ENERGY EFFICIENCY AS AN ENABLER OF ENERGY ACCESS FOR ALL FOR SUSTAINABLE DEVELOPMENT

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Abstract: Energy efficiency (using advanced technologies to provide better quality energy services with the same or a lesser amount of energy) and energy access (increasing the consumption of modern energy services) are sometimes seen as topics incompatible with each other. As a result, energy efficiency has largely been ignored as countries sought to achieve greater energy access. This paper will dispel this misconception by highlighting areas where energy efficiency is an enabler of energy access. In doing so, it will also highlight the importance of the availability, accessibility, and affordability of clean and efficient products. The so-called "3-A's" is critical because the problem is not a lack of solutions, but making them widely available and affordable in the most underserved and impoverished regions of the world. It is hoped that a wide dissemination of best practices in energy efficiency and energy access will kick-start the the transformation towards sustainable development.

Keywords**:** captive generation, energy access, energy efficiency, renewable energy, sustainable development

INTRODUCTION

With Resolution 65/161, the United Nations General Assembly declared 2012 the International Year of Sustainable Energy for All, recognizing that "… access to modern affordable energy services in developing countries is essential for the achievement of the internationally development goals, including the Millennium Development Goals, and sustainable development, which would help to reduce poverty and to improve the conditions and standard of living for the majority of the world's population." [1] The Resolution also calls on UN Secretary-General Ban Ki-moon to organize and coordinate activities to be undertaken during the Year that would increase awareness of the importance of addressing energy issues.

In response to this challenge, the Secretary-General has developed a new global initiative called Sustainable Energy for All. Announced to the General Assembly in September 2011, the initiative aims to mobilize action from governments, the private sector, and civil society partners to meet three interlinked objectives by 2030: ensuring universal access to modern energy services; doubling the rate of improvement in energy efficiency; and doubling the share in renewable energy worldwide. [2]

THE IMPORTANCE OF ENERGY EFFICIENCY AND ENERGY ACCESS

Energy efficiency, defined as using advanced technologies to provide better quality energy services with the same or a lesser amount of energy, is important for sustainable development because it is widely regarded as the quickest, cleanest, and least expensive option to address challenges related to environmental degradation, energy security, and economic development.[1] To illustrate, the International Energy Agency estimates that almost 60% of the carbon abatement required to reach the 450 ppm pathway by 2030 can be met through energy efficiency. [3] Furthermore, McKinsey & Company has estimated that by 2020, the United States can reduce annual energy consumption by 23 percent from a business-as-usual projection by deploying an array of energy efficiency measures in the commercial, industrial, and residential sectors. [4] This amounts to 9.1 Quad BTU of energy savings, roughly equivalent to the total primary energy consumed by the United Kingdom in 2008.

On the other hand, energy access is a prerequisite to economic development, as energy services enable basic human needs such as food and shelter to be met. They also contribute to social development by improving education and public health. The lack of access to modern energy services[2] as well as modern forms of energy[3] is therefore a serious hindrance to economic and social development, which must be overcome if the UN Millennium Development Goals are to be achieved. Today, over 1.3 billion people in the world (more than 95% of these people are either in sub-Saharan Africa or developing Asia and 84% are in rural areas) do not have access to electricity and another 1 billion do not have access to reliable sources of electricity. Furthermore, 2.7 billion people – some 40% of the global population – rely on the traditional use of biomass for cooking. [5]

Synergies between Energy Efficiency and Energy Access

There are several synergies between energy efficiency and energy access. For instance, efficiency reduces the amount of energy needed to power appliances and equipment, lengthening their operational times. As a corollary, more efficient pieces of appliances and equipment require smaller (and perhaps cheaper) energy systems to power. Additionally, modern energy services are more efficient than biomass; hence, increasing access to modern energy will contribute to a more rapid reduction in net energy intensity.[4] [6] Moreover, reduced energy demand from efficient appliances and equipment frees up valuable capital resources to invest in energy access or other areas of the economy. The potential for financial savings is crucial because finding ways to provide energy more efficiently benefits the poor more than the rich. After all, the world's poor can spend more than 30% of their income on energy services, but only 2 to 3 percent of Gross Domestic Product (GDP) is spent on energy in wealthy countries. [7]

AREAS WHERE ENERGY EFFICIENCY CONTRIBUTES TO ENERGY ACCESS

This section highlights three areas where energy efficiency can enable greater energy access. This is by no means an exhaustive list.

