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(Research/Review) Article

Energy Efficiency and Emission Reduction through Cloud Technology: A Green Economy Perspective

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Abstract: Digital transformation through adoption cloud technology has become catalyst in effort efficiency energy and reduction greenhouse gas emissions glass (GHG). Research This aim for analyze contribution cloud technology against efficiency operational and impact the environment in framework economy green. With use approach studies literature and secondary data analysis from report institution international and journals scientific, research This find that migration to cloud computing can reduce consumption energy up to 84% and emissions carbon up to 88% compared to with traditional IT infrastructure. These results show that cloud computing is not only solution technology, but also important strategy in support development sustainable.

Keywords: cloud computing, efficiency energy, emissions carbon, economy green, digital transformation

1. Introduction

Change global climate is driving various sector For adopt approach more operational sustainable . In the midst of acceleration digitalization , cloud technology emerges as solution strategic in support transition going to economy low carbon . Cloud computing does not only increase efficiency data management , but also has the potential big in reduce consumption energy and greenhouse gas emissions glass through optimization digital infrastructure .

Change climate and degradation environment has push various sector For adopt approach economy green . Technology Information and communication technology (ICT), especially cloud computing, plays a role important in support efficiency energy and reduction Cloud emissions allows consolidation data center , optimization burden work , and use energy renewable in a way more wide . However, it is still limited study Which linking cloud technology in a way direct with green economy principles , especially in the sector public And country develop like Indonesia.

In Indonesia, adