

An Review of the Effective Energy Consumption Within the Green IT and Green Energy Strategies

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Abstract. The paper provides analysis on the current state of the art in the field of green technologies, including green information technologies, and methods aimed to achieve effective energy consumption goals. Recent advances in the field summarized in prospective publications, were analysed. Modern Green IT and Green Energy strategies, aimed to reduce power consumption, environmental influence and improve sustainability, which assume the use of Cloud Technologies, renewable energy sources, proper recycling and reuse of devices and resources, were singled out. Finally, recommendations for IT and industrial companies aimed helping to achieve green strategies' goals, were formulated.

Keywords: green IT, cloud computing, green energy, sustainability.

I. INTRODUCTION

The concept of green information technologies (IT) and green energy has become increasingly popular in recent years. Green IT is the practice of using various technologies to reduce energy consumption and increase efficiency within an organization. Green energy is the use of renewable sources such as wind, solar, or geothermal power to generate electricity and reduce reliance on fossil fuels. Both strategies can help organizations save money by reducing their carbon footprint while also increasing sustainability efforts. This paper will analyze the effectiveness of these two strategies in terms of their ability to reduce energy consumption and promote a more sustainable future.

Green IT strategies focus on reducing the amount of energy consumed by technology systems through improved design and efficient usage practices. These methods include virtualization, cloud computing, and the use of more efficient hardware. Virtualization is a process by which multiple virtual machines are created on one physical server, reducing the amount of energy needed to power them. Cloud computing allows for data and applications to be hosted in a remote location, eliminating the need for local servers that consume energy. Finally, using more efficient hardware such as LED monitors or low-power processors can help reduce energy consumption.

Green energy strategies focus on increasing the use of renewable sources to generate electricity instead of relying solely on fossil fuels. These methods include solar panels, wind turbines, geothermal plants and hydroelectric dams. Solar panels convert sunlight into electricity while wind turbines generate electricity from the motion of air currents. Geothermal plants use the heat from underground sources to generate electricity and hydroelectric dams utilize the power of moving water. These methods are more sustainable than traditional energy sources, as they do not produce greenhouse gas emissions or require fossil fuels to operate.

Both green IT and green energy strategies can be effective in reducing energy consumption and promoting sustainability efforts. Green IT strategies focus on improving efficiency within an organization by using virtualization, cloud computing, and efficient hardware. This reduces the amount of energy needed to power

Print ISSN 1691-5402

Online ISSN 2256-070X

<https://doi.org/10.17770/etr2023vol2.7295>

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technology systems while also increasing productivity levels. On the other hand, green energy strategies focus on increasing the use of renewable sources such as solar panels, wind turbines, geothermal plants and hydroelectric dams instead of relying solely on fossil fuels for electricity. This reduces the amount of greenhouse gas emissions released into the atmosphere while also providing a more sustainable energy source.

II. MATERIALS AND METHODS

The issue of the rational use of natural resources became topical during last decades. Since then, number of standards and regulations were established in different countries and by different international organizations to make production process 'greener' and decrease overall energy consumption. Thus, in [1] authors present an integrated framework for 'greening' the enterprise based on ISO 14001 standard requirements. The authors argue that this framework can be used as a tool to identify and address environmental issues, increase corporate sustainability, and reduce costs associated with compliance. The paper also outlines how this framework can help organizations in their transition to sustainable operations by providing guidance on selecting appropriate measures, implementing them effectively, and monitoring results. The paper provides a comprehensive overview of the key elements of ISO 14001 certification requirements and discusses how they contribute to 'greening' the enterprise. It examines various approaches such as environmental management systems (EMS), pollution prevention/minimization strategies, energy efficiency initiatives, waste reduction efforts and other areas related to resource conservation. Additionally, it highlights some case studies which demonstrate successful implementation of these strategies at different types of organizations ranging from manufacturing companies to government offices. Overall in [1] authors offer an insightful look into how organizations can benefit from adopting an integrated approach towards achieving sustainable operations through ISO 14001 standards-based frameworks. The authors provide useful information about best practices for developing such frameworks that could prove beneficial for businesses looking to make their operations more environmentally friendly while reducing compliance costs in the process.

