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A Methodology for Creating Energy Sustainability in an Enterprise

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***Abstract*—**As we enter the new era of Artificial Intelligence (AI) and cloud computing, we mostly rely on the machine and natural language processing capabilities of AI, and energy efficient hardware and software devices in almost every industry sector. In these industry sectors, much emphasis is on developing new and innovative methods for producing and conserving energy and to sustain the depletion of natural resources. The core pillars of sustainability are Economic, Environmental, and Social, which are also informally referred to as 3 P's (People, Planet and Profits). The 3 P's play a vital role in creating a core sustainability model in the enterprise. Natural resources are continually being depleted, so there is more focus and growing demand for renewable energy. With this growing demand there is also a growing concern in many industries on how to reduce carbon emission and conserve natural resources while adopting sustainability in the corporate business models and policies. In our paper, we would like to discuss the driving forces such as climate changes, natural disasters, pandemic, disruptive technologies, corporate policies, scaled business models and emerging social media and AI platforms that influence the 3 main pillars of sustainability (3P's). Through this paper, we would like to bring an overall perspective on enterprise strategies and the primary focus on bringing cultural shifts in adapting energy efficient operational models. Overall, many industries across the globe are incorporating core sustainability principles such as reducing energy costs, reducing greenhouse gas (GHG) emissions, reducing waste and increase recycling, adopting advanced monitoring and metering infrastructure, reducing server footprint and compute resources (shared IT services, cloud computing and application modernization) with the vision for a sustainable environment.

***Keywords*—**AI, cloud computing, machine learning, social media platform.

I. Introduction

ENERGY sustainability and climate change are two of the biggest problems of our era. Smart energy efficiency can help solve the climate crisis and promote sustainability. The forces driving sustainability in an enterprise in general fall into two areas: reducing energy costs and helping save the planet from the effects of climate change. The authors have collaborated on several papers on green computing and green healthcare, based on their work with IBM and creating energy efficient data centers, e.g. [1]-[3]. In this paper, we expand the scope to cover a wider area to save energy.

Much of this paper is also an update of the 2019 IEEE UEMCON paper by Lamb, "Smart Energy Efficiency for a Sustainable World" [4], and information from the July 2018 Springer book by Lamb: "Making Healthcare Green: The Role of Cloud, Green IT, and Data Science to Reduce Healthcare Costs and Combat Climate Change" [5]. This book and paper are the basis for much of our continued work on green IT, and the significant relationship between smart energy efficiency and climate change. A significant amount of information on the use of AI for smart energy efficiency has been added to this paper. Also, we have further researched the use of simulation and use of digital twins to enhance smart energy efficiency.

Green IT (Information Technology) provides an excellent way to reduce electricity use and save money. Al Gore's 2009 book "Our Choice: A Plan to Solve the Climate Crisis" [19], and many more recent publications [17], [18], continue to point to the urgency of having everyone worldwide help to solve this urgent crisis. Al Gore's 2017 book and movie, "An Inconvenient Sequel: Truth to Power" [20], are both very optimistic on the progress made in fighting climate change

We all need to help combat global warming. Global warming is a worldwide issue. Both technical and non-technical people need to participate, since science and arts have always gone together. The great Renaissance man, Leonardo da Vinci, is famous both as an inventor and scientist and as a great artist. In our current age of computers and electronic devices, technology and design are very much connected. Steve Jobs, the Apple founder, was more into design than technology. He left the technology details to the "other Steve" (Steve Wozniak). Elon Musk, who launched Tesla electric automobiles, is another modern-day Renaissance Man. Design and energy efficiency are very much a part of Tesla cars and Musk's SpaceX reusable rockets for launching commercial satellites and even for getting adventurous people to Mars. Musk is also helping create green electric energy through his Solar City venture. And, of course, we cannot forget Greta Thunberg, the young Swedish girl who went on strike to get people to do something to combat climate change. So, combatting climate change needs to involve all of us.

II. Infrastucture for Sustainable Systems

Infrastructure is a very important part in creating sustainable energy. The infrastructure requires technology such as the Smart Grid to balance energy supply and demand. Information and Communications Technology (ICT) will play a very vital role in creating an information and telecommunications infrastructure which will have the proper collection and control of data. ICT will also play a vital role in the data processing technology that

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will enable the effective use of the data [4].

Fig. 1 shows a view of smart energy management that could be used for smart energy efficiency.

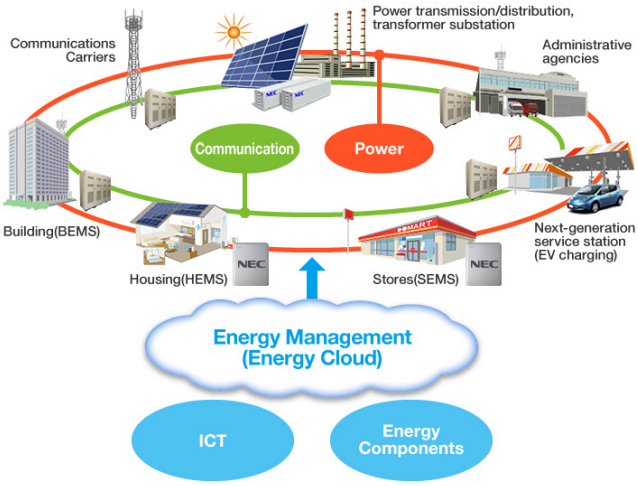

Fig. 1 Smart Energy Management [15]

Data centers are most often the starting point for green IT initiatives for companies. Data Centers are the buildings, or sections of buildings, that contain the electronic equipment used for data processing, data storage, and communications networking. Data centers are essential for the functioning of business, communications, academic, and governmental systems. Data centers have continued to grow and expand quickly as our economy continues the shift from paper-based to digital information management.

As discussed in [4], almost every sector of the economy has data centers. These sectors include financial services, media, high-tech, universities, and government institutions. The extensive server growth at data centers is exemplified by well-known web services such as Google, Amazon, and eBay. Google has more than one hundred thousand servers in dozens of cities around our earth. There are major Google data centers in California, Georgia, Virginia, Ireland, and newer facilities in Oregon and Belgium. There are also thousands of servers for Amazon.com and eBay.

Energy efficient data centers will significantly help reduce GHGes. That reduction in GHGes will help reduce global warming which has become a worldwide problem. The UN and White House sessions on climate change over the past few years emphasize the environmental importance of green projects. The implementation of Green Data Centers provides a great opportunity to help reduce GHGs.

Over the past few years, we have greatly improved energy systems. Thus, implementing green systems has become very financially rewarding. Going to green ICT is a win/win for all parties involved. We have found that Green IT has created customer interest throughout the world [6]. Much of the customer interest is from the financial benefits that come from investment in green data centers.

In a green data center, the mechanical, lighting, electrical and computer systems are all designed for maximum energy efficiency and minimum environmental impact. A green data center includes the use of advanced technologies and strategies, such as [4]:

- Minimizing the footprints of the buildings
- Using low-emission building materials, carpets, and paints
- Sustainable landscaping
- Waste recycling
- Installing catalytic converters on backup generators
- Using alternative energy technologies such as photovoltaics and fuel cells
- Improved efficiency of heat pumps, variable speed fans and free cooling technology
- Mandating the use of hybrid or electric company vehicles

Data centers can become more energy efficient in many ways. Basic technologies to check when working with existing data centers are:

- Using energy efficient IT systems such as virtual servers, virtual data storage, and blade centers.
- Using efficient cooling towers and variable speed blowers.

Server consolidation – although initially undertaken to save server hardware capital – is also an excellent way to reduce server energy use. Going way beyond server consolidation is data center consolidation, which is also done to reduce facility and personnel resource cost. However, an important aspect of data center consolidation is reduced energy use in the overall data center. Many data centers currently employ new IT technology such as virtual servers or server consolidation, so in this paper we will first explore the technologies that have already started to be employed at many data center for capital cost saving – and discuss the ways this same technology can significantly reduce energy use. Case studies are an excellent way to see how to leverage lessons learned on energy efficiency at data center and overall sustainable buildings.

Energy efficient data center design (e.g., using server and data storage virtualization, server consolidation) in addition to cutting power requirements by 50% or more, also reduce the floor space requirements for data centers. As an example, if we replace eight individual physical servers with one large physical machine, that includes eight virtual servers, using virtual server techniques, we can easily reduce the data-center floor space required by 80% or more. Therefore, Green IT can be a winning solution for all aspects of your data center. The wins include electric-power reduction, server cost reduction, data-center floor space reduction, and simpler server management since there is a reduced number of physical boxes [6].

It can be expensive to build and certify a green data center, but long-term cost savings can be realized on operations and maintenance. Of course, there are also significant non-financial returns to consider, e.g., green facilities offer employees a healthy, comfortable work environment. In addition, we should consider the fact that green facilities enhance relations with local communities.

The requirement for server refresh offers data centers a convenient opportunity to go green, which almost always makes economic (as well as environmental) sense. For example, IBM Consulting has estimated that an ordinary 25,000 square foot data center with electrical costs at 12 cents per KWH would cost

a company about $2.5 million a year in electrical energy costs [6]. IBM Consulting has also estimated that by going green, a typical data center could reduce its annual electricity cost by up to 50%. In addition, as energy costs continue to climb, the savings from the use of energy-efficient IT equipment and the more energy efficient data center cooling techniques, will also continue to climb.

Environmental Protection Agency (EPA) reports [16] indicate that the U.S. data center industry is still in a major growth period based on continued demand for additional data processing and storage. This demand is driven by several factors, which include:

- Increasing use of electronic transactions in financial services, such as on-line banking and electronic trading.
- Growing use of Internet communication and entertainment.
- Shift to electronic medical records for healthcare.
- Growth in global commerce and services.

Here are additional important trends contributing to data center growth in the government sector:

- The use of the Internet to publish government information.
- Many government regulations require digital records retention.
- The use of enhanced disaster recovery requirements.
- Growth in emergency, health, and safety services.
- Extensive information security and national security.
- The digital provisioning of government services (e.g., e-filing of taxes and US Postal Service on-line tracking).
- High performance scientific computing.

Continued increasing demand for computer resources has led to significant growth in the number of data-center servers. There is also an estimated doubling of the energy used by these new servers and a doubling of the power and cooling infrastructure that supports them. This increase in energy use has several important implications, which include:

- The increased energy costs for business and government.
- An increasing number of emissions, including GHGs, from electricity generation.
- An increased strain on the existing power grid to meet the increased electricity demand.
- Increasing capital costs for expansion of data center capacity and construction of new data centers.

There has been increasing interest in the many opportunities for energy efficiency in data centers. Because of this increased interest, IT groups have been actively investigating the opportunities and developing solutions, that include such things as power-managed servers and adaptive cooling.

It should be noted that the direct energy use of IT and infrastructure equipment is not the only way that data centers affect energy use. Data Center services can quite often lead to reductions of energy use in other parts of the economy. These reductions in energy use in other parts of the economy can often exceed the data center energy expenditures for the services. For example, the use of e-commerce and telecommuting will reduce both freight and passenger transportation energy use. If we use an electronic bookstore, such as Amazon.com, that use of e-commerce would save us from driving to the local bookstore, which saves energy. We can also attend a "virtual" conference with the use of a web-conferencing service (such as Zoom) and save energy due to an airline flight to the conference, use of a rental car, and all of the many other energy costs that travel includes.

Implementing the numerous energy efficiency opportunities at data centers is very important since the rapid growth of direct energy use in data centers is estimated to continue. Without improved data center energy efficiency, there would be a significant impact on both the power grid and U.S. industries.

We are all aware of rising energy costs in today's data centers and the continued concerns over global warming and other environmental issues. These concerns have made green IT a hot topic in the IT area. We will now further explore the concepts, benefits, and business value of green computing, including:

- A further definition and analysis of green computing and its benefits
- An overview of the many green computing solutions
- The many business cases for going green.
- Implementation of an energy management solution
- Information on why energy efficiency is so important to the planet.

