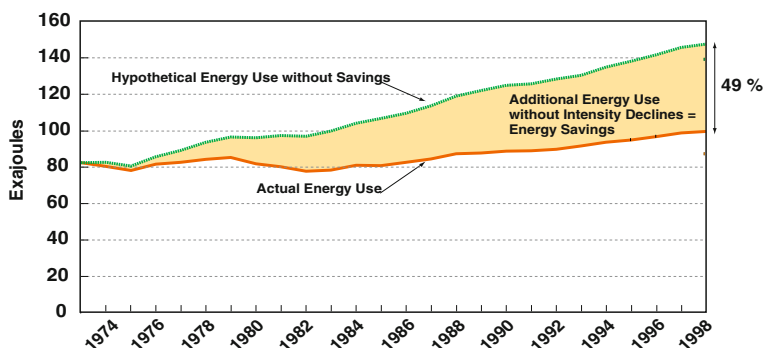


## Chapter 2

# Background and Literature Review on Energy Efficiency Gaps



**Abstract** This chapter presents background information on the potential for energy efficiency, global energy efficiency investment gaps, and market barriers that cause the gaps. The chapter also reports on efforts that have been pursued to close the gaps. These efforts include government policies and measures, capacity-building and enabling activities, technology transfer and deployment, and incremental costs and co-finance. Historic trends and key issues of global energy efficiency considered by international organizations are also reviewed. Finally, this chapter discusses how the Global Environment Facility (GEF) has addressed these trends and considered key issues while financing energy efficiency projects in developing countries over the past 20 years.



**Fig. 2.1** Impact of energy efficiency policy on energy saving in IEA countries (1974–1998). *Source* Developed from data of the IEA (2010)

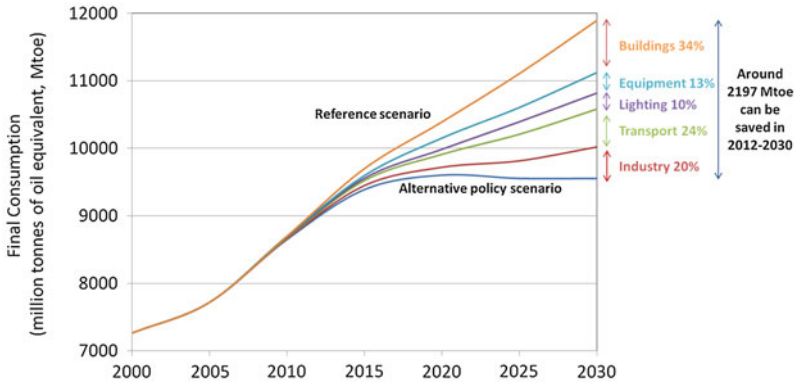
## 2.1 Energy Efficiency Potential

The International Energy Agency (IEA) estimated the potential for efficiency improvements to be in the range of approximately 20–50 % of the total final energy consumption. According to the IEA, energy efficiency policies in 11 Organisation for Economic Co-operation and Development (OECD) countries (US, Japan, Australia, UK, France, Italy, Germany, Denmark, Norway, Sweden, and Finland) between 1973 and 1998 had saved approximately 49 % of the actual energy use (IEA 2007) (Fig. 2.1). Jollands showed that energy efficiency policies would help save an average of 20 % of the final energy consumption from 2010 to 2030 in five major sectors, namely buildings, equipment, lighting, transport, and industry, in OCED countries (Jollands et al. 2010) (Fig. 2.2). If other sectors are considered, the saving potential would be more than 20 %.

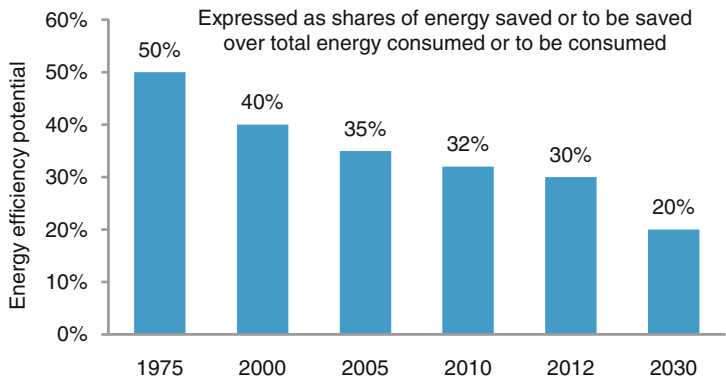
A review of the IEA literature on the potential for energy efficiency improvements in the past and the future demonstrates that energy efficiency potentials in selected IEA/OECD countries from 1975 to 2030 would be within a range of 20–50 %. Figure 2.3 illustrates the range of possibilities and is expressed as the percentage of energy that could be saved over the total final energy consumption from 1975 to 2030. The potential for energy efficiency savings in developing countries could be higher than IEA/OECD countries because of the widespread use of inefficient energy technologies.

