Japan's nuclear industry, in November 2011 the Japanese government released its aspirational Action Plan for Energy Supply-Demand Stabilization, which budgets nearly $30 billion for an extraordinary push in efficiency improvements across sectors by 2015 (NPU 2011b). The plan expands support for the introduction of high-efficiency AC and lighting in households, for research and development investments in energy-saving technologies for industry, and for an intensive roll-out of smart-meter–enabled feedback technologies and dynamic rate plans (NPU 2011a).

In the longer term, the most important opportunity for energy efficiency for Japan exists in the buildings sector. Energy consumption in residential and commercial buildings almost doubled from 1990-2009, outpacing the growth of GDP over the same period (METI 2011). Japan has a great opportunity to increase the energy efficiency performance of its building stock, particularly commercial buildings, by strengthening building codes; improving code compliance and enforcement in the design, construction, and operation phases; and implementing mandatory building-labeling programs.

References

Hirayama, S. 2011. The Worst Electricity Crisis Ever: How Tokyo Cut Its Electricity Use 15%. Presented at 2011 Behavior Energy and Climate Change Conference, December 1, 2011, Washington, DC www.beccconference.org.

[Keidanren] Nippon Keizai Dantai Rengokai (Japan Federation of Economic Organizations). 2010. *Results of the Fiscal 2010 Follow-up to the Keidanren Voluntary Action Plan on the Environment (Summary), Section on Global Warming Measures <Performance in Fiscal 2009>*. Tokyo, Japan: Nippon Keizai Dantai Rengokai. http://www.keidanren.or.jp/english/policy/2010/109.pdf.

Kimura, O. 2009. *Japanese Top Runner Approach for Energy Efficiency Standards*. SERC Discussion Paper 09035. Tokyo, Japan: Central Research Institute of Electric Power Industry, Socio-economic Research Center. http://www.denken.or.jp/en/serc/research_re/09035.html.

[METI] Ministry of Economy, Trade and Industry. 2011. *Waga kuni no shou enerugi seisaku ni tsuite* (Concerning Japan's Energy Efficiency Policy). Tokyo, Japan: Ministry of Economy, Trade and Industry, Energy and Resource Agency. http://www.meti.go.jp/committee/summary/0002015/014_s01_00.pdf.

[METI] Ministry of Economy, Trade and Industry. 2010a. *The Strategic Energy Plan of Japan: Meeting global challenges and securing energy futures*. Summary, revised in June 2010. Tokyo, Japan: Ministry of Economy, Trade and Industry. http://www.meti.go.jp/english/press/data/pdf/20100618_08a.pdf.

[METI] Ministry of Economy, Trade and Industry. 2010b. *Top Runner Program: Developing the World's Most Energy-Efficient Appliances*. Tokyo, Japan: Ministry of Economy, Trade and Industry. http://www.enecho.meti.go.jp/policy/saveenergy/toprunner2011.03en-1103.pdf.

[METI] Ministry of Economy, Trade and Industry. 2006. *New National Energy Strategy (Digest)*. Tokyo, Japan: Ministry of Economy, Trade and Industry. http://www.enecho.meti.go.jp/english/report/newnationalenergystrategy2006.pdf.

[NPU] National Policy Unit. 2011a. *Immediate Supply-Demand Stabilization Measures. Accelerate the implementation of structural reforms related to energy*. Tokyo, Japan: Japan National Policy Unit. http://www.npu.go.jp/policy/policy09/pdf/20110908/20110908_en.pdf.

[NPU] National Policy Unit. 2011b. *Enerugi Jyukyuu Antei Koudou Keikaku (Action Plan for Energy Supply-Demand Stabilization)*. Tokyo, Japan: Japan National Policy Unit. http://www.npu.go.jp/policy/policy09/pdf/20111101/siryo4.pdf.

Table Notes

Table 14—METI 2010a

Table 14—Asia Pacific Energy Research Centre. 2011. Compendium of Energy Efficiency Policies of APEC Countries 2010. Tokyo, Japan: Institute for Energy Economics, Japan, Asia Pacific Energy Research Centre. http://www.ieej.or.jp/aperc/CEEP/2010/Compendium_2010.pdf.

Table 18—Ministry of Internal Affairs and Communication. 2010. Heisei 22 nen do koutei shisan no kakaku tou no gaiyou chousho, mokuzou kaoku ni kan suru Chou (2010 Summary of Fixed Asset Taxes on Wooden Buildings). Tokyo, Japan: Ministry of Internal Affairs and Communication. http://www.soumu.go.jp/main_content/000128931.pdf.