According to Gartner research firm, the "green wave" continues to rise. Most IT organizations have placed environmental concerns among their top buying criteria. Also, most companies are using carbon-footprint [7] considerations in calculating their hardware-buying strategies, and most large enterprises have developed policies requiring their suppliers to prove their "green credentials" through an auditing process.

III. Smart Buildings – Planning and Construction

Planning and constructing smart, energy efficient buildings are an extremely important part of a sustainable world. This section gives details on the different procedures. First, let's discuss the concept of "Zero Energy Buildings" [8].

A. Zero Energy Buildings

Large buildings or homes that consume large amounts of energy from the Common Energy Grid and consume environmental resources (without replenishing them) cannot be considered "sustainable". The concepts, 'Net Zero-Energy Building (ZEB) or Zero Net Energy Building (ZNEB) or NZEB (net zero energy building) [8], are interesting. A ZNEB building is a commercial or residential building that has very low energy needs because of efficiency gains such that all remaining energy needs can be supplied with renewable technologies. Only a ZEB/ZNEB that meets zero energy standards (zero net energy consumption and zero carbon emissions) can be considered "sustainable". Such buildings have their own source of solar or wind power or a combination thereof [9].

An important concept in the context of this discussion is, understanding the difference between *green*, *sustainable,* and *healthy buildings*. These terms, although sometimes used interchangeably, there are some key differences. As implied by the term 'green building', it is the one that helps reduce the impact left by the building on the environment from construction and use – as such, it typically includes 'energy efficiency measures' to the building by maximizing the performance of the 'building fabric' to not use energy in the first place plus the

additional use of renewable energy sources such as wind, water or solar.

The definitions or rather the descriptions mentioned in the preceding text are theoretical definitions so to say. Despite the hype over the phrase "zero energy," there is no common definition, nor is there a common understanding about 'ZEB' or 'ZNEB' in terms of what it really means i.e., at the implementation level.

The way we define the zero-energy-goal affects the choices that are available for building designers to make to achieve this goal and whether they can indeed claim to be successful in achieving such a goal. The ZEB/ZNEB/NZEB definition can consider different strategies to meet a ZEB goal. Here are four documented definitions: (1) net-zero site energy, (2) net-zero source energy, (3) net-zero energy costs, and (4) net-zero energy emissions, that have been studied and these definitions have been applied to a set of low-energy buildings for which the energy data available are extensive. Let's now discuss the more common ways to create what we call green buildings.

B. Better Design and Simulation Tools

There are many design and simulation tools to help in the construction of green buildings. Author Lamb spent over five years using building simulation tools to help design energy efficient buildings for IBM [6]. The simulation used a year's worth of detailed hourly weather data for the location of the new building. The simulation would allow the architect to evaluate different building designs from an energy efficiency standpoint. Author Godbole [4], [5] has been researching the green building activity in India. In the last 20 years, India has witnessed the green building movement gaining tremendous impetus. In 2012, the market for LEED-rated green buildings in India was about $5 billion, with the total market for green building materials and products in India at around $45-50 billion.

C. LEED Building Certification to Save Energy and Money

The Leadership Achieving LEED certification has become a very cost-effective goal. LEED stands for Leadership in Energy and Environmental Design and is the accepted benchmark for sustainable building practices in renovating existing facilities or building new ones. Using a stringent rating system, the USGBC certifies projects Silver, Gold, or Platinum. While it may cost slightly more initially, many organizations around the United States are finding it financially beneficial to receive LEED certifications by the U.S. Green Building Council (USGBC) for sustainable designs, green building materials and energy-efficient systems.

LEED is by far the most widely used green building rating system in the world. The LEED certification process provides incentives for sustainable and environmentally friendly decisions during the construction process. LEED-certification provides a way to showcase the fact that during the design and construction of the structure or facility that is being certified, certain environmental goals have been achieved. LEED certification is important for building owners and users. To be LEED-certified, the building project is required to earn a certain number of points and meet 'green building' standards that are validated during the LEED certification process.

