World Academy of Science, Engineering and Technology
International Journal of Economics and Management Engineering
Vol:11, No:1, 2017

Viability of Smart Grids for Green IT Sustainability: Contemplated within the Context of Sri Lanka

Manuela Nayantara Jeyaraj

***Abstract*—**Information Technology (IT) is considered to be the prime contributor towards most of the energy releases and hence recursively impacting on the environmental Carbon Footprint on a major scale. The hostile effects brought about due to this massive carbon release such as global warming and ecosystem wipe-outs are currently being realized in Sri Lanka due to the rapid development and merging of computer based technologies. Sri Lanka, being a nature-rich island, has the undying need to preserve its natural environment hence resolving to better 'Green IT' practices in all possible spheres. Green IT implies the IT related practices for environmental sustainability. But the industrial divisions in Sri Lanka are still hesitant to fully realize the benefits of applying better "Green IT" principles due to considerations related to costs and other issues. In order to bring about a positive awareness of Green IT, the use of Smart Grids, which is yet a conceptualized principle within the Sri Lankan context, can be considered as a feasible proof in hand. This paper tends to analyze the feasibility of utilizing Smart Grids to ensure minimized cost and effects in preserving the environment hence ensuring Sustainable Green IT practices in an economically and technologically viable manner in Sri Lanka.

***Keywords*—**Green IT, industry, smart grid, Sri Lanka, sustainability.

I. Introduction

FIRST and foremost, the concept of 'Green IT' should be well elucidated in order to understand the importance of stirring the nation towards a sustainable Green-IT-influenced environment. This has been defined in several instances according to the requirement that the concept is utilized to satisfy. The term *'Green'* is basically used in instances that emphasize on anything that tends to preserve environmental quality [1]. It has been applied to illustrate a reusable, degradable, environmentally-friendly form of energy or material. Though this cannot be visualized as a tangible output, it can be said that the results tend to preserve both tangible and non- tangible resources that are governed under a 'Green' concept. But there are always questions, doubts and contradictions that arise when a new concept is introduced. Trying to insert the 'Green' ideology in a society or locale can be challenging. Especially since the scope of this ideology is taken within Sri Lanka, a still-developing country, the feasibility of its applicability needs to be proven on grounds of technology, economy, literacy, and some other related sensitive issues.

This paper tends introduce smart grids as a feasible proof in order to bring about sustainable green IT in Sri Lanka, proposing various modes in which this inkling could be implemented realistically

Manuela Nayantara Jeyaraj is with the Sri Lanka Institute of Information Technology (SLIIT) (phone: 0094-77-3265306; e-mail: nayantara_94@yahoo.com).

II. Understanding the Importance of Green IT

A. Definition

An industrial sector's carbon footprint can be diminished by a considerable amount by the implementation of apposite Green IT practices. But Green IT has a scope that is not simply confined to the IT industry and its computing activities. It places its main aim towards directing organizations to utilize proper ICT practices to help them cutback on their overall toxic energy releases that add up to the carbon footprint accumulated in the environment. [2]

B. Realizing the Importance

There are several reasons that dictate the value of implementing Green IT practices.

1) Cutting down Energy Consumptions

Energy consumed by IT resources is continually augmenting on an annual basis [3]. These can recursively impact on the economic stability of Industry in context. But, with the implementation of proper Green IT power management principles, energy consumptions can be contracted, cutting down costs expended due to energy wastage.

2) Moving towards an Energy Efficient Work Environment

An average desktop computer has a power usage between 80 and 250 watts [4]. This serves as an indicator of the entire energy that an industry exploits for its daily activities and tasks. These tasks can either utilize a direct application of computers and related IT services such as software development or they could be tasks that apply the usage of computers and related technologies to achieve non-IT based tasks such as at reception counters, store billing, information centers and many other intermediaries as well.

3) Societal Verification and Reliance

A decade ago, 'Green IT' was not that much in trend that it was still a conceptual context. But currently, as the society began to lean more towards nature and disaster management, concerned with the explosion of IT and its related impacts, researchers and industries have started to seek the aid of philosophies or principles to govern this negativity. In recent times, the concern has risen way too high that even customers of software and hardware technologies, seek industries that value the environment. It has become important for industrial divisions to be branded as 'Green', along with their reputation

in order to attract a target customer base.