Table 18—___. 2010. Heisei 22 nen do koutei shisan no kakaku tou no gaiyou chousho, mokuzou igai kaoku ni kan suru Chou (2010 Summary of Fixed Asset Taxes on Non-wooden Buildings). Tokyo, Japan: Ministry of Internal Affairs and Communication. http://www.soumu.go.jp/main_content/000128932.pdf.

Table 18—Energy Data and Modelling Center, The Institute of Energy Economics, Japan. 2011. Handbook of Energy & Economic Statistics in Japan. Tokyo, Japan: The Energy Conservation Center, Japan. http://eneken.ieej.or.jp/en/publication/index.html.

Tables 19 and 20—Evans, M., B. Shui and T. Takagi. 2009. Country Report on Building Energy Codes in Japan. U.S. Department of Energy, Pacific Northwest National Laboratory. http://www.pnl.gov/main/publications/external/technical_reports/PNNL-17849.pdf.

Tables 19 and 20—METI 2011

Table 29—Act on the Rational Use of Energy. Revised May 2008. http://www.asiaeec-col.eccj.or.jp/law/revised/rue_2.pdf.

Table 31—METI 2011

Table 32—Ministry of Internal Affairs and Communication. 2011. Japan Statistical Yearbook 2012. Chapter 12 Transport and Tourism. Tokyo, Japan: Ministry of Internal Affairs and Communications. http://www.stat.go.jp/english/data/nenkan/1431-12.htm.

Country Summary: RUSSIA

	TOTAL	National Efforts	Buildings	Industry	Transportation
Score	36/100	6/25	8/28	9/24	13/23
Rank	12	11	12	10	5

Overall, Russia scored last among the economies analyzed. In recent years, Russia has intensified its focus on energy efficiency, and a large number of laws, efficiency targets, and other related goals have been put in place. However, these efforts are relatively recent, and dollars of GDP produced per tonne of oil equivalent remains extremely low. This is due, in part, to structural characteristics of the Russian economy and its large share of energy-intensive industries. The overall efficiency of thermal power plants is also exceptionally low, 21% (after distribution losses).

The national government invests a modest but growing amount of money in energy efficiency. The State Program on Energy Efficiency is the government's largest public investment program and aims to encourage private investment through a loan guarantee program for efficiency investments in heavy industry, power plants, large heating systems, the public sector, and housing stock. The national government has energy-efficiency targets and several layered targets for the reduction of energy intensity (). The most recent target, adopted in January 2011 as part of the Federal Targeted Program on Energy Saving and Energy Efficiency Improvement to 2020, calls for annual efficiency improvements averaging 1.35% for 2011-2020, totaling 13.5% for the ten-year period. The program also has a goal of 40% reduction in energy intensity by 2020 (from 2007 levels), to be achieved through structural shifts in the economy. Over the longer term, these efforts are intended to contribute to a 56% (2.24% annual) economy-wide reduction in energy intensity by 2030 (from 2005 levels) as established in the Energy Strategy for Russia to 2030.

Residential buildings' energy consumption per square foot of floor space in Russia is higher than in almost every other country analyzed, and energy intensity in commercial buildings is also moderately high. While we did adjust for heating and cooling degree days, Russia has extremely cold regions that are heavily populated. In recent years, Russia has made considerable policy improvements for energy efficiency in buildings. The Thermal Performance of Buildings code, updated in 2003, establishes required technical targets for thermal energy efficiency in commercial and residential buildings. Building ratings and "energy passports," equivalent to a building label, are required of all new and existing buildings. Passports identify a building as belonging in one of seven performance categories and are to be made available to potential buyers and residents. As of 2010, construction of new buildings that would fall into one of the three lowest performance categories has been prohibited. Russia currently has only one appliance standard in place, covering incandescent light bulbs. Appliance labels with continuous scales are in place for six products and have been developed and await implementation for nine other products.

