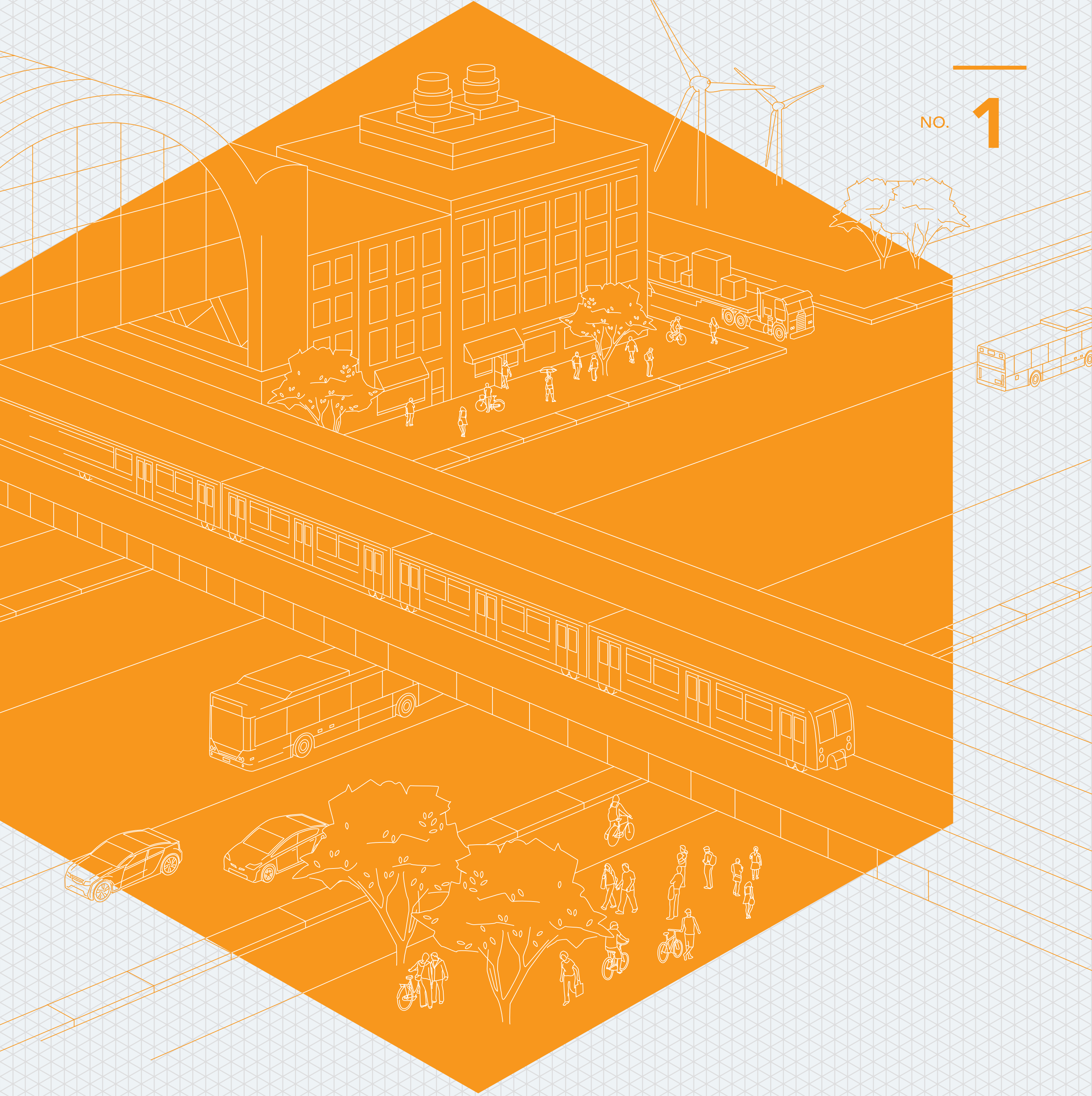


NO. 1

POLICIES THAT WORK:

HOW TO BUILD A LOW-EMISSIONS ECONOMY

ClimateWorks
FOUNDATION

Policies That Work analyzes energy, transportation, and climate policies from around the world to determine which work, which don't, and why. Written by leading policy and technical experts in the ClimateWorks Network, the Policies That Work reports provide an analytical framework to help government leaders evaluate proposed policies in terms of their economic benefits and effectiveness in reducing greenhouse gas emissions.

Policies That Work focuses on the sectors responsible for the vast majority of the world's energy use and greenhouse gas emissions, including vehicles and fuels, appliances, power, industry, and buildings. Policies That Work is published by the ClimateWorks Foundation.

How to build a low-emissions economy

By Hal Harvey and Laura Segafredo, ClimateWorks Foundation

Thousands of energy policies have been adopted worldwide, but only a small number are truly successful. The best ones save money, boost the economy, and preserve the environment. By adopting these proven policies, government leaders can reduce greenhouse gas emissions, foster innovation and economic growth, bolster national security, improve public health, and put the world on a path to a livable climate future. Failure to do so will cost more and lead to massive climate disruption.

While the number of important policies is small, getting them right, and getting them adopted soon, is a big job. As policymakers look for solutions to energy challenges, they can benefit from understanding which policies have worked, and why.

"Policies That Work" was developed by the ClimateWorks Foundation and its affiliated Best Practice Network organizations to analyze energy and climate policies from around the world and identify the top characteristics of successful options. Each report will focus on a different economic sector. As outlined in this introductory report, nations that design, adopt, and implement these policies will reap an immense payoff in reduced greenhouse gas emissions and economic growth.

Executive summary

Policymakers have three types of energy policies in their toolbox: economic signals, performance standards, and support for research and development. Each has different strengths and weaknesses, but if they are well designed and coordinated, they complement and reinforce each other, accelerating deployment of new technologies and lowering costs.

Evidence suggests that getting 10 policies right—provided they are customized to fit specific regions and economic sectors—can produce substantial economic benefits and successfully address climate change.

These policies include:

1. Vehicle performance standards
2. Fuel and vehicle levies
3. Energy efficiency standards and labels
4. Clean energy supply policies
5. Utility-scale energy efficiency programs
6. Industrial energy efficiency programs
7. Effectively enforced building codes
8. Properly aligned economic incentives
9. Smart urban design
10. Support for R&D and innovation

How can policymakers evaluate such policies to assess their likelihood of success? Based on an extensive review of existing policies worldwide, we have identified the top criteria for successful energy policies:

- Set goals and let the market work out the best solutions.
- Require consistent, predictable performance improvements.
- Go upstream in the manufacturing process and capture 100 percent of the market.
- Facilitate private sector investment and innovation.
- Reward performance, not investment, and beware unintended consequences.
- Influence investments in new infrastructure when it is designed, rather than waiting to retrofit or replace it.

Each criterion must be tailored to suit the specifics of a given economic sector; some criteria are more important in certain sectors, and others may not apply at all.

In this introduction to the Policies That Work series, we describe these concepts, examine why they are important, and argue that following these guidelines will help address climate change and provide substantial economic benefits. In subsequent reports we will apply this analysis to specific sector policies.

Why focus on energy policy?

Roughly $6 trillion is spent each year worldwide on the infrastructure that determines energy consumption—including factories, houses, power plants, offices, and cars. The global energy bill for oil, electricity, and natural gas amounts to another $5 trillion per year. With global GDP at about $60 trillion in 2010,[1] these infrastructure and energy expenses account for almost 20 percent of the global economy. The size of these investments alone makes sound energy policy a priority. No energy strategy can succeed unless it channels these expenditures into wise choices.

