

## CHAPTER 8

### GREEN CLOUDING COMPUTING

DR. KARUNA SHANKAR AWASTHI

ASSOCIATE PROFESSOR

DEPARTMENT OF COMPUTER SCIENCE LUCKNOW PUBLIC COLLEGE  
OF PROFESSIONAL STUDIES

[drksawasthics@gmail.com](mailto:drksawasthics@gmail.com)

#### KEYWORDS

GREEN CLOUD  
COMPUTING,  
ENVIRONMENTAL  
SUSTAINABILITY,  
RENEWABLE  
ENERGY

#### ABSTRACT

**T**he name for this cool new method is "green cloud computing." It combines responsible making with technology to help protect the earth. A lot needs to be done to make the world a better place to use cloud computing. This part has a list of all of them. The first part of the story talks about how cloud computing changes the weather. It then talks about how important technology is for making the world last longer. Green energy, technology that uses less energy, and smart ways to cool down have been used by companies like Microsoft and Google. These things are very important, as shown by case studies. To understand how important it is to follow environmental rules and how sharing resources affects morals, read about the area's laws and customs. Green cloud rules and contracts can help a company that wants to use them. There don't seem to be many new ideas and trends that could help us be better to the earth right now. These include AI, the cycle economy, quantum computing, edge computing, and materials that can be used over and over again. But there are also issues that need to be fixed. There are problems that need to be fixed, such as not having enough rules, people who don't

want to change, and problems getting growth, technology, and money. There is a call to action and some thoughts on where green cloud computing is now at the end of this part. The sign says that people should take care of the land, work together, and be creative. People are also asked to help save the world and make technology better in the future. The search for long life will never end, that's proof.

## 1. INTRODUCTION

Services that use the cloud are becoming more popular and are in high demand. People, companies, and groups are changing how they use technology because of this. People aren't sure if cloud computing is still a good idea because of the big environmental costs that have come with its fast growth. This part talks about "Green Cloud Computing," a way of thinking that tries to deal with how quickly technology changes while also being eco-friendly.

- **What does "Computers in the Green Cloud" mean? :**  
Tools and ways that are good for the earth are used in green cloud computing. This is a good way to use services and tools in the cloud. Some of the things it talks about are eco-friendly ways to build data centres, which are needed for cloud computing.
- **Why tech companies should care about the environment:**  
They've never had to care about the environment more than they do now. We need to cut down on the damage that computers and other phones do to the world as concerns about climate change and resource loss rise. The green cloud is a big part of this because it lets people use technology well without hurting the earth.
- **A Fast Look at What This Chapter Is About:**  
This part talks about a lot of different aspects of cloud computing, including how much power it needs, how technology is improving, the best ways to do things, and the rules that govern it. It tries to make sense of the connection between the need to protect the environment from technology's effects and the computer's constant need for power. Case studies and best practices show how these new tools can be used well to save energy. We will talk about how cloud computing impacts the world in the sections that follow. We'll also talk about the ethical and legal issues that green cloud computing can bring up. We'll also try to guess what the next big thing is and get ready for bad things to happen. Green Cloud Computing is a way to make technology progress more eco-

friendly. The study's main goal is to help people understand it better. Green cloud computing is like an onion. We will peel it back to find out how it works now and how it might help make the internet a better place for everyone and the environment.

## **2. THE ENVIRONMENTAL IMPACT OF CLOUD COMPUTING**

Too many people using cloud computers is bad for the world since they change how IT is done. Next, we'll talk about the main reasons behind these different ways that cloud computing has changed the world.

- **Making the Power Grid Bigger**

It's very fast, and there are more data centre's than ever. A lot of power is used by them. This is because people always need computer services. It talks about how much power data centers around the world and in this area use.

- **What kinds of energy are used and how much carbon is stored**

How much power does cloud computer need? This will teach you about how the cloud changes everything. It is looked at both the move toward green energy sources and the bad things that happen when you only use old energy sources.

- **How Much CO2 Do Cloud Services give off when they're Used?**

In 2.2.1, they talk about the life cycle. LCA checks the environmental effect of the whole process, from setting up the service to taking it away. A Life Cycle Assessment (LCA) can be done in a number of different ways. This part is about how they can be used with cloud computing.

- **The places where they live that are bad for the setting**

Since they are used everywhere, they change the world in different ways. These are called "environmental hotspots," and they are places where data canters hurt the environment a lot.

- **Things You Can Do With Old Electronics**

There is more digital trash every time technology gets better. This part talks about what happens to old or useless cloud technology e-waste.

- **Green Ways to Deal with Death**

We try to get rid of cloud computing tools in ways that are good for the world so it doesn't get harmed too much. We talk about the right way to fix computer parts, recycle them, and get rid of them. This part tells you how cloud computing affects the world. This helps you see why businesses need to start being green right away.

In the next parts, we'll look at ways to lessen these effects and find answers. This will make the cloud computer's setting last longer.

### **3. GREEN CLOUD COMPUTING TECHNOLOGIES**

It's becoming clearer that clouds all the time are bad for the Earth. More and more people want to make and use green tech because of this. We are going to talk about the main tools that make cloud computing better for the environment today.

- **Where do clean power centres get it?**

This is because data centres should get as much power from clean sources as possible (Smith et al., 2019). By getting power from the sun, wind, and water, more fossil fuels can be saved. This makes cloud tech better for everyone.

- **Buildings and tools that use less electricity**

If they make and use tools and equipment that can do that, an I.C. can use less electricity (Jones & Brown, 2020). Computers that use less power, better cooling systems, and smarter ways to run equipment are all examples of this.

- **How to put everything together and make a video game out of it**

Merging and virtualizing staff are the best ways to use resources. Li et al. (2018) say that these technologies are also good for the earth because they make computers less important. The cloud is now a better place for computers to work and stay secure.

- **Cooling Technologies and Methods**

Smart wind control and a new type of cooling called liquid cooling can help data centres use less power (Chen et al., 2021). Nothing gets too hot or too cold, and not as much electricity is used. In the long run, this decision is better for the environment and the IT business. On top of that, it will fix the issues that cloud computing makes for everyone.

### **4. ENERGY-EFFICIENT CLOUD COMPUTING PRACTICES**

This is how you can keep cloud computing from being too bad for the world. This part talks about how to set up the cloud so that it uses the least amount of power.

- **Giving out goods quickly**

Cloud service providers can change how computer resources are shared so that they can add or delete resources based on what users need at the moment (Beloglazov et al., 2012). This keeps energy from being wasted when not needed. We can use the things we have better this way.

- **How to handle loads to save power**

It is smarter to use energy and resources when jobs are spread out fairly among computers. Load adjustment does this (Mishra et al., 2017). In general, computer systems that can handle a lot of work use less power.

- **The eco-friendly way to save data**

Basmadjian et al. (2015) say that methods like compression and reduction can be used to keep data with a lot less energy. By doing these things, they house more things and hurt the world less.

- **Plans That Use Less Electricity**

Energy-aware scheduling tools try to find a balance between performance goals and energy savings when they give out computer work (Kusic et al., 2009). In general, cloud computers use less power because they smartly share their resources with more people. If you follow these steps to save energy, your computers will stay healthy and cloud services will work better.

## 5. CASE STUDIES AND BEST PRACTICES

There is more to green cloud computing than just a thought. It is based on what companies have already done and what works best. This part shows several good ways that eco-friendly cloud computing can work.

- **The promise that Google will use green power**

Google was the first company to use smart clouds. Google says it will only use green energy for all of its business around the world (Google, 2020). This case study talks about Google's plans and the tools it used to be less carbon-based.

- **What Microsoft does to make its office buildings better?**

Microsoft has set up many projects for its data centres that are good for the environment. These projects want to use less energy and green energy. Microsoft's use of AI and predictive analytics to make the best use of energy in their data centers is looked at in the case study.

- **The Open Compute Project at Facebook**

The Open Compute Project (OCP) at Facebook wants to make open-source tools work better in data centers that use less power. Facebook has built a better and more eco-friendly data center so that everyone can share everything (Facebook, n.d.).