4) Ensure Sustainability

Production and usage of technological devices approximately double on an annual basis. Though, this might be mistakenly taken as an indicator of a blast towards a digital era, it also brings about the adverse bearings of posing threats towards toxic energy and gas releases associated with the operation of all these digital devices. If this situation continues, there can be a risk of most of the industries being called out to shut down operations as the environment could be placed at its breaking point of disaster. Hence *Green IT* can be illustrated as a brand or validity. Any industry that assures the best Green IT practices to be followed in its functionalities provides an added value to the customers in deciding on service contenders to proceed with.

C. The Carbon Footprint

The drivers of the 'Importance of Green IT' reason themselves towards a single concept: The Carbon Footprint. The carbon footprint can be defined as "a technique for identifying and measuring the individual greenhouse gas emissions from each activity within a supply chain process step and the framework for attributing these to each output product" [5].

The changes occurring in the environment used to be merely observable and no valid measures were available to show how exactly these changes were affecting the atmosphere, before the turn of the century. But with the carbon footprint, various industries' contribution towards the environmental carbon release can be measured and necessary actions can be proposed to reduce these. Since the latter part of the 20th century, CO_2 emissions in Sri Lanka have seen an unhindered gradual increase (Fig. 1) [6].

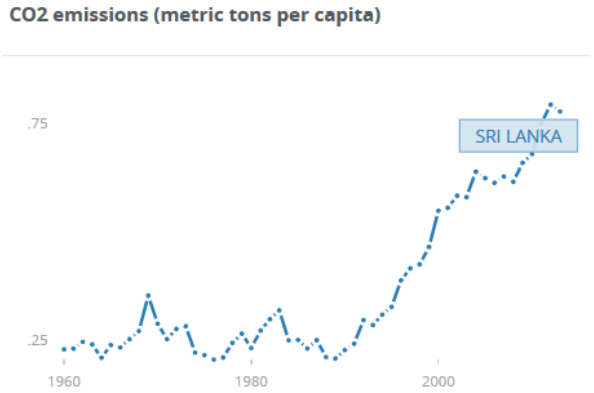

Fig. 1 CO_2 emissions from Sri Lanka [6]

The statistics from Fig. 1 with regard to the CO_2 emissions from Sri Lanka depict a rapid increase in the carbon emissions from Sri Lanka. Though 0.794 metric tons per capita might not seem like a massive deal, this release comparison with entire South Asia's CO_2 release (Fig. 2) [7] draws the attention towards the need to create awareness of this energy release in Sri Lanka.

