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Energy Efficiency as a Driver of More and Better Goods and Services

THE BOTTOM LINE

Energy efficiency is seen more often as a means of reducing energy consumption and costs than as a way to expand the production of goods and services. But it can help raise a company's manufacturing capacity, improve the quantity and quality of a city's water supply, and provide more heating and cooling to improve attendance and learning in schools—all while keeping energy costs down. It is important to recognize such benefits of energy efficiency for low- and middle-income countries—and to factor them into economic assessments of projects and programs.

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What can energy efficiency do for developing countries?

Energy efficiency investments can improve goods and services—while also raising living standards

Across the developing world, energy consumption has nearly doubled since 2000; it is projected to increase by another 40 percent by 2030 (Benoit 2019). Investments in energy efficiency can reduce energy consumption as economies grow (IEA 2019). In so doing, they play a leading role in low-carbon transition scenarios (IEA 2018) and in progress toward meeting the global Sustainable Development Goals.

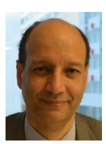
Equally important—though often underappreciated—is the fact that energy efficiency can stimulate production of more of the goods and services developing countries need to raise living standards. It can help improve a city's water supply system; cool and heat school buildings better to encourage attendance and learning; and increase firms' manufacturing output while holding energy costs down.

Yet the potential of energy efficiency remains largely untapped.

While energy efficiency is generally supported in developing countries, many economically viable investments are not being implemented (IEA 2019). The barriers range from policy and regulatory issues to high project costs and behavioral inertia (Lukas 2018; Singh 2016).

Policy and regulatory issues include, for example, low energy pricing; lack of performance codes and standards; failure to enforce codes and standards where they do exist; import duties on needed equipment; and weaknesses in relevant institutions. The World Bank's Regulatory Indicators for Sustainable Energy make clear that energy efficiency regulations are lagging in low-income countries (ESMAP 2020).

High costs for project development are another barrier. Conducting energy audits, comparing alternative technologies, and investing in small and dispersed projects all entail high transaction costs. Energy efficiency measures often have high initial costs owing to unavailability of equipment in the market, insufficient competition, or lack of access to financing.



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The energy efficiency narrative has often failed to resonate in developing countries because it focuses on reducing energy consumption rather than on development objectives such as expanding the production of goods and services and raising standards of living.

Widespread lack of awareness and behavioral inertia compound the problem. There is a shortage of credible data on energy consumption, information on energy efficiency opportunities, and evaluations of programs and their costs and impacts. There is a reluctance to do things differently, try new approaches, or take action in the face of perceived risk. Inertia is reinforced if consumers are not charged prices that reflect the true cost of energy.

Existing incentives are far from sufficient to overcome the inertia. The entities making capital investment decisions may not be the same as those paying the energy bills; thus they have competing priorities. Investors may expect to see returns in an unrealistically short time frame.

In addition to these obstacles, the energy efficiency narrative, explained below, has often failed to resonate in developing countries and has not been aligned with their development objectives.

Where does the current energy efficiency narrative go wrong in developing countries?

Energy efficiency is often misunderstood solely as a means of reducing energy consumption

The benefits of saving energy and reducing emissions of greenhouse gases (GHG) have been well received in developed countries, where living standards are high and demand for essential services—electricity for appliances and lighting, water supply and sanitation, space heating or cooling—is largely met. However, they do not resonate in a developing country context where demand for such goods and services is unmet.

The focus on saving energy in developed countries spawned the term "rebound effect," which may be understood as the effect of consumers' behavioral responses on expected energy savings. For example, after residential air conditioners are replaced with more efficient units, improved efficiency can reduce incentives to switch off air conditioners or prompt users to set the units at a lower temperature, pushing up consumption as costs fall. But these behavioral responses can also represent economic benefits through their utility to the user and, more broadly, the economy (IEA 2014; Ryan and Campbell 2014; de la Rue du Can, McNeil, and Leventis 2015; van den Bergh 2011). In the example just cited, the user values a cooler room and derives additional utility from it.

The focus on energy savings is also apparent in the approaches taken by national agencies, multilateral development banks, and other international organizations in evaluating energy efficiency projects. Technical documents on evaluating energy efficiency projects tend to focus on the value of energy saved and on averted GHG emissions as the main economic benefits of such projects (ESMAP 2017; European Investment Bank 2013; European Commission 2014; Li, Haeri, and Reynolds 2018; Rajbhandari and Zhang 2017; UK Government 2018; World Bank 2015, 2017).

Although there is recognition that other benefits can be substantial in some cases, the guidance documents usually note that these are difficult to quantify. Moreover, they seldom refer to the additional goods and services produced by more efficient processes.

Where energy efficiency investments do lead to an increase in the production of goods and services, existing guidance captures the benefits using an "adjusted baseline" methodology. This approach shows energy savings relative to a hypothetical *counterfactual case* in which an equivalent amount of goods and services was produced in a less energy-efficient fashion. For example, if a building retrofit produces more-comfortable indoor temperatures, existing guidance for economic analysis approximates this benefit by quantifying energy savings relative to a counterfactual circumstance in which the same temperature is reached, at greater expense, without the retrofit.

This approach might be acceptable when it is difficult to assess the value of additional goods and services being produced. Still, it should be recognized that the value of the economic benefits is highly dependent on the assumptions (and the plausibility) of the counterfactual scenario deemed to produce the same level of goods and services. More important, by casting energy efficiency projects into a framework of economic analysis that, by default, measures benefits in terms of energy savings, one neglects the point that investments in energy efficiency can and often do boost the production of goods and services. If the benefits of a project shift from energy savings toward providing more goods or better services, it may be argued that the focus of the project objective and the economic analysis should shift accordingly. The issue becomes even more compelling when there is no clear counterfactual that could deliver the same goods and services. It becomes obvious in greenfield projects—namely, projects designed to provide goods or services not by replacing existing infrastructure or equipment but by installing new infrastructure or equipment. Greenfield projects (discussed below) aim to provide these additional goods or services in a more energy-efficient manner than would be possible under business as usual, but they nevertheless *increase* energy consumption over the status quo.

A sound framework for the economic analysis of energy efficiency must recognize the benefits of additional goods and services and strengthen the case for energy efficiency investments that bring those benefits.

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How can we do justice to energy efficiency's productive role?

An essential step is to recognize the economic benefits of the additional goods and services brought about through energy efficiency

Energy efficiency measures can be broadly defined as those that decrease the energy intensity (specific energy consumption per unit of output) of goods or services compared with a business-as-usual approach. We describe four types of projects below—three on the demand side and one on the supply side. Table 1 presents the changes introduced by these projects, compared with the status quo, in terms of (i) the level of goods or services provided, (ii) their absolute final energy consumption, and (iii) the specific energy consumption involved in producing them.

Brownfield projects in category 1 are designed to reduce energy consumption, not to raise the level of goods or services provided. An example would be an investment to install efficient light bulbs in households that had been using inefficient ones. The investment provides the same level of service while reducing a specific type of energy consumption.

Brownfield projects in category 2 aim to reduce "specific energy consumption" (a term of art designating units of energy consumed per unit of a good supplied) while raising the level of goods or services provided. An example is an investment that increases industrial production after replacing existing equipment with more energy-efficient equipment. The absolute energy consumption may (i) decrease, (ii) remain the same, or (iii) increase over the status quo.

Greenfield energy-efficiency projects (category 3) aim to provide additional goods or services by supplying new infrastructure or equipment (as opposed to replacing existing equipment). An example would be installing streetlights where none had been present or installing air conditioners in previously uncooled public buildings. Since greenfield projects add new infrastructure or equipment, a specific status quo equivalent of energy consumption, even if easily defined, would be beside the point.