Technical and Non-Technical Losses Pertaining To Electricity Generation, Transmission, and Distribution

Greater energy access can be achieved by minimizing technical and non-technical losses pertaining to electricity generation, transmission, and distribution through energy efficiency measures.

Technical losses occur naturally and consist mainly of power dissipation in electricity system components such as transmission and distribution lines, transformers, and capacitors. Reducing technical losses is important not only because they represent an economic loss, but also because the electricity saved can be delivered to more end-users. The size of these savings can be significant, as experts have estimated that they account for 15% to 20% of the total losses experienced in India. [8] Improving the efficiencies of the generation, transmission, and distribution process is largely an engineering issue which involves conventional solutions in power systems planning and modeling.

Non-technical losses are losses caused by actions external to the power system and consist primarily of electricity theft, non-payment by customers, and errors in accounting and record-keeping. [9] These losses are significant, as electricity theft can reach up to 50% of all households in some pockets of South

*The views presented in this article are those of the author and do not necessarily represent the views of the United Nations Foundation.

[1] Energy efficiency is a different concept from energy conservation, which is to use a lesser amount of energy for a reduced level of services.

[2] Modern energy services are defined as household access to electricity and clean cooking facilities (i.e. clean cooking fuels and stoves, advanced biomass cookstoves and biogas systems).

[3] This is defined to include fuels such as natural gas, liquid petroleum gas (LPG), diesel, biofuels such as biodiesel and bioethanol, and renewables such as solar and wind energy.

[4] Energy intensity is calculated as units of energy per unit of GDP. High energy intensities indicate that a large amount of energy is used to produce a unit of GDP. Conversely, low energy intensities indicate a lesser amount of energy used to produce the same unit of GDP.

Asia, Sub-Saharan Africa, and the former Soviet Union. This phenomenon not only leads to energy shortages for customers who are legally hooked up to the grid, utility companies are also not receiving the proper amount of revenue from the power it supplies. Consequently, they do not have the financial resources to invest in greater power generation or upgrading transmission and distribution lines. Non-technical losses cannot be trivialized, as they are estimated in the billions of dollars every year in India alone. [10]

One solution to address both technical and non-technical losses is to install a technology usually associated with energy efficiency – energy meters.[5] Metering is critical for several reasons. One, it allows end-users to become aware of how much energy they are consuming, which may discourage over-consumption and encourage energy efficient behavior. Secondly, meter installations allow utilities to implement billing systems based on the amount of energy consumed, thereby providing utilities with the financial resources to improve its services. This type of billing system is especially important in regions of the world where a flat monthly fee is charged to all households. Third, energy subsidies can be more efficiently allocated through meters by identifying non-poor households (sometimes the wealthiest individuals or companies in a country) that use large volumes of electricity and retain a large percentage of the total subsidy. Eliminating this group of end-users from the pool allows energy subsidies to be redirected to customers who need it most. [11]

The advantages listed above can be met by traditional meters, but "smart" meters can provide two additional benefits.[6] On the human side, there will no longer be a need for utility companies to send employees into the field to read analog meters. This is crucial because meter readers have been reported to encounter violence by angry customers who are worried that their illegal grid connections will be detected. Removing humans from the equation also mean that end-users can no longer collude with dishonest meter readers to cheat the power company. On the technical side, smart meters equipped with sophisticated software can monitor usage remotely and in real time, giving utility companies the ability to rapidly detect and address unusually heavy demand, which may signal an illegal hookup. [12]

[5] To achieve desired results, faulty meters need to be minimized and measures need to be in place to prevent meter tampering.

