REGULATED INDUSTRIES COMMISSION

PROMOTING ENERGY EFFICIENCY

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Consultation Document

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1. INTRODUCTION

The Kyoto Protocol to the United Nations Framework Convention on Climate Change (UNFCCC) is an international treaty that sets binding obligations on industrialized countries to reduce emissions of greenhouse gases. The goal of the UNFCCC is the prevention of dangerous anthropogenic (i.e., human-induced) interference of the climate system. Developing countries do not have binding targets under the Kyoto Protocol, but are still committed under the treaty to reduce their emissions. Actions that have been undertaken by developed and developing countries to reduce emissions include support for renewable energy, improving energy efficiency, and reducing deforestation. The Protocol was adopted by Parties to the UNFCCC in 1997 (Trinidad and Tobago signed on and ratified its participation in 1999), and entered into force for most Parties including Trinidad and Tobago in 2005.

One of the eight Millennium Development Goals agreed to in 2005, by the members of the United Nations, sought to ensure environmental sustainability throughout the world by 2015, more specifically, by the integration of the principles of sustainable development into country policies and programmes and the reversal of the loss of environmental resources. Thus, over the last decade, more and more countries around the world have been engaged in promoting and implementing energy efficiency programmes and/or energy conservation efforts as a means of reducing the demand of traditional energy resources, thereby, safeguarding their energy supplies as well as reducing the harmful effects of greenhouse gas emissions on the environment. Although energy efficient technologies have been employed to reduce energy demand, realizing large scale energy savings has continued to be a significant challenge for most countries as there are many barriers which have hindered efforts to date.

The reduction in the consumption of energy produced from traditional resources can be achieved through either of the following practices or a combination of both. The utilization of energy derived from renewable resources, such as sun, wind and water (hydro or tidal), to offset part of the consumption, and/or the more efficient utilization of energy throughout the chain of production, distribution and final consumption of electricity. There are a number of cost-

effective supply and demand-side energy efficiency options and demand side management (DSM)[1] that reduce the demand for electricity, thereby displacing or deferring the need for investment in generation and network capacity.

In 2006, the RIC included in the Final Determination (Rates and Miscellaneous Charges) for the Electricity Transmission and Distribution Sector some supply and demand-side options. An incentive mechanism for the Trinidad and Tobago Electricity Commission (T&TEC) to manage the system losses on its transmission and distribution networks was provided in order to motivate the utility to improve the efficiency of its processes. With respect to incentivizing the adoption of energy efficient technologies and energy conservation practices by the residential users of electricity, the RIC included an inclining block tariff structure for billing these customers in three tiers; therefore, these customers obtain a financial benefit by reducing electricity consumption. Indeed, the RIC also required that T&TEC create and implement a database of energy efficient appliances and products that consumers could refer to, as well as, provide tips to consumers on conservation practices. As such, the RIC[2] and T&TEC [3]have each published literature (from as early as 2008) targeting primarily residential customers in order to educate this group on the benefits of energy efficient practices and technologies.

Currently, the Ministry of Energy and Energy Affairs (MEEA) is developing a Sustainable Energy Program (SEP) which, as part of its mandate, will facilitate and promote the utilization of renewable energy (RE) and the implementation of energy efficiency (EE) programmes throughout the following consumption sectors: government, commercial, small industrial, tourism and residential. An EE study[4], outlining specific efficiency measures that could be employed by individual industrial companies in the Point Lisas Industrial Estate, was conducted in 2011 and serves as the guide for the large industrial sector. It was noted that the larger

[1] DSM includes load management, energy efficiency and electrification. Load management includes peak dipping, valley filling and load shifting. Energy efficiency involves a reduction in overall energy use. Electrification involves load building over all hours, inclusive of the development of new markets and customers.
[2] "Save money on your next electricity bill".
[3] "Appliance usage and its impact on your bill"; "Conserve Energy".
[4] CBCL Limited in association with ICF Marbek April 2011: Consultancy Services for the Establishment of Frameworks for Energy Efficiency Policy and Programme. National Energy Corporation (NEC) of Trinidad and Tobago.

industrial customers in Trinidad and Tobago have been focussing on operational energy efficiency in order to maximize their earnings.

The RIC strongly believes that there are substantial cost-effective opportunities to utilize energy efficiency options that are currently being overlooked and/or not being effectively implemented. The RIC believes that EE initiatives should be central to the future development of the energy sector thus leading to a reduction in the capital investment that may be required for new energy/electricity production plant. Ultimately, end-users would benefit through lower total energy bills. There would also be the environmental benefit of reduced greenhouse gas emissions once less electricity has to be generated.

Purpose of Document

This paper examines the current EE framework and initiatives in place in Trinidad and Tobago, their effects to date with respect to motivating various classes of electricity consumers to reduce their consumption. It also reviews international experiences and proposes measures to be undertaken locally in order to better exploit existing demand-side EE technologies and energy conservation practices throughout the national community. It is also expected that this report will help focus the debate on the issues surrounding the progress of EE implementation in the country.

Structure of Document

The rest of this document is structured as follows:

Section 2: Potential for Energy Efficiency.
Section 3: International and Local Experiences with respect to EE Programmes.
Section 4: Proposals for increasing Energy Efficiency.

Responding to this Document

All persons wishing to comment on this document are invited to submit their comments. Responses should be sent by post, fax or e-mail to:

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All responses will normally be published on the RIC's website unless there are good reasons why they must remain confidential. Any requests for confidentiality must be indicated. A copy of this document is available from the RIC's website at **www.ric.org.tt.**

2. POTENTIAL FOR ENERGY EFFICIENCY

2.1 Overview

An examination of the data contained in the World Bank's database of World Development Indicators revealed that the use of electricity in Trinidad and Tobago had been growing between 2006 and 2011 at a rate of 3.8% per annum while the growth in peak demand over the same period had been 2.3% per annum. The level of energy consumption per capita in 2011 was 6,264 kWh per annum, the 28th highest consumption per capita level in the world. At the present growth rates substantial capital investment will soon be required to develop additional generation capacity, while at the Transmission and Distribution level, capital investment would be needed to expand the network along with a consequential increase in maintenance and rehabilitation costs. These outcomes may impact on the level of indebtedness of T&TEC and its cost of doing business. These costs may eventually be passed on directly or indirectly to consumers by increases in tariffs and/or taxes, which can impact negatively on other aspects of the national economy.

Supply and demand-side energy efficiency options have the potential to reduce energy costs to consumers, by reducing both the quantity and cost of electricity used. The key to reducing the costs of electricity is achieving better utilization of existing assets, deferring the need for new capital expenditure on additional capacity and promoting EE while concurrently replacing assets that are no longer economical to keep in service.

A range of demand-side activities can be used to increase the efficiency of energy usage, including[5]:

- **Utility (Demand Response/Load Management)**, that is, activities that reduce load and/or shift load on the system; and

[5] May also include Distributed Generation/Embedded Generation – that is, electricity generation that is connected within the distribution system rather than the transmission network.

- **Consumer** – this involves all changes which lead to lower energy use for a given energy service (e.g. lighting, water heating or cooling) or for a given level of activity, through the use of more efficient equipment/appliances.

An emerging trend for utilities is to more efficiently serve the end-user by taking a holistic look at the way that electricity usage is managed. Through the utilization of advanced metering infrastructure (AMI), which can enable two-way communication with the end-user at specific intervals of time, utilities have implemented different practices, which include:

- the timely reporting of usage to the end-user during billing cycles;
- monitoring consumers' behaviour in order to adjust tariffs and establish good pricing signals; and
- implementing and automating the utility's control of some of the end-user's appliances in order to reduce the peak demand on the system.

The local electricity sector has, thus far, largely relied on supply-side options to meet growing demand rather than engaging in EE options to control the rate of growth. To bring about the required changes, it would be necessary to employ a number of different mechanisms to encourage or stimulate demand reduction. Ultimately, demand reduction would depend on end users making informed decisions and thus changing their behavioural patterns. Among other mechanisms, the approaches may include:

- establishment of mandatory performance codes and minimum standards applied to appliances and equipment and specification of a minimum level of energy performance. Equipment and appliances not meeting minimum standards should not be sold;
- rewarding energy efficiency practices through economically efficient pricing;
- promoting public awareness through extensive public education campaigns and programmes;
- establishing benchmarks for electricity generators with respect to the greenhouse gas emissions of their plants, leading to increased use of lower emission technologies, etc.; and

- providing incentives to support the development and use of innovative technologies.

2.2 Role of the RIC

Energy conservation is not the sole responsibility of any single entity in the provision and use of energy services. There are a number of stakeholders locally, including the Government of the Republic of Trinidad and Tobago (GORTT) and its executing ministries/agencies, T&TEC, consumers, and the RIC. The RIC's role in this regard will be to examine the current EE initiatives and practices in the country and to propose measures that can be undertaken by the GoRTT, T&TEC and the RIC to increase the level of integration of EE practices and the consequential benefits.

As the economic regulator for the water and electricity sectors, the RIC regulates tariffs and charges. The Regulated Industries Commission Act, 1998 (the Act), also requires the RIC to consider certain regulatory principles and objectives, including:

- financial viability and sustainability of the service providers;
- maximum efficiency in the use and allocation of resources to ensure as far as is reasonably practicable, that services are reliable and provided at the lowest possible cost;
- the impact on customers and the public interest; and
- the national environmental policy.

The above objectives broadly point to the need to consider the most efficient means of consuming electricity and the benefit of delaying the need for additional electricity generation, least cost planning and pricing policies that protect the environment. The RIC has focused on mechanisms aimed at incentivising the service provider to undertake specific activities to improve efficiency. In making its Final Determination (Rates and Miscellaneous Charges) for the Electricity Transmission and Distribution Sector in 2006, the RIC had considered price related DSM techniques, such as, rate restructuring and load shifting and non-price related DSM techniques, such as, promoting EE appliance usage and consumer education programmes highlighting the benefits of EE practices.

2.3 Transmission and Distribution Network Efficiency

The transmission and distribution of electricity to end users can be made more efficient in a number of ways, including:

- By the service provider:
    - reducing technical losses through measures such as increasing transmission voltage, replacing overloaded lines with larger-sized conductors and installing higher efficiency transformers in substations.
    - locating transformer and substation sites closer to consumers using large loads.
- By the regulator:
    - instituting a cap on the amount of system losses that the service provider should incur and pass through to consumers.
    - instituting incentives/penalties for the service provider to improve the system power factor[6].

Revenue Cap tariff structures combined with decoupling[7] mechanisms can promote energy efficiency as they break the link between a service provider's incentives to increase sales and the disincentive to promote energy efficiency.

2.4 Demand Response

In broad terms, demand response (DR) programmes provide an opportunity for consumers to play a significant role in the operation of the electric grid by reducing or shifting their electricity usage during peak periods in response to time-based rates or other forms of financial incentives. At the core of demand response is the goal of optimizing usage by helping utilities, commercial and industrial organizations to better manage peak demand. DR options result in the reduction of system peaks through demand-side management and the shift of load patterns through the application of inverted block/time-of-day tariffs and allow utilities to avoid or defer significant capital

[6] In an electric power system, a load with a low power factor draws more current than a load with a high power factor for the same amount of useful power transferred.

[7] Revenue Decoupling mechanisms ensure that the revenue collected by a utility remains at the level that was determined by the regulator to represent the utility's efficient and reasonable costs (inclusive of a fair rate of return), that is, its allowed revenue.

investments in new capacity. These options include standby generation, interruptible supply options, power factor correction and distributed generation.

2.4.1 Enabling Technology

Smart grids have, in part, been developed to facilitate the efficient and effective delivery of electricity to the consumer. Smart grids allow for the real-time interaction between the utility and consumers and enable utilities to forecast consumer behavior in order to predict peaks in the demand for electricity, perceive system overloads, detect electricity pilferage, and manage loads through advanced system modeling in order to improve energy efficiency, reduce system losses and lower gas emissions. Smart grids incorporate smart meters to operate, and a number of countries are in the early stages of utilizing smart grid technologies. In Trinidad and Tobago, smart meters have been deployed throughout all the customer classes. However, T&TEC has not yet implemented a comprehensive smart grid with advanced hardware features and analytic tools.

2.5 Energy Efficiency (EE) Potential Locally

Energy efficiency practices can be undertaken by all classes of consumers, such as, residential, non-residential and industrial. The non-residential class of customers can be broken down into two groups with distinct outlooks with respect to energy efficiency; private business enterprises inclusive of the service industries (**Commercial**), and public and state run enterprises (**Government**). Industrial customers can also be distinctly classified as either small or large industrial customers. Therefore, the different consumer groupings in Trinidad and Tobago to be discussed within the context of this paper will be:

- Residential;
- Commercial;
- Government;
- Small Industrial; and
- Industrial.

In 2011, Trinidad & Tobago's energy intensity index (EII) was reported by the Latin American Energy Organization (OLADE) to be 5.03[8], the highest in all of Latin America and the Caribbean (LA&C). Brazil, the most industrialized country in the Latin American region had an EII of 1.43 and other industrialized countries in the region also had lower EIIs than Trinidad & Tobago, which is an indicator that the country could have possibly made more efficient use of the energy it consumed in that year. Trinidad & Tobago was also reported by OLADE to have the highest dependency on fossil fuels in the region: almost 100% percent of its total energy consumption was generated from this source. Diesel and gasoline prices were reported to be the fourth lowest in the region trailing Venezuela, Cuba, and Ecuador respectively, and residential electricity prices were the third lowest in the region behind Argentina and Venezuela respectively. Therefore, the circumstances to promote EE locally were and still are not favorable due to the fact that fuel price subsidies and low retail energy prices would result in lengthy payback periods for the investments made by consumers opting for the implementation of EE measures.

2.5.1 Residential Sector

In Trinidad and Tobago, the high level of electricity consumption, as reported by OLADE, is most likely due to the low cost of energy and electricity, which can influence consumers to inefficiently use appliances and light fixtures. Therefore, it is anticipated that the impact of rebound effect [9] would possibly be lower than what has been observed in other jurisdictions due to the fact that electricity consumption levels are already high. The levels of public awareness on energy efficiency practices and energy conservation measures are estimated to be low. Therefore, a significant savings could be potentially achieved from the successful implementation of EE measures.

[8] The complete ranking is given in the Latin American Energy Organization (OLADE), November 2012: Energy Economic Information System Energy Statistics Version No.22 Quito. Energy intensity is a measure of the energy efficiency of a nation's economy. It is calculated as units of energy per unit of GDP. High energy intensity indicates that a country needs more energy consumption to generate one dollar of GDP, and low energy intensity indicates that the country needs less energy consumption to generate one dollar of GDP. Many factors, such as climate, structure of sectoral energy consumption and the technology used by predominant industries, can influence an economy's overall energy intensity.

[9] A behavioral response to the reduction in energy costs caused by an improvement in technical efficiency: as the cost of using energy is reduced due to efficiency improvements, there is the tendency for longer periods of utilization of energy efficient appliances, thereby offsetting the energy savings made possible by the efficiency improvements.

EE in the residential sector can include a range of options such as the replacement of incandescent lamps with compact fluorescent lamps, replacement of less efficient appliances with more efficient models, use of efficient electrical water heaters showerhead/ tank, etc. Despite the benefits of reduced energy costs as a result of investing in EE technologies, there are many impediments/barriers for success such as, the upfront costs and the lack of public awareness/information. The main ways to encourage these programmes are usually through rebates on purchases, favourable financing rates and technical assistance. The following are some EE measures that have a fair chance of success among this class of customers:

- efficient lighting;
- efficient appliances;
- efficient water heating;
- efficient cooling of buildings; and
- appropriate tariffs.

On the basis of experience from a number of World Bank client countries, **energy efficient lighting** technologies seem to offer one of the most promising solutions to help reduce electricity usage. Lighting end-users consume about 19% of global electricity consumption[10] and in most developing countries, lighting is the most important use of electricity in the residential sector[11]. Locally, the evening lighting loads comprising street lights, lighting of public spaces and residential lighting, contribute significantly to the utility's peak load.

Two types of programmes have had particular success in many countries. Firstly, the replacement of energy-intensive incandescent lamps (IL) with more efficient high-quality compact fluorescent lamps (CFL) and light-emitting-diode (LED) based systems. These can provide savings in energy costs of more than 75-80% compared to ILs for the

[10] International Energy Agency, Paris, 2006. "Lights Labour's Lost: Policies for Energy Efficient Lighting,"
[11] The World Bank's Energy Sector Management Assistance Program (ESMAP). 2009 "Large-Scale Residential Energy Efficiency Programs Based on Compact Fluorescent Lamps (CFLs) Approaches, Design Issues, and Lessons Learned"

equivalent lighting output (measured in lumens), and the CFLs last 5-10 times longer than ILs thus reducing replacement costs. In fact, the benefit of CFL installation programmes in different countries has been observed to be substantial (**see Box 1**).

Box 1: Examples of Peak Load Reduction from CFL Installation

Country	No. of CFLs Installed	Reported MW Reduction	Peak Reduction/ 100,000 CFL
South Africa	2,700,000	90	3.3
Vietnam	1,000,000	33	3.3
Uganda	800,000	30	3.8
Sri Lanka	733,000	34	4.6
India – BELP	300,000	13.5	4.5
Source: World Bank[12]			

A review of World Bank data revealed that a typical one million CFL installation programme conducted by a government can cost US$2 Mn. and would provide load reductions amounting to 38.9 MW, thus, representing utility cost savings of more than US$69 Mn. over the life of the CFL. The programme can also provide reduction in GHG emissions of over 300,000 tons of CO_2 equivalent (**see Box 2**).

Box 2: Cost-Benefit of Replacing 1 Million 60 Watt ILs with 15 Watt CFLs

Total Cost of CFL of US$1 Mn. plus other costs US$1 Mn.

- Peak demand savings 38.9 MW.
- Capacity savings - US$37.9 Mn. plus total energy savings - US$31.6 Mn.
- Customer bill savings - US$44.8 Mn.
- GHG reduction about 317,000 tons providing revenue of US$3.2 Mn.
- **NPV of national benefits (at 10% discount rate over an approximate life span of 6years 3months) of more than US$50 Mn., compared with total cost of US$2 Mn.**

Source: World Bank[12]. Based on several recent programmes in developing countries.

Different countries have utilized different phase-out policies and plans in which ILs can no longer be purchased by consumers. Cuba was the first country to implement the phase-out programme of ILs with CFLs in **every** household, where 116 million ILs were

[12] The World Bank's Energy Sector Management Assistance Program (ESMAP). 2009 "Large-Scale Residential Energy Efficiency Programs Based on Compact Fluorescent Lamps (CFLs) Approaches, Design Issues, and Lessons Learned"

replaced with CFLs supplied and installed by government workers. This exercise achieved a reduction in the maximum demand of electricity in peak hours by more than 3,980 MW and annual emission savings of more than 8 million tons of CO_2 equivalent[13]. Thailand, on the other hand, facilitated consumers to voluntarily change out ILs with CFLs, which could have been purchased from suppliers at prices subsidized by government. Large-scale implementation of CFLs has also been accomplished in other countries in different ways, including:

- Bulk Procurement and Distribution – where government or its agency bulk procures, provides any subsidies or other financing and the electric utility implements the programme.
- Market Channel Based Approach – where existing market channels are used to distribute/sell CFLs that meet specified technical criteria. Rebate and voucher programmes are generally utilized to promote the sale of CFLs.