Today's investments in buildings, transportation systems, factories, and cities will set future energy use patterns for decades. Absent good policy, that infrastructure will lock in enormous waste and leave the world with the consequences, including high and volatile energy prices, excessive pollution, and dangerous climate change. Sound policies can steer those investments toward low-carbon technologies and sustainable growth. Performance standards for appliances, equipment, buildings, and vehicles, for example, have proven track records of saving significant energy and money. While the international community seeks top-down climate commitments, there is tremendous potential to influence investments in infrastructure and equipment through complementary bottom-up, sector-specific policies.

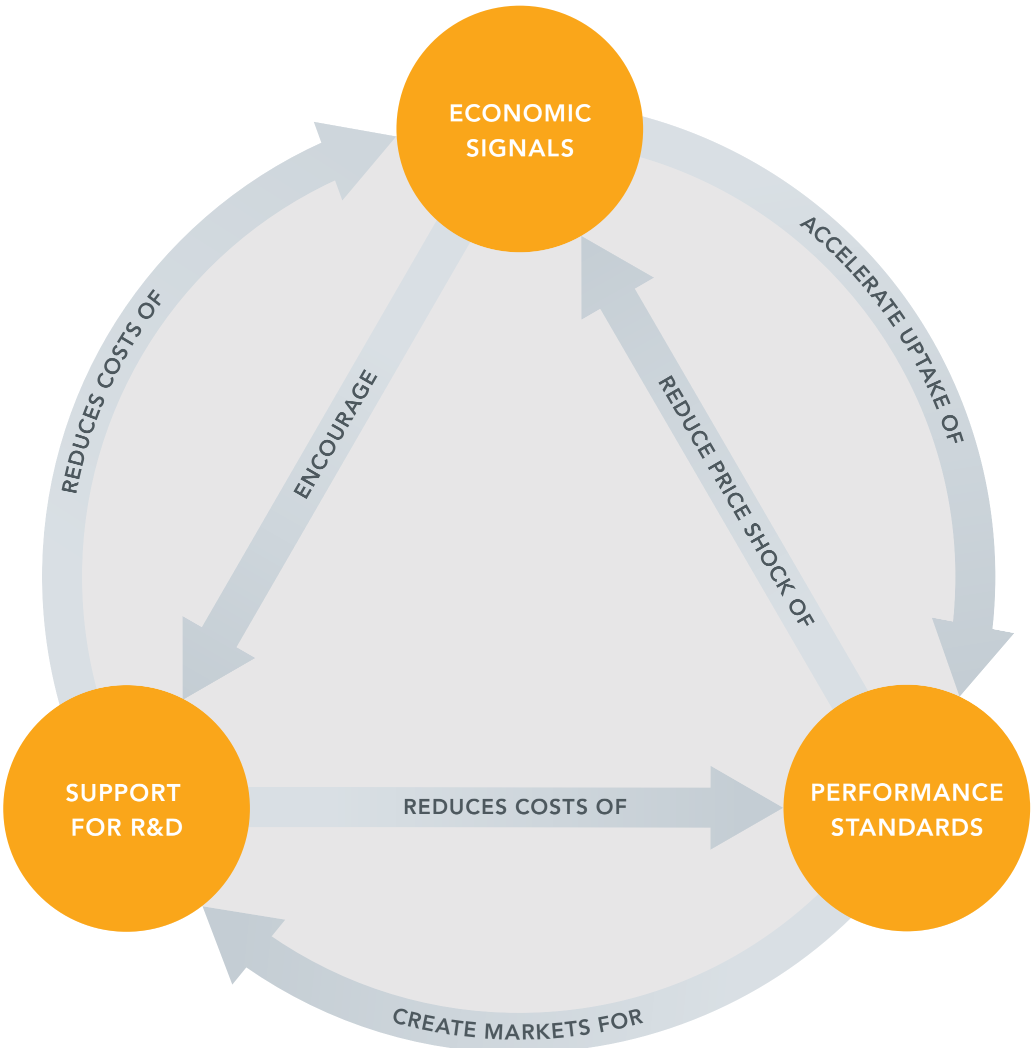
Evidence suggests that 10 policies—provided they are customized for specific regions and economic sectors—can successfully address climate change and produce substantial economic benefits.

Getting these policies right entails highly skilled technical support and a clear understanding of global best practices and local conditions. Developing effective building codes, for example, requires knowledge of technical feasibility and incentive mechanisms, as well as local costs, materials, climate, and other elements. It also requires the institutional capacity to establish, update, and enforce the codes. The general idea, however, is that for any country or region, it pays to build efficient buildings instead of inefficient ones. The same is true of standards for urban planning, vehicle fuel economy, industrial energy use, and a handful of other sector-specific policies.

[1] World Bank, World Development Indicators, last updated April 26, 2011.

Three kinds of energy policies

There are three general types of energy policy: economic signals, performance standards, and support for research and development. Each has unique strengths and delivers different results; done well, they complement and reinforce each other, accelerating deployment of new technologies and lowering costs.



Economic signals

Economists generally think of prices as the most efficient way to encourage society to make wise buying decisions. To reduce energy waste (and the associated greenhouse gas emissions), prices should reflect the full costs of the energy, including externalities such as pollution. Incorporating the true costs allows businesses and consumers to make more-informed investment, production, and consumption choices. This approach has several advantages:

- Economic signals let markets find the lowest-cost solution. The U.S. Acid Rain Program, for example, set a cap on total emissions of sulfur dioxide and nitrogen oxides, then let the market find the cheapest way to meet that limit. The program reduced emissions 50 percent and cost only a quarter of what policymakers had projected.[2]

- Economic signals, such as a price on carbon, do not require governments to intervene in individual sectors, choose a particular technology, or dictate consumer behavior.

- Prices affect decisions about technology (for example, whether to purchase efficient or wasteful equipment) and behavior (such as adjusting the thermostat or driving less), and these reinforce each other.

But the pricing approach also has limitations:

- Some sectors are resistant to price signals. In the construction sector, for example, architects and builders, not the homeowners and renters who pay the energy bills, determine how much energy buildings will use.

- Some consumers are indifferent to energy prices because energy is a very small part of their budget, as in many wealthy countries, or because alternatives may not be available.

- Setting a price that reflects the full costs of energy—whether through a cap-and-trade system or a tax—can be politically difficult.

[2] U.S. Environmental Protection Agency, "Cap and Trade: Acid Rain Program Results," *www.epa.gov/capandtrade/documents/ctresults.pdf.*

Performance standards

Vehicle fuel efficiency standards, building codes, and other performance standards have been the most effective policies for saving energy. Well-designed standards can also stimulate technological innovation and quickly reach 100 percent market saturation.

Of course, the reverse is also true: Poorly designed performance standards can induce unreasonable prices, freeze technologies at suboptimal levels, or miss large segments of the market. Furthermore, even well-designed performance standards do little to alter consumer behavior and can even have a negative effect. Reducing the cost of driving through vehicle performance standards, for example, may encourage consumers to drive more.

Support for R&D and innovation

New technology can dramatically expand our energy options and boost prosperity. Changing the menu of available technologies—from super-efficient refrigerators to cost-effective wind turbines—can solve energy problems without significant economic or social trade-offs. Accelerating such innovations can spur investment, create jobs, foster new businesses, and reduce reliance on volatile, expensive power sources.

Unfortunately, the energy sector has a structural tendency to underinvest in innovation, and the consequence is that our mid- and long-term options are diminished. The scale of investment needed to fuel significant energy innovation often exceeds a company's risk threshold. In addition, some innovations generate benefits, such as reduced pollution and improved public health, that are not rewarded by the market. Developing a full complement of innovative energy technologies will require some form of public support.

