WORLD BANK GROUP

livewire

A KNOWLEDGE NOTE SERIES FOR THE ENERGY & EXTRACTIVES GLOBAL PRACTICE

2016/55

THE BOTTOM LINE

Industry accounts for approximately 30 percent of global final energy consumption and a similar share of CO2 emissions. Its total energy intensity could be reduced by about 25 percent by modernizing technology, particularly in developing countries. The main barriers to achieving broad energy efficiency gains are insufficient information; difficulty obtaining financing; and, in many developing countries, insufficient capacity for identifying, preparing, and delivering projects. A well-designed national industrial energy efficiency program should include clear policy goals linked to tangible targets; a range of policy instruments to guide and encourage action; and measures to build implementation capacity and facilitate financing.

Feng Liu is a senior energy specialist in the World Bank's Energy and Extractives Global Practice.

Robert Tromop is a senior energy efficiency consultant.

Designing Effective National Programs to Improve Industrial Energy Efficiency

Why is industrial energy efficiency a priority?

Even minor adjustments to industrial processes have high impact, yielding large gains with minimal effort

Increasing industrial energy productivity is essential to doubling the global rate of improvement in energy efficiency, one of the three objectives of the Sustainable Energy for All initiative. Worldwide, industry accounts for approximately 30 percent of final energy consumption and for a similar share of carbon dioxide (CO2) emissions. By 2050, population growth and economic development in developing countries could increase demand for raw materials by between 45 and 60 percent (relative to 2010). Unless energy efficiency is rapidly accelerated, industrial emissions of CO2 could rise 50 to 150 percent by 2050, substantially affecting global efforts to mitigate climate change (IPCC 2014).

Industrial energy efficiency is closely linked to the economic competitiveness of countries with significant manufacturing bases and to the energy security of countries that rely heavily on imported energy. For individual enterprises, improving energy efficiency strengthens the bottom line, often reducing direct energy costs by 10 to 30 percent (http://www.iipnetwork.org/IEE).

Are there major opportunities to improve industrial energy efficiency?

Huge improvements can be made where technologies are outdated and new capacity is just being developed

Worldwide, the greatest opportunities to improve industrial energy efficiency are found in countries outside the Organisation for Economic Co-operation and Development (OECD), particularly in Asia (table 1). Some emerging economies already have large industrial bases (for example, China, India, and Turkey), some have a legacy of outmoded and inefficient plants (notably the nations of the former Soviet bloc), and some have ambitions for industrialization (for example, Vietnam, Uzbekistan, and nations in Sub-Saharan Africa). The potential for industrial energy efficiency is already evident: China's rapid improvements in the energy intensity of the gross domestic product highlight the dual role of energy efficiency in increasing economic productivity while reducing energy demand.

Although most analyses of the potential of industrial energy efficiency have focused on energy-intensive industrial processes, substantial opportunities exist in small and medium enterprises (SMEs), where most countries have the bulk of their manufacturing employment and GDP productivity. Figure 1 shows the expected capacity growth in energy-intensive industries and also highlights that the largest growth in non-OECD economies lies in the category of "other industries," which tend to be less energy intensive and distributed across larger areas than the energy-intensive production

"Worldwide, the greatest opportunities to improve industrial energy efficiency are found in countries outside the OECD, particularly in Asia."

Table 1. Estimated need for global investment in energy efficiency, 2012–35

	OECD			Non-OECD		
	Additional investment ($ trillion)	Energy savings (Mtoe)	Fuel cost savings ($ trillion)	Additional investment ($ trillion)	Energy savings (Mtoe)	Fuel cost savings ($ trillion)
Industry	0.4	668	1.2	0.7	3,482	2.2
Transport	1.6	1,121	3.0	3.2	2,731	2.7
Buildings	3.2	3,478	5.9	1.4	3,704	1.7
Total	5.3	5,267	10.0	5.2	9,917	6.6

Source: IEA 2012.

Note: Mtoe = million ton oil equivalent; OECD = Organisation for Economic Co-operation and Development.