After lighting, household appliances consume the most electricity. Therefore, the establishment of energy efficiency standards for appliances is the second most cost-effective option for controlling demand. Efficient appliances allow for a high return on investment due to the energy savings from the lower consumption of electricity.

Retrofitting buildings and housing with more energy-efficient structures, equipment or appliances has been an important means of improving energy efficiency in most developed countries, as widespread programmes can significantly reduce the demand of the energy. With a growing demand for air conditioning appliances locally, energy efficient housing designs and retrofitting programmes (such as insulation, weather stripping, and other building shell improvements) can contribute to lowering the demand for electricity.

2.5.1.1 Consumer Behaviour

Another important factor to consider with respect to the uptake of EE practices is the significance of consumer behaviour. Different studies have been conducted examining

[13] Worldbank – Based on Roberts Gonzales, "The Replacement of Incandescent Bulbs – The Cuban Experience.

the potential impact of behavioural change on the outcome of EE programmes. It has been shown that when more frequent and specific feedback of electricity usage is provided to consumers, there is a greater level of application of EE practices[14]. The current billing cycle for residential consumers is bi-monthly and therefore the provision of more frequent billing information (e.g. monthly) may allow consumers to gain a better sense of appreciation of how their usage of appliances impact on their household energy consumption and assist in positively modifying their behaviour.

2.5.2 Commercial / Tourism and Small Industrial Sectors

In these sectors the main load arises from the use of lighting, ventilation/ air-conditioning and chiller systems. Types of EE programmes that redound in savings include the use of high efficiency motors and fans, lighting upgrades and upgrades of office equipment. Due to the low cost of energy and electricity, the focus on achieving EE has not been given the same attention as in other countries where the price of energy and electricity is relatively higher. The level of engagement of Energy Service Companies (ESCOs) by these consumer groups to identify savings potentials and implement energy saving projects should increase once tangible incentives, such as, the 150% tax allowance proposed by the GoRTT, are given to these consumers to implement EE practices.

2.5.3 Government Sector

Public sector facilities typically have significant scope for energy efficiency improvements. The public sector's energy demand in most countries is usually a significant percentage of the commercial demand, and the public sector is also a major buyer of office appliances, light bulbs and to a lesser extent kitchen appliances. The use of air conditioning equipment is typical for most offices. The benefits of improving energy efficiency practices in the public sector are many and include lower energy bills for office spaces and reduced demand for investments in energy supply systems. The public sector's purchasing power can be used to increase the otherwise low demand for more expensive efficient technologies and thus create entry markets for more of these products, such as air conditioning units and imported energy efficient bulbs and fittings.

[14] Carrie Armel "Behavior & Energy" 2008. Standford University's Precourt Institute of Energy Efficiency.

The increased demand may then positively impact on prices, as more suppliers enter the market and increased competition lower prices to the benefit of all customers. In the future, highlighting any positive outcomes of EE practices, which have been implemented in the public sector, to the consumers in other sectors may have a motivating effect in stimulating them to implement proven measures.

The potential for energy savings varies among different public sector activities, and available measures include both simple, low cost measures, such as lighting, and more complex and time-consuming improvements in building retrofits, and other infrastructure systems. In general, no attention has been given to implementing EE initiatives within the office spaces utilized by governmental agencies or the large scale housing developments constructed under the Government's housing initiative. The potential for the integration of EE initiatives is higher within this sector due to the Government's capacity and capability to implement the necessary measures. In addition, changes in the attitudes of public sector workers' with respect to reducing energy consumption through education, role play and assignment of responsibilities and other demand-side management initiatives can be instituted in order to harness the significant potential for improved energy efficiency, especially in light of the fact that the end-users in this particular sector invariably exhibit behaviors of over consumption and wastage of publicly financed utility services.

2.5.4 Industrial Sector

Traditionally, greater attention has been paid to the contribution of the expenditure for energy to the overall operational costs for this group of consumers. Energy audits and the implementation of recommendations based on these audits are ongoing. Overall, this sector can further benefit from the accurate monitoring and reporting of the EE efforts being undertaken. The main areas where the greatest gains can be achieved through improved EE in the industrial sector consists of:

- high efficiency motors and variable speed drive systems;
- improved process heating controls; and
- energy efficient lamps and ballasts.

2.5.5 Energy Efficiency – Conclusions

There is now a wide range of energy efficient equipment and household appliances that can be purchased and utilized in order to reduce the energy consumed by the various end users of electricity. However, the motivating factors for using energy efficient equipment that exist in many other countries are not necessarily present in Trinidad and Tobago due to the low cost of energy. Nevertheless, the use of these appliances has been proven to reduce the amount of electricity consumed by the end users in other countries.

As part of the SEP currently being developed by the MEEA, an assessment of the technical potential of commercially available energy efficient devices and appliances to reduce energy consumption in Trinidad and Tobago has been conducted[15]. The energy ratings of these energy efficient appliances were compared with the ratings of equipment typically used in Trinidad and Tobago and a score was assigned with respect to the level of reduction in energy consumption that could be potentially achieved. The technical potential scores for the various appliance categories generally ranged from medium to high, which is an indication that most of the electrical appliances presently used in the country are highly inefficient. The anticipated levels of acquisition and use of these devices by the various consumption sectors (uptake) based on present local conditions was also assessed and scored from none to medium. These low uptake ratings can, however, be positively impacted through a combination of measures. The consumption sectors that would benefit greatly from the use of specific energy efficient devices and the estimated uptake of these devices by the sectors have already been determined in the SEP and this information is summarized in **table 1**.