Table 1. Categories of energy efficiency projects from the perspective of the production of additional goods and services

		Project category and type	Changes from status quo: Level of goods or services provided (unit of output)	Changes from status quo: Absolute final energy consumption (energy input)	Changes from status quo: Specific energy consumption for goods or services provided (energy input/unit of output)
1	Demand side	Brownfield: Reduce energy consumption	No change	Decrease	Decrease
2	Demand side	Brownfield: Increase goods or services	Increase	Decrease, increase, or no change (more than one state is possible)	Decrease
3	Demand side	Greenfield	Increase	Increase	Not defined
4		Supply-side	Increase	Increase	Not defined

Source: Authors' original compilation.

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Supply-side energy efficiency projects (category 4) involve measures to improve efficiency in the production and delivery of energy to consumers—for example, by improving the efficiency of electricity generation by upgrading gas turbines to combined cycle or by reducing technical losses in electricity transmission or distribution. These projects typically deliver more energy to consumers. In other words, they increase both the level of goods and services *and* final energy consumption.

In any economic analysis of a project, the counterfactual needs to be clearly established. Typical counterfactuals for energy efficiency projects are status quo counterfactuals and alternative scenario counterfactuals.

Status quo counterfactuals. A status quo counterfactual for a street lighting project to install efficient streetlights in an unserved area would be based on the assumption that the area continues to have no street lights.

Alternative scenario counterfactuals. An example of an alternative scenario counterfactual for a project to install efficient streetlights in an unserved neighborhood would be the installation of conventional streetlights in the same neighborhood.

The rest of this Live Wire focuses on demand-side energy efficiency projects that yield increases in goods or services—namely projects in categories 2 and 3. We do not concern ourselves further with categories 1 and 4. Brownfield energy efficiency projects designed to increase goods or services (category 2) and greenfield energy efficiency projects (category 3) may be evaluated using either type of counterfactual, depending on circumstances. When evaluating a project compared with a status quo counterfactual, the economic benefits result from the increase in the level of goods or services provided by the project (table 2).

When evaluating a project against an alternative scenario counterfactual, the first step is to establish an alternative scenario that provides the same level of goods or services as the project without improvements in energy efficiency. For a brownfield energy efficiency project, the alternative scenario could incorporate increases in the level of goods or services using the existing infrastructure or

Table 2. Economic analysis of energy efficiency projects using the status quo counterfactual

	Category 2. Brownfield	Category 3. Greenfield
Project example	Water supply project that raises energy efficiency and service levels (e.g., quantity, quality, and reliability of water supply) by improving reservoirs, treatment plants, transmission/distribution pipes, etc.	Streetlight project that installs efficient streetlights in an unserved area.
Estimate the value of the incremental goods or services	Avoided "coping" costs, both direct (e.g., cost of constructing household water tanks to cope with unreliable supply) and indirect costs (e.g., reduced sickness caused by poor water quality); plus value of incremental water accessible owing to expanded hours of supply.	Improved safety, reduced traffic accidents, benefits from stimulation of local commerce.
Estimate the value of the change in energy consumption and associated GHG emissions	This involves a comparison of energy consumption before (status quo) and after the project. For example, the energy efficiency of water supply would be improved through greater efficiency in pumping and a reduction of water losses, thus reducing specific energy consumption (units of energy consumed per unit of water supplied). However, better service levels could require more energy. The net effect on absolute energy consumption may be higher or lower. Changes in GHG emissions would follow from any differences in absolute energy consumption.	Increased energy consumption and associated GHG emissions from new street-lighting installations.
Estimate other project economic costs and benefits	Capital expenditures for investments in water supply infrastructure, changes in operation and maintenance of water supply system, other externalities.	Capital expenditures to install new streetlights, poles, controls, and distribution lines; cost to operate and maintain new street-lighting infrastructure.

Source: Authors' original compilation.