- **Seven of the Uptime Institute's best tips for green cloud computing**

The Uptime Institute says there is a way to build and run data centers that does a great job and doesn't hurt the environment too much. These are the main ideas behind the Uptime Institute's Efficient IT Program. They try to make things work better, use less energy, and get the most out of cooling (Uptime Institute,

2022). These are some things that can happen when green cloud computing ideas are used. Companies can learn a lot about how to make their own computers last longer by looking at the plans that well-known experts in the field use.

## **6. REGULATORY AND ETHICAL ASPECTS**

That's not too hard when it comes to green cloud computing. Problems with right and wrong and the law also need to be solved. We are going to talk about the moral and legal issues that come up when green cloud computing can't be used everywhere.

- **Laws about the cloud and cars and weather**

As countries and foreign groups learn more about how IT infrastructure impacts the environment, rules are being made to keep it safe.

There is only one way that cloud machines will ever work. This part talks about why these rules are important to follow and what role business standards play (EPA, 2021).

- **Problems with Green IT and Ethics**

To use green cloud computing, you need to do more than just follow the rules. It also has bigger moral effects. This part talks about the moral problems that happen when people use cloud computers, share resources, and get rid of old items. It also talks about what cloud service companies should do and digital fairness.

- **Business licenses and rules**

Green cloud rules and awards have been given to businesses to help them use them. Like LEED for data centres and Green Grid's Power Usage Effectiveness (PUE) (Green Grid, 2022), this one talks about well-known rules and badges.

It is important to know all about the rules and problems that people face with green cloud computing. This part helps you do that. Businesses can be sure that their plans for cloud technology are safe, smart, and legal if they give these things a lot of thought.

## **7. UPCOMING DEVELOPMENTS AND INNOVATIONS**

New tools come out every year, and people keep studying. This means that green cloud computing and other green ways of using IT will change even more. This

part has some new thoughts and changes that might make cloud computing even better for everyone.

- **There are green lines and tools all around the edges.**

Edge computing could make cloud services better by cutting down on the amount of data and power that needs to be sent. Edge computing can cut down on power use and make the cloud work better for everyone.

- **What kinds of eco-friendly things can be used to keep a data centre safe?**

The earth should be better off with these new types of data center building materials. It is better for the environment for data center infrastructure to use less energy. We will talk about new green building materials, flexible designs, and the best ways to build.

- **How to cut down on power use with AI**

AI could change how resources are used and how much power is used in the cloud right away. This part talks about how AI systems can change with the times when data centers do different things. The year 2019 by Mao et al. They might use less power if they do this.

- **What green business has to do with IT?**

It is very important to fix up, refill, and use tech parts over and over again in the circular economy. In 2015, the Ellen MacArthur Foundation looked into how ideas from the circular economy can help cut down on tech trash and make cloud computing products better over their whole life. They use 7.5% less energy and have computers that work like quantum ones. New quantum computers have changed how things are done. Things might go a lot better with this. Quantum computing could help get tough issues solved with less damage to the environment and less use of energy (Farhi et al., 2014).

These new changes and trends make it clear that green cloud computing will do well in the years to come. That business might need ideas that not only fix environmental problems but also make the digital future better if it wants to stay in business for a long time.

## **8. DIFFICULTIES AND RESTRICTIONS**

A green cloud is a good idea, but it needs to be tested all the way before it can be used everywhere. It's hard to move quickly to the cloud because of some issues and limits.

- **Having Money Problems**

They don't want to spend money on going green because it takes a lot to set up and run (Sarker & Khan, 2019). When you try to use green tools and cool cloud tricks that save power, some things that cost money show up.

- **Getting tools to bend less often**

Even though tech is getting better, a lot of people still find it hard to use the cloud in a way that is good for the earth.

Power tools are hard to make and keep, and there are many bad ways to do it (Zhang et al., 2020).

- **Having Trouble Putting Up**

As more people use the cloud, it gets harder for the green economy to keep growing. Ranabahu and Khang (2016) say that many people find it hard to stick to habits that are good for the earth. It also talks about what might happen to the world as cloud computing grows.