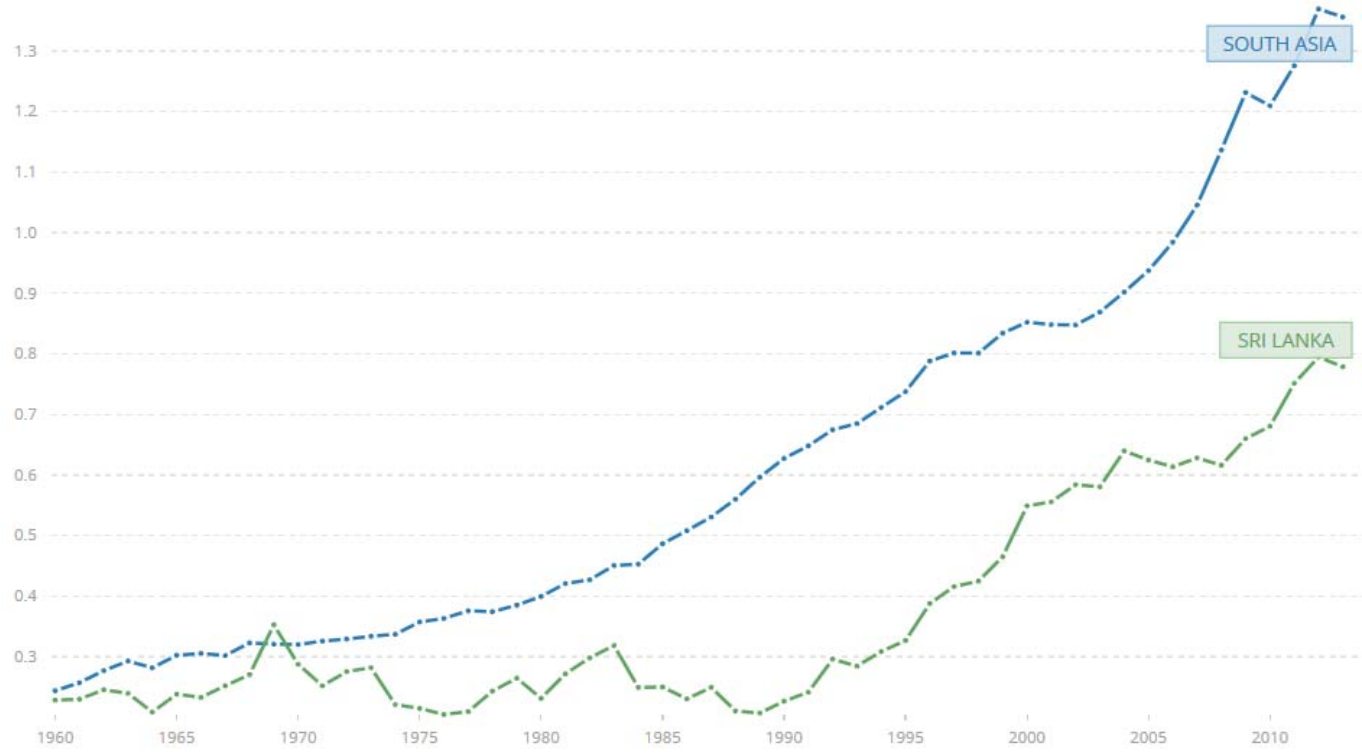

Fig. 2 CO_2 emissions from Sri Lanka compared to South Asia [7]

The reason for considering the carbon footprint is to illustrate the natural imbalance in nature that is brought about due to the continual increase in this measure.

D. Nature's Imbalance Due to Increased Carbon Release

The environment has taken a toll with the increase in the release of carbon to the atmosphere, which was brought about due to the rapid growth of IT based industries.

Some of the environmental threats are discussed here.

1) Global Warming: Global Warming is the increase of Earth's average surface temperature due to effect of greenhouse gases, such as carbon dioxide emissions, which trap heat that would otherwise escape from Earth [8]. The underlying cause for this increase in heat is the ozone layer depletion. And circling back to the root cause, the carbon emissions along with the other toxic emission from industries bring about this rapid ozone layer depletion.

The increase in heat causes a variety of problems such as ecosystems experiencing changes that could lead to extinction. Sri Lanka being a nature-rich island has the prime duty of protecting its rare and valuable ecosystems such as rain forests, mangroves, coral reefs, etc. Global Warming has threatened this natural balance of the ecosystems at present.

2) Water Level Rise: Sri Lanka is a relatively small island surrounded by the Indian Ocean. With the continuous increase in heat caused by the release of carbon, ice region meltdowns take place at the poles that cause increase in the ocean water levels. Though at present, this is not considered to bring about drastic effects, if it continues, there is a risk of this small island being submerged completely.

These are the two major disasters around which many other catastrophic effects are built and are considered within the Sri Lankan context. The main point is that these natural disasters are all results of ill practices of carbon release from the industrial sector which continues to expand its spread in Sri Lanka.

III. Legislation Concerning Green IT Practices

The legislative grounds on Green IT practices are extremely weak in Sri Lanka. There are no visible rules, acts or amends made with regard to Green IT principals. This alone, proves the level of concern that the Sri Lankan bounds hold for the importance of implementing Green IT practices. But, it is necessary to understand that Sri Lanka has enforced strong rules and regulations regarding the environment and computer based industrial principles. But the major issue in this structure is that these are still overseen individually rather than binding the two together by enforcing strict Green IT principles that could be feasibly followed in Sri Lanka.

IV. Sri Lankan Industries and Green IT Policies

Though the legislation for Green IT policies is not strong enough in Sri Lanka, it was found that industries have implemented certain policies to some extent in Sri Lanka.

A. Existence of Green IT in Sri Lankan Industries

It was discovered that out of the industries that have implemented green IT practices, though being very few, almost 96% are large Software Companies affiliated with foreign companies.

B. Effectiveness of Implemented Policies

Though companies claim to have implemented proper Green IT practices that could aid in the reduction of carbon releases, the effectiveness needs to be proven.

In order to better comprehend the reasons for less effective results from implemented Green IT policies in Sri Lankan industries, we need to understand the Empirical Model of Green IT proficiencies.

The success of Green IT practice implementation can be assessed based under two key classes (Fig. 3) [9].

I. Green IT Strategies: An industry's sustainability along with its IT sustainability is considered under these strategies.