[6] Smart meters are generally more expensive than conventional meters, representing a financial burden to resource-constraint nations. A range of concerns (e.g. privacy) also needs to be addressed before they can be widely deployed.

Energy Cross-Subsidization and Captive Generation

Generally speaking, subsidies are necessary to ensure that the price of electricity is affordable or perceived to be fair. [13] As a result, the practice of cross-subsidization between different categories of consumers (commercial and industrial versus agricultural and domestic) and income groups (rich versus poor) is common around the world. However, cross-subsidization can lead to misuse since the subsidized consumers are not paying for the real cost of energy. Conversely, the subsidizing consumers (e.g. industries and commercial) may have to cut back on much needed energy use to prevent cost overruns. Cross-subsidization may eventually cause the subsidizing consumers to stop purchasing electricity from the grid and move towards captive generation.[7] When this happens, utilities will have even less financial viability to make investments in electricity generation, transmission, and distribution. Hence, it is important to ensure that one group of consumers is not overburdened while ensuring adequate access to energy for the other group of consumers. [14]

Captive plants are generally not used as a primary supply source, but as back-up power to hedge against the unreliable electric grid. Consequently, the average load factor of captive plants in India hover between 30-40 percent in the years 1971 to 2007. Increasing the load factor of these captive plants can have significant implications for energy access, as up to 55 TWh (8.6% of the total electricity consumed by India in 2009) could have been available if they were running at full capacity. [15] To enable this outcome, policies need to be in place so that selling surplus power back to the grid makes financial sense for the owners of these captive generation systems.

Several environmental impacts must be taken into consideration in the deployment of captive power. One, the fuel mix of captive plants is carbon intensive as large generating capacities are usually coal and diesel based. Two, captive generation systems tend to be smaller in size, which often lack emission control equipment. Three, the systems are likely to be widely dispersed, making their greenhouse gas emissions difficult to monitor. To address these concerns, policies are needed to incentivize the use of renewable energy or co-generation systems. Co-generation, also known as also known as combined cooling, heating, and power (CCHP) systems, is a particularly interesting option for captive generation systems because they are significantly more efficient

[7] Captive generation, or captive power, refers to generation from a unit set up by industry for its exclusive consumption.

than conventional electricity generation systems. To illustrate, conventional fossil-fueled power plants lose two-thirds of their energy input to the environment as heat, resulting in an average efficiency of 33%. Conversely, CCHP systems recycle and use this waste heat, leading to efficiencies between 60% and 80%. These higher efficiencies not only reduce energy demand, but also contribute to a reduction in both greenhouse gas emission and air pollution. [16]

Despite its advantages, co-generation faces two major barriers against its deployment. On one hand, they are more expensive than conventional power generation systems, making them a financial burden in both developed and developing countries alike. On the other hand, co-generation is not a "defined" technology, but an approach to applying a range of technologies. [17] The lack of uniformity can be troublesome in ensuring grid interconnectivity, potentially discouraging the sale of surplus power back to the grid. Hence, standardizing interconnections to the grid may be an issue that needs to be addressed for co-generation to contribute to greater energy access.

Energy Efficient Appliances for Energy Access

In addition to the 'large scale' opportunities, energy efficiency can also contribute to energy access in end-use products such as solar lanterns and clean cookstoves.

Better light is a critical enabler of development because it allows learners to study at night without straining their eyesight and lets teachers prepare lessons and grade papers. Household incomes can also be raised, as extra work such as beading, weaving and sewing can now be conducted after the sun has gone down. [18] Since solar lanterns charge a battery during the day and then use that stored energy during the night to provide light, a common challenge is how to prolong the time in which visible light is provided. One solution is to use very energy-efficient solid light bulbs known as light-emitting diodes (LEDs), which are twice as efficient as compact fluorescent light (CFL) bulbs and eight times more efficient than incandescent light bulbs.