DSM = demand-side management; ESCO = energy service company

of iron and steel, cement, chemicals, and pulp and paper. Future efforts to improve industrial energy efficiency should focus on this category.[1]

Investments in industrial energy efficiency typically focus on renovation or new capacity. Renovation involves the replacement of particular pieces of equipment (old boilers, inefficient motors, and so on) or other improvements (for example, the recovery of waste heat) that do not fundamentally change production technologies or substantially alter production capacity. Reducing energy costs (and thus improving energy efficiency) is usually the primary driver of such investment. Developing new capacity, on the other hand, involves the replacement of existing production facilities or the installation of new production capacity for the same or new products through improved or new technologies. Here, energy efficiency is only one of the many factors considered in investment decisions.

[1] Upstream industrial production—ranging from mining and extraction to the production of raw materials such as glass, cement, steel, and petrochemicals—is particularly energy intensive (that is, a lot of energy is consumed per unit of value added), relatively concentrated (a small number of countries account for a large portion of global output), and highly polluting. Mid-stream and downstream industrial production covers a wide spectrum of products, from machine tools to consumer goods to textiles and processed foods. Compared with the production of raw materials, these processes tend to be substantially less energy intensive and more evenly distributed geographically.

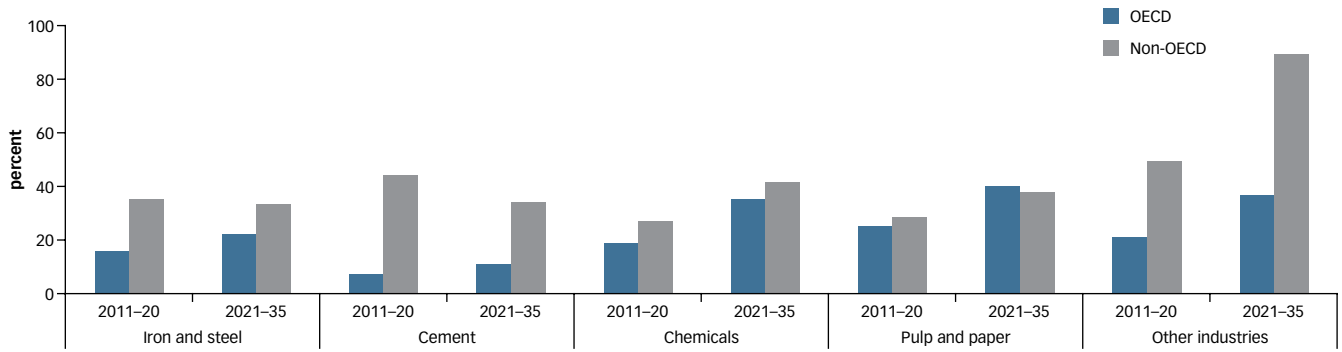
Is there a need for government intervention in industrial energy efficiency?

Yes, limited and careful intervention ensures that common barriers will not hamper the achievement of long-term goals

In a market economy, industrial enterprises respond to market signals, such as energy prices. Government intervention in enterprise investment decisions should be limited to ensuring that market principles are operative; more intrusive measures, such as mandatory standards or performance requirements, should be kept to a minimum.

Market failures or barriers often prevent the implementation of financially viable investments in industrial energy efficiency, investments that typically require the alignment of several important factors. These factors include information on existing inefficiencies, appropriate interventions, and estimated returns on investment, as well as the willingness of financiers to provide needed capital. Since the alignment of these factors depends on the decisions and actions of multiple stakeholders (including industrial enterprises,

Figure 1. Growth in capacity in energy-intensive and other industries, 2011 and forecasted



Source: IEA 2012.

Note: Includes replacements of currently existing capacity. OECD = Organisation for Economic Co-operation and Development.

"The role of the government is to facilitate or even to mandate the removal of impediments to successful investment in energy efficiency. Carefully calibrated interventions can address local and global environmental concerns while generating social and economic benefits."

providers and suppliers of energy services and technologies, and financiers), it is not easy to implement projects to improve industrial energy efficiency. Table 2 provides a broad review of market barriers, grouped into two main categories, as follows:

- *Knowledge, capacity, and incentive barriers.* These may arise where enterprises have not developed a knowledge base for their own energy use or are overly focused on growth or market share; where there is a dearth of service providers offering expert advice or data on the energy performance of various technologies, processes, and equipment; or where energy is perceived as a fixed cost.
- *Finance barriers.* These may arise where financiers misperceive risks and returns for lack of familiarity with energy efficiency measures and technologies; where the transaction costs of relatively small investments are high; or where there is general risk aversion surrounding SMEs.