Table 1: Energy Efficiency Technologies, Potential Applicability and Estimated Uptake

EE Type	Description	Potential sector of application	Technical EE Potential	Estimated uptake
CFL lamps	Small fluorescent lamps with electronic ballast in base, designed to replace regular incandescent lamps and provide the light output for one-fifth to one- third the electricity consumption, with an average lifetime 8 times longer.	Residential Commercial*	High High	Low Low

[15] Conducted by Centro de Alianzas para el Desarrolla and presented in the document "Support to the Sustainable Energy Program (TT-L1023) First Intermediary Report Inter-American Development Bank" (January 2013)

EE Type	Description	Potential sector of application	Technical EE Potential	Estimated uptake
T8 fluorescent lamps with electronic ballast	Slim, 1" dia. efficient fluorescent tube that operates using electronic ballasts as well as the traditional magnetic ballast.	Residential Commercial Government Small Industrial	Medium-High Medium-High Medium-High Medium-High	Low Low-Medium Low-Medium Low
T5 fluorescent lamps (electronic ballast)	Slim, 5/8" dia. efficient fluorescent tube that operates with electronic ballast. More efficient but significantly higher investment cost than T8 tube.	Commercial Government Small Industrial	High High High	Low Low Low
LED lamps	Highly efficient lighting based on light-emitting diode (LED) technology. Very high investment cost.	Residential Commercial Government Small Industrial	High High High High	Very Low/None Very Low/None Very Low/None Very Low/None
LED Street lamps	Street lighting that utilizes highly-efficient LED lamps for illumination, Very low energy usage, but very high cost of installation.	Government	High	Very Low/None
Variable-frequency drives	Electronic controller for AC motors that allow the speed and power (and hence the energy consumption) of the motor to be varied to suit the motors load.	Commercial Small Industrial Industrial	Medium-High Medium-High High	Low Low Low-Medium
High-efficiency air- conditioning units	Room air-conditioning units with an energy efficiency ratio (EER) of 10 or more. The EER is the ratio of the cooling capacity in Btu per hour) to the power input (in watts).	Residential Commercial	High High	Low Low
High-efficiency commercial and industrial scale chiller units	High-capacity cooling with efficient compressors employing variable-frequency drives, or absorption chillers utilizing waste heat.	Commercial Government Industrial	High High High	Low Low Low
High- efficiency domestic appliances and consumer electronics devices	Appliances and consumer electronics devices achieving Energy Star or similar rating for energy efficiency.	Residential	Medium	Low

*** The Tourism Sector was not identified in the source document but it is assumed that its potential would compare closely with that of the Commercial sector.**

Source: Centro de Alianzas para el Desarrolla (January 2013): Support to the Sustainable Energy Program (TT-L1023) First Intermediary Report Inter-American Development Bank

On the basis of the analysis that has been conducted by the MEEA, the Residential sector will benefit most from the use of the energy efficient technologies in the areas of lighting, air-conditioning and household appliance use. The Commercial/Government Sectors have the potential to achieve higher levels of energy efficiency in the areas of lighting, air-conditioning, motors, and cooling/heating, while the Small Industrial Sector should benefit by upgrading their lighting and motor equipment.

3. INTERNATIONAL AND LOCAL EXPERIENCES WITH RESPECT TO EE PROGRAMMES

3.1 International Experiences

The approaches that have been undertaken in many countries with respect to their national EE programmes have been similar in nature, that is, they share key components. Dedicated EE agencies were established to coordinate and execute the countries' EE Plans and the efforts of these agencies were supported by the enactment of new legislation, and the passing of regulations. In all cases there has also been the introduction of various types of financial and fiscal incentives to provide the motivational stimuli to bring about changes in consumers' use of energy. A more recent and innovative measure that has been instituted in some jurisdictions is "energy savings obligations" where energy companies (supplier/retailer or distributor) have been given a legal obligation to promote and stimulate investment, which will result in energy savings in their customers' premises or households.

3.1.1 Strengthening of Institutional Capacity

By 2009, 60 countries around the world had established national EE agencies in addition to having a governmental Ministry or Department dedicated to the issue of energy efficiency[16]. The primary objective of these institutions was to provide the technical expertise, to governments and consumers, which could not always be found in existing government institutions. Some EE agencies were also required to play a key role in certifying the quality of energy efficiency equipment and services available locally. The governments' EE implementation programmes thus benefited from having a dedicated body, consisting of technical experts in the relevant fields, that was capable of interfacing with scattered and multiple energy consumers throughout the course of the implementation of their national energy efficiency policy, as well as in some cases the national environmental policy. EE agencies were typically mandated to design, implement and evaluate EE programmes and measures, to contract a range of

[16] The full listing is given in the World Energy Council (WEC), 2010: Energy Efficiency: A Recipe for Success

stakeholders, such as companies, local authorities, or non government organizations (NGOs) and, finally, to ensure coordination with higher or lower levels of authorities (international, national, regional and local). Yet another function of EE agencies was to act as a coordinator of all governmental initiatives in the field of energy efficiency in order to avoid scattered and uncoordinated actions by different ministries. In particular, the existence of such EE agencies has proven to be very useful in negotiating sectoral agreements with groups of consumers or equipment producers to reach specific targets for efficiency improvements. Although, some electric utilities may be very active in promoting EE interests, in general, they are in the business of selling electricity and thus do not necessarily have a strong enough interest in promoting energy efficiency internally and externally over the long-term, especially in the context of growing competition. Therefore, there is the need for EE agencies to establish targets for utilities, with respect to the levels of energy efficiency to be attained on a long-term basis, and the mechanisms to monitor and hold utilities responsible for their performance.

These EE agencies were usually public institutions funded by the State budget, and in developing countries were often supported by overseas technical assistance funds. In an increasing number of countries, part of the budget was based on a tax on energy (e.g. Norway, Spain, Switzerland, Thailand, and Tunisia). Some countries have set up EE agencies with private sector participation (e.g. Morocco, Portugal), whilst others have established the EE agencies to operate as partially private bodies that have to earn their operational income. In countries that receive aid from international development assistance programmes, such EE agencies can in addition act as the national counterpart with whom donors negotiate the implementation of financial packages for energy efficiency. More generally, such EE agencies can work alongside financial institutions to develop new funding schemes.

3.1.2 Legislation and Regulations

Regulations are widely used in the residential and service sectors as they have proved to be effective in lowering energy consumption by mandating the use of specific appliances and equipment, and speeding up the diffusion of energy efficient equipment, energy

savings investments and practices throughout these sectors. Regulations are more powerful than traditional incentives to transform the market in these sectors by exploring the existing EE options and instituting the best practices for consumers who most often lack adequate information and resources to research and implement EE initiatives on their own accord.

In general, regulations aim either at imposing minimum efficiency standards by law or imposing energy efficient practices, as well as providing systematic information to consumers (e.g. energy audits, labels). Regulations and standards have been classified by the World Energy Council into 3 main categories:

- mandatory labeling for new appliances, new cars and buildings;
- minimum energy performance standards (MEPS) for new appliances and lamps, new cars, new buildings and even existing buildings; and
- other regulations, such as obligation of maintenance (e.g. boilers, air conditioners, cars), obligation for designated consumers (mainly in industry and for large buildings), of energy managers, energy consumption reporting, of energy audits, of energy saving plans and finally, obligation for energy utilities to make energy savings with their consumers ("energy savings obligation").

