GREEN IT : HARVESTING HEAT USING TPV(THERMOPHOTOVOLTAIC)

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ABSTRACT:

Information technology (IT) has revolutionized our modern life and contributed significantly to economic and social prosperity. IT is moving at an incredible pace. Yet, there is a downside to IT expansion.

The energy consumption for IT is significantly high especially if we consider the total life cycle of IT products and datacenters power usage.

In view of the above concern, IT professionals are now turning to Green-IT in order to develop IT activities in a sustainable manner.

In fact, Green-IT includes all practices that aim to reduce the environmental impact of IT use. It is mainly about energy efficiency, environmentally friendly products and proper disposal of IT products.

In this paper I will start by defining Green-IT, the ecological issues related to it and the need to adopt this. Then I will describe a method using the TPV (Thermo -photovoltaic) that will help to reduce the ill-effects of the heat dissipated from data centre's thus encouraging the practice of Green-IT.

KEYWORDS: Green-IT , Data-Centre , Thermo photovoltaic

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1. **INTRODUCTION:**

Paper based information processing is a thing of the past. Running businesses sans Computers in today's time is highly unimaginable and unthinkable in today's time. Be it developed or developing economies, migration from paper based information processing to that of digital processing has happened real quickly. More and more computers got added to the enterprise, globally. This spurt in growth of computers has brought its own set of challenges, especially in terms of massive energy requirements to power them and cool them.

Growing energy requirements result in higher emissions from electricity generating points and an increased strain on the existing power grid. Some governments are trying their best to educate consumers of the ill-effects of the growing energy requirements. Businesses are too putting their best foot forward by espousing and implementing green initiatives.

The introduction of Carbon Reduction Committee in UK and similar such initiatives around the world have led to the rapid growth of green computing as a mandatory requirement for regulatory compliance.

Of late, enterprises have doubled up their efforts in not only monitoring and reducing the carbon footprint but are also actively engaging in finding and developing green IT solutions.

3. GREEN IT

Although currently there is no standard definition for the emerging body of knowledge and best practices that are collectively reported under names such as "sustainable computing" and "green computing," a simple working definition of Green IT can be stated as follows:"Green IT is the study and practice of using computing resources in ways that help reduce energy and operating costs, enable sustainable business practices and reduce the environmental impact of IT practices in the larger Community"

Although the definition us not precise and does not identify a set of green practices or technologies, it indicates that Green-IT is about considering environmental protection while using IT. Practices like datacenter efficiency, green procurement and e-waste management are only a few of possible
Green -IT actions.

Green IT practices attract media and management attention today, in part, because of a broader interest and emphasis on corporate social responsibility (CSR) programs. With increasing public awareness of environmental issues, CSR efforts also are tied to initiatives that build a positive environmental brand image. In the infrastructure support and data center management communities, there is a growing body of evidence that IT organizations can also "green-up" their energy, procurement and recycling practices. These efforts are being closely watched across the industry because, while they contribute to the broader corporate social and environmental agenda, evidence indicates that the initiatives make sound economic sense and in many cases generate substantial savings.

With this "win-win" opportunity emerging across CGI's network of clients, IT is increasingly becoming a major area of focus and opportunity for organizations looking to adopt green or sustainable business practices. In a practical sense, the new programs target a wide range of energy, cost, environmental and travel-related issues.

Among the issues most commonly reported, and those that appear to be fuelling the Green IT movement, are the following:

- Rising energy demand with a more limited supply and increasing utility costs.
- Management of hazardous waste and electronic equipment disposal (e-waste).

4. Programs, practices and processes

The need to take action to address this growing list of business and environmentally linked issues are driving a wide range of thinking and problem-solving activities.

As a result, many IT organizations are looking at Green IT programs to achieve objectives that include improving energy efficiency and power management practices, increasing hardware utilization, reducing life-cycle costs and looking for ways to cut down on computer waste. The major areas of activity associated with these programs fall generally into three categories:

4.1 Energy efficiency programs**:** These programs focus on maximizing energy use and computing efficiency in the IT infrastructure and data center levels to reduce energy consumption, electric utility costs and associated global greenhouse gas impacts.

4.2 Power consumption: This category includes efficient approaches to power conservation. For instance, as part of CGI's technology infrastructure management offering, CGI's ongoing data center electromechanical improvement program combines methods, processes and energy-focused solutions for power and cooling efficiency. For example, CGI data centers use raised floor lighting and cooling retrofits to orient projects toward energy conscious and cost-saving solutions. Using current and efficient power consumption technologies has enabled the centers to reduce utility inefficiency and waste by right-sizing to new, more efficient cooling and power solutions.