The role of the government is to facilitate or even to mandate the removal of these impediments to successful investment in energy efficiency. Carefully calibrated interventions can address local and global environmental concerns while generating social and economic benefits.

How can barriers to energy efficiency be best overcome?

Barriers can be lowered by reinforcing market principles and institutions

Those developing countries and economies in transition that have achieved significant and consistent improvements in industrial energy efficiency over the past two decades (for example, China) have made deliberate efforts to pursue market reforms and to pilot, demonstrate, and scale up policy interventions. Meanwhile, highly developed industrial economies, such as Japan and the Netherlands, have made efforts to encourage, facilitate, and at times mandate industries to achieve significant long-run improvements in energy efficiency.

"Developing countries and economies in transition that have achieved significant and consistent improvements in industrial energy efficiency over the past two decades have made deliberate efforts to pursue market reforms and to pilot, demonstrate, and scale up policy interventions."

National energy efficiency agendas must be underpinned by relevant legislation, institutions, and broad-based market principles (for example, energy prices set at cost-recovery levels). Governments may choose among a broad set of policy instruments and implementation support systems to address the barriers faced by market participants. Instruments include minimum energy performance standards for broadly used energy-consuming equipment (for example, boilers and electric motors); voluntary or mandatory energy savings agreements with large energy users; requirements for energy audits and energy managers (again for large energy users); tax incentives (for example, for the installation of efficient equipment); incentive grants tied to verified energy savings; special assistance to SMEs (for example, grants or in-kind assistance for energy audits and project development); assistance in establishing energy-management systems; information and training programs; and assistance in the development of energy service companies (ESCOs) and in the facilitation of commercial financing for industrial energy efficiency. Appendix 1 provides examples of government efforts to facilitate industrial enterprises, undertake cost-effective energy efficiency investments, and increase access to finance.

Table 2. Barriers to implementing energy efficiency projects in the industrial sector

	Industrial energy users	Energy service or technology providers	Financiers
Knowledge, capacity, and incentive barriers	• Excessive management focus on short-term benefits such as sales revenue and growth • Low energy efficiency benefits relative to other costs and priorities • High perceived risks of new technologies or systems • Lack of credible data and information needed for decision making • Inadequate technical and financial expertise • Poor access to energy-efficient technologies and relevant services	• Limited demand for energy efficiency services and technological innovations • New contractual mechanisms (for example, energy savings performance contracts) that may increase business risks • Limited technical, business, and risk-management skills • Poor communication with bankers	• Lack of information on energy-efficient technologies and their benefits • Lack of customized financial products and appraisal procedures • Lack of capacity for measurement and verification • Limited understanding and capacity among loan officers and risk managers
Financial barriers	• High up-front capital costs, usually for energy-intensive industries • High borrowing costs and limited access to financing, especially for SMEs • Expectation of a high return on investment (quick payback) • High project development and transaction costs relative to project size, particularly for SMEs	• High project-development costs • Limited access to financing and equity	• High transaction costs associated with small and widely dispersed energy efficiency projects • Competition for capital from other high-return, low-risk business opportunities • Financial risks associated with SMEs, including energy service companies

Source: Authors.

Note: SMEs = small and medium enterprises.

"Governments should take a leadership role by analyzing how energy drives productivity and how improvements in energy efficiency can increase the bottom line."

What have we learned?

Better information, better incentives, and better financing packages will encourage investments in energy efficiency

Overcoming information barriers. Information barriers can be overcome by innovative learning networks, energy-management techniques, and tools such as audits, standards (for example, ISO 50001), benchmarking, and technical programs that are embedded in new learning processes in businesses. The first step is to convince businesses to invest in these information tools, which are necessary to generate demand for energy efficiency and associated investments.

Energy efficiency continues to be undersold and undervalued. Although it brings clear benefits related to energy productivity, and in turn to human health, economic growth, and the environment, better outcomes in these areas are rarely considered in business cases or in the evaluation of energy efficiency policies and measures.

Coordinating and cooperating to address incentive and capacity gaps. Alone, none of the available policies and measures can advance energy efficiency. Substantial results require a strategic mix of policies and measures. Countries that have been successful in implementing energy efficiency improvements have done so over time through carefully calibrated actions.