In approximately 70% of European states, most of the new regulations that were passed were related to energy efficiency standards. In developing and emerging countries, labeling appliances, specifically refrigerators, has been frequently enforced and is often among the first measure to be introduced, such as in Thailand, Iran and Tunisia[17]. Labeling aims at both encouraging consumers to purchase more efficient appliances and manufacturers to remove inefficient appliances from the market. The most common measures other regulators have implemented have been mandatory requirements for designated consumers, such as energy audits, mandatory energy consumption reporting, mandatory energy managers, and mandatory energy saving plans. These designated consumers are usually large consumers, identified from energy consumption thresholds, in selected sectors (e.g. steel, cement, public sector, large commercial buildings). Other

[17] World Energy Council (WEC), 2010: Energy Efficiency: A Recipe for Success

regulations implemented include mandatory maintenance, mandatory installation of solar water heaters and obligatory energy savings imposed on utilities.

3.1.3 Implementation of Financial and Fiscal Incentives

Many countries have introduced financial incentives in order to promote energy efficiency (e.g. subsidies for energy audits or investment, soft loans), as well as fiscal measures. These have been aimed at encouraging investment in energy efficient equipment and processes by reducing the investment cost, either directly (economic incentives) or indirectly (fiscal incentives). Economic incentives are dependent upon an EE labeling system as these incentives are usually granted only for equipment that have approved EE labels. In the same way, these incentives can also be granted to encourage the use of qualified and licensed installation contractors. To be effective, financial and fiscal incentives need to be combined with public information and awareness campaigns to stimulate public interest in energy efficient equipment. Where regulations have been introduced in the construction sector, additional economic or fiscal incentives may be necessary to ensure that the initial extra costs involved (at least during the early stages of the enactment of new legislation) do not give rise to increased construction costs and make home ownership more difficult for lower-income families.

Economic incentives fall into three broad categories: subsidies for audits, investment subsidies and soft loans. Subsidies for audits aim at making energy audits more attractive and sought after by consumers, especially in instances when they are not mandatory. The subsidy is either a fixed amount or a percentage of the audit cost. Investment subsidies are intended to reduce the investment cost to retrofit existing buildings or dwellings or industrial facilities, and thus to shorten the payback time. They are also used to lower the price of energy efficient equipment that are more expensive than the market average price (e.g. CFL, efficient motors or boilers, solar water heaters). Presently, approximately one third of the subsidies given by governments around the world for the purchase of energy efficient equipment have been dedicated to solar water heaters and 25% has been dedicated to purchases of CFLs[18]. Soft loans (loans at subsidized interest rates i.e. lower

[18] World Energy Council (WEC), 2010: Energy Efficiency: A Recipe for Success

than the market rate) have also been an option afforded to consumers who invest in energy efficient technologies and equipment. Various measures are often used in developing countries to overcome traditional barriers for low income households, such as the establishment of specific credit lines with the help of donors, and the establishment of credit guarantee schemes by governments to encourage banks to be more active in financing such operations by taking more risk.

Fiscal incentives include all measures to reduce the annual income tax paid by consumers who invest in energy efficiency: they comprise tax allowances, such as accelerated depreciation (industry, commercial sector), tax credits and tax deductions (households). Another form of a fiscal incentive is a reduction of the tax paid when purchasing energy efficient equipment (VAT, import duties or purchase for cars) or when investing to improve energy efficiency in buildings (reduction in VAT rate on labour cost). Tax credits and accelerated depreciation are considered better than subsidies, as they are less costly for the state budget. They can work well if the tax collection rate is sufficiently high. They usually exhibit poor performance in an economy in recession or in transition. They are more adapted to well-developed countries. However, unlike subsidies, tax credits do not lower the barrier of the initial upfront payment, and therefore do not help low-income households. Reduction of VAT and import taxes on energy efficient equipment (e.g. CFL, efficient motors) has mostly been used in emerging and developing countries in Asia, Africa & Middle East. The CFL is the most common equipment to which this measure has been applied followed by solar water heaters.

3.1.4 Energy Savings Obligations

Energy savings obligations are similar in some aspects to the older DSM activities in that there is an obligation on energy companies to undertake energy efficiency activities with their customers. However, compared to many of the older DSM programmes, the obligatory approach focuses on the outcomes (i.e. energy saving targets) rather than only on the money spent on the activities and much cheaper monitoring and verification systems have been developed to administer the programme.

Belgium (Flanders Region), France, Italy, UK, Denmark and Brazil currently have active and significant energy savings obligations for energy companies[19]. The characteristics of the programmes in these countries are presented in **Table 2**. Three of these countries impose penalties on energy companies that do not fulfill their energy savings obligation. In practice, no penalties have been issued as virtually all the energy companies have met their targets. Usually the size of the target and the sectors to be covered are decided by the Government rather than the regulator for that energy industry although often the regulator is the appointed body to oversee and verify the energy savings obligation process. This may have to do with the fact that the energy savings obligations are typically linked to environmental concerns and are determined in a broader social context.

Table 2: Countries with significant energy savings obligations

Country	Obligated Company	Eligible Customers	Target set by	Administrator
Belgium-Flanders	Electricity distributors	Residential and non intensive industry and service	Flemish Government **0.58 TWh annual**	Flemish Government
Denmark	Heat, electricity, gas & oil distributors	All except transport sector	Government **0.82 TWh Annual**	Danish Energy Authority
France	All suppliers of energy	All including transport except EU ETS	Government **54 TWh over 3 yrs**	Government
Italy	Electricity & gas Distributors	All including transport	Government **24.7 mtoe/yr ≅ 0.29 TWh/yr in 2009**	Regulator (AEEG)
UK	Electricity & gas suppliers	Residential only	Government	Regulator (Ofgem)
Brazil	Electricity suppliers/distributors	All except transport sector	Government **0.5% of electricity Revenue**	Regulator (ANEEL)

Source: World Energy Council (WEC), 2010: Energy Efficiency: A Recipe for Success

[19] World Energy Council (WEC), 2010: Energy Efficiency: A Recipe for Success

To date, most of the obligations have focused on energy saving measures and less on renewable energy sources or cogeneration, as usually different policy mechanisms exist to support the development of renewable generation technologies. Replacement of CFLs has been the mainstay activity of the programmes in these countries excluding France.