## 2.2 Energy Efficiency Gaps and Market Barriers

The energy efficiency gap is a term that is widely used in the literature by many organizations including the IEA. It refers to the difference between levels of investment in energy efficiency that appear to be cost effective based on



**Fig. 2.2** Impact of energy policy on world energy consumption (2000–2030). *Source* Developed from data of Jollands et al. (2012)



**Fig. 2.3** Trends in energy efficiency saving potential in OECD countries (1975–2030)

engineering-economic analysis and the lower levels actually occurring (SERI 1981). The efficiency gap can also be defined as the difference between the actual level of energy efficiency and the higher level that would be cost-effective from an individual’s or firm’s point of view. The concept of an energy efficiency gap and market barriers to energy efficiency investment has been used since the early 1970s. Lovins was among the first to develop a definition of energy efficiency: using less energy to produce greater economic output (Lovins 1976). This definition, coupled with a review of the apparently highly inefficient use of energy by society, indicates that markets alone cannot produce the most desirable social outcomes in the use of energy without government policy intervention (IEA 2007). Barriers cause market failures and lead to insufficient investment in energy efficiency.

The IEA reports also reveal that market barriers in many forms have hindered energy efficiency improvements. These barriers include inadequate access to capital, isolation from technologies and price signals, information asymmetry, and a lack of knowledge about the costs and benefits of energy efficiency investments (IEA 2007). Our understanding of these market barriers comes from many disciplines, including economics, engineering, sociology, anthropology, and psychology. There is no consensus about which government interventions are necessary to overcome the market barriers and different opinions about the nature of these barriers remain.

Golove identified six market barriers to energy efficiency investments: (1) misplaced incentives, (2) lack of access to finance, (3) flaws in market structure, (4) mispricing imposed by regulation, (5) decision influenced by custom, and (6) lack of information (Golove and Eto 1996). The IEA argued that market barriers leading to energy efficiency gaps occur under three conditions: (1) when barriers in capital markets inhibit the purchase of energy-efficient technologies, (2) when energy-efficient markets are incomplete, and (3) when energy costs are a low priority relative to other factors (IEA 2007). In summary, the arguments by Golove and the IEA imply that providing additional project finance to incentivize or mobilize capital resources in the market for purchasing energy efficiency technologies is vital to close energy efficiency gaps and address market failures.

Additional literature review in this area reveals that there are several capital market barriers to purchasing energy-efficient technologies. First, transaction costs in financing energy-efficient technologies can be high. This is particularly true for small businesses and individual households. DeCanio found that hurdle rates established internally by firms for energy efficiency investments are higher than the capital costs to the firm (DeCanio 1993). In other words, a firm will not invest in energy efficiency technologies unless the internal rate of return for energy efficiency investments is higher than the cost of capital. Consequently, policy and financial incentives are necessary to close the gaps of capital investments in energy efficiency even if energy efficiency projects are financially viable.

Second, energy efficiency investments are often small scale and dispersed and it could be difficult to quantify the benefits from all the investments. In contrast, investment in renewable energy technologies, such as solar photovoltaic panels or biomass-fired power plants, is more centralized and it is relatively easier to quantify the investment benefits. To overcome this barrier, it is worthwhile to develop and invest in energy efficiency programs at the national level with the involvement of multi-provinces/states, multi-sectors, and multi-areas (e.g., policy development, technology transfer, and capacity-building). Global Environment Facility (GEF) investments in energy efficiency projects in developing countries over the past 20 years have involved multi-provinces/states, multi-sectors, and multi-areas. Many GEF energy efficiency projects were developed to scale up energy efficiency investments in key economic sectors.