On the other hand, clean cookstoves are designed to have a wide range of advantages compared to conventional cooking options. For example, clean cookstoves reduce the time people (usually women and girls) have to spend collecting fuel; time that can be put into more productive uses such as going to school or engaging in entrepreneurial activities. Moreover, a clean cookstove can not only reduce carbon emissions by up to three tons per year, but also reduces human exposure to harmful cookstove smoke. Finally, enhanced combustion efficiencies can lead to both fuel and financial savings. Taking into account the accumulated fuel savings over the lifetime of a clean cookstove, the money saved can be spent on a range of livelihood-enhancing activities, such as income-producing enterprises for women, medicine, and school attendance for children. [19] An example of this financial saving can be seen from the Toyola stove model, where consumers pay for their clean cookstoves using money saved (in a 'Toyola money box') from the reduction of charcoal demand. [20]

THE "3 A'S" OF CLEAN AND EFFICIENT PRODUCTS

Beyond areas where energy efficiency can enable greater energy access, there is also a need to ensure the availability, accessibility, and affordability of clean and efficient products. The so-called "3 A's" are critical because the problem is not a lack of solutions, but making them widely available and affordable in the most underserved and impoverished regions of the world. It is, however, important to note that consumers will not purchase clean and efficient products just because they are available, accessible, and affordable.[8] Hence, policies are needed to induce the purchase of these products. One option is to adopt energy efficiency codes, labels, and standards, in order to push underperforming products out and pull high performing into the market[9]. Governments can also implement public awareness raising programs to educate the public on the benefits of clean and efficient products. Additionally, rewards programs (e.g. a rebate or a discount on other products) can be offered to encourage large energy efficiency deployment.

Availability

The availability clean and efficient products depend on whether it is locally manufactured or imported, either through international trade, government procurement[10], or foreign donations. Two issues are of note if these products have to be imported from abroad. One, enacting policies to create a local market can contribute to poverty alleviation by equipping individuals with the technical training and marketing skills to both manufacture and sell these products. Two, governments must be mindful that

[8] Explanations for this behavior include unfamiliarity with new products, generally higher prices, and a lack of awareness of their benefits.
[9] Transitioning from voluntary to regulatory can help mitigate the impact caused by standards and codes.
[10] Government procurements can have a big impact because purchases by governments of goods, services and works account for 15-19% of GDP in industrialized countries and even more in emerging economies.

domestic environmental policies can create barriers for the trade of goods and services. Thus, countries wishing to block the import of products that do not meet certain emission or energy consumption standards must find a way to address these trade barriers.[11] [21] Today, the rules and regulations regarding such barriers are scattered and do not offer an integrated solution. Hence, countries might have to solve these trade issues bilaterally, through plurilateral, or regional trade forums.

Accessibility

The accessibility of these products is another area of importance, as the costs of traveling to a market where goods are available may easily exceed the price of the product. Fortunately, there are many existing models that the energy sector can piggyback on, as this problem is not unique to clean and efficient products. One of the most effective ways of increasing product accessibility provide local entrepreneurs with a reduced-risk business model so that they can sell basic products such as eyeglasses, cookstoves, and solar lamps to rural villagers in "Bottom of the Pyramid" markets. To illustrate, the start-up Solar Sister is using the "micro-consignment model" to distribute solar energy in Uganda, Sudan, and Rwanda. The micro-consignment model works in the following way: a supplier gives a product to a retailer, who then sells it. After the sale is completed, the retailer reimburses the supplier, keeping a commission. This model reduces the risk borne by the retailer because the need for start-up capital is eliminated; hence, the risks of financial failure resulting from outstanding loans or failed franchises are avoided.[12] [22]

Affordability

Affordability is the third critical piece of the puzzle, as products will not be purchased if they are too costly, even if they are readily available and accessible. A conceptual model which utilizes the attributes of energy efficiency to advance energy access is presented in Figure 1.

Step 1

In the first step, loans are provided by local banks or microfinance institutions (MFI) for the purchase of new clean and efficient products.[13] Often times, these loans will have to be funded by a multilateral development bank (MDB) such as the World Bank, Asian Development Bank, or the Inter-American Development Bank. Obtaining loans from MDBs can be highly beneficial, as they may be supported by a robust program of capacity building and technical training. This assistance is crucial to laying the groundwork for sustainable development, as it will familiarize local loan officers with investment opportunities in sustainable energy, educate policy makers on how sustainable energy contributes to sustainable development, and train the local workforce to carry out sustainable energy projects.