II. Green IT Governance: Strategic prudence and green matrices to observe Green IT efficiency are considered here.

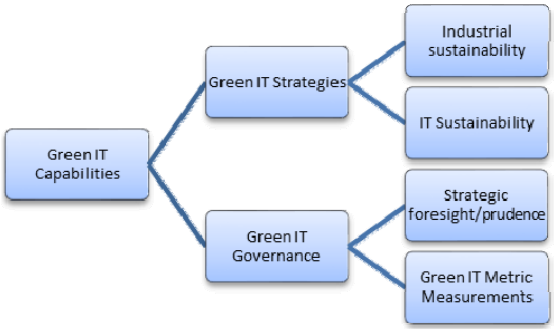

Fig. 3 Empirical Model of Green IT Capabilities

Failure to clearly differentiate and define their green IT practices could have led to poor results in industries that have attempted to implement Green IT principles. Also, the existence of misconceptions with regard to the capital that needs to be invested in implementing these practices effectively in an industry lead other companies towards not even considering Green IT as a viable solution to their needs. The Sri Lankan industrial sector is more bent towards investing to render services to its customers. The relative costs concerned with the environment, are hardly considered.

Though the facts are not quite obvious, investing towards better Green IT policy implementations in an industry assures better return on investment and revenue and also seals a verified label on the Industry attracting more customers. This brings about the most important section of this paper where methods to help Sri Lankan industries see the underlying benefits of implementing Green IT practices, will be discussed.

V. Proof of Gains from Green IT Implementation

A. Smart Grid

The Smart Grid's definition spans over a wide scope depending on the context within which it is applied. But most commonly, it can be described as a technology that provides bidirectional communications and exchange channel for the users of a smart grid where these transmission channels bundled as a whole, create the grid. The grid's transmission channels or lines will be a composition of substations, transformers and more that deliver electricity from the power plant to a business; a smart grid [10].

B. How Does It Work?

The smart grid subsumes a larger scope of devices that necessitate digital components that will certify a simple yet sophisticated integration and an augmented infiltration of renewable energy. The smart grid encapsulates an omni-various range of technological resources, both already existent and expected to be newly inserted into the grid or digital network, to utilized minimized energy. This prevents the waste of energy such as harmful greenhouse gases, toxic radiations and heavy metal particles, saving costs and resources expended due to unmanageable energy releases. The type of energy that is very often associated with this context is, electrical energy. Since electrical energy can be considered as the set enumerating most of the other types of energies that modern day work arounds are concerned of, the sources that expend electrical energy irresponsibly will have to be considered in this scenario.

Electrical energy can branch out into several categorizations. But here, we will be considering the electrical energy consumed and released by computer-based electrical and electronic devices.

Table I shows the energy requirements of an average desktop computer. The information gathered in such a manner can be used to conclude two summarizations:

1. The amount of energy expended by the device under consideration.
2. Mapping these metrics with a smart grid to validate Green IT sustainability.

TABLE I
Energy Requirements of a Desktop Computer [11]

Description	Power draw (Watts)		
	Active	Low Power	Off
Desktop	55	25	1.5
Desktop with power management	36	27	-
Desktop without power management	48	-	-
Desktop Manufactured in 2000-2001	70	9	3
Integrated computer system manufactured 2000-2001	54-131	4-31	4-8
Desktop (Pentium and pre-Pentium)	55	25	-
Desktop(Macintosh)	50	48	-

These metrics gathered could be utilized to derive certain smart grid related contemplations that would aid in a beneficiary manner to an organization.

C. Smart Grid Metrics

The smart grid is an encapsulation of further devices like the *'Smart Meter'*. The smart meter, in simple terms can be coincided with the electrical meter that measures the electrical consumption of a unit or industry, in this case.

The output of the electrical meter is plainly depicted in terms of the total energy consumed by all appliances that are connected within a networked or grid unit. No further information can be drilled down using this metric being output by the electrical meter. But, a smart meter can be used to gather information in a drilled down data mining procedure. Information gathered and presented in Table I is taken in different states of the device, i.e. Active, Low Power and Off. This categorized data collection cannot be done in a single test run using the electrical meter. But the smart, once connected to the grid including the necessary devices pertaining to a department of an industrial organization, E.g. IT department of the organization or different teams/departments of a Software Engineering Company, can collect data periodically with its various states and the energy expended during such states.

Data, such as the energy collected during different states of the computing device, are only a single example of the many metrics that could be possibly collected by a smart meter. Similarly, the smart grid which encapsulates the smart grid, also contains various other smart components or devices that could be used to deduce various metric based conclusions.

D. Realizing the Value of Smart Grid Metrics

The smart grid metrics can be used considered as a data cube once a considerable amount of data has been collected over a time period and auto- calculated as desired for various purposes.