Third, many financial institutions are unfamiliar with energy efficiency, and they are reluctant to lend resources for energy efficiency improvements. This is particularly true for local commercial banks in developing countries where staff

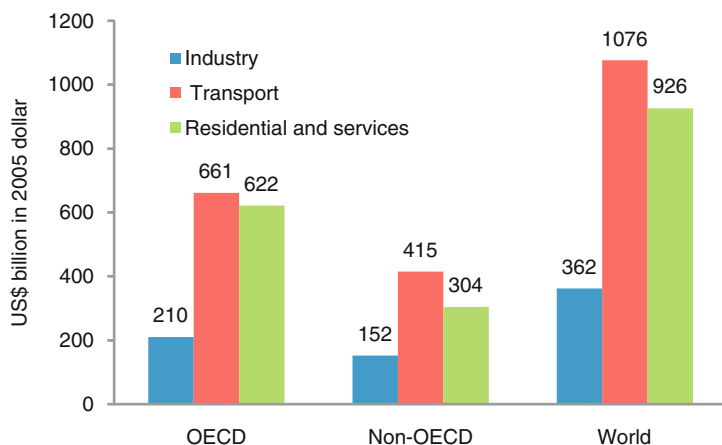
members have little knowledge of energy efficiency technologies and engineering. The lack of knowledge of energy efficiency causes energy efficiency investment gaps in the country. Therefore, providing training for capacity building or enabling activities to local institutions and commercial banks is valuable. The GEF recognizes this challenge and has involved local commercial banks as co-finance partners in energy efficiency projects as much as possible.

Fourth, the market for energy efficiency investments is usually incomplete in developing countries. In the industrial, residential, and commercial sectors of many developing countries, energy efficiency is not a priority for customers when they acquire goods and services. For example, when purchasing or renting a property, a household would first consider factors such as location, size, and age of the building. The energy efficiency of the property itself and its appliances would not be a priority. In these situations, there is an energy efficiency gap for the properties unless there is a building standard or code stipulated by laws or regulations for energy efficiency. Recognizing this barrier, the GEF has financed the development of policies and regulations in almost every energy efficiency project.

Finally, when energy efficiency is not a major concern for consumers or firms, there are few incentives to invest in energy efficiency. For example, if the ratio of energy costs to the income/revenue of an individual household or firm is like a rabbit to an elephant, little attention would be paid to energy efficiency investment. This will likely cause energy efficiency gaps at each household or firm. When added together, these energy efficiency gaps can add up to a substantial energy savings opportunity at the national level. To address this issue, the GEF has focused its resources on reducing the incremental costs to close the gaps at all levels including households, small businesses, large industrial enterprises, and national economies.

It is difficult to forecast how much funding should be invested in global energy efficiency, since investments in global energy efficiency depend on many factors including the GHG emissions mitigation targets set by the international community, future oil prices, climate change policies of national governments, and breakthroughs in energy efficiency technologies. Many international organizations and individuals have attempted to estimate worldwide capital costs for end-use efficient technologies to mitigate GHG emissions. These include the European Environment Agency (EEA 2005), Argonne National Laboratory (Hanson and Laitner 2006), and the Asian Development Bank (ADB 2006), Chantanakome (2006), and Shen (2006).

In the 2000s, the IEA developed an Alternative Policy Scenario for a portfolio of clean energy technologies and policies (IEA 2006). It is a package of policies and measures that countries around the world are considering that would, if implemented, significantly reduce the rate of increase in energy demand and emissions. The costs of these policies would be more than outweighed by the benefits from producing and using energy more efficiently. The IEA estimates that, on average, an additional US\$1 invested in more efficient electrical equipment, appliances, and buildings avoids more than US\$2 in investment in electricity supply (IEA 2006). These savings are particularly valuable in economies where



**Fig. 2.4** Capital investments needed to fill the global energy efficiency gap (2012–2030). *Source* Developed from data of the IEA (2006)

the lack of capital is a constraint to economic growth. This book uses the same definitions and descriptions used in the IEA's Alternative Policy Scenario in estimating global energy efficiency gaps.