3.2 Local Experience

The GORTT has instituted incentives designed to encourage implementation of EE practices in the residential, commercial and industrial sectors. There has also been dissemination, through the media and electronically, of public awareness tips on how to conserve energy. In 2013, the MEEA commenced the ad hoc distribution of CFL bulbs to schools and communities in various parts of the country. However, no formal statement has been issued with regard to the overall approach to be undertaken with respect to the distribution of CFL bulbs.

3.2.1 Institutional Capacity

The MEEA is the principal ministry responsible for coordinating these activities. It has formed a number of committees to deal with various aspects related to EE and have encouraged the participation of various stakeholders such as other government agencies, regulators, private companies and NGOs. There has not been any formation of a dedicated EE agency to champion energy efficiency as yet.

3.2.2 Legislation and Regulations

National EE standards for lighting and appliances are presently being developed by the Trinidad and Tobago Bureau of Standards (TTBS). The completion of this exercise in conjunction with the labeling of the EE ratings of household appliances and equipment is an important step in the successful implementation of EE initiatives. Once consumers can accurately estimate the amount of energy that is consumed when these appliances are in use, they would be able to use this information to formulate the best way to change their behavior with respect to energy usage.

3.2.3 Financial and Fiscal Incentives

The fiscal incentive that households are currently being offered by the GORTT is a 25% tax credit that can be claimed on the cost of acquiring solar water heating installations with the maximum limit set at TT$10,000. In the case of the commercial, light and heavy industrial companies a 150% Tax Allowance incentive is being proposed for the cost of their EE investments once they achieve at least a 15% reduction in their energy consumption after implementation of an EE programme. Companies will be required to engage Energy Service Companies (ESCOs) to identify their energy savings potential and implement energy savings projects on their behalf. However, this incentive mechanism has not been implemented as yet due to the fact that the ESCO Certification Committee, which was established to certify ESCOs, develop procedures and standards for the conduct of energy audits and to make recommendations on the applications for and award of the tax incentives, is still in the process of developing the implementation framework for this incentive. These incentives form part of the SEP under which broader incentives and regulations are being considered in order to better incentivize the implementation of EE initiatives across all the consumption sectors in Trinidad and Tobago.

4. PROPOSALS FOR INCREASING ENERGY EFFICIENCY

As indicated above, the GORTT is taking steps to promote EE initiatives through legislative amendments, import restrictions, subsidies and other incentives while concentrating on the implementation of EE measures throughout the government sector. The uptake of EE technologies can increase if the untargeted subsidies that currently reduce the cost of electricity are removed and consumers pay cost reflective prices, thus stimulating the need to seek ways to reduce the overall cost of their electricity consumption. However, a focused and holistic approach is needed with full involvement of all stakeholders and improved coordination across different stakeholders.

In this regard, the RIC proposes a number of practical measures aimed at encouraging and facilitating the implementation of efficient and effective EE programmes in the short-to-medium term. These should include:

GORTT

- The establishment of a "quantitative" energy efficiency (EE) target for the country.

- The establishment of a national Steering Committee comprising all stakeholders to develop and oversee the progress of EE options, as there would be the need for improved coordination among stakeholders and also to increase the profile of EE options. The MEEA is positioned to take the lead in this regard due to the ongoing work to develop a Sustainable Energy Program, and the Committee should include representatives from the RIC, T&TEC, the electricity generation companies, Point Lisas Industrial Estate, Chambers of Commerce, RE technology manufacturers/suppliers, relevant NGOs and consumer groups. The Committee would be required to develop energy efficiency targets for the different classes of consumers, as well as develop and oversee renewable energy options. The Committee would also be responsible for establishing

protocols to evaluate, monitor and report on the performance of the EE programmes with respect to achieving the established targets.

- The establishment of a "Energy Efficiency Fund (EEF)" with the objective of providing financing for the implementation of EE programmes and encouraging EE initiatives among a wide range of stakeholders, including government, equipment suppliers and the building industry. The monies for the fund can be sourced from government, and grants and loans from the World Bank or other multilateral development banks.

- The implementation of a comprehensive public awareness campaign on energy efficiency and energy conservation practices. This will support other initiatives by providing pertinent information to customers in order to fully appreciate the impact of behavior change in the use of electricity and the use of energy efficient technologies in reducing their electricity bills. The public awareness campaign should also target the commercial building sector by identifying and providing demonstrations and training programmes on applicable technology and design modifications that can be used to improve the energy efficiency of newly constructed or renovated buildings.

- Establishing time frames and providing resources for the relevant agencies to develop EE standards and issue EE labels on locally distributed household, water heating and air conditioning appliances in the short term.

- The implementation of an energy management system in all the offices that the GORTT owns or occupies. The ISO 50001 energy management standard is a model that could be considered for implementation.

- Ensuring that all newly distributed Housing Development Corporation (HDC) housing units are outfitted with CFL bulbs at the onset and in instances where hot water will be provided to units that solar water heating systems should be installed. Solar lighting and motion activated lighting should be installed in the outdoor and indoor public spaces of these developments. In fact, all new Government office buildings should be constructed to EE standards and Government should look at introducing EE technologies at its schools.

- Increasing the import duties on electric water heaters.

- Phasing-out the importation and sale of ILs and commencing a programme of substituting ILs with CFLs in all households.

- Phasing-out the importation and sale of low-efficiency air conditioning units.

- Providing tax deductions for the purchase of more efficient household appliances.

- Implementing a state sponsored trade-in programme for the replacement of inefficient household appliances.

- Ensuring that the 150% tax allowance programme on EE audits and investments by commercial consumers is operational as soon as possible in order that the relevant consumption sectors are incentivized by the benefits of this programme.

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- Adjusting all T&TEC's billing cycles from a bi-monthly to a monthly period in order to provide all of its customers with a better appreciation of the cost of their monthly energy use.

- Exploring the feasibility of a demand side-management programme, structured around the existing AMI, aimed at modifying the pattern of electrical consumption across all of the consumption sectors, and the RIC including all investments for DR and EE measures as negative revenue in calculating regulated revenue.

Comments are invited on the RIC's proposals for promoting Energy Efficiency.