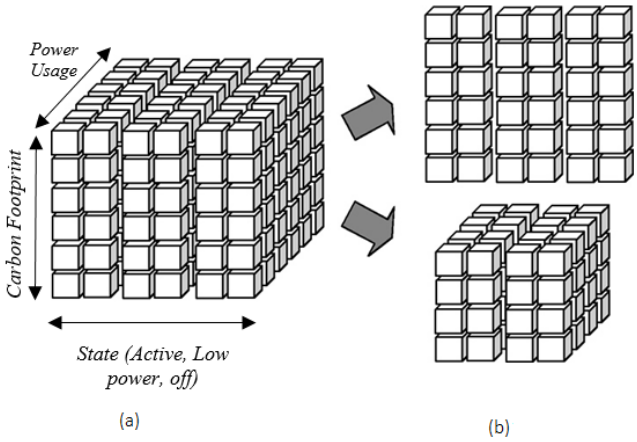

Fig. 4 Smart Grid Metrics as a Data Cube

Fig. 4 (a) shows the drilled down versions that evaluate the metrics within each specification's confined scope. These evaluations can all be automated by the smart grid and the final result as summaries could be collected and illustrated to Industry Managers and Green IT implementers of that industrial division. By doing so, we can depict the amount of energy expended against factors such as their industry's contribution towards the addition of carbon footprint based on

each department (specifically, the various computer departments). This subdivision can be further rendered to display the even miniscule details such the devices that contribute more towards the adverse natural effects and so.

VI. Feasible Green IT Principles Based on the Smart Grid for Sri Lankan Computer-Based Industries

There are a number of practices that could be followed. But the viable practices that are implementable in Sri Lankan Industries depend on the type of industrial division, the budgetary allocations for the implementation, employee awareness and willingness towards Green IT practices and a few other factors. Considering these, a few plausible Green IT practice suggestions have been presented here. These practices are merely vague guidelines that need to be expanded with utmost comprehensiveness by the Industrial sector's various divisions such as:

1. The Management
2. Financial Team
3. Green IT Group
4. Human Resource Management
5. Hardware and networking Technical Assistance Team

Some best Green IT practices derived through smart grid implementations could be followed in various Sri Lankan IT-related industries.

a. Switch to solar energy power sources: Solar Energy is a carbon emission-free energy form hence is considered as Green Energy. Sri Lankan industries willing to install a considerable capital on the installation of these solar panels, could reap back the cost spent on installation in forms of going green and saving energy by cutting down waste energy emissions. Another important benefit is that, excessive solar energy stored by an Industries grid can be sold to external grids, hence making profit while cutting down costs and most of all *moving towards a greener energy source.*

b. Periodically assess smart grid metrics: Once the industrial division is integrated via smart grid technologies, the metrics need to be collected and correlated against each individual characteristic partition studied by the smart grid. Then these periodical changes can be analyzed by appropriate methods to identify the areas and features or components that contribute negatively towards the Green IT concept (also stated as the environmental well-being).

VII. Conclusion

Sri Lankan Industries dealing with computer based technologies bear feasibility in resorting to the Smart Grid implementations to analyze their IT departments' energy consumption in terms of various metrics gathered from bounded scopes and related green IT practices. Smart Grids and Green IT practices need to be evaluated purely by the type of the industry, the capital that can be allocated towards the implementation without affecting the company's financial status and the change management process' complexity and complications while resolving towards better Green IT practices via the smart grid technology application. All the stakeholders of an organization need to take part actively in deciding on the viability of smart grids for green IT sustainability and recursively, the country's economic stability.

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Manuela N. Jeyaraj (M'15). This author became a Member of World Academy of Science, Engineering and Technology in 2015. The author was born in Sri Lanka in 1994-10-05. Following the Biological Science stream for the Advanced Levels, the author then pursued onto Software Engineering for the undergraduate phase of the higher studies. This author's degree which reads as 'Bachelor of Science (Hons.) in information technology specializing in software engineering' is offered by the author's affiliated university which is the Sri Lankan Institute of Information Technology (SLIIT). The author has been a 3- time consecutive Dean's List Student and a multiple full scholarships winner in recognition of her academic performance.

During her academic course, she was accepted as a Complex Event Processing Developer, for her internship that commenced in May of 2016, at WSO2, an Open Source technology company providing service oriented architecture (SOA) middleware.

Ms. Jeyaraj is a member of IEEE and the British Computer Society (BCS), the Chartered Institute for IT.