The IEA's Alternative Policy Scenario projects that a total of additional US\$2.4 trillion (Fig. 2.4) on top of its Reference Scenario (or business-as-usual scenario) is needed to improve energy efficiency in three major sectors to address the efficiency gap from 2005 to 2030 worldwide (IEA 2006). Investment in the transport sector would increase by US\$1.1 trillion, which is close to half of the total additional end-use energy efficient investments in all sectors in the world. Investment in the residential and services sectors (including agriculture) is approximately US\$0.92 trillion higher over the Reference Scenario, while the industrial sector has an extra investment of US\$0.36 trillion. In brief, the IEA analysis says that from 2012 to 2030 the world needs to invest approximately US\$96 billion per year (US\$ 2,400 billion divided by 25 years) to address the energy efficiency gap in the industrial, transport, residential, and commercial sectors.

### 2.3 Incremental Costs and Reasoning

In economics, incremental cost is defined as the change in total cost associated with a change in business activity (Burch 1974). At the GEF, the definition for incremental costs is slightly different. The GEF defines incremental costs as the additional costs that are associated with transforming a project with national benefits into one with global environmental benefits (GEBs). For example, choosing solar energy over coal or diesel fuel can meet the national development

goal of power generation, but is more costly. GEF grants cover the difference or increment between a less costly, more polluting option, and a costlier, less polluting option (GEF 2012a). The GEF Instrument states that

GEF...shall operate for the purpose of providing new and additional grant and concessional funding to meet the agreed incremental costs of measures to achieve agreed global environmental benefits

(GEF 2011).

The GEF approach of determining incremental costs includes four steps: (1) determining the environmental problem, threat, or barrier, and the business-as-usual scenario (i.e., what would have happened without the GEF); (2) identifying the GEBs and fit with GEF priorities within GEF focal areas and themes identified in GEF focal area strategies; (3) providing the incremental reasoning; and (4) negotiating the role of co-finance. The following paragraphs detail these analysis steps (GEF 2007).

The first step of building a GEF project is to define the baseline under business-as-usual conditions. Business-as-usual describes the situation or context relevant to the proposed project intervention in a country or proposed project site as it would unfold without the support of the GEF. It provides an assessment of ongoing and planned activities in the absence of the GEF and the expected/projected losses of GEBs if left unattended. It also identifies trade offs such as those between short-term socioeconomic gains and long-term socioeconomic and environmental sustainability. It will also identify how the different ongoing or planned interventions will contribute to achieving environmental and developmental goals. To justify the requested GEF grant, the business-as-usual baseline will be analyzed in terms of the objectives and outcomes that might be achieved, and the quantitative (e.g., budgets and planned expenditures) and qualitative (e.g., institutional capacity) inputs and outputs that would be forthcoming without GEF intervention.

The second step is to identify and agree on the GEBs of the project once the environmental problems, threats, and barriers have been identified. GEBs in the GEF Climate Change Mitigation focal area are the sustainable mitigation of the concentration of anthropogenic greenhouse gases in the atmosphere that are not covered by the Montreal Protocol.<sup>1</sup> Specifically, these include:

- mitigated GHGs of carbon dioxide (CO<sub>2</sub>) equivalent;
- increased use of renewable energy and decreased use of fossil energy resources;
- improved efficiency in primary energy production, energy process, energy conversion, transportation, transmission, and final energy consumption at the end use;

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<sup>1</sup> The Montreal Protocol on Substances that Deplete the Ozone Layer (a protocol to the Vienna Convention for the Protection of the Ozone Layer) is an international treaty designed to protect the ozone layer. Focal areas: Ozone layer. Focal in the 1980s by phasing out the production of numerous substances believed to be responsible for ozone depletion.

- increased adoption of a low-carbon development path through technology transfer, market transformation, and enabling activities;
- increased sequestration of carbon; and
- reduced GHG emissions and enhanced carbon stocks under sustainable management of land use (including peat lands), land use change, and forestry.

Provision of incremental reasoning is the next step in defining the role for the GEF in closing the efficiency gaps for a proposed project. It is based on an assessment of the value added by involving the GEF. The identification of the GEF's role is of great importance for the design and implementation of a project, and therefore requires documentation of the dialogs and negotiations among key stakeholders of the project. The purpose of such negotiations is to mobilize other resources, in addition to the limited GEF resources, for the project.