4.3 Cooling: By leveraging local climates and using chilled loop and free cooling strategies, IT organizations can decrease energy consumption through cooling practices. For example, CGI has decreased energy consumption with its own data center cooling strategies. Through the use of dual, air-cooled, split-type screw chillers, N+1 redundancy is achieved. This use of innovative, green, renewable energy resources enables CGI to reduce its demand for electricity, which also relieves the pressure on already over-burdened local electricity grids.

4.4 Green procurement and asset management:

This category includes initiatives that focus on purchasing computing equipment that is more energy efficient and environmentally friendly and includes programs to extend equipment useful life, recycle and engage with suppliers that demonstrate a commitment to reducing hazardous materials in their manufacturing, packaging and factory waste management programs.

4.5 Technology-based solutions: This category includes programs that employ technology in ways that are designed to reduce travel, commuting and real estate costs along with the environmental impacts of jobs related to people movement.

5. Data Center:

A data center (sometimes spelled datacenter) is a centralized repository, either physical or virtual, for the storage, management, and dissemination of data and information organized around a particular body of knowledge or pertaining to a particular business. It generally includes redundant or backup power supplies, redundant data communications connections, environmental controls (e.g., air conditioning, fire suppression) and security devices.

Fig 1: Data Center

The National Climatic Data Center (NCDC), for example, is a public data center that maintains the world's largest archive of weather information. A private data center may exist within an organization's facilities or may be maintained as a specialized facility.

According to Carrie Higbie, of Global Network Applications, every organization has a data center, although it might be referred to as a server room or even a computer closet.

Large data centers are industrial scale operations using as much electricity as a small town and sometimes are a significant source of air pollution in the form of diesel exhaust.

6. Heat Dissipation:

In the enclosed space of a server room, the heat that all those boxes generate can quickly increase the ambient temperature beyond equipment specifications. The results can be ugly:

1) Hardware failure
2) Loss of data
3) Uncomfortable working environment are all distinct possibilities.

It's critical to keep your Data temperature within the listed tolerances of your hardware. Tallying up the heat dissipation from your servers and other hardware can help you ensure your server room is designed and built with adequate ventilation and cooling.

Since nearly all power consumed by the processors is converted to heat—which must be removed via air (convection)—the data center in which this equipment resides must efficiently provide cold air to network equipment intakes and recycle the hot exhaust to remove the heat and keep vital
networking equipment operating.

Data center equipment has followed Moore's Law in many respects. "As the transistor density increases or the amount of processing increases, the amounts of power consumed and heat produced also increase."

Electrical and electronic devices have become smaller but higher performing, thus consuming more power and generating more heat in a given space.
The relationship between power and heat is direct. The power entering network equipment equals the amount of heat produced: watts (power) in equals watts (heat) out. All power that comes into network equipment results in heat, with the exception of a mere fraction: 1 percent of the total power is consumed by outgoing digital signals.

7. THERMOPHOTOVOLTAIC (TPV)

"Promoting the idea to save the climate and utilizing the heat dissipated from the server rooms where there are aplenty number of workstations and servers. To convert this waste into electricity we can make use of the TPV (Thermo photovoltaic)."

Thermophotovoltaic (TPV) energy conversion is a direct conversion process from heat differentials to electricity via photons. A basic thermophotovoltaic system consists of a thermal emitter and a photovoltaic diode cell.

The temperature of the thermal emitter varies between different systems from about 900 °C to about 1300 °C, although in principle TPV devices can extract energy from any emitter with temperature elevated above that of the photovoltaic device (forming an optical heat engine). The emitter can be a piece of solid material or a specially engineered structure. Thermal Emission is the spontaneous emission of photons due to thermal motion of charges in the material. For normal TPV temperatures, this radiation is mostly at near infrared and infrared frequencies.

The photovoltaic diodes can absorb some of these radiated photons and convert them into free charge carriers that are electricity.

Thermophotovoltaic systems have few, if any, moving parts and are therefore very quiet and require low maintenance. These properties make thermophotovoltaic systems suitable for remote-site and portable electricity-generating applications. Current research in the area aims at increasing the system efficiencies while keeping the system cost low.