Information technologies, as well as proper production and use of IT equipment, could make significant contribution into Green Energy strategies as well. In [2] authors provide an overview of Green IT and its potential to reduce carbon emissions from information systems. The authors discuss the challenges associated with implementing Green IT, such as the need for a comprehensive understanding of system architecture and energy consumption patterns, as well as the difficulty in measuring actual reductions. They also provide several strategies for reducing carbon emissions through Green IT initiatives, including increasing energy efficiency, optimizing resource utilization, and utilizing renewable energy sources. Finally, they suggest that organizations

should develop long-term plans for implementing these strategies over time to maximize their effectiveness. Overall, this paper offers an insightful look into how organizations can use Green IT practices to reduce their environmental impact while still meeting their business objectives.

Similar suggestions are presented in [3]. Authors provide an analysis of green ICT initiatives as a strategic approach towards sustainable development. The authors examine the potential for green technology to reduce environmental impacts, improve energy efficiency and create new economic opportunities. They discuss how governments, corporations and individuals can all play a role in advancing green ICT solutions through regulatory frameworks, public-private partnerships and consumer behaviour changes. They also consider the importance of taking a holistic view of sustainability that considers both economic growth and environmental protection when developing policies related to green ICTs. Overall, this paper provides a comprehensive overview of the current state of green ICT initiatives, their potential benefits and implications for policy makers looking to promote sustainable development through these technologies.

In [4] it was presented an overview of the concept of "Green IT" and its importance for sustainable development. The paper argues that Green IT is a strategic approach to sustainability, as it involves the implementation of technologies and practices that reduce the environmental impact of computing systems while improving their efficiency. The authors discuss various approaches such as energy-efficient hardware design, software optimization techniques, virtualization, cloud services, and green data centers. They also provide examples of how organizations can use these methods to reduce their carbon footprints and save money in the process. Finally, they conclude by emphasizing that Green IT should be seen as an integral part of corporate strategy for achieving long-term sustainability goals. Overall this paper provides a comprehensive look at how organizations can use Green IT strategies to improve their environmental performance while reducing costs associated with infrastructure operations. It serves as a useful resource for those interested in learning more about this topic and making informed decisions on how best to implement such initiatives within their own organization or industry sector.

Best green practices, adopted in information technologies, also could be adopted by organizations of a different type. Thus, in [5] authors present research exploring the potential for organizations to reduce their carbon emissions through the implementation of green information technology practices. The authors provide an in-depth analysis of existing literature and propose several strategies for reducing organizational carbon emissions. They identify four key areas where green IT can be used: energy efficiency, virtualization, eco-friendly applications, and recycling/reuse initiatives. In addition, they provide detailed recommendations on how each area can be implemented within an organization's operations. Overall, this paper provides valuable insight into how organizations can use green information technology

practices to reduce their environmental impact by reducing carbon emissions. It is comprehensive in its approach and offers practical advice that could be applied in real-world settings with relative ease. This makes it a useful resource for organizations looking to reduce their carbon footprint while also improving operational efficiency and productivity levels.

Even if cloud technologies and big data centers are used for more effective energy usage, they still remain one of the biggest energy consumers in the world. So, a number of researches are devoted to the question of their energy consumption reduction.

An extensive review of green IT and green energy strategies for effective energy consumption in data centers is given in [6]. The authors identify various strategies, such as the use of virtualization technologies, improved cooling systems, efficient power supplies, and renewable energy sources. They also discuss the importance of metrics such as Power Usage Effectiveness (PUE), Carbon Usage Efficiency (CUE), and Data Center Infrastructure Efficiency (DCIE). The authors conclude that while there are many potential benefits to implementing these strategies in data centers, further research is needed to optimize their effectiveness. Overall, this paper provides a comprehensive overview of current approaches to reducing energy consumption in data centers. It highlights the need for further research into optimizing existing practices and exploring new methods for managing resources more efficiently. Given the growing demand for computing power worldwide, it is essential that organizations consider how they can improve their sustainability efforts through green IT initiatives

Paper [7] examines the role of green IT strategies in data centers and their effectiveness in utilizing energy resources. The authors conducted a systematic literature review to assess the current state of research on this subject, finding that while some studies have been done, there is still much unknown about these technologies. They conclude that more research is needed to fully understand how green IT strategies can be best utilized in data centers for maximum efficiency and cost savings. Overall, this paper provides an important foundation for further exploration into the field of green IT strategies and their potential benefits for data center operations.