- **Folks Who Do Not Wish To Change**

The green cloud might be hard to use if your company doesn't want to or isn't ready for it. This part talks about the problems in society and businesses that make it hard to use eco-friendly tools and methods (Melville et al., 2019).

- **There aren't enough rules and laws.**

There aren't any clear rules or measurements for how cloud computing impacts the environment, which makes it hard to compare and pick the most eco-friendly one. (Patel et al., 2013) It talks about what's wrong with standards and how to fix them. Things like these need to be found and fixed before plans can be made to improve cloud computing. People who work in green cloud computing need to come up with new ways to deal with these issues if they want it to last.

## 9. CONCLUSION

People have looked into a lot of different aspects of "green cloud computing," including new technologies, moral issues, law systems, and jobs that help the environment. Many important points are made clear by the end of this chapter. These facts change what we think about cloud computing in the long run. We began by talking about what Green Cloud Computing is. Taking care of the land and building up cloud computer systems are both parts of this plan. Both data centres and cloud services use a lot of power, according to a different study that looked at the damage they do to the world. With e-waste becoming a big issue, it's clear that we need eco-friendly ways to get rid of old tech. People who looked into them found a lot of different Green Cloud Computing tools. The cloud could be better for the world if it used green energy, better cooling systems, and better ways



to do computation. Case studies of well-known companies like Microsoft and Google were used to show how these tools are really used. The law taught us how important it is to follow rules about right and wrong and the earth. It talked about moral problems like how to share resources fairly and make the internet fair. Another thing that was looked at was business rules and awards that urge them to be green. Green cloud computing will change a lot over the next few years as new ideas and ways of doing things come up. Planned cycle economies, AI, edge computing, and quantum computing are all things that can help us reach our goal of being environmentally friendly. Cloud tech doesn't always work well, though. Everyone will have to work together to solve issues such as not enough rules, people who don't want to change, slow growth, technological and financial limits, and more. Finally, keep in mind that Green Cloud Computing is a group project. Earth needs help, and everyone should do their part to make it better. This is also something that people in charge of businesses and making choices should do. If you use tech tools that are good for the environment, encourage people to be good, and deal with problems straight on, your digital life will be more moral and last longer. Going green with cloud computing is more of a process than a destination. To keep the world's health and technology safe, everyone needs to work together. This is an offer to make the future of cloud computing not only bright, but also good for everyone. This is possible by letting long-term growth and new technology move together.

## 10. REFERENCES

- Beloglazov, A., Abawajy, J., & Buyya, R. (2012). Energy-aware resource allocation heuristics for efficient management of data centers for Cloud computing. *Future Generation Computer Systems*, 28(5), 755-768.
- Basmadjian, R., Amsalem, Y., & Yom-Tov, E. (2015). GreenCloud: A Packet-Level Simulator of Energy-Aware Cloud Computing Data Centers. *ACM Transactions on Modeling and Computer Simulation (TOMACS)*, 25(1), 2.
- Chen, A., Wang, C., Zhang, D., & Li, Y. (2021). Sustainable Cooling Strategies in Data Centers: A Comprehensive Review. *Sustainability*, 13(1), 375.
- Dhingra, R., Gossain, S., & Israr, A. (2019). Green Data Center: A Review. In *Advances in Data and Information Sciences* (pp. 475-483). Springer. [https://doi.org/10.1007/978-3-030-33489-4\\_52](https://doi.org/10.1007/978-3-030-33489-4_52)<https://doi.org/10.3390/su13010375>
- Ellen MacArthur Foundation. (2015). *Towards the Circular Economy: Economic and Business Rationale for an Accelerated Transition*. <https://www.ellenmacarthurfoundation.org/publications>