Mobilizing co-finance for projects is the last step. Different Agencies have different definitions for co-finance. For example, the OECD defines co-finance as

The joint or parallel financing of programs or projects through loans or grants to developing countries provided by commercial banks, export credit Agencies, other official institutions in association with other Agencies or banks, or the World Bank and other multilateral financial institutions

(OECD 2011). This book employs the GEF definition of co-finance (GEF 2003a):

GEF Co-financing comprises the total of cash and in-kind resources committed by governments, other multilateral or bilateral sources, the private sector, NGOs, the project beneficiaries and the concerned GEF Agency, all of which are essential for meeting the GEF project objectives.

The purpose of mobilizing co-finance is to maximize efficiency and effectiveness of resources from other parties to close efficiency gaps. Finance activities that are not essential for achieving the GEF's objectives, but are processed for transactional convenience in the same loan or technical assistance package, are not considered as co-finance but as parallel finance (GEF 2003a). Co-finance can be either part of the underlying project as ongoing interventions or new and additional funding secured for the project. Co-finance can be considered as the incremental costs of a project if it achieves GEBs, thus allowing the GEF to share or co-fund the incremental costs of the future proposal with other partners. According to the above definition, co-finance mobilized for GEF projects shall serve as funds to close global energy efficiency gaps. Over the past 20 years, GEF grants and the co-finance have been utilized in a number of categories, including: (1) energy policies and measures to remove barriers, (2) capacity building and training for local professionals, (3) technology transfer, and (4) hardware and software asset acquisitions.



## 2.4 Energy Policies and Measures to Close Gaps and Remove Barriers

Removing barriers to energy efficiency investments with governmental policies and measures has been well documented in the energy literature, but few attempts have been made to develop global energy efficiency policies and measures. Four relatively prominent attempts that are related to the development of global energy efficiency policies and measures include: (1) the work by a group of international experts on energy efficiency convened by the United Nations Foundation (UNF) (UNF 2007); (2) a study commissioned by the World Wildlife Fund (WWF) International (Klessmann et al. 2007); (3) an analysis conducted by the IEA (Jollands et al. 2010); and (4) an energy savings policy report commissioned by the European Climate Foundation (ECF) (Wesselink 2010).

The UNF report is based on a detailed study of the potential of energy efficiency and the importance of spurring decisive action on climate change during 2010–2020 (UNF 2007). The report presents 22 recommendations on energy policies and measures that are related to national strategies, international cooperation, and data collection. These 22 recommendations cover key economy-wide areas including buildings, industry, transport, energy supply, and energy efficiency for developing and transition economies. The aim of these recommended actions is to assist the Group of Eight (G8) countries in meeting the goal of a 2.5 % annual rate of energy efficiency improvement in these countries from 2012 to 2030.

The WWF International-commissioned report presents a portfolio of energy efficiency policies and measures. The recommendations are categorized into eight areas for action by all countries in the world. These international policy and measure recommendations on energy efficiency cover all sectors ranging from transport to public procurement.

The IEA also proposes 25 recommendations on energy policies and measures (Jollands et al. 2010). These 25 recommendations were prepared under the mandate of the G8 Gleneagles Plan of Action. In fact, energy efficiency has become an important item on the G8 agenda. At the Gleneagles Summit in July 2005, G8 leaders addressed the challenges of climate change and securing clean energy and sustainable development, and adopted a Plan of Action. A dialog was also launched between G8 and other significant energy consuming countries. Brazil, China, India, Mexico, and South Africa were also represented at the Summit. The IEA 25 recommendations are applicable not only to OECD countries, but also to developing countries. The IEA published nine policies and measures in energy efficiency covering from nine aspects: (1) education and outreach; (2) financial; (3) incentives/subsidies; (4) policy processes; (5) public investment; (6) research and development; (7) regulatory instruments; (8) tradable permits; and (9) voluntary agreement (IEA 2012).

The Energy Savings 2020 report, commissioned by the ECF, assesses the impact of current European Union (EU) energy and climate policies. It makes recommendations on the design of an overarching and binding energy savings

policy framework to achieve the EU's 20 % energy savings target by 2020. The report analyzes the opportunities and challenges of four policy options: (1) an economy-wide energy savings target at the EU level; (2) end-user targets set at the EU level for sections of the economy; (3) an economy-wide energy savings target for each member state; and (4) end-user targets for member states for sections of national economies (Wesselink 2010).