Although Russia is a leader in some industrial efficiency issues, such as combined heat and power, there are considerable gaps which represent opportunities for energy efficiency improvements. In the industrial sector, energy consumption per unit of industrial GDP is very high compared to that of other countries, while investment in research and development in the manufacturing sector as a percentage of GDP is lower in the other countries analyzed. There is no requirement for industrial facilities to employ energy managers, but energy intensive facilities are required to undertake energy audits at least once every five years. Voluntary agreements between the government and industry around energy efficiency are in place for a variety of energy intensive sectors, including petrochemicals, metallurgy, and forestry, as well as many individual firms. Though the share of industrial electricity consumption provided by combined heat and power has been decreasing slowly over the past several decades, it still provides nearly 15% of industrial electricity.

Data and policies regarding the energy efficiency of passenger transportation are limited in Russia, leaving considerable room for error. Fuel economy for passenger vehicles is in the bottom tier compared to other countries, and there is no mandatory fuel economy standard. Data on transportation energy use are particularly limited for private vehicle passenger travel, making it difficult to compare this with other passenger travel modes; however research indicates that vehicle miles traveled per person is low. Also on the positive side, Russia has a lower energy intensity for freight transport than any other country analyzed, and it scores well on its transportation infrastructure spending, with slightly more spent on rail investments than roads in 2009.

Best Practices

Russia is a leader in some forms of low energy intensity infrastructure, notably the high level of combined heat and power used in industry and the extensive use of and investment in rail transportation. Russia's vast geography and industrial economy make rail a particularly appropriate mode of transportation. Although much of its rail infrastructure is the result of historical legacy, Russia continues to spend more on rail infrastructure than on roads, a situation almost unique among the countries analyzed (the U.K. also scores well for this metric). As a result, Russia benefits from a large mode share for rail, both passenger and freight, giving their transport system a low energy intensity overall(Popov 2012). On the policy front, Russia has made many positive advances in recent years including setting energy intensity reduction targets, expanding public investments, and encouraging private investments. One of the most notable policies is the new momentum in mandated energy auditing and labeling for buildings. This and other new efficiency policies are too new to be effectively evaluated yet, but future *International Scorecards* may show an improvement in Russia's energy efficiency.

Area for Improvement: Policy areas where Russia lags behind include investments in research and development for energy efficiency in manufacturing, adoption of appliance standards, and adoption of fuel economy standards for passenger vehicles. In addition, much stronger building policies will have a substantial impact on overall energy efficiency in Russia. Better data on energy consumption and energy intensity are needed for Russia. This is particularly true for commercial and public buildings as well as transportation energy disaggregated by mode and sector (Trudeau and Murray 2011).

References

Popov, Sergey. 2012. *Comparison of Russian and Japanese patterns for energy use: implications for business and policy*. Tokyo: Institute for Energy Economics, Japan. http://eneken.ieej.or.jp/data/4241.pdf.

Trudeau, Nathalie and Isabel Murray. 2011. *Development of Energy Efficiency Indicators in Russia*. Paris: International Energy Agency. http://www.iea.org/papers/2011/Russia_En_Eff_Ind.pdf.

Vassiliouk 2011.

Table Notes

Table 14—ABB 2012. "Russia Energy Efficiency Report." Trends in global energy efficiency. http://www05.abb.com/global/scot/scot316.nsf/veritydisplay/9549bd5f263fc6b6c12579d0004f36b9/$file/Russia%20Energy%20efficiency%20Report.pdf. Zurich: ABB.

Table 14—Комиссии по модернизации экономики России [Commission on modernizing the Russian economy]. 2010. "Программа повышения энергоэффективности до 2020 года одобрена правительством РФ [Program to increase energy efficiency by 2020 adopted by the Government of the Russian Federation]." 22 October 2010. http://www.i-russia.ru/energy/news/1786/.

Table 15—Burger, Richard. 2008. "Russian Federal Targeted Programme for Research & Development in Priority Fields for the Development of Russia's S&T Complex for 2007–2012: An outside view." Presented at RUSERA EXE training course: Opportunities & challenges for EU-Russian RTD cooperation, January 30–February 1. http://rp7.ffg.at/upload/medialibrary/08_Burger81299.pdf.

Table 18—[Rosstat] Federal State Statistics Service. 2011. "Table 7.15. Housing Stock" Russia in Figures—2011. http://www.gks.ru/bgd/regl/b11_12/IssWWW.exe/stg/d01/07-15.htm. Moscow, Russia: Federal State Statistics Service.

Table 18—Primary sources for commercial estimates: Petrichenko, Ksenia. 2010. Low-Energy Future of Russian Building Sector. Master of Science Thesis for Department of Environmental Sciences and Policy. www.etd.ceu.hu/2010/petrichenko_ksenia.pdf. Budapest, Hungary: Central European University.