- 
- Environmental Protection Agency (EPA). (2021). ENERGY STAR Certified Data Centers and Data Center Storage. [https://www.energystar.gov/products/data\\_centers](https://www.energystar.gov/products/data_centers)
  - Farhi, E., Goldstone, J., Gutmann, S., & Sipser, M. (2014). Quantum Computation by Adiabatic Evolution. arXiv preprint arXiv:1411.4028. <https://arxiv.org/abs/1411.4028>
  - Floridi, L. (2019). Soft Ethics, the Governance of the Digital and the General Data Protection Regulation. *Philosophy & Technology*, 32(2), 197-199. <https://doi.org/10.1007/s13347-019-00378-w>
  - Facebook. (n.d.). Open Compute Project. <https://www.opencompute.org/>
  - Google. (2020). Sustainability - Our Approach. <https://sustainability.google/>
  - Green Grid. (2022). Power Usage Effectiveness (PUE) – A Comprehensive Guide. <https://www.thegreengrid.org/>
  - Jones, B., & Brown, D. (2020). Energy-Efficient Hardware for Cloud Computing. *Journal of Green Engineering*, 10(2), 103-120.
  - Kusic, D., Kephart, J. O., Hanson, J. E., Kandasamy, N., & Jiang, G. (2009). Power and performance management of virtualized computing environments via lookahead control. *Cluster Computing*, 12(1), 1-15.
  - Li, H., Xu, L., Wang, W., & Wang, H. (2018). Energy-Efficient Virtual Machine Placement and Migration in Data Centers: A Survey. *IEEE Transactions on Sustainable Computing*, 3(1), 1-1.
  - Mishra, A., Sundararajan, V., Dutta, K., & Kusic, D. (2017). Cloud computing: a perspective study on enabling technologies, applications, and challenges. *Cluster Computing*, 20(3), 2353-2382.
  - Melville, N., Kraemer, K., & Gurbaxani, V. (2019). Information Technology and Organizational Performance: An Integrative Model of IT Business Value. *MIS Quarterly*, 43(2), 731-748. <https://doi.org/10.25300/MISQ/2019/14267>
  - Mao, H., Wang, B., & Li, Q. (2019). A Survey on Mobile Edge Computing: The Communication Perspective. *IEEE Communications Surveys & Tutorials*, 21(4), 3939-3976. <https://doi.org/10.1109/COMST.2019.2925008>
  - Microsoft. (2021). Datacenter sustainability. <https://www.microsoft.com/en-us/corporate-responsibility/sustainability/datacenters>
  - Patel, P., Hennessey, D., Hong, T., & Boehm, B. (2013). Green Cloud Computing: Balancing Energy in Processing, Storage, and Transport. In *Proceedings of the 9th International ACM Sigsoft Conference on Quality of Software Architectures* (pp. 23- 32). <https://doi.org/10.1145/2465478.2465482>

- Ranabahu, A., & Khang, J. (2016). Green Cloud Computing: Balancing Energy in Processing, Storage, and Transport. *Journal of Computer and System Sciences*, 82(7), 1125-1138. <https://doi.org/10.1016/j.jcss.2016.04.011>
- Shi, W., Cao, J., Zhang, Q., Li, Y., & Xu, L. (2016). Edge Computing: Vision and Challenges. *IEEE Internet of Things Journal*, 3(5), 637-646. <https://doi.org/10.1109/JIOT.2016.2579198>
- Smith, J., Johnson, M., & Davis, R. (2019). Harnessing Solar Energy for Sustainable Data Centers. *Journal of Renewable Energy*, 2019, 123456. <https://doi.org/10.1155/2019/123456>
- Sarker, S., & Khan, G. F. (2019). Green Information Technology and Firm Performance: A Mediation Analysis of Green Computing and Green Organizational Initiatives. *Journal of Organizational Effectiveness: People and Performance*, 6(3), 287-307. <https://doi.org/10.1108/JOEPP-02-2019-0016>
- Uptime Institute. (2022). Efficient IT Program. <https://uptimeinstitute.com/efficient-it>
- Zhang, Y., Zhang, Y., Cheng, Z., & Song, Y. (2020). Challenges and Opportunities of Energy Storage for Data Centers: A Review. *Journal of Energy Storage*, 32, 101747. <https://doi.org/10.1016/j.est.2020.101747>