GEF policy recommendations for participating countries have been made and executed during GEF project implementation. As of June 2012, the GEF has invested in over 270 energy efficiency projects worldwide (GEF 2012b). All projects have policy initiative and development components. For example, in a GEF project aimed at encouraging the adoption of more efficient boilers in China, revised national standards for thermal efficiency, an environmental emissions policy, and a coal quality policy for industrial boilers were recommended to the People's Republic of China (PRC) government. The energy efficiency policies and measures recommended by the IEA have also been applied by the GEF implementing Agencies and participating countries in GEF energy efficiency projects.

## **2.5 Capacity Building to Close Efficiency Gaps and Remove Barriers**

Capacity building, or "education and outreach" in the IEA's definition, has become a major priority in global conventions and the international community. Recent events such as the World Summit on Sustainable Development reaffirmed the priority of building the capacity of developing countries (UNEP 2002). The European Commission has funded the European Union—United Nations Development Programme (EU-UNDP) Climate Change Capacity Building Programme to strengthen the capacity of developing countries in areas such as monitoring, reporting, and verifying greenhouse gas emissions as well as designing low-emission development strategies (UNDP 2010).

In May 1999, the GEF Council, aware of the growing importance the United Nations Framework Convention on Climate Change (UNFCCC) placed on capacity building, approved the 18-month Capacity Development Initiative (CDI) as a strategic partnership between GEF and the UNDP, for the preparation of a comprehensive approach to developing the capacities needed at the country level to meet the challenges of global environmental action. The CDI was undertaken to: (1) conduct a comprehensive assessment of capacity building needs of developing countries and countries with economies in transition; (2) take stock of earlier and ongoing efforts to assist national capacity building; and (3) prepare a strategy as a basis for strengthening the GEF portfolio. The CDI was undertaken in a highly consultative manner, based on national inputs, regional expertise, contributions by civil society organizations (CSOs) and bilateral/multilateral agencies, and the discussions with the UNFCCC (GEF 2003b).

Under the CDI, the GEF can assist with the capacity building efforts in developing countries to strengthen what countries undertake with their own resources. The GEF clearly recognizes the need to mobilize other resources and to assist countries in identifying complementary sources of financial and technical assistance, either multilateral or bilateral, to meet capacity building needs. Valuable opportunities to achieve this exist in countries that prepare an action plan for capacity building on the basis of National Self-Assessments of Capacity-Building Needs (NCSAs) and/or countries for which country programs will be developed. To measure NCSAs, both qualitative and quantitative indicators can be used.

In this book, the qualitative indicators for capacity building cover the following 11 dimensions: (1) awareness and knowledge; (2) national policy, legal, and regulatory frameworks; (3) institutional mandates, coordination, and processes for interaction and cooperation among all stakeholders; (4) information management, monitoring, and observation; (5) mobilization of science in support of decision making; (6) financial resources and technology transfer; (7) incentive systems and market instruments; (8) negotiation skills; (9) cooperation and networking within regions; (10) institutional management and performance; and (11) individual skills and motivation in key institutions. Other elements are related to specific projects. For example, a number of projects provided International Organization for Standardization (ISO) energy management standards training for local professionals. Quantitative indicators for capacity building include the number of people trained and the number of workshops or seminars conducted.

## **2.6 Technology Transfer to Close Gaps and Remove Barriers**

Technology transfer plays a critical role in closing the gaps in the level of energy efficiency investments and becomes a global issue for countries to combat climate change. The transfer of environmentally sound technologies (ESTs) has been embodied in the UNFCCC (UNFCCC 1992). Article 4.5 of the UNFCCC states:

The developed country Parties and other developed Parties included in Annex II shall take all practicable steps to promote, facilitate, and finance, as appropriate, the transfer of, or access to, environmentally sound technologies and know-how to other Parties, particularly developing country Parties, to enable them to implement the provisions of the Convention.

Since 1991, the GEF has emerged as the largest multilateral funding organization for transferring ESTs. The GEF has two outstanding characteristics in promoting technology transfer. First, the GEF uses its funds to directly finance projects that have technology transfer components. Second, the GEF has provided resources for technology needs assessments (TNAs) and other enabling and capacity-building activities in more than 100 countries.