D. LEED and Carbon Trading

To reduce carbon emissions, LEED buildings can benefit from carbon trading credits. The USGBC (US Green Building Council) has been working to mitigate the effects of climate change through carbon trading credits with its LEED rating system. By adopting specific, credit-based strategies and rigorous standards, LEED guides builders as well as building occupants towards structures to be proud of, structures that add as little as possible to our world's GHG emissions and water and energy use. Of the total points in LEED version 4, 35 reward climate change mitigation strategies. These include four different credits for GHG emission reductions, and credits for sustainable site location, access to public transportation, water use, energy performance, carbon offsets and life cycle impact reduction [5].

E. LEED Green Building Rating System

LEED as mentioned in Subsection *C*, is a widely used green building rating system. Various 'LEED Rating Systems' are available - the latest LEED rating system has 5 different areas addressing multiple projects:

1. Building Design and Construction
2. Interior Design and Construction
3. Building Operations and Maintenance
4. Neighborhood Development
5. Homes

These five areas are further divided into smaller components where points are given and depending on the number of points received, they can obtain one of the following categories:

- *CERTIFIED* 40-49 Points
- *SILVER* 50-59 Points
- *GOLD* 60-79 Points
- *PLATINUM* 80+ Points

The LEED rating system can be used for both new construction and for existing buildings. *LEED Certification* levels require minimum requirements for the construction organizations/builder community that wishes to obtain the certification needs to meet at a minimum these requirements as part of the LEED certification process:

1. Must follow *environmental regulations and standards.*
2. Meet the *threshold of floor area* requirements.
3. Must meet a minimum of *building occupancy* (in terms of number of users)
4. Must maintain a *reasonable site boundary.*
5. Must be a *permanent building.*
6. Must share energy and *water usage data.*
7. Have a minimum *building to site area ratio.*

LEED is a popular guide for green building in the United States and much of the world. LEED is developed and continuously modified by workers in the green building industry.

F. Additional Green Building Rating Systems

Buildings are one of the main consumers of energy. In the construction sector, for example, in the United States and UK buildings use 45% and 42% of the entire energy countrywide,

while in OECD countries the corresponding share is 31% [5]. Due to such high energy consumption, it is necessary to set up plans and establish rules for minimizing the use of energy by buildings. Therefore, many domestic and international green building certification systems have been constructed and they are expected to be used by the construction sector.

There are several Green Building Certifying Agencies [5]. They assist/support building developers in implementing principles/criteria that are required to get green certification. In addition to LEED-USGBC, there are several certifying agencies in India:

1. LEED-India – LEED for India is an important certification system, on an international level, for green buildings. LEED-India is a rating system (provided by IGBC) for the design, construction, and operation of high-performance green buildings.
2. IGBC Ratings – IGBC (Indian Green Building Council) is a division of the Confederation of Indian Industry. The IGBC division works closely with the government of India. The purpose of IGBC is to help develop sustainably built green environments.
3. BEE-ECBC – The ECBC (Energy Conservation Building Code) was created by the Indian Bureau of Energy Efficiency (BEE). This code is used to help set energy efficiency standards for design and construction of green buildings.
4. TERI GRIHA – GRIHA (Green Rating for Integrated Habitat Assessment). This is a green building rating system in India that is used while designing and evaluating new buildings.

G. Smart vs Intelligent Buildings

A Smart Building is a combination of communication technologies to enable many functions within a building to interact and communicate with each other and to be managed, controlled, and automated in a remote way.

Intelligent buildings are a unified system of network connected hardware and software, providing a clear view into a building's performance - controlling and monitoring electricity, lighting, plumbing, digital signage, HVAC, security systems and more. They could enhance productivity and efficiency and at the same time reduce energy costs and environmental impact, through the seamless integration of every device and system — regardless of manufacturer or communications protocol.