Cooperation among governments, utilities, financial institutions, and industries is necessary to create a critical mass of capabilities and resources. Governments should take a leadership role by analyzing how energy drives productivity and how improvements in energy efficiency can increase the bottom line. Establishing relevant governance frameworks is a necessary first step; these frameworks will ensure that programs can be sustained to achieve long-term benefits.

Utilities can make energy efficiency gains both by ensuring that the price of delivering energy to consumers reflects its cost, and by applying their substantial technical, marketing, and commercial resources. If energy price subsidies are not addressed, other policies may be ineffective, so identifying ways to shift to less distorting policy options is an important step.

Enabling energy efficiency finance. Current investments in global energy efficiency, estimated at $300 billion per year, are small compared with global capital resources of $300 trillion.

The challenge is to package financing so as to make it more accessible. Steps include addressing the gulf between the business and finance spheres with technical assistance, enabling local banks to act as project integrators, and developing local banks' abilities to manage risk and uncertainty.

International finance institutions (IFIs) are already making progress in designing instruments that integrate technology assistance with the financing of energy efficiency. Among other relevant efforts, they offer a range of risk-sharing and -mitigation options and conduct operations via local banks—all of which can ease the pain of accessing finance.

How can IFIs help governments scale up investment in industrial energy efficiency?

IFIs can assist governments in developing effective policy instruments to promote industrial energy efficiency

IFIs can support governments, industries, and suppliers in developing solutions for industrial energy efficiency that promise benefits for all. Successful programs are embedded in a supportive policy environment and sustained by private sector capabilities. Necessary elements include governance capability and a supportive fiscal context, utility programs, and sound operational policies. If one element is missing, its absence can easily undermine the operation of the others. For example, relevant policies are unlikely to be successful if energy prices are subsidized or if utilities have an incentive to sell more and more energy regardless of efficiency.

Recent experiences in both industrial and emerging economies underscore the importance of national governments in removing barriers to the knowledge, incentives, capacity, and finance needed to scale up investments in industrial energy efficiency. A well-designed national industrial energy efficiency program has clear policy goals linked with tangible energy efficiency targets and a range of policy instruments to guide and encourage action, facilitate financing, and

"International financial institutions can support governments, industries, and suppliers in developing solutions for industrial energy efficiency that promise benefits for all."

build the implementation capacity of market participants. A portfolio of policies and measures to realize an economy's industrial energy efficiency potential might be realized by:

- *Setting ambitious, yet realistic, national energy efficiency targets* that are based on a sound understanding of energy efficiency gaps, cost-effective investment opportunities, and available resources. Examples include China's energy intensity reduction target and the European Union's 20-20-20 targets.
- *Developing sector-specific programs and underlying core policy instruments* that can deliver the contribution of industries toward achieving national energy efficiency targets. Examples include China's 10,000 Enterprise Program, which is based on mandatory energy savings agreements, India's Perform Achieve Trade scheme, and the national energy efficiency action plans adopted by EU member countries.
- *Developing supplementary policies and implementation-support systems*, such as requirements and support for enterprise energy managers, energy audits and energy management, facilitation for commercial bank financing, support for energy-performance contracting, and support for training and information dissemination.

IFIs could thus help promote comprehensive approaches to industrial energy management by (i) assisting governments in developing and deploying appropriate policy instruments, (ii) leveraging local banks' financing and building their capacity, (iii) supporting the development of energy service markets and energy efficiency supply chains, and (iv) helping industrial enterprises identify opportunities to improve energy efficiency.

References

Forster, Hillary Jane, Patrick Wallace, and Nicolas Dahlberg. 2013. *2012 State of the Efficiency Program Industry—Budgets, Expenditures, and Impacts.* Boston, MA: Consortium for Energy Efficiency. http://library.cee1.org/sites/default/files/library/10533/CEE_Annual_Industry_Report.pdf.

IEA (International Energy Agency). 2012. *World Energy Outlook*. Paris: IEA.

———. 2013. *Energy Efficiency Market Report 2013*. Paris: IEA. http://www.iea.org/bookshop/460-Energy_Efficiency_Market_Report_2013.

———. 2014. Energy Efficiency Market Report 2014. Paris: IEA.

IPCC (Intergovernmental Panel on Climate Change). 2014. *Climate Change 2014: Mitigation of Climate Change.* Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. United Kingdom: Cambridge University Press. http://mitigation2014.org/report/publication/.