Among the ESTs that the GEF has supported over the past years, more than one-third are energy-efficient technologies, ranging from efficient lighting and

appliances to chillers, boilers, motors, and brick kilns. Investments address building designs and construction materials, district heating systems, power generation and distribution, combined heat and power (cogeneration), and industrial energy efficiency. As of June 2010, the total GEF funding to close the gaps of transferring ESTs was approximately US\$1 billion.

## **2.7 Mobilizing Co-finance to Close Gaps and Remove Barriers**

Financial contributions to GEF projects come from various sources. These contributions include: (1) resources from the Agency itself; (2) resources from other nonGEF sources that will be managed jointly or in parallel with the GEF resources without which the project could not be implemented; (3) government counterpart resources; (4) finance for other baseline or foundational activities upon which the project would build or without which the project could not be implemented; (5) finance for activities other than the GEF activities that are processed for transactional convenience in the same loan or technical assistance package of the GEF Agency; and (6) funds that are expected to be mobilized in the future for follow-on or replication activities, even though implementation of the project would proceed before mobilization is confirmed (GEF 2003b).

Co-finance is a driving force of the GEF's success in positively impacting the global environment. Co-finance for GEF projects is important. First, with limited financial resources and a growing demand for assistance in developing countries, it is essential for the GEF to mobilize additional resources. Co-finance expands the resources available to close the investment gaps in energy efficiency. Second, co-finance is an important indicator of the strength of the commitment of counterparts, beneficiaries, and GEF Agencies to GEF projects. Third, co-finance helps ensure the success and local acceptance of GEF projects by linking them to sustainable development and increasing the chances of achieving the project goals, and thereby maximizing and sustaining the impacts.

Co-finance can also take many different forms, including: (1) grants, (2) loans with concessional or market rates, (3) credits, (4) equity investments, (5) committed in-kind support, and (6) other (specified) types (GEF 2003). Due to its importance in closing energy efficiency investment gaps, co-finance has become a key indicator in cost-effectiveness analysis and the review of GEF projects. Every GEF dollar invested in energy efficiency has effectively mobilized about US\$8 dollars of co-finance. A significant portion of the co-finance comes from the private sector in developing countries.

## 2.8 Energy Efficiency Cost-Effectiveness Analysis

One of the key criteria to determine whether to finance a project in energy efficiency is its cost effectiveness. Cost-effectiveness analysis is a method to identify the lowest cost and most beneficial option from among competing alternatives for achieving a stated objective (GEF 2005). Quantitative and qualitative approaches are used to conduct cost-effectiveness analysis. In a quantitative cost-effectiveness analysis, indicators that best describe project outcomes would be identified, and the cost of achieving a unit of each of those indicators for the competing alternatives would be computed. The alternative that has the lowest cost per unit of indicators would be regarded as the most cost-effective means of realizing the stated outcomes.

The qualitative approach is used when quantification of specific project costs and benefits is not possible. For example, when evaluating the technical assistance for capacity building provided to developing countries, although the number of workshops or seminars or trainees can be measured, it is difficult to measure and compare the knowledge and skills gained by trainees. In practice, quantitative and qualitative approaches can be used alone or can be combined for project development, review, and evaluation.

The GEF project review criteria consider both quantitative indicators and qualitative approaches for reviewing project proposals and estimating their cost effectiveness (GEF 2011). Since 2001, the GEF has used a combination of both quantitative and qualitative approaches in project identification, selection, and evaluation. The most-used quantitative indicator for estimating cost-effectiveness is the incremental cost per metric ton of CO<sub>2</sub> emissions' mitigation, if feasible and applicable. Qualitative information includes: (1) educating consumers and professionals about the nature, costs, and benefits of energy-efficient technologies and products; (2) reducing retail prices of energy-efficient products through rebates or subsidies; (3) conducting bulk purchases and procurements; (4) providing consumer finance; and (5) offering buy-back or recycling programs (GEF 2005).

The design of a GEF project that aims to close global efficiency gaps may adopt some or all of the above indicators. A project's cost-effectiveness is ensured through a process of examining alternative approaches and activities and selecting only the most cost-effective ones. The most cost-effective option of project development is presented with qualitative information and quantitative indicators. Table 1.1 presents an example of the review summary of a GEF project with qualitative and quantitative information.