Each of these three approaches to energy policy has advantages and shortcomings. Each accomplishes things the others cannot, and they are intrinsically connected. Moreover, economic signals, performance standards, and R&D support can all be wisely or poorly designed and implemented.

What defines a successful energy policy?

Thousands of energy policies are in place around the world, but only a small number have produced large-scale results including economic benefits and reduced greenhouse gas emissions. These successful policies:

- **Set policy goals and let the market work out the best solutions.** Rather than dictating technical specifications, policymakers should set performance standards or emissions limits and let innovators find the cheapest way to meet those goals. The best policies leave technology, market, price, and performance risks in the hands of the private sector. The advantage of this approach is simple: The number of strategies to reduce emissions is large, the combinations are even larger, and no policymaker can know in advance which strategies are best.

- **Require consistent, predictable performance improvements.** Policies often fail to adapt to external factors such as evolving technology and changing prices. By designing standards that become progressively more stringent over time, policymakers can ensure that performance will continue to ratchet up and benefit from ongoing innovation.

- **Go upstream in the manufacturing process and capture 100 percent of the market**. Policies designed to affect a dozen car manufacturers or regional utilities, for example, are likely to be far more effective than those aimed at millions of consumers.

- **Facilitate private sector investment and innovation.** This requires steadily growing, long-term markets that send predictable signals to galvanize private investment and unleash innovation. Policymakers should also consider non-price issues that can hamper investment, such as contract structure, siting, and transmission access.

- **Reward performance, not investment, and beware unintended consequences.** Policies that subsidize investment tend to generate expensive results. In California, for example, early incentives provided tax credits for investments in wind projects regardless of whether they produced any power, leading to windmills that didn't run very well but were nonetheless profitable. Poorly designed policies can also generate negative side effects: Energy subsidies, for example, may seem like a useful way to help low-income people pay for basic needs, but they encourage waste. Badly designed fuel economy standards shifted consumer demand from cars to trucks and SUVs.

- **Influence investments in new infrastructure when it is designed, rather than waiting to retrofit or replace it.** Energy and climate policies that are synchronized with capital stock turnover are much more cost-effective than those that necessitate replacing or retrofitting capital equipment.

Ten policies can make the difference

The following policies, if well designed and implemented, help nations lower their greenhouse gas emissions *and* reap extensive environmental and economic benefits.

1 Vehicle performance standards

Over the past 50 years, a quiet transformation has taken place in motor vehicle design, fuels, and environmental performance. These changes, triggered by government standards, have garnered extensive economic, health, and climate benefits.

Regulations in the European Union, the United States, and Japan have reduced vehicle emissions of conventional pollutants by about 99 percent, at a cost to the consumer of roughly $500[3]—or less than 2 percent of the average cost of a new gasoline-fueled car. According to the U.S. Environmental Protection Agency, the social benefits—such as reducing premature deaths, respiratory ailments, and crop damage—outweigh the manufacturing costs on the order of two to five times.[4]

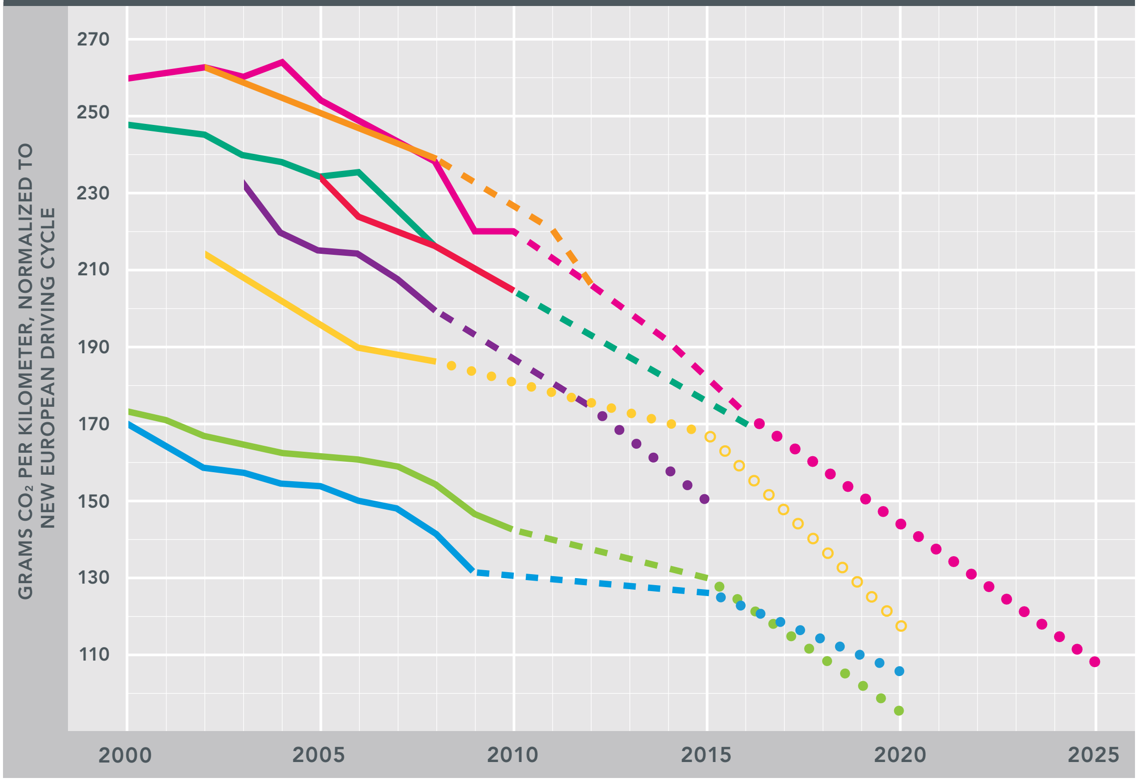
This is a remarkable example of how government standards transformed the environmental performance of passenger vehicles by setting performance-based goals to drive new technologies.

The benefits of controlling vehicle pollution outweigh the costs on the order of two to five times.

[3] J. Lee, F. M. Veloso, D. A. Hounshell, and E. S. Rubin, "Forcing Technological Change: A Case of Automobile Emissions Control Technology Development in the U.S.," *Technovation* 30: 249–264, 2010.

[4] U.S. Environmental Protection Agency, "Regulatory Impact Analysis—Control of Air Pollution From New Motor Vehicles: Tier 2 Motor Vehicle Emissions Standards and Gasoline Sulfur Control Requirements," 1999, *www.epa.gov/tier2/frm/ria/r99023.pdf.*

HISTORICAL FLEET CO_2 EMISSIONS PERFORMANCE AND CURRENT OR PROPOSED STANDARDS



LEGEND

- Japan
- E.U.
- China[1]
- S. Korea
- Australia
- Canada[2]
- California[2]
- U.S.[2]
- Historical performance
- Enacted standards
- Proposed standards
- Targets under study

[1] China's target reflects a gasoline fleet scenario. If other fuel types are included, the target will be lower.

[2] U.S. and Canadian light-duty vehicles include light commercial vehicles.

Such standards are now being harnessed to reduce greenhouse gas emissions—primarily carbon dioxide but also nitrous oxide and air conditioner refrigerants. Australia, Canada, China, the European Union, Japan, South Korea, and the United States have adopted some form of vehicle performance standards, thus bringing about 70 percent of global transportation-related greenhouse gas emissions under regulation. Mexico and India are considering adopting vehicle efficiency standards, while other major markets such as Russia, Brazil, and Indonesia have not yet taken this step.

These vehicle efficiency standards have proved very effective in reducing fuel use and CO_2 emissions. Between 1978 and 2005, Germany's voluntary targets, which are less effective than mandatory standards, yielded a drop in CO_2 emissions of up to 10 percent *per year* compared with business-as-usual trends. Since China adopted a weight-based fuel economy standard for autos and light trucks in 2005, nationwide new-vehicle fuel economy has improved by 10 percent. In the United States, fuel economy standards reduced oil consumption by about 3 million barrels per day and lowered annual CO_2 emissions by roughly 25 percent between 1975 and 2005.

Experience shows that vehicle performance standards must be well designed and regularly improved to be successful. In the U.S., for example, the federal government increased the stringency of its standards every year from 1975 to '85. As a result, automobile and light truck fuel economy nearly doubled during that decade. But from 1985 to 2008, the standards remained static and fuel economy improvement halted, stagnating at about 28 miles per gallon for cars and 20 mpg for light trucks (8.4 liters per 100 kilometers and 11.8 l/100 km, respectively). That failure cost the U.S. economy some 12 billion barrels of oil by 2010.[5]

[5] Calculation based on total U.S. fleet (per U.S. Department of Transportation) traveling 11,500-11,800 miles per year (per McKinsey & Co.) with an average 27-mpg starting point. It assumes forfeited fuel efficiency improvements of 2 percent per year for new vehicles, with a roughly 10-year lag before the fleet average reflects the higher fuel economy. Savings start to accrue in 1996, becoming bigger each subsequent year.

10%

annual drop in vehicle CO_2 emissions in Germany, 1978–2005

33B

barrels of oil saved by U.S. fuel economy standards, 1975–2005

99%

of conventional vehicle pollutants eliminated by E.U., U.S., and Japanese standards

2 Fuel and vehicle levies

Looking ahead 20 years, it is unlikely that vehicle performance standards alone will be able to offset the growth in fuel consumption and CO_2 emissions from increased vehicle use worldwide. An additional layer of economic incentives will be needed, and well-designed levies nicely complement performance standards.

Fiscal policies for cars and trucks can take the form of fuel or vehicle fees. Fuel fees offer two levers to reduce CO_2 emissions from the transportation sector: First, consumers respond to higher fuel prices by driving less and favoring public transit, biking, and walking. Second, fuel fees influence consumers' car and truck purchases, thus encouraging automakers to improve the fuel economy of vehicle fleets.

Fuel levies also make economic sense, as the additional fiscal revenue can be used to fund infrastructure development or clean energy research, or to reimburse consumers via payroll tax reductions (thus encouraging job growth). And if they are set to approximate external costs (including pollution, price volatility and disruptions in oil imports, and national security concerns), they make the whole economy more efficient. In addition, fuel fees can dramatically reduce balance-of-payment problems.

[6] International Council on Clean Transportation, "Passenger Vehicle Greenhouse Gas and Fuel Economy Standards: A Global Update" and datasheet of global passenger vehicle FE/GHG regulations, *www.theicct.org/passenger-vehicles/global-pv-standards-update.*

[7] T. Sterner, "Fuel Taxes: An Important Instrument for Climate Policy," *Energy Policy* 35, no. 6: 3194–3202, *www.efdinitiative.org/research/publications/publications-repository/fuel-taxes-an-important-instrument-for-climate-policy.*

High transportation fuel fees can reduce fuel consumption and CO_2 emissions significantly. This has been proved in Europe and Japan, where levies are significantly higher than in the U.S. and passenger vehicle fleets display average fuel economy levels that are 50 percent higher: 6.2 liters per 100 kilometers (42 mpg) in Europe and 5.6 liters per 100 km (45 mpg) in Japan versus 8.4 liters/100 km (28 mpg) in the U.S. in 2010.[6] According to a recent study, if all OECD countries had adopted gasoline fees on par with those levied on European consumers, CO_2 emissions from the transportation sector would have been 44 percent lower in 2005 than they actually were—a difference of 850 megatonnes (Mt), or million metric tons, of CO_2.[7]

Vehicle fees can be assessed as a lump sum at time of purchase or annually as registration fees. Countries that have established sales or registration fees based on fuel consumption have strongly shifted consumer demand to more-efficient cars. Although this approach influences vehicle purchases, cars that use less fuel may encourage more driving.

If all OECD countries had adopted gasoline fees on par with Europe's, transport CO_2 emissions would have been 44 percent lower in 2005.

2,780

terawatt-hours saved by
U.S. appliance standards, 1990–2005

50%

higher fuel economy in Europe
and Japan than in the U.S.

$2.7B

saved by Mexican consumers in 2005
from appliance standards

3 Energy efficiency standards and labels

Energy efficiency standards and labels have proved to be an outstanding method to reduce energy use and greenhouse gas emissions from appliances and commercial equipment. Standards mandate that all products on the market meet a certain level of energy efficiency. Labels supplement standards and push the envelope, by educating customers about the benefits of energy efficient products and encouraging them to buy more-efficient models.

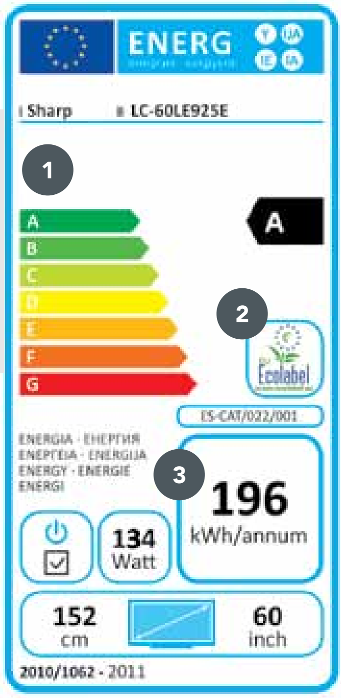
These policies not only save energy; they also help consumers save money. As of 2010, more than 1,700 appliance standards had been adopted in 78 countries around the world. In 1995, for example, the Mexican government introduced energy efficiency standards covering four major appliance classes: refrigerators, air conditioners, three-phase electric motors, and clothes washers. These standards reduced the country's electricity use by 10 percent, or more than 15 terawatt-hours (TWh), in 2005. This avoided emissions of 40 Mt of CO_2 and saved consumers $2.7 billion.[8]

China established its first energy efficiency standards in 1999; by 2008 it had enacted national standards covering 18 major types of appliances. The Chinese government increases their stringency every three to five years to reflect technological improvements and cost reductions. From 2000 to 2005, these standards lowered energy consumption by 47 TWh, reduced CO_2 emissions by 50 Mt, and saved $3.4 billion.[9] The majority of these savings, which accounted for about 5 percent of China's total annual energy consumption in 2005, came from refrigerator standards. These savings will grow quickly as the new technologies penetrate the market.

[8] I. S. Ramos et al, Instituto de Investigaciones Eléctricas and Lawrence Berkeley National Laboratory, "Assessment of the Impacts of Standards and Labeling Programs in Mexico," 2006, *www.iie.org.mx:8080/SitioGUEE/Articulos/Art13.pdf.*

[9] D. Fridley et al, Collaborative Labeling and Appliance Standards Program and Lawrence Berkeley National Laboratory, "Impacts of China's Current Appliance Standards and Labeling Program to 2020," 2007, *http://china.lbl.gov/sites/china.lbl.gov/files/LBNL-62802.pdf.*

WHAT'S IN AN ENERGY LABEL

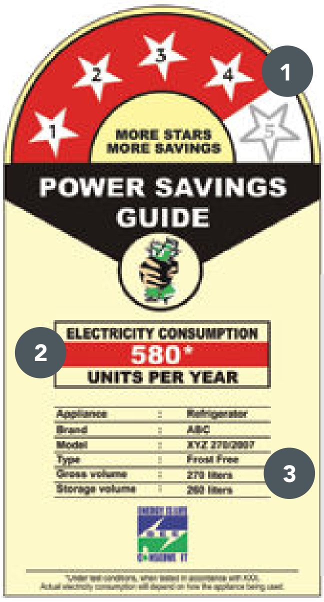


EUROPEAN UNION

1 The make and model.

2 The energy rating ranges from A, the most energy efficient, to G, the least efficient.

3 Additional information about the appliance's energy use.

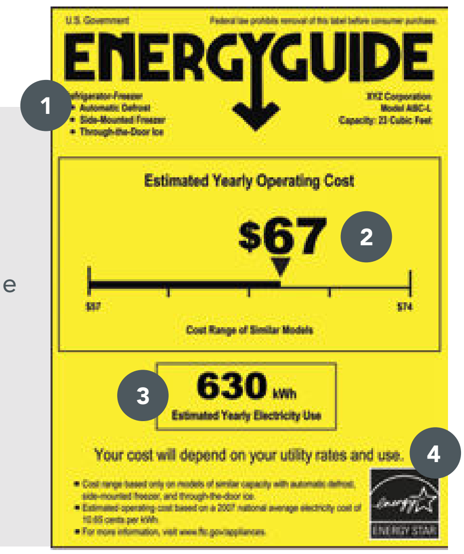


INDIA

1 The highlighted stars indicate the relative efficiency of the appliance.

2 The average amount of electricity used by the appliance in a year.

3 The make, model, size, and key features of the appliance.



UNITED STATES

1 The make, model, size, and key features of the appliance.

2 The estimated cost to run the appliance for a year; the range shows costs for similar appliances.

3 An estimate of how much electricity the appliance uses in a year.

4 Energy Star logo identifies products that use less energy than standard models.

Energy labels supplement appliance efficiency standards, educating consumers about the benefits of efficient products and enabling those who want to invest in more-efficient models to do so.

Perhaps the most dramatic example of the effectiveness of energy efficiency standards and labels is the transformation of the U.S. refrigerator market.[10] New refrigerators sold in the United States today use, on average, less than a quarter of the electricity of those sold 30 years ago, despite their increased size and added features. Appliance and equipment standards reduced total U.S. energy consumption by a cumulative 2,780 TWh from 1990 to 2005, with most of the savings coming from the residential sector. This is equivalent to taking more than 375 million cars off the road.[11] In addition, appliance and equipment efficiency standards created more than 300,000 jobs in 2010.[12]

Although such standards have been very successful in reducing energy consumption and CO_2 emissions, poorly designed policies often failed to capture a significant proportion of the available savings. This is primarily because only a relatively small number of products are covered by standards, particularly in the commercial sector. The stringency of regulations varies by country, and there is considerable room for more-ambitious targets. Aligning product standards with the best technology available and accelerating the timing of improvements in standards to comport with product cycles (about every three to four years) would significantly increase the future savings potential.

This is precisely the idea behind Japan's successful Top Runner program, introduced in 1998.[13] Under this system, officials periodically test all the products currently available in a specific market category, determine the most efficient model, and make that model's level of efficiency the new baseline for energy efficiency standards. In this "survival of the fittest" program, the best available technology becomes the new normal, which significantly promotes technology development and market transformation. The new Super-efficient Equipment and Appliance Deployment program is an international effort to quickly make the most energy efficient products available worldwide.

[10] Collaborative Labeling and Appliance Standards Program, "Effectiveness of Energy Efficiency S&L," *www.clasponline.org/WhyStandardsAndLabeling/StandardsLabelsEffectiveness.*

[11] U.S. Environmental Protection Agency, Greenhouse Gas Equivalencies Calculator, *www.epa.gov/cleanenergy/energy-resources/calculator.html.*

[12] American Council for an Energy-Efficient Economy, "Appliance and Equipment Efficiency Standards: A Moneymaker and Job Creator," 2011, *www.aceee.org/research-report/a111.*

[13] J. Nordqvist, "Evaluation of Japan's Top Runner Programme," 2006, *www.aid-ee.org/documents/018TopRunner-Japan.PDF.*

4 Clean energy supply policies

A clean, reliable, and sustainable energy supply is a *conditio sine qua non* for meeting the climate challenge and ensuring a prosperous future. Today's fossil-fuel-based power sector is a major source of CO_2 emissions: Energy-related greenhouse gas emissions totaled 29 gigatonnes (Gt), or billion metric tons, in 2009. Of that, 12 Gt, or 40 percent, is attributable to electricity generation.

Although some renewable energy technologies are already cost-competitive with new fossil fuel generation (such as onshore wind versus combined-cycle natural gas plants), policy is still needed to drive investments in clean energy and ensure that it is deployed on a massive scale. Good policy is especially important to encourage development of technologies that are close to becoming commercial as well as those that are less mature but have large potential. The knowledge gained from R&D and market deployment can accelerate technological innovations (see policy No. 10 on page 33).

As some countries start to address the planet's pressing energy and climate challenges, they are sparking a "race to the top" to reap the economic growth, job creation, and public health benefits that accompany the development of innovative clean technologies. Even in the U.S., which is arguably falling behind in this race, conservative estimates tallied more than 700,000 green jobs at the end of 2007, versus 1.3 million people employed by utilities, coal mining, and oil and gas extraction.[14] Another report estimates that the U.S. could add 4.2 million green jobs by 2038.[15] According to the International Energy Agency, however, only a few countries have implemented policies to effectively increase the penetration rate of renewable energy sources.[16] Significant potential remains to improve policy design and implementation.

[14] The Pew Charitable Trusts, "The Clean Energy Economy: Repowering Jobs, Businesses, and Investments Across America," 2009, *www.pewcenteronthestates.org/uploadedFiles/Clean_Economy_Report_Web.pdf.*

[15] Global Insight, "Current and Potential Green Jobs in the U.S. Economy," 2008, *www.usmayors.org/pressreleases/uploads/GreenJobsReport.pdf.*

[16] International Energy Agency, *Deploying Renewables: Principles for Effective Policies,* 2008, *www.iea.org/w/bookshop/add.aspx?id=337.*

Three policy instruments have been widely used to support the deployment of renewable energy sources:

- **Renewable portfolio standards** (RPSs, also known as renewable obligations) mandate a specific fraction of the electricity supply to be produced from renewable energy sources such as wind, solar, biomass, small hydro, and geothermal. RPSs generally obligate electricity suppliers to meet these requirements.

- **Feed-in tariffs** (FITs) guarantee generators a premium price for the renewable electricity they produce, along with preferential grid access and, in most cases, long-term, guaranteed purchase contracts. Typically, the obligation to purchase this electricity falls on grid operators.

- **Renewable energy tenders** are a form of auction in which developers bid for the right to build and operate renewable energy plants of a predetermined capacity. Essentially, bidders compete to enter into a power-purchasing agreement with the government at a guaranteed price and for a specific contract duration.

The experience of countries that have implemented one or more of these policies provides valuable insights.

According to Bloomberg New Energy Finance, FITs have proved extremely successful at encouraging wind and solar energy deployment, given that about 64 percent of global wind capacity and 85 percent of solar photovoltaic (PV) capacity have been built in markets subject to these rules.[17] However, their cost-effectiveness has varied. Onshore wind power FITs have demonstrated their cost-effectiveness, with Germany the model for

[17] Bloomberg New Energy Finance, "Assessing the Effectiveness of Clean Energy Policy," 2011.

85%

of solar PV capacity has been built in countries with FITs

1,700

appliance standards adopted in 78 countries

4.2M

U.S. green jobs could be created through smart energy policies by 2038 good policy design. But FITs for solar PV and other less mature technologies have proved so costly (accounting for 0.1 to 0.4 percent of a country's GDP) that most countries, including Germany, Italy, and Greece, are considering abandoning them. FITs set the price over the life of the policy; if costs go down more than anticipated by the FIT program, that price discovery or cost reduction goes straight into the pockets of investors—mainly equipment manufacturers and developers.

In contrast, by fixing the proportion of renewable energy rather than the price, RPS programs offer almost the opposite benefits and shortcomings of FITs. Although designed to set a minimum, an RPS can become a de facto cap on the share of renewable energy in a given region. Price variability and the attendant uncertainty of future cash flows can also create financing issues for renewable energy companies. This can be especially apparent during a weak or contracting economy, when energy demand is lower than anticipated. To accommodate such uncertainties, renewable energy investors demand higher margins.

These factors have made renewable energy tenders an increasingly popular policy option, especially in countries where energy prices are a politically charged issue. Argentina, Brazil, Chile, China, Egypt, Mexico, Morocco, Peru, and Uruguay have all conducted successful wind auctions. Tenders are a sound way to lower the cost of policy support for renewable energy sources. But if developers underbid and the profit margin is too tight, they may fail to deliver the contracted capacity. This is a typical example of "winner's curse."

Successful renewable energy policies have two elements: They let the market find the price, and they ensure that the contracts are long-term and stable, so that developers can mobilize capital at a reasonable rate. These conditions can be built into all three renewable energy policies—but, likewise, any of them can fail on this front. Other approaches, such as power plant performance standards that establish a ceiling on CO_2 emissions per kilowatt-hour (kWh) that becomes more stringent over time, can also be very effective.

5 Utility-scale energy efficiency programs

What would motivate utilities, which make money when they sell gas and electricity, to reduce demand for energy? In most cases they don't have any economic incentive to do so. But utility-scale energy efficiency is a cheap, vast, and largely untapped economic opportunity to save money and direct it toward more-efficient uses—and good policy can unlock that potential.

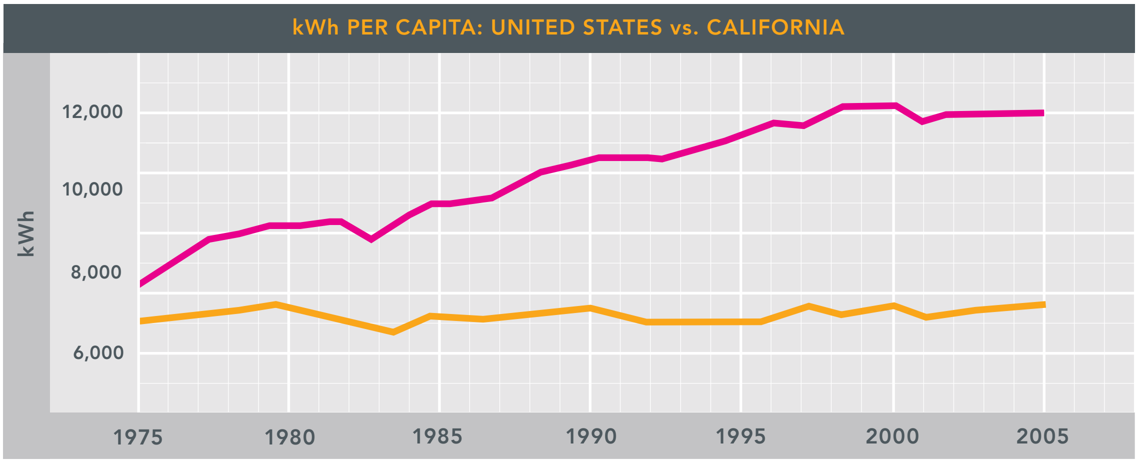
In a regulated market, utilities' earnings are typically based on the amount of capital invested in generation and transmission assets and the volume of electricity sold. To encourage utilities to promote and invest in energy efficiency, regulations must be revised to "decouple" utility profits from sales of electricity. One way to accomplish this is to allow utilities to earn a return on energy efficiency investments that is equal to or greater than their return on generation- or transmission-related investments. Alternatively, utilities can be rewarded for meeting certain efficiency targets. For example, they could be allowed to keep a fraction of the economic benefits realized from energy savings. Along with incentives, fines should be introduced to penalize utilities that perform poorly or fail to implement concrete energy-saving measures.

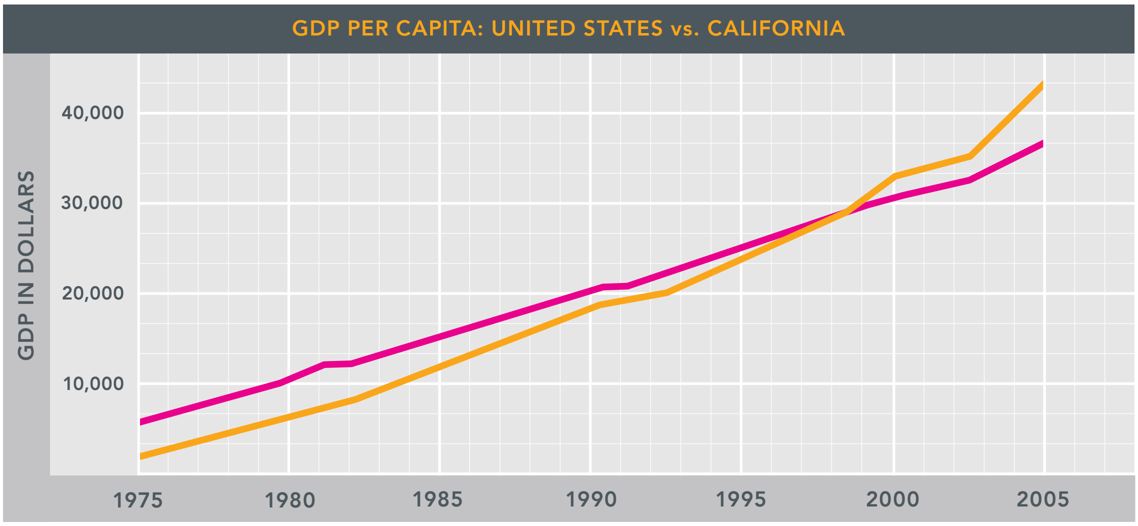
As of 2009, 17 U.S. states had implemented decoupling mechanisms, covering 28 natural gas distribution utilities and 12 electric utilities.[18] One of the most formidable and long-standing examples of decoupling is in California, where per capita energy use has remained flat since 1978, when the policy was introduced, versus an increase of 50 percent in the rest of the country.

In November 2010 China adopted a policy that requires utility companies to spend a portion of their revenues on large-scale energy efficiency programs to reduce energy sales by at least 0.3 percent per year. This program is projected to save approximately 10 Mt of CO_2 and 11 billion kWh each year.

[18] National Renewable Energy Laboratory, "Decoupling Policies: Options to Encourage Energy Efficiency Policies for Utilities," 2009, *www.nrel.gov/docs/fy10osti/46606.pdf.*

DECOUPLING AND EFFICIENCY PROGRAMS SAVE ENERGY AND MONEY





LEGEND

United States — California

Since the mid-1970s, California's per capita electricity consumption has remained nearly constant, while U.S. use has risen roughly 50%. By 2005, Californians used 43% less electricity per person than the national average. This efficiency did not hamper economic growth; during the same period, California's per capita GDP grew faster than that of the U.S.

Source: *Science* magazine, California Energy Commission

75%

less energy used by new U.S. refrigerators, compared with 30 years ago

400Mt

CO_2 emissions avoided by China's Top 1,000 industrial efficiency program, 2006–2010

$300B

spent on fossil fuel subsidies in 2010

6 Industrial energy efficiency programs

The industry sector, including production of iron and steel, cement, chemicals, fertilizers, and paper, is responsible for nearly a third of the world's energy consumption and roughly 36 percent of global CO_2 emissions. It also employs a large percentage of the world's labor force. Those countries that are first to develop clean industrial technologies and processes will win the race to the top, garnering clean jobs, economic growth, and improved public health from reduced pollution.

An effective way to reduce industrial greenhouse gas emissions is to regulate the energy efficiency of ubiquitous, standardized equipment such as electric motors, pumps, and compressors. Most countries that enforce appliance standards have also adopted standards for industrial equipment, but policy improvements could make significant additional progress by establishing widespread, stringent efficiency standards for industrial processes and equipment.

One very successful example is China's Top 1,000 Energy-Consuming Enterprises Program. In 2005 China announced an ambitious goal: It would reduce its energy intensity, or the energy used per unit of GDP, by 20 percent between 2005 and 2010. To help meet that goal, it targeted the companies that used the most energy. In 2004 the top 1,000 manufacturers accounted for a third of the nation's energy use and almost half of the industry sector's consumption.

The Top 1,000 Program employs sticks and carrots to improve companies' energy performance. If a factory doesn't meet its goals, its managers and even local officials can be penalized. The government also offered financial incentives and technical assistance to phase out inefficient equipment and processes. From 2006 to 2010, the Top 1,000 Program saved almost 400 Mt of CO_2 emissions, equal to the total emissions of other large nations,[19] and contributed approximately 10 to 25 percent of the savings needed to meet China's energy intensity goal. Many aspects of this approach can be replicated in other countries.

[19] *Energy Policy* 38, no. 11, November 2010.

7 Effectively enforced building codes

A large share of the world's energy is used in buildings to control the temperature and power appliances, lighting, and other equipment. While appliances and equipment are typically replaced every few years, buildings last for decades or even centuries. Poorly designed, leaky homes and offices can lock in high energy demand for a long time, so building them right is crucial.

Many barriers hamper the inclusion of energy efficient features in new and existing buildings.[20] When buildings are designed and built, developers focus on construction costs, with very little concern for operating costs, since they won't be responsible for the utility bills. This "split incentive" means that, absent a strong code or effective retrofit programs, buildings tend to waste a great deal of energy.

Building codes can be made smarter by including certain provisions, such as automatically incorporating additional features as they become cost-effective. For example, a code could mandate "rolling in" all energy efficiency improvements whose increased up-front costs will be recouped through energy savings within a predetermined payback period (say, seven years). In California, which has such a provision, the Energy Commission estimates that the state's building efficiency standards have saved more than $56 billion in electricity and natural gas costs since 1978 and will save an additional $23 billion by 2013. New buildings in California use 80 percent less energy than those built before the code was enacted.

Because many actors with divergent interests are involved in the buildings sector, code compliance can be a challenge in developed and developing countries alike. A system of enforcement and penalties must be in place for any mandatory building code to be effective.

Retrofit programs, often administered through utilities or cities, can also slash the energy used by homes and other buildings, save money, and create numerous local jobs.

[20] International Energy Agency, "Energy Efficiency Requirements in Building Codes, Energy Efficiency Policies for New Buildings," 2008, *www.iea.org/g8/2008/Building_Codes.pdf.*

8 Properly aligned economic incentives

To have a 50-50 chance of limiting the rise in average global temperatures to 2° C, the world must reduce CO_2 emissions from energy use by approximately 7 Gt by 2020 compared with business-as-usual levels. Well-designed climate policies—such as establishing a carbon cap or ending perverse economic incentives—can help reach that goal. Eliminating fossil fuel subsidies, for example, would provide almost a third of that reduction (1.5 to 2 Gt) by 2020, according to the International Energy Agency (IEA).

In 2010 governments worldwide spent more than $300 billion to subsidize fossil fuels.[21] If these subsidies were abolished, the IEA estimates that global energy demand would drop by 5 percent; this reduction is equal to the combined energy consumption of Japan, Korea, and New Zealand. In addition, the money that currently subsidizes fossil fuels could be shifted to fund energy efficiency improvements, clean energy development, and other societal benefits.

The case against fossil fuel subsidies is straightforward and overwhelming.[22] First, subsidies encourage inefficient energy use. Second, in countries that produce oil and gas (Iran, Saudi Arabia, and Russia, for example), subsidizing home markets translates into a loss of export revenue. Third, although subsidies are often justified in terms of helping the poor, the lion's share of the benefits—85 to 90 percent—typically accrue to middle-income and wealthy consumers, since the poor typically do not use a lot of energy and rarely drive. A better strategy is under development in India, where subsidies will be targeted to individuals.

Finally, the argument that subsidizing fossil fuels stabilizes prices within a country even as they rise on the international market is tenuous, since damping volatility in sheltered markets only increases it in open ones—and even in sheltered markets, global price increases will eventually take their toll. As the IEA points out, 95 percent of the current growth in oil demand is coming from countries where the oil price is subject to subsidies.

[21] IEA, World Energy Outlook, 2010.

[22] "Green View: How to Save $300 Billion," *The Economist*, 12 November 2010, www.economist.com/blogs/newsbook/2010/11/fossil-fuel_subsidies.

9 Smart urban design

Over the next 15 years, more than a billion people worldwide are projected to move from rural to urban areas.[23] Hundreds of cities will need to be built or expanded to accommodate this migration. The dangers of unplanned urban expansion, including gridlocked roads and heavily polluted skies, are already visible in the world's fastest-growing megacities. How cities are planned and built will help determine whether the world succeeds in addressing its energy, climate, and development challenges. With the right policies in place, high-density cities can minimize their use of limited natural resources, reduce their environmental impact and greenhouse gas emissions, and attract the high-tech businesses and top-notch talent that are crucial to economic growth.

An international team of urban planning experts has identified eight principles of sustainable urban development[24] that can create prosperous, livable, low-carbon cities:

1. Develop neighborhoods that promote walking.

2. Prioritize bicycle networks.

3. Create dense networks of streets and paths.

4. Support high-quality transit.

5. Zone for mixed-use neighborhoods.

6. Match density to transit capacity.

7. Create compact regions with short commutes.

8. Increase mobility by regulating parking and road use.

[23] United Nations Department of Economic and Social Affairs, "World Urbanization Prospects, the 2009 Revision," *http://esa.un.org/unpd/wup/doc_highlights.htm.*

[24] ClimateWorks Foundation, "Planning Cities for People: A Guide to Prosperous, Low-Carbon Urbanization," 2011, *www.climateworks.org/PlanningCities.*

5%

of subway construction cost will pay for a BRT system

1B

people migrating to cities in the next 15 years

$56B

saved by California's building efficiency standards since 1978

These principles have a proven track record. Affluent cities including Hong Kong, New York City, and Singapore have the densest public transit networks in the world. While subways and light rail can be an integral part of a transit network, many cities are turning to bus rapid transit (BRT) for its low cost, quick implementation, and flexible routes. A good BRT system can run at the same speed and capacity as a metro system—and can be built for 5 to 10 percent of the cost.[25]

In China, for example, the Guangzhou BRT took just nine months to build. It opened in early 2010 and already carries 800,000 passengers per day. The Seoul Metropolitan Area BRT system, which launched in 2004, improved bus speed and reliability; boosted ridership; and reduced accidents, traffic jams, fuel use, and pollution. By replacing older, polluting buses and providing a convenient alternative to private car use, Mexico City's Metrobus system eliminates an estimated 100,000 tonnes of CO_2 equivalent emissions per year. And the BRT in Johannesburg, South Africa, avoided almost 400,000 tonnes of CO_2e emissions from 2009 to 2010.

Other cities encourage alternate modes of transit by discouraging driving. London, Hamburg, and Zurich, for example, restrict parking in popular destinations served by public transit. Singapore's Electronic Road Pricing system has cut congestion and raised money for public transit and other uses.

Eliminating fossil fuel subsidies would provide almost a third of the CO_2 emissions reduction needed by 2020.

[25] C. Hughes and X. Zhu, Institute for Transportation and Development Policy, "Guangzhou, China, Bus Rapid Transit—Emissions Impact Analysis," 2011.

10 Support for R&D and innovation

Governments can and should play a key role in accelerating energy innovation.[26] Policy support for energy research and development is needed for two reasons: First, innovations in energy technology can generate significant, quantifiable public benefits that are not reflected in the market price of energy. Second, the energy business requires investments of capital at a scale that is beyond the risk threshold of most private sector investors. This high level of risk, combined with existing market structures, impedes replacement of energy equipment. A slow turnover rate exacerbates the historic dearth of investments in new ideas, creating a vicious cycle of status quo behavior. The government must therefore act to spur investments in energy innovation and mitigate risk for large-scale energy projects.

The main purpose of R&D investment is to make new technologies affordable. The cost of solar photovoltaic cells, for example, has dropped by about 22 percent with each doubling of capacity. But falling prices are not a foregone conclusion; support for the following three basic phases of technology development is required:

- **Basic scientific research.** Many of the most urgently needed innovations depend on fundamental advances in biology, chemistry, materials science, or thermodynamics. For example, grid-scale energy storage would make renewable power far more useful, but making it affordable will require fundamental advances in electrochemistry. Today's basic science research will provide the foundation for tomorrow's energy technologies.

[26] American Energy Innovation Council, "A Business Plan for America's Energy Future," 2010, *www.americanenergyinnovation.org/full-report.*

- **Engineering.** The engineering phase converts science into workable products. This includes making a new technology easy to manufacture, scaling up production, integrating it into existing systems, and constructing large, first-of-a-kind pilot projects.

- **Commercialization.** Manufacturers must foresee large-scale, long-term markets for a new technology. For example, renewable portfolio standards created the demand required to drop the cost of wind power from 40 cents per kilowatt-hour to 8 cents.

Support for R&D will provide a pipeline of inventions and drive market adoption of new technologies, but sufficient market demand for these inventions will only materialize if a comprehensive suite of smart energy policies is in place. A strong market signal will increase the intensity of energy research, add large private sector commitments, reduce barriers between the lab and market, and ensure technologies perform better and cost less over time. A price or cap on CO_2, a renewable energy portfolio requirement, and technology performance standards can all contribute to the success of policies that support innovation and R&D.

The first countries to develop clean energy technologies will win the race to the top, garnering jobs, economic growth, and improved public health from reduced pollution.

Accelerating smart policies

Designing effective energy policies requires great technical expertise, sound economic analysis, a good understanding of international results, and deep local knowledge. Badly designed energy policies will not achieve vital climate goals, but they will absorb time, political capital, and institutional resources. What's more, bad policies will quickly gather benefiting industries and adherents to defend them, so further political capital would have to be expended for any reform. The United States, for example, designed its vehicle fuel efficiency standards so that they plateaued within 10 years—and then got stuck there for another 25 years, wasting vast amounts of oil and cash.

To make matters more complicated, even good policy design is not static. The German feed-in tariff, for example, was best in class when it was introduced, but India's approach includes a great improvement: an auction to find the proper subsidy.

Although these challenges are real, the benefits of good policy design are profound. Given the state of global greenhouse gas emissions, the time for that design is very short. For such an effort to succeed, it must be guided by an intense, focused mission: Get the most important policies adopted and enforced, and do it quickly.

The ClimateWorks Network created the Policies That Work series to accelerate and facilitate this process. These reports will provide high-level policymakers with an analytical tool kit and relevant data to design, evaluate, adopt, and implement the most effective climate policies. Done well, these policies will also reduce urban congestion, create livable cities, improve public health, and boost economic competitiveness. This job must get done, or the world will not reach a reasonable climate future.

THE CLIMATEWORKS NETWORK

Regional Climate Foundations

The **China Sustainable Energy Program** (CSEP) supports China's transition to a sustainable energy future by promoting energy efficiency and renewable energy.

The **Climate and Land Use Alliance** (CLUA)—a collaborative initiative of the ClimateWorks, David and Lucile Packard, Ford, and Gordon and Betty Moore Foundations—works in Indonesia and Brazil to support the potential of forests and other land to provide climate, socioeconomic, and ecological benefits.

The **Energy Foundation** works in the United States to advance new energy technologies that enable economic growth with far less pollution.

The **European Climate Foundation** (ECF) promotes climate and energy policies that greatly reduce Europe's greenhouse gas emissions and helps Europe play an even stronger international leadership role in mitigating climate change.

ClimateWorks' **Latin America Program** works with the William and Flora Hewlett Foundation and others to provide analytical support for sector-specific policies that grow Latin American economies while reducing greenhouse gas emissions.

The **Shakti Sustainable Energy Foundation** (Shakti) is helping to build a secure future for India's citizens by supporting policies that promote energy efficiency, sustainable transportation, and renewable energy.

Best Practice Networks

The **Collaborative Labeling and Appliance Standards Program** (CLASP) promotes appliance energy standards and labels that save consumers money, reduce power demand, and lower greenhouse gas emissions.

The **Global Buildings Performance Network** (GBPN) focuses on the design, implementation, and enforcement of building codes for new buildings, as well as retrofits of existing buildings.

The **Institute for Industrial Productivity** (IIP) provides analytical and research support for policies that reduce carbon emissions from industrial practices and improve companies' productivity.

The **Institute for Transportation and Development Policy** (ITDP) promotes sustainable, equitable transportation policies that offer alternatives to driving, reduce local air pollution, and limit carbon emissions.

The **International Council on Clean Transportation** (ICCT) provides regulators unbiased technical support, research, and analysis to improve the environmental performance and efficiency of vehicles and fuels.

The **Regulatory Assistance Project** (RAP) focuses on the long-term economic and environmental sustainability of the power sector; its global experts provide technical and policy assistance to government officials on a broad range of energy-related issues.

The ClimateWorks Foundation supports public policies that prevent dangerous climate change and promote global prosperity.

ClimateWorks' goal is to limit annual global greenhouse gas emissions to 44 billion metric tons by the year 2020 (25 percent below business-as-usual projections) and 35 billion metric tons by 2030 (50 percent below projections).

These ambitious targets require the immediate and wide-spread adoption of smart energy and land use policies. ClimateWorks partners with an international network of affiliated organizations—the ClimateWorks Network—to promote these policies in the regions and sectors responsible for most greenhouse gas emissions.

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