5. APPENDIX

GLOSSARY OF TERMS AND DEFINITIONS

Advanced Metering Infrastructure (AMI)	Typically refers to the full measurement and collection system that includes meters at the customer site, communication networks between the customer and a service provider, and the data reception and management systems that make the information available to the service provider. These systems enable measurement of detailed, time-based information and frequent collection and transmittal of such information to various parties.
Compact Fluorescent Lamp (CFL)	It is a fluorescent lamp designed to fit into the light fixture formerly used for an incandescent bulb. The lamps use a tube which is curved or folded to fit into the space of an incandescent bulb, and there is a compact electronic ballast fitted into the base of the lamp. Compared to incandescent lamps giving the same amount of visible light, CFLs use one-fifth to one-third the electric power, and last eight to fifteen times longer.
Demand Response (DR)	The changes in the electric usage by end-use customers from their normal consumption patterns in response to changes in the price of electricity over time, or to incentive payments designed to induce lower electricity use at specific times. It is expected that demand response programs will be designed to decrease electricity consumption or shift it from on-peak to off-peak periods depending on consumers' preferences and lifestyles.
Demand Side Management (DSM)	Refers to the full set of efficiency, demand response and load reduction efforts by an individual customer, group of customers, utility initiated or third party. The goal of demand side management is to encourage the consumer to use less energy during peak hours, or to move the time of energy use to off-peak times such as nighttime and weekends.
Demand-Side Energy Efficiency Options	These measures stimulate the reduction of consumers' demand for energy through various methods, such as, financial incentives and education.
Energy Conservation	Energy conservation refers to reducing energy consumption through using less of an energy driven service. Energy conservation differs from efficient energy use, which refers to using less energy for a constant level of service.

Energy Efficiency (EE)	This is defined as a net reduction of energy required to meet a specific load.
Energy Efficiency Ratio (EER)	This is the ratio of output cooling energy (in British Thermal Units) to input electrical energy (in Watthours) at a given operating point for a particular cooling device.
Energy Intensity (EI)	This is the ratio of units of energy consumed by a country to the unit of the country's gross domestic product (GDP). Higher energy intensities indicate a higher price or cost of converting energy into GDP.
Fluorescent Lamp (FL)	It is a gas-discharge lamp that uses fluorescence to produce visible light. A fluorescent lamp converts electrical energy into useful light much more efficiently than incandescent lamps. The luminous efficacy of a fluorescent light bulb can exceed 100 lumens per watt, several times the efficacy of an incandescent bulb with comparable light output.
Greenhouse Gases (GHG)	These are gases that absorb radiation and contribute to the warming of the Earth's atmosphere by reflecting the absorbed radiation back onto the Earth's surface, e.g. carbon dioxide, ozone, water vapor, methane, and nitrous oxide.
Incandescent Lamp (IL)	It is an electric bulb which produces light when a filament wire is heated by an electric current passing through it until it glows brightly. Incandescent bulbs convert less than 5% of the energy they use into visible light (with the remaining energy being converted into heat). The luminous efficacy of a typical incandescent bulb is 16 lumens per watt.
Load Management	This is the process of balancing the supply of electricity to the network with the consumers' electrical load by adjusting or controlling the load rather than the power station output. This can be achieved by direct intervention of the utility in real time, by the use of frequency sensitive relays triggering circuit breakers (ripple control), by time clocks, or by using special tariffs to influence consumer behavior.
Mega Watts (MW)	A unit of power equal to 1,000,000 Watts. Many events or machines produce or sustain the conversion of energy on this scale, including lightning strikes or large electric motors. A large residential or commercial building may use several megawatts in electric power and heat.

Net Present Value (NPV)	The economic value of a project, at today's prices, calculated by netting off its discounted cash flow from revenues and costs over its full life.
Peak Demand	In terms of energy use, peak demand describes a period of simultaneous, strong consumer demand or a period of highest demand in a billing period. It is attributable to a period in which electrical power is expected to be provided for a sustained period at a significantly higher than average supply level. Peak demand fluctuations may occur on daily, monthly, seasonal and yearly cycles.
Renewable Energy (RE)	This is generally defined as energy that comes from resources which are naturally replenished such as sunlight, wind, rain, tides, waves and geothermal heat. Renewable energy replaces conventional fuels in four distinct areas: electricity generation, hot water/space heating, motor fuels, and rural (off-grid) energy services.
Revenue Cap	This is a system for setting the prices charged by regulated monopolies by limiting the total revenue in a given period. It is contrasted with rate-of-return regulation, in which utilities are permitted a set rate of return on capital, and with price-cap regulation where price is the regulated variable.
Revenue Decoupling	This is generally defined as a ratemaking mechanism designed to eliminate or reduce the dependence of a utility's revenues on sales. It is adopted with the intent of removing the disincentive a utility has to administer and promote customer efforts to reduce energy consumption and demand or to install distributed generation to displace electricity delivered by the utility's T&D system.
Smart Grids	This is a modernized electrical grid that uses analog or digital information and communications technology to gather and act on information, such as information about the behaviors of suppliers and consumers, in an automated fashion to improve the efficiency, reliability, economics, and sustainability of the production and distribution of electricity.
Supply-Side Energy Efficiency options	These measures improve the efficiency of the delivery of energy to consumers. An example is the use of energy storage units to store energy during off-peak hours and discharge them during peak hours in order to supply the peak demand without running additional generators.

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System Losses	The total of all energy lost or wasted on a system due to line losses and other forms of technical energy losses, and non technical losses due to unaccounted energy use and theft among other factors.
System Power Factor	This is defined as the ratio of the real power flowing to the load, to the apparent power in the circuit. Real power is the capacity of the circuit for performing work in a particular time. Apparent power is the product of the current and voltage flowing through the circuit. A load with a low power factor draws more current than a load with a high power factor for the same amount of useful power transferred.
Ton of Carbon Dioxide (CO_2) equivalent	This is the quantity that describes, for a given mixture and amount of greenhouse gas in the environment, the amount of CO_2 that would have the same global warming potential (GWP), when measured over a specified timescale (generally, 100 years). The GWP of a greenhouse gas is relative to the warming potential of CO_2, which is set at a value of 1. For example, the GWP value of methane is 21, which means that a metric ton of methane is approximately 21 times as effective at warming the atmosphere as is a metric ton of CO_2. Thus, in terms of CO_2-equivalents, a metric ton of methane is the same as 21 metric tons of CO_2.
Ton of oil equivalent (toe)	The amount of energy released by burning one ton of crude oil, approximately 42 GigaJoules. Multiples of the **toe** are used, in particular the megatoe (**Mtoe**, one million toe) and the gigatoe (**Gtoe**, one billion toe).
Terawatt Hours (TWh)	Terawatt Hours are equivalent of 1,000,000,000 kilowatt-hours. The kilowatt-hour is commonly used as a billing unit for consumption (energy delivered to consumers by electric utilities).