## 2.9 Conclusions

There is a great potential for enhancing energy efficiency worldwide. The IEA has successfully helped its initial 11 member countries cut energy consumption by about 50 % from 1973 to 1998 through energy efficiency policies and investments.

**Table 1.1** A sample of GEF project review summary with qualitative and quantitative information

GEF ID	
Country/-IES	China
Name of project	Urban-scale building energy efficiency and renewable energy
GEF agency/-IES	The world bank
Date received by program manager (PM)	April 05, 2012
Date review completed by PM	April 10, 2012
Program manager	Ming Yang
Focal area	Climate change
Project type	Full size project

*Brief reasoning for recommendation to CEO (max 0.5 page):*

The objective is to support transformational scaling-up of energy efficiency (EE) and renewable energy (RE) in urban built environment through city pilots/demonstrations and national replication/dissemination.

There are three major components in the project:

1. Beijing pilot and demonstration in investing in EE and new RE technologies; and
2. National guidance and support for city-based policies and programs;
3. Ningbo pilot and demonstration in investing in EE and new RE technologies.

Besides US\$152.1 million co-finance, this project will likely mobilize much more funds from individual households and small commercial enterprises to invest in EE and RE in other cities in China.

The target of GEB of this project is to mitigate 69 million metric tons of CO<sub>2</sub> on top of the baseline of the project. This approximately generates a ratio of GEF incremental cost versus GHG emissions mitigation at US\$0.17 per metric ton of CO<sub>2e</sub>. The project will also considerably mitigate other pollutants including mercury, sulfur dioxide (SO<sub>2</sub>), and nitrogen oxides (NO<sub>x</sub>) in cities at low GEF cost.

The main component of this project is capital investment in hardware assets. US\$5.5 million or 45.8 % of total GEF resources, and US\$141 million or 92.7 % of the total co-finance will be used in asset investment. The ratio of these two figures, US\$5.5 million and US\$141 million, is 1:25.6.

*Finance:*

1. Requested GEF project grant: US\$12,000,000; Co-finance: US\$152,100,000
2. Project Co-financed at a ratio 1 : 12.68
3. Project Management Budget US\$500,000 actual 4.17 % of project management with respect to the total GEF Grant.
4. Ratio of Project Management to the co-finance for Project Management 1 : 4.20

Program manager	Team leader	Program assistant
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The IEA projected that additional potential energy savings through policy measures and investments in OECD countries could be at least 20 % by 2030 compared to their 2010 levels. In developing countries, this potential is greater since there are more low-cost energy efficiency opportunities in developing countries that have not been targeted yet.

Energy efficiency gaps occur when there is the potential for energy savings and a shortage of capital investment to address it. Many organizations have tried to

estimate the size of the global energy efficiency gap. The IEA has projected that between 2012 and 2030, the world will need approximately US\$96 billion per year to address the energy efficiency gap in the industrial, transport, residential, and commercial sectors.

Energy efficiency gaps are caused by at least six market barriers. Lack of capital or access to finance is widely recognized as the major barrier. Further research reveals that five other factors also pose barriers to energy efficiency investments. These factors are: (1) high transaction costs; (2) small-scale and dispersed investments; (3) lack of knowledge of financial institutions that can provide such investments; (4) insufficient market mechanisms; and (5) lack of concern about energy efficiency by consumers.

The definition of incremental costs used by the GEF is different from its conventional meaning in economics. The GEF has two purposes for incremental costs in financing projects. First, it helps transform a project with national benefits into one with GEBs. Second, it aims to mobilize financial resources from other sectors and stakeholders to close energy efficiency gaps.

A number of international organizations have well-documented national government policies and measures that can effectively achieve high energy efficiency levels and remove market barriers to investments in this area. The IEA has published a comprehensive list of policy measures that have been used in OECD countries. GEF energy efficiency projects address all of these policy components. In addition, capacity building, technology transfer, and co-finance are other important issues that are frequently discussed and addressed by the UNFCCC and the UN Agencies. Consequently, developing strong national energy efficiency policies, building capacity and launching enabling activities, transferring new technologies, and mobilizing co-finance become key criteria in developing cost-effective GEF energy efficiency projects.

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