Table 3. Economic analysis of energy efficiency projects using the alternative scenario counterfactual

	Category 2. Brownfield	Category 3. Greenfield
Project example	A building retrofit project that improves the energy efficiency and comfort levels of buildings by increasing the indoor temperature to the norm (typically 20 to 22°C). Measures might include upgrades of heating and ventilation systems, lighting, insulation, windows, and so on.	A space-cooling project that installs energy efficient air conditioners in public buildings that presently have no cooling.
Establish a realistic alternative scenario that provides the same level of goods or services as the project	The buildings are not retrofitted and the indoor temperature is adjusted using the next best means (e.g., existing space heating) resulting in higher consumption of heating fuel.	Less efficient air conditioners are installed to provide the same level of cooling as the project but with greater electricity consumption.
Estimate the value of the reduction in energy consumption and associated GHG emissions of the project versus the alternative scenario	The project investments deliver desired temperature levels with less heating fuel than the alternative scenario, resulting in energy savings and GHG emission reductions compared with the alternative scenario.	The project investments deliver the desired cooling levels more efficiently than the alternative scenario, resulting in energy savings and GHG emission reductions compared with the alternative scenario.
Estimate other economic benefits and costs over the alternative scenario	Capital expenditures for the building retrofits, increased O&M costs due to additional equipment, etc. Benefits may include a decrease in O&M cost due to the lower cost of maintaining new equipment.	Incremental capital expenditures for more efficient air conditioners compared with conventional air conditioners.

Source: Authors' compilation.
O&M = operations and maintenance

The concept of *energy productivity*—the inverse of energy intensity—emphasizes energy efficiency as a means to produce the goods and services that developing countries need.

equipment, if its capacity can accommodate such an increase. If it cannot—and this also applies for all greenfield energy efficiency projects—the alternative scenario involves constructing or installing new conventional infrastructure or equipment (business as usual) using feasible assumptions (World Bank 2020). The economic benefits result from the energy savings and associated reductions in GHG emissions brought about by the project, as compared with the alternative scenario (table 3).

When a rebound in energy consumption spurs greater consumption of goods and services, it is often accompanied by economic benefits, the valuation of which is no different from that laid out above for projects in categories 2 and 3. Where the rebound is minimal, or where the economic framework does not value the additional goods or services consumed, a second-best approach would be to value the additional goods and services at the cost of the energy consumed by the rebound. For example, if the beneficiary of a residential air-conditioning project pays the electricity bill and sets air conditioners at a lower temperature after receiving an upgrade to energy efficient air conditioners, one could argue that increased cooling benefits are valued by at least the cost of energy to the beneficiary.

How can we implement this approach?

Change the narrative, explore greenfield energy efficiency, and collaborate across sectors

Recognizing the power of energy efficiency to increase goods and services is particularly important for low- and middle-income countries. Stronger narratives about how energy efficiency projects can boost production, improve essential services, and reach a range of SDG targets would help communicate the benefits of such projects. And they might facilitate shifts from energy efficiency projects that save energy in absolute terms toward projects that increase goods and services. Stronger narratives about energy efficiency projects can also address the rebound effect of energy efficiency measures. The concept of *energy productivity*—the inverse of energy intensity—can be useful here. It emphasizes the narrative

An overly restrictive focus on energy savings and averted GHG emissions may divert attention from equally viable—and possibly preferable—alternative investments that raise energy efficiency while also raising standards of living and producing more goods and services.

that energy efficiency is a means to produce the goods and services that developing countries need.

An overly restrictive focus on energy efficiency savings and averted GHG emissions may divert attention from equally viable—and possibly preferable—investment alternatives. This is of particular concern for projects in categories 2 and 3 that are analyzed using a status quo counterfactual. Even though the estimated value of additional goods and services that these projects bring can be subject to significant uncertainty, efforts to determine these values can provide useful information and, if done consistently over time, would permit a better ranking of investment alternatives. At the very least it should be recognized that the minimum value of additional goods and services produced by energy-intensive processes (whether intentional or by rebound) can often be approximated by the energy cost of their production (see case study on determining the economic value of space cooling from air conditioners in Benoit, Lukas, de Wit, and Zinetti 2020).

Since demand-side energy efficiency generally requires measures and actions outside the energy sector—for example, in buildings, transport, industry, agriculture, and municipal services—quantifying increases in the production of goods or services will often require collaboration with experts in these sectors. In fact, many opportunities for energy efficiency that involve boosting production and service levels are likely to be led by stakeholders in these sectors. For that reason, collaboration between the energy sector and other sectors is essential.

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