Another paper related to this question represents a survey of green IT and green energy strategies for reducing the electricity consumption in data centers [8]. The authors provide an overview of existing technologies such as virtualization, cloud computing, renewable energy sources such as solar and wind power, energy efficiency measures such as cooling systems and efficient lighting solutions. They also discuss the challenges faced by organizations when implementing these technologies. In addition to this analysis, they propose several recommendations for improving the overall efficiency of data centers through

better management practices and improved infrastructure design. Overall, this paper provides a comprehensive review of current green IT and green energy strategies used to reduce electricity consumption in data centers. It offers a valuable insight into how organizations can improve their operations while simultaneously achieving cost savings through improved sustainability initiatives. Furthermore, it highlights some potential areas where further research could be conducted to further optimize the use of technology within these environments.

As the power management plays crucial role ensuring overall effectiveness of the datacentre power consumption, related research results are presented in [9]. In this paper authors investigate the potential of Green IT/energy management strategy for improving power efficiency in cloud computing. This paper is a comprehensive review of existing green energy strategies that can be employed to reduce energy consumption and improve power efficiency in cloud computing environments. The authors focus on four key areas: data centers, virtualization, server consolidation, and workload optimization. They also discuss various techniques such as dynamic resource scheduling, CPU throttling algorithms, and intelligent cooling systems which can be used to reduce energy consumption while maintaining system performance. The findings of this paper are significant because they demonstrate how organizations can use green IT/energy management strategies to significantly improve the power efficiency of their cloud computing infrastructure while reducing costs associated with high levels of electricity usage. Additionally, these strategies have been shown to result in improved environmental sustainability by decreasing carbon emissions from data centers. Overall, this paper provides a valuable insight into effective ways for companies to optimize their cloud computing environment without sacrificing performance or incurring additional costs related to excessive electricity usage.

In particular, studies [10–13] authors revealed the potential opportunities and risks of implementing ICT as a tool and driver of smart transformations according to the traditional (high-carbon) and "green" (low-carbon) scenarios of global economics evolution in general. Analytical reviews [14, 15] summarize strategic initiatives to improve environmental performance, combat global warming, and improve resource management by means of the ICT industry. Methodical approaches for assessing the social and ecological and economic efficiency of ICT implementation at different stages of the product life cycle were developed in [16–18]. Determination of "green" ICT implementation in organizations, as well as the terminology, are given in [19].

Provided analysis allowed us to single out pros and cons for green IT and green energy strategies implementations, summarized in table 1.

TABLE 1 PROS AND CONS FOR GREEN STRATEGIES IMPLEMENTATION

<i>Pros</i>	<i>Cons</i>
Green IT strategies implementation	
Reduced costs - Companies can save money on energy bills, water and other resources by implementing green IT strategies.	High initial investment - Green technology often requires high upfront costs in order to purchase equipment or software needed for implementation which may not be feasible for all businesses depending on size or budget constraints.
Increased efficiency - By utilizing green IT solutions, companies can increase the performance of their systems while reducing resource consumption and waste production	Technical complexity – The implementation of new technologies such as cloud computing or virtualization require technical expertise which many small businesses lack making it difficult for them to adopt these technologies without outside help from consultants or vendors who charge additional fees for services rendered.
Improved public image - Implementing green IT practices can project a positive image to customers, shareholders and the general public that a company is committed to sustainability and environmental protection.	Limited resources – Many organizations do not have access to adequate resources such as skilled staff members with knowledge about green IT solutions which make it hard for them to implement these strategies successfully within their own organization.
Enhanced employee morale - Knowing that their work contributes to the environment may lead employees to be more productive as they feel proud of working for an environmentally conscious organization.	Regulatory uncertainty – The lack of clear and consistent regulations on sustainable practices makes it difficult for companies to know what is expected from them in order to be compliant with the law.
Green Energy strategies implementation	
Reduces the company’s carbon footprint and helps to protect the environment.	The initial cost of setting up a green energy system may be high, depending on what type of technology is used and how much infrastructure needs to be built or upgraded.
Can save on energy costs, as green energy sources are often cheaper than traditional sources of power.	Some types of renewable technologies may not be available in certain areas due to lack of resources or other factors
May qualify for government incentives such as tax credits or grants that can offset some of the upfront costs associated with implementing a green energy strategy.	Green energy systems require ongoing maintenance and monitoring which can add additional costs over time
It can be used to attract new customers who are interested in supporting environmentally friendly companies	It can be difficult to measure the impact of green energy initiatives on a company’s bottom line