We can say that an intelligent building is a building that provides a comfortable and productive environment to the occupants through automated control systems such as: HVAC, fire safety, security, with facilities for the management of energy/lighting. It is a building in which these control systems are integrated and interact with each other. An intelligent building is also one that integrates control services along with telecommunications through one structured cabling network and management system that meets current and future technologies and building/user demands.

IV. Smart Energy Efficiency with Simulation and Use of Digital Twins

The use of simulation and digital twins for smart energy efficiency is a very significant future technique for many aspects of smart energy efficiency.

A. The Use of Digital Twins in Veterinary Medicine

In 2002, the concept of a digital twin, or a "dynamic virtual model of a system, process or service", was described [12]. Since then, its applications have spread through various businesses and industries, including model-based systems engineering, prototyping, and livestock management. Digital twins can be modeled after anything from drones to assembly lines, and even to the life and behavior of animals when replicated as a series of processes. The use of AI in the form of digital twin technology can greatly improve outcomes and efficiency while contributing a wealth of knowledge to the field when applied to veterinary medicine.

To create a digital twin, the physical model (e.g., an animal in the vet's office) must be connected by a digital thread to the internet or a computer that can download and process the data received. This is often done by inserting a sensor into the physical model to track and analyze the structure, performance, health status, and the characteristics of interest to those utilizing the twin [12]. This allows for the monitoring of the physical system and for computer simulation of how the system will react in response to certain stimuli. Problems and their causes can be detected, and predictions can be made about how the model will fare when any alterations or preventative maintenance is performed. Overall, the use of digital twin technology in any field of study provides a useful way to gain insights into the physical system performance by using software that runs analysis on the data collected, so that those utilizing this data can allocate their own time and efforts more efficiently.

In addition to automated systems, digital twins can also be created as a model of an animal; this tactic has been introduced in farm management by studying the virtual models of cows. Farmers who have incorporated digital twin technology with wearable sensors on their cattle have seen significant benefits, such as a 30% increase in dairy production and a 50% reduction in antibiotic use. By the end of 2019, they have seen an overall increase in efficiency of 20% to 30%, and the data collected to date predicts a 58% increase in dairy cattle by 2050 [13]. These positive statistics are largely because farmers are now able to catch disease earlier by determining and recognizing early symptoms of illness; as a result, they distribute antibiotics only to those cattle who show signs of falling ill, whereas in the past antibiotics would be administered to the whole herd regardless of symptoms as a preventative measure. Cutting down on preventative antibiotic distribution cuts costs and decreases wastefulness while simultaneously reducing the possibility of creating an environment in which antibiotic resistant bacteria and viruses can form and thrive due to unnecessary over distribution of antibiotics to cows that are not ill. By eliminating this practice, cattle who do fall sick will most likely have a treatable strain that can easily be cured by antibiotics, as the bacteria have had no prior opportunity to grow resistant to the

treatment. In the long run, these preventative measures and early response to illness will lead to an increase in cattle population, as deaths due to illness will become increasingly sparse.

The use of AI in the form of digital twin technology in veterinary medicine shows promising positive results. In cattle alone, farmers have seen an increase in dairy production, efficiency, and overall number of healthy livestock, with a corresponding decrease in deaths due to illness and in overall costs and losses. This allows farmers to allocate their own efforts more efficiently while being able to respond to problems with the herd in a prompt and informed manner. The more this technology is incorporated into medicine, the more data can be collected and analyzed, and the more scientists are able to learn about animals and their behavior, illnesses, and responses to certain stimuli. This will rapidly increase the rate of research and help in developing drugs and processes in medicine. The world of veterinary medicine can gain a lot of insight and growth by incorporating the use of digital twins.

V. Ways that AI Can Help Combat Climate Change

Climate Change, one of the biggest challenges on the planet, would benefit from machine learning to help with solutions. This section discusses some of the solutions [9]. Since climate change is an enormous challenge facing the planet, every solution possible should be employed, including technology like AI.