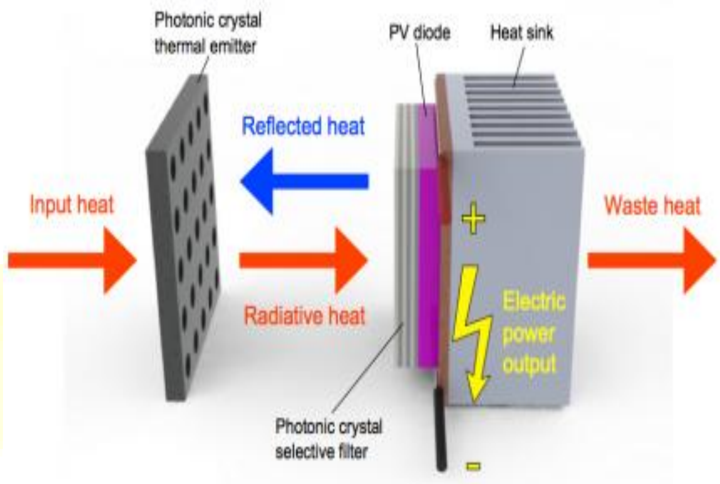

Fig 2: Architecture of a Thermophotovoltaic

What is required is a thermophotovoltaic device which is less susceptible to the detrimental effects of long wavelength energy.

According to the present invention there is provided a thermophotovoltaic device which includes an energy source compatible with thermophotovoltaic cells. A filter, adapted to filter out long wavelength energy, is positioned between the energy source and the thermophotovoltaic cells. The filter has dual walls with a low conductivity space between the walls which is adapted to break the convection heat transfer path from the energy source to the thermophotovoltaic cells.

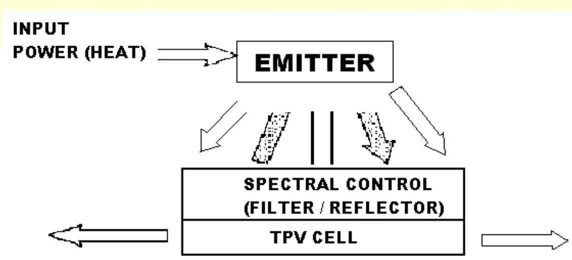

Fig 3: Working of a Thermophotovoltaic

The filter, as described above in FIG 3, filters out long wavelength energy, which the thermophotovoltaic cells are incapable of utilizing. The low conductivity space preferably created by a vacuum prevents heat transfer to the thermophotovoltaic cells. This makes the thermophotovoltaic cells work efficiently. The thermophotovoltaic calls can be made even more efficient, if a dielectric filter, adapted to filter mid-wavelength energy, is positioned between the energy source and the thermophotovoltaic cells.

TPV systems consist of a heat source above about 1300 K, Coupled with a broadband or selective emitter, thermophotovoltaic converter cells with or without a filter/reflector, and a cooling and heat recuperation system.

Some attractions of this technology are:

7.1 High power densities − 1 −2 W/cm^2 are reported in prototype systems. Mature systems expected to be on the order of 5 W/cm^2.

7.2 Quiet Operation—TPV conversion uses no moving parts (except cooling or combustion air fans in some designs) and can be expected to be essentially silent. This feature makes it attractive for military applications and recreational use.

7.3 Low Maintenance—due to lack of moving parts maintenance requirements will be minimal.

7.4 Cogeneration—for high efficiency, TPV systems must include a heat recovery system as a part of cell cooling and to preheat fuel and air before combustion. TPV devices are an excellent candidate for combined heat and power applications.

7.5 Versatility—TPV systems may be fuelled by almost any combustible material, although the burner must be designed for that particular fuel in order to maintain high efficiency.

7.6 Low emissions—are possible with well-designed burner/fuel selection.

8. FUTURE SCOPE:

The amount of heat that is dissipated from the data centre's can be utilized effectively to generate electricity. This waste heat can be harvested in a proper manner making use of the TPV.

The amount of electricity required to power the data centres and the amount of heat dispelled is equivalent. The TPV can yield an ample amount of electricity which can be further used to power up devices.

TPV cells could also be used to power generators or charge batteries in a range of commercial, industrial or domestic solutions.
Some believe that TPV cells could reduce waste and enhance energy efficiency of domestic heating systems; having the ability to combine the generation of electricity.

Further study and research is going on as to how the heat can be attenuated and garnered to contribute to the Green IT.

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