Kato, T., J. Ellis, P. Pauw, and R. Caruso. 2014. "Scaling Up and Replicating Effective Climate Finance Interventions." http://www.oecd.org/env/cc/Scaling_up_CCXGsentout_May2014_REV.pdf.

Tanaka, K. 2011. "Review of Policies and Measures for Energy Efficiency in Industry Sector." *Energy Policy*. http://linkinghub.elsevier.com/retrieve/pii/S0301421511005933.

The task team leader for the Energy Efficiency Outreach activity within the World Bank's Europe and Central Asia region is Kathrin Hofer. That activity is sponsored by the Energy Sector Management Assistance Program, a multidonor technical assistance trust fund administered by the World Bank and cosponsored by 13 official bilateral donors. The authors acknowledge the assistance of the following peer reviewers: Ashok Sarkar (senior energy specialist, GEEDR), Ivan Jaques (senior energy specialist/ESMAP) and Jonathan Davidar (knowledge management officer, GEEDR).

Appendix 1. Examples of government interventions that address barriers related to knowledge, capacity, incentives, and finance

Energy savings targets (national or sector targets underpinned by specific actions) and energy savings agreements (with a group of enterprises or individual enterprises)

China

A binding national energy efficiency target was included in the Five-Year National Social and Economic Development Plan set up in 2006. The implementation of the target was underpinned by the Top 1,000 Enterprises Program from 2006 through 2010 and was further scaled up to the Top 10,000 Enterprises Program from 2011 to 2015. Among the key features of the Top 10,000 program are energy savings agreements in which specific energy savings targets are set for individual enterprises over the plan period. Achievement of such targets is supported by a range of initiatives. http://iepd.iipnetwork.org/policy/top-10000-energy-consuming-enterprises-program.

India

Perform Achieve Trade (PAT) is a market-based trading scheme suited to the Indian business context. The PAT scheme targets energy consumption reductions of 6.6 million tons of oil equivalent (Mtoe) in 478 covered facilities in the aluminum, cement, chlor-alkali, fertilizer, iron and steel, pulp and paper, textiles, and thermal power industries. The scheme establishes plant-specific targets rather than sectoral targets, with the average target being a 4.8 percent reduction. Facilities making reductions in excess of the mandatory targets receive "energy saving certificates" that can be banked for future use or traded to facilities having trouble meeting targets. http://iepd.iipnetwork.org/policy/perform-achieve-trade-scheme-pat-scheme.

Japan

Mandatory energy efficiency targets were introduced by the Act on the Rational Use of Energy (amended in April 2010) in the form of benchmarks that were spelled out in secondary legislation. The act also introduced a 1 percent annual energy-efficiency-improvement obligation for all businesses. Medium- (2015) and long-term (2020) targets for designated sectors (steel, electricity, cement, paper and pulp, oil refining, and chemicals) were set at the energy efficiency levels of the best-performing companies in that industrial subsector (top 10–20 percent). The benchmarks were based on sector studies and negotiated between the government and private sector. http://iepd.iipnetwork.org/policy/mandatory-energy-efficiency-benchmarking-industry.

The Netherlands

Introduced in 2009, the Long-term Agreement on Energy Efficiency was negotiated between the government and enterprises under the EU emissions trading system. Participating companies were required to develop an energy efficiency plan and to implement all profitable measures (those with payback periods of five years or less). http://iepd.iipnetwork.org/policy/long-term-agreement-energy-efficiency-eu-ets-enterprises-lee.

European Union

20/20/20 targets require member states to achieve 20 percent energy efficiency improvements by 2020, against a defined baseline. EU member states are required to prepare and implement a national energy efficiency action plan geared to achieve EU energy efficiency targets. For large industrial energy users in EU member states, energy efficiency investments are primarily driven by the EU emissions trading system. http://ec.europa.eu/europe2020/index_en.htm.

Capacity building for industries, including assistance in energy audits and the establishment of energy management systems

Canada

The Industry Program for Energy Conservation is a longstanding partnership between private industries and the Canadian federal government. It counts 1,400 companies and trade associations as partners. The program includes sector task forces, a cost-shared assistance program for ISO 50001 implementation pilots, process integration studies, industry networking, and customized energy efficiency workshops. http://www.nrcan.gc.ca/energy/efficiency/industry/cipec/5153.