Table 18—World Bank Group. 2008. Energy Efficiency in Russia: Untapped Reserves. http://www.ifc.org/ifcext/rsefp.nsf/AttachmentsByTitle/FINAL_EE_report_Engl.pdf/$FILE/Final_EE_report_engl.pdf. Moscow, Russia: International Finance Corporation and World Bank.

Table 18—McKinsey & Company. 2009. Pathways to an energy and carbon efficient Russia: Opportunities to increase energy efficiency and reduce greenhouse gas emissions. Moscow, Russia: McKinsey & Company.

Tables 19 and 20—Vassiliouk 2011.

Tables 19 and 20—Matrosov,Yurij A., Mark Chao, and Cliff Majersik. 2007. "Increasing Thermal Performance and Energy Efficiency of Buildings in Russia: Problems and Solutions." In *Proceedings of ASHRAE Buildings X Conference,* December. http://www.cenef.ru/file/St-267e.pdf. Atlanta, Ga.: American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.

Tables 19 and 20—Matrosov, Yurij A., Mark Chao, David B. Goldstein, and Cliff Majersik. 2004. "Recent Advances in Energy Codes in Russia and Kazakhstan: Innovation, Energy Savings, Market Transformation" In *Proceedings of the 2004 ACEEE Summer Study on Energy Efficiency in Buildings.* http://aceee.org/proceedings-paper/ss04/panel04/paper21. Washington, DC: American Council for an Energy-Efficient Economy.

Table 29—ABB. 2012. "Russia Energy Efficiency Report." Trends in global energy efficiency. http://www05.abb.com/global/scot/scot316.nsf/veritydisplay/9549bd5f263fc6b6c12579d0004f36b9/$file/Russia%20Energy%20efficiency%20Report.pdf. Zurich: ABB.

Table 31—Primary sources used for estimates:

Table 31—[UNECE] United Nations Economic Commission for Europe Statistical Database. 2012. "Motor Vehicle Movements on National Territory by Country, Vehicle-kilometres (millions) and Time." http://w3.unece.org/pxweb/dialog/varval.asp?ma=ZZZ_TRRoadVehKm_r&path=../database/STAT/40-TRTRANS/02-TRROAD/&lang=1&ti=Motor+Vehicle+Movements+on+National+Territory+by+Country%2C+Vehicle-kilometres+%28millions%29+and+Time. Geneva, Switzerland: United Nations Economic Commission for Europe.

Table 32—McKinsey & Company. 2009. Pathways to an energy and carbon efficient Russia: Opportunities to increase energy efficiency and reduce greenhouse gas emissions. Moscow, Russia: McKinsey & Company.

Country Summary: UNITED KINGDOM

	TOTAL	National Efforts	Buildings	Industry	Transportation
Score	67/100	18/25	17/28	18/24	14/23
Rank	1	2	4	1	1

The United Kingdom (U.K.) is the highest scoring country in our analysis with a total score of 67 points. The U.K. produces over $17,000 dollars of gross domestic product (GDP) per tonne of oil equivalent consumed as primary energy. This is very high compared to other economically developed nations. The efficiency of thermal power plants is high as well.

The U.K. has made significant commitments to energy reduction through their policies linked to the Low Carbon Transition Plan (LCTP) such as the Energy Bill 2010 and the 2011 "Green Deal" (Odyssee 2011). The government also has programs to encourage private investment in energy efficiency including tax incentives/loan programs and social support programs to tackle fuel poverty under the Energy Act 2010. While government and utility investment in energy efficiency per capita is only moderate relative to other countries, investment in energy efficiency research and development per capita is high.

The U.K. energy consumption per square foot of residential building space is relatively high, but energy intensity of commercial buildings is moderate, compared to that of other industrialized nations. Both residential and commercial buildings in the U.K. are subject to mandatory building codes that cover a range of practices including a mandatory disclosure of building energy consumption. The U.K. focuses on existing buildings, primarily through supplier savings obligations; however, the U.K. uses Energy Performance Certificates for all buildings for sale or lease. These certificates contain recommendations for cost-effective action to improve building efficiency. Appliance and equipment standards adopted by the European Commission are directly applicable.