A recently published paper, "Tackling Climate Change with Machine Learning" [14], gives details on the many climate change problems that can be meaningfully addressed with machine learning. Machine Learning can be deployed in many different areas, including CO_2 removal, energy production, solar geoengineering, education, and finance. In these areas, machine learning could be used for more energy-efficient buildings, creation of new low-carbon materials, improved monitoring of deforestation, and greener transportation. Although it might not be a perfect solution, AI brings essential insights into the energy efficiency problem. Three ways machine learning helps combat climate change based on [14] are:

A. Better Climate Predictions

Better climate predictions can be made with Climate Informatics, a discipline created in 2011. Climate Informatics sits at the intersection of data science and climate science. AI using Climate Informatics covers a wide range of topics, including improving prediction of extreme events such as hurricanes using paleoclimatology. Paleoclimatology is a study that consists of the reconstruction of past climate conditions using data collected from things such as climate downscaling and ice cores.

Scientists can use AI to get new insights from the vast amount of data generated by the field of climate modeling. Of course, climate modeling has come a long way since the first system was created in the 1960s at Princeton [14]. There are many models that have come into existence since the early days of the 1960s. The models represent the atmosphere, oceans, land, cryosphere, or ice. However, even when there is agreement on basic scientific assumptions, the models will usually agree in the short term, but there can be significant differences when it comes to forecasting for the long term.

Machine learning algorithms can be used by weather scientists to compare and put together the predictions of about 30 climate models used by the Intergovernmental Panel on Climate Change. Better predictions would help make more informed climate policy, provide an opportunity for governments to prepare for change, and should also make clear areas that could possibly reverse some effects of climate change [9], [14].

B. Using AI to Help Show Effects of Extreme Weather

Some of us have already experienced the effects of a changing environment. For others, the effects of climate change are less noticeable. Researchers from the Montreal Institute for Learning Algorithms (MILA) used an AI tool called GANs, to simulate what homes are very likely to look like after being impacted by climate change phenomenon such as rising sea levels and intense storms [9]. That is a good way to make the changing environment more realistic for many people.

MILA researchers have met with Montreal city officials and NGOs who would like to use the tool [9]. There is an app what could show individuals what their neighborhoods and homes might look like in the future with different outcomes due to climate change. However, the app still needs more data. The app developers have stated that they would eventually like to let people upload photos of floods and forest fires. More data would improve the algorithm.

C. Using AI to Help Measure Where Carbon Is Coming From

To meet the UN goal of preventing new coal plants from being built, a significant tool is Carbon Tracker, which is an independent financial think-tank. Carbon Tracker can monitor coal plant emissions with satellite imagery. This could then be used to help convince the finance industry that carbon plants are not profitable.

A grant from Google is expanding Carbon Tracker's satellite imagery input to include gas-powered plant emissions. This will give us better information on where air pollution comes from. This satellite imagery is a way to provide monitoring of all power plants that do not measure CO_2 emissions.

AI can be used to automate the analysis of images of power plants. That would be a good way to get regular updates on emissions. AI also introduces new ways to measure a plant's impact, by evaluating information on nearby infrastructure and electricity use. That's a way to evaluate gas-powered plants since they are not as easy to measure as coal-powered plants that have very distinctive plumes.

Carbon Tracker will be used to make information available on thousands of power plants and make that information available to the public. Carbon Trackers could also be used to help put a price on emissions for future carbon taxes.

VI. Conclusions

The future of sustainability is a worldwide concern. Smart energy efficiency contributes to helping solve the climate crisis by reducing CO_2 in the atmosphere and saving electrical energy.

Technologies such as cloud computing can easily reduce costs and improve services in the ICT field. The continued significant use of electric energy for the IT infrastructure has increased the need for green IT initiatives and sustainability.

As we go into the future, all of us in IT have a role in helping improve the outlook for smart energy efficiency. We can do that by contributing to ICT infrastructure electric energy sustainability, data protection [11], and the continued improvement in cloud computing for IT cost reduction along with improved data protection [10]. Climate Change, and the use of AI and other solutions to combat the impact of climate change, will continue to receive much needed attention [17], [9], [18].

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