So, we can conclude, that Green IT plays extremely important role in achieving environment-friendly society, which helps in achieving sustainability goals. A number of approaches aimed to either use IT to increase efficiency of energy use in production and industry, or implement energy saving approaches within IT itself, are analysed, and recommendations based on provided analysis are presented in the next section.

III. RESULTS AND DISCUSSION

As it follows from provided analysis, Green IT and Green Energy strategies are two important tools that organizations can use to reduce their energy consumption. By using these strategies, organizations can achieve significant cost savings, reduce their environmental impact, and improve the efficiency of their operations. This analysis helps to explore the effective energy consumption within each strategy and how they can be used together to maximize savings. Green IT is a set of practices designed to optimize IT systems for improved performance while reducing energy usage. It involves implementing technologies such as virtualization, cloud computing, server consolidation, and efficient power management techniques in order to maximize resource utilization while minimizing waste.

The primary goal of Green IT is to reduce the amount of electricity consumed by an organization’s IT infrastructure so that it uses less resources overall. Studies have shown that up to 75% of an organization’s total electricity bill may be attributed directly or indirectly to its

IT equipment alone – making it essential for any business looking to save money on its utility bills. Green IT methods are practices and technologies that reduce the environmental impact of information technology. Examples include using energy-efficient hardware, virtualizing servers, optimizing data center cooling systems, utilizing cloud computing services to reduce server power consumption, recycling old computers and electronics responsibly, monitoring air quality in the office environment, and implementing energy efficient lighting solutions.

Green Energy strategies involve utilizing renewable sources such as solar or wind power instead of traditional fossil fuels like coal or natural gas in order to generate electricity more efficiently and with fewer emissions than conventional methods do. Renewable energy sources also provide greater reliability since they do not rely on finite fuel reserves like oil or gas does; this makes them inherently more sustainable over time as well as cheaper in terms of long-term costs associated with fluctuating prices for traditional fuels.

Additionally, investing in green energy projects has been demonstrated both economically beneficial due to government incentives provided for doing so; consequently, many businesses now view green investments from a financial perspective rather than just from an environmental one – leading some large companies even go beyond simple compliance measures towards carbon neutrality goals altogether. When combined properly Green IT and Green Energy strategies create a powerful synergy which greatly reduces an

organization's overall electricity usage – allowing them take advantage both cost savings through reduced bills but also increased sustainability via lower emissions output compared against non-green options available elsewhere otherwise. When implemented correctly these approaches should result in substantial reductions both immediate operational expenses incurred during day-to-day operations plus future maintenance costs associated with replacing outdated hardware/software after useful life period expires without having invest heavily into new replacements every few years too frequently either way – allowing companies focus other initiatives more effectively.

The cost of implementing a green energy strategy in a small company will vary depending on the size and scope of the project. Typically, costs range from \$500 to several thousand dollars for an audit and assessment, plus the cost of any equipment or materials needed to implement green energy strategies. In addition, there may be additional costs associated with training staff and educating customers.

The cost of implementing a green energy strategy in a middle size company can vary greatly depending on the type of green energy technology being implemented, the size of the company, and any incentives available from local or federal government programs. Generally speaking, however, it is estimated that installing solar panels to generate electricity can start at around \$10-15k for an average sized business. Other technologies such as wind turbines or geothermal systems may cost more upfront but have lower operating costs over time.

In any case, under modern conditions, it is reasonable implement Green IT and Green Energy strategies for companies. Although it may require some upfront investment and resources, implementing these strategies can help the company save money on energy costs in the long run and also reduce its environmental impact. Additionally, many governments provide tax incentives or subsidies for companies that invest in green technology, so this could be an added financial benefit as well.

If we take a look at a state level, we could conclude, that Latvia is a country that has seen dramatic changes in its energy efficiency and usage over the years. With the implementation of green strategies, it has become one of the leading countries in Europe in energy generation from renewable resources, after Sweden, Finland and Denmark [20]. Following we describe how Latvia's effective energy consumption has been impacted by these green strategies and what can be done to further improve of their effectiveness.