Germany

Learning Energy Efficiency Networks support innovative companies in their efforts to increase energy efficiency and improve their own competitive position. Companies cooperate to save energy

MAKE FURTHER CONNECTIONS

Live Wire 2014/11. "Designing Credit Lines for Energy Efficiency," by Ashok Sarkar, Jonathan Sinton, and Joeri de Wit.

Live Wire 2014/18. "Exploiting Market-Based Mechanisms to Meet Utilities' Energy Efficiency Obligations," by Jonathan Sinton and Joeri de Wit.

Live Wire 2014/25. "Doubling the Rate of Improvement of Energy Efficiency," by Jonathan Sinton, Ivan Jacques, Ashok Sarkar, and Irina Bushueva.

Live Wire 2016/53. "Why Energy Efficiency Matters and How to Scale It Up," by Jas Singh.

Live Wire 2016/54. "Fostering the Development of ESCO Markets," by Kathrin Hofer, Dilip Limaye, and Jas Singh.

in the most cost-effective way through cross-cutting technologies (for example, compressed air systems, combined heat and power systems, and electrical drives). Thirty networks in Germany took 4,000 profitable measures with an average internal rate of return of 35 percent. Cooperating companies increase their efficiency twice as fast as the German industrial average. http://leen.de/en/leen-netzwerke/.

U.S. Industrial Assessment Centers for small and medium-sized enterprises

Assessments are performed by local teams of engineering faculty and students from 24 centers and 32 participating universities across the United States. A university-based IAC team conducts a survey of the eligible plant, followed by a one- or two-day site visit to take measurements as a basis for assessment recommendations. The team writes up a detailed recommendations on cost, performance, and payback times. Within 60 days, a confidential report detailing the analysis, findings, and recommendations of the team is sent to the plant. In two to six months, follow-up phone calls are placed to the plant manager to verify that the recommendations are being implemented. http://iac.rutgers.edu/about.php.

Ireland

From 2007 to 2011, the Irish Sustainable Energy Authority's SME program has supported 1,470 SMEs with 130,000 employees. In 2012, cost reductions of €2 million (from a total energy bill of €19.7 million) were achieved in 200 SMEs with a total of 2,000 employees (IEA 2014).

Energy efficiency programs implemented through energy utilities and efforts to develop an ESCO industry

China

In 2010, the Chinese government issued "Electricity Demand-side Management Implementation Measures" that required all grid companies to deliver energy reduction of at least 0.3 percent from the previous year's sales, and peak demand reductions of at least 0.3 percent from the previous year's peak demand (IEA 2013).

With assistance from the World Bank, China introduced energy performance contracting and energy service companies in the late 1990s. It has since developed its ESCO market into the world's largest to gain substantial industrial energy savings.

United States

In 2011, $7 billion was invested in ratepayer-funded energy efficiency projects, producing an estimated 117 terawatt hours (TWh) of energy reductions. In 2012, there were 25 states with energy efficiency resource standards and a further 9 states adopting other policies (Forster, Wallace, and Dahlberg 2013).

The European Union

Countries such as the United Kingdom, Italy, and Poland have adopted energy efficiency obligations that require energy utilities to achieve mandatory energy savings by investing in energy efficiency improvements that benefit their customers. https://openknowledge.worldbank.org/handle/10986/18678.

Addressing finance barriers by facilitating commercial financing

International financial institutions such as the World Bank and the European Bank for Reconstruction and Development have partnered with many developing countries to establish and scale up financing for industrial energy efficiency by utilizing local commercial banks. Notable efforts include:

- The World Bank's industrial energy efficiency credit lines in China, Turkey, Ukraine, and Uzbekistan.
- The International Finance Corporation's partial risk guarantee program in China (Kato and others 2014).
- The World Bank's partial risk sharing facility for energy efficiency in India.
- The EBRD's Sustainable Energy Financing Facilities in 20 countries (IEA 2014).

Addressing finance barriers through fiscal and other financial incentives

Some countries give industries favorable tax treatment for their energy-saving efforts. For example, tax deductions are used to partially offset the costs of energy efficiency investments in Canada, Japan, the Netherlands, and the United Kingdom. Some countries provide grant subsidies for energy efficiency investments, w0hich are often tied to verified energy savings (as in China) (Tanaka 2011).