Step 2

In the second step, consumers receive a credit or voucher based on the size of their demand reduction after deploying energy efficient measures. The size of the savings can be calculated in several ways. For example, if the consumer is replacing an existing appliance, then the difference in demand between the new and old appliances can be determined. If the consumer is purchasing a new appliance, the difference can be calculated against an established baseline or market average. Tangibly monetizing the financial savings from energy efficiency is critical to overcome the perception that financial savings from energy efficiency is "virtual money" that is not usable.

Step 3

In the third step, consumers can use this credit or voucher to pay for their electricity bills, purchase a renewable energy system, or loan repayment. Using the credit or voucher for something other than energy access is discouraged not only because it dilutes the impact of this model, it also defeats the purpose of treating energy efficiency and energy access as a "package", prompting the advancement of both.

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[11] Trade-related barriers can come in two forms – de jure or de facto – depending on how they are designed. Tariffs are the most obvious kind of de jure barriers. Other forms of barriers include local content requirements (LCR), government subsidies, export restrictions, taxes and dual pricing, government procurement policies, standards and certification, etc.

[12] Other social enterprise models include micro-enterprise and micro-franchise. For more information, *see* [23] and [24], respectively.

[13] Subsidizing these products will lead to the same outcome as a loan. However, a subsidy is not recommended because of its ability to distort markets as well as causing a burden to national budgets. Furthermore, end-users may not fully appreciate these products if they are obtained at subsidized rates.

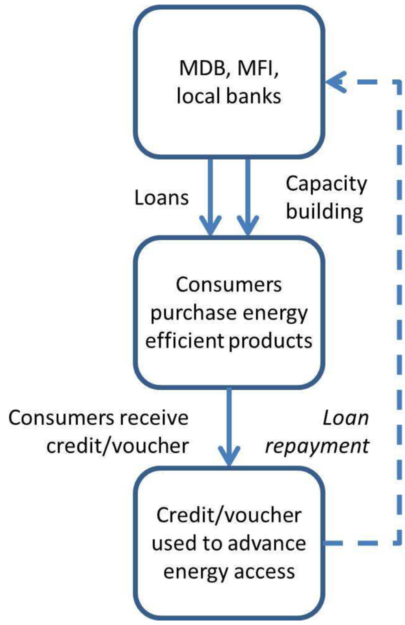

Figure 1: A financial model to scale-up energy access with energy efficiency

CONCLUSION

Development is not possible without energy and sustainable development is not possible without sustainable energy. In this context, energy efficiency can no longer be ignored as countries seek to achieve greater energy access. For instance, utilizing energy efficiency technologies to minimize technical and non-technical losses in the generation, transmission, and distribution of electricity allows electricity to be utilized by more end-users. Enhancing the energy efficiencies of captive generation systems also have the potential for large gains in energy access. Moreover, energy efficiency can contribute to energy access at the end-user level, such as using an LED to prolong the light output of solar lanterns and using a clean cookstove to reduce fuel consumption. Just as importantly, the availability, accessibility, and affordability of clean and efficient products must be addressed to ensure that they are widely available and affordable in the most underserved and impoverished regions of the world.

Achieveing universal energy access to modern energy services and an aggressive deployment of energy efficiency measures will be challenging. Hence, the international community must act decisively in order to break the vicious circle of energy poverty and human underdevelopment in the world's poorest countries. National government initiatives will be critical on the pathway towards sustainable development, but sustained success can only be achieved with the active and coordinated engagement of consumers, utilities, policy makers, financial institutions, the private sector, etc. It is hoped that that a combination of capturing the opportunities for energy efficiency and energy access, a wide deployment of clean and efficient products, and the active involvement of all stakeholders, will kick-start the transformation towards sustainable development.

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