One key factor that affects Latvia's effective energy consumption is its commitment to renewable sources of energy. In recent years, Latvia has significantly increased its investments into renewable sources such as hydropower and biomass generation, which in 2016 accounted for more than 56% of total electricity production [21].

Additionally, with government support through subsidies and incentives, green initiatives have become increasingly popular among businesses in the country, leading to an even bigger focus on sustainability across all sectors. In addition to focusing on renewable resources for power generation, Latvia also focuses on reducing overall demand for electricity by promoting greater efficiency throughout households and industry alike. The Latvian government offers various schemes aimed at improving building insulation standards or encouraging businesses to undertake retrofitting projects; this helps reduce both direct emissions from heating/cooling systems as well as indirect emissions resulting from reduced reliance on imported fossil fuels. Moreover, since 2019 all new buildings must comply with stringent EU-wide standard regulations regarding minimum energy performance requirements before they can receive any form of construction permit approval; this ensures efficient use of resources within newly constructed structures while also ensuring compliance with international laws related to carbon footprint reduction targets set out by European Union member states. Finally increasing public awareness about climate change and implementing policies geared towards reducing waste are additional ways through which Latvia could further reduce its environmental impact moving forward. Through campaigns which encourages people living near coastal areas not only clean up but also prevent litter pollution, or via incentives for switching regular lightbulbs with LED ones, Latvian citizens would be able to make meaningful contributions towards decreasing their own carbon footprints. Overall, it can be concluded that through continued investment into renewable technologies combined with promotion of efficient design principles coupled with public education and prevention programs, Latvia is well positioned continue making advances when it comes efficient utilization and management of natural resources as well as creating a cleaner environment in the future.

Green IT in Latvia is aimed at reducing the amount of energy and resources used by IT systems. This includes initiatives to increase energy efficiency, reduce data center emissions, promote green computing practices, and develop sustainable digital infrastructure. Efforts are also being made to improve access to e-services for Latvian citizens with the goal of increasing ICT sustainability across the country. The government has established a National Green Information Technology Program which provides funding for projects that focus on improving environmental awareness among businesses and individuals. Additionally, there have been several conferences held in Latvia focusing on green IT topics such as cloud computing and virtualization technologies.

Summarizing provided research results, we can conclude, that to achieve Green IT goals, we should suggest following recommendations:

- implement energy-saving technologies: adopting energy-efficient technologies such as LED lighting, motion sensors and automated temperature control systems which can help reduce power consumption in the IT environment;

- reduce paper use: reducing the amount of paper used throughout organization is an easy way to make a green impact; utilize digital document management solutions and encourage staff to print double-sided documents when necessary (for example, for documents such as reports, presentations, brochures, manuals and booklets. It can also be used for printing out emails or webpages that have a lot of content.);
- update hardware regularly: consider upgrading outdated computer hardware that is no longer efficient or reliable on a regular basis with more energy efficient models; this will reduce electricity consumption significantly over time and improve performance at the same time;
- virtualize data centers: cloud services provide organizations with access to powerful computing resources while eliminating the need for expensive physical hardware setups, thus reducing electricity costs and freeing up valuable office space as well;
- recycle old equipment responsibly: when disposing of old computers or other IT equipment, be sure to properly recycle them in accordance with local laws and regulations – preventing hazardous materials from entering landfills is crucial for maintaining a healthy planet.

IV. CONCLUSION

In conclusion, we may state that green IT and green energy strategies can be effective in reducing energy consumption and promoting sustainability efforts. Green IT focuses on improving efficiency within an organization by using virtualization, cloud computing, and efficient hardware while green energy focuses on increasing the use of renewable sources such as solar panels, wind turbines, geothermal plants and hydroelectric dams instead of relying solely on fossil fuels for electricity. Both strategies can help organizations save money by reducing their carbon footprint while also increasing sustainability efforts. Nowadays governments and international organizations promote green IT and green energy strategies, and support organizations and individuals following such strategies. Thus, meeting sustainable environmental goals, besides its original idea to protect environment, could also be beneficial to organisations and individuals from financial point of view.

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