Commitment to energy efficiency in the U.K.'s industrial sector is one of the areas where the U.K. has made great strides. The percentage of electricity consumed by the industrial sector that is generated from combined heat and power is significantly higher than in any other country we analyzed. In addition, the U.K. has the second lowest amount of energy consumed by the industrial sector relative to industrial GDP. But in spite of these successes, investment in research and development in the manufacturing sector relative to total GDP is relatively low, and there are a number of policies that should be put in place, such as requiring periodic energy audits and mandating on-site energy managers in manufacturing plants.

In the transportation sector the U.K. ties for 1st place. Average on-road passenger vehicle fuel economy is high compared to that of other nations, though vehicle miles traveled per person is also relatively high. The U.K. has a mandatory fuel economy standard in place. The use of public transit (rail, bus and coach) is low compared to other economically developed nations, but national investment in rail compared to roads is higher than that of any other nation analyzed. The energy required per ton-mile of freight is higher in the U.K. than in any other nation surveyed, though the ton-miles of freight in relation to GDP is the second lowest.

Best Practices

The U.K. has invested significantly in improving energy efficiency through government spending, and its commitment to reducing energy consumption in the buildings, industry, and transportation sectors has been producing positive results. Each sector has several government programs that help advance the general objectives of reducing energy consumption and carbon dioxide emissions.

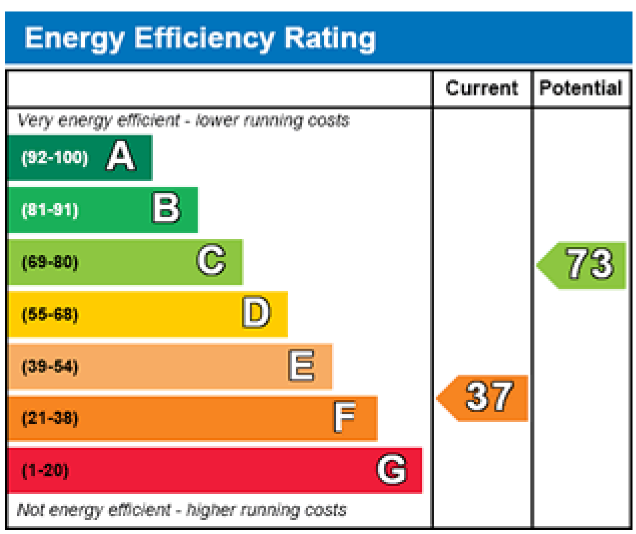
The United Kingdom has adopted an overall national energy savings target of 9% over the period from 2008 to the end of 2016. The U.K. also has in place an Energy Efficiency Action Plan which was originally set out and adopted in 2004. The Action Plan is a package of policies and measures put in place to deliver improvements in energy efficiency in the U.K. to contribute to the targeted savings. The key components of the plan include buildings, public, transport, and business sectors. The plan works in conjunction with the European Union's Energy Efficiency Action Plan to promote an international framework for energy efficiency. For more details, see http://ec.europa.eu/energy/demand/legislation/doc/neeap/uk_en.pdf

The U.K. has also made great strides to improve energy efficiency in the industrial sector. The U.K. has established a mechanism to monitor, evaluate, and report industrial energy consumption. The government publishes the *Digest of UK Energy* Statistics and the associated *Energy Consumption in the UK*, which breaks consumption down into 12 industrial subsectors (HMRC 2011). The U.K. government also implemented the Carbon Reduction Commitment in 2009, which is a mandatory cap-and-trade system for large non-energy-intensive commercial and public sector organizations (DEFRA 2007).

The U.K. combines voluntary agreements and tax breaks in its Climate Change Agreements, introduced as part of the Climate Change Levy package. The government's Climate Change Levy is a tax on the use of energy (natural gas, coal, liquefied petroleum gas, and electricity) that applies to industry, commerce, agriculture, and the private sector. The revenues from the levy are returned to the taxed sectors through a reduction in the rate of employer's national insurance contributions and used to fund programs that provide financial incentives for adoption of energy efficiency and renewable energy. For more details, see http://customs.hmrc.gov.uk/channelsPortalWebApp/channelsPortalWebApp.portal?_nfpb=true&_pageLabel=pageExcise_ShowContent&id=HMCE_CL_000290&propertyType=document#P57_3542.

The U.K. implemented mandatory Energy Performance Certificates for all buildings for sale or lease. The certificates are all categorical, giving grades to homes for their current and potential energy efficiency, and they contain recommendations for cost-effective action to improve building efficiency and links to sources of advice. U.K. government departments are currently exploring options to strengthen the Energy Performance Certificates system to ensure that information for buyers or renters is relevant, targeted, and applicable to a specific property. For more details, see http://www.direct.gov.uk/en/HomeAndCommunity/BuyingAndSellingYourHome/Energyperformancecertificates/DG_177026.

Example of Energy Efficiency Rating Graphs for Homes



In addition to a fuel economy standard, the government has put in place several policies that promote the purchase of fuel-efficient vehicles, such as investment in public transport, behavioral programs, an integrated package of technological improvements and taxation measures, along with a set of local transportation policies, under the National Energy Efficiency Action Plans (EC 2009). The U.K. established a color-coded energy-efficiency labeling system for new cars called the Fuel Economy Label, which provides consumers with greater information on a car's emissions of carbon dioxide and other greenhouse gas emissions (Odyssee 2011). The U.K.'s vehicle fuel taxes are some of the highest in the world, and the Vehicle Excise Duty and Company Car Tax systems are structured to reward those who purchase the most fuel-efficient vehicles (HMRC 2008). The Vehicle Excise Duty program was originally established in 1889, and the stringency and funding has been incrementally increased over the last 100 years. The program is commonly known as the vehicle tax, and it is a road-use tax in which most types of vehicles that are driven or parked on public roads in the U.K. must display their proof of payment. The Vehicle Excise Duty's bands range from £0 to £950. Budget 2008 introduced six new Vehicle Excise Duty bands from in 2009 and 2010, bringing the total number of bands to 13. These bands are a visual scale indicator to alert to consumers and enforcers the level of fuel efficiency for each car model. For more details on this program, see http://www.publications.parliament.uk/pa/cm200708/cmselect/cmenvaud/907/907.pdf and for details on the National Energy Efficiency Action Plans, see http://ec.europa.eu/energy/efficiency/doc/sec_2009_0889.pdf.

Area for Improvement: The U.K. would benefit from increasing the use of public transit and reducing vehicle miles traveled per person. While government commitment to public transit through spending is commendable, other policies and programs to increase ridership would likely improve energy efficiency in the transportation sector.

References

[DEFRA] Department for Environment Food and Rural Affairs. 2007. *UK Energy Efficiency Action Plan 2007*. http://ec.europa.eu/energy/demand/legislation/doc/neeap/uk_en.pdf London, UK: Department for Environment Food and Rural Affairs.

[EC] Commission of the European Communities. 2009. Synthesis of the complete assessment of all 27 National Energy Efficiency Action Plans as required by Directive 2006/32/EC on energy end-use efficiency and energy services. http://ec.europa.eu/energy/efficiency/doc/sec_2009_0889.pdf. Brussels, BE: European Commission.

[HMRC] Her Majesty's Revenue and Customs. 2011. A general guide to Climate Change Levy. http://customs.hmrc.gov.uk/channelsPortalWebApp/channelsPortalWebApp.portal?_nfpb=true&_pageLabel=pageExcise_ShowContent&id=HMCE_CL_000290&propertyType=document#P57_3542 HM Revenue and Customs.

[HMRC] Her Majesty's Revenue and Customs. 2008. Vehicle Excise Duty as an environmental tax. http://www.publications.parliament.uk/pa/cm200708/cmselect/cmenvaud/907/907.pdf. London, UK: House of Commons.

Odyssee. 2011. *Energy Efficiency Profile: UK*. http://www.odyssee-indicators.org/publications/country_profiles_PDF/uk.pdf.

Table Notes

Table 14—Commission of the European Communities. 2009. Commission Staff Working Document. http://ec.europa.eu/energy/efficiency/doc/sec_2009_0889.pdf. Brussels, Belgium: Commission of the European Communities.

Table 14—International Energy Agency. 2011. "Policies and Measures Databases." http://www.iea.org/textbase/pm/?mode=pm&id=4428&action=detail. Paris, France: International Energy Agency.

Tables 18, 19, and 20—Buildings Performance Institute Europe. 2011. Europe's buildings under the microscope: A country-by-country review of the energy performance of buildings. http://dl.dropbox.com/u/4399528/BPIE/HR_%20CbC_study.pdf. Brussel, Belgium: Buildings Performance Institute Europe.

Table 31—European Commission. 2012. Eurostat Transport: Road Traffic. http://epp.eurostat.ec.europa.eu/portal/page/portal/transport/data/database. Brussels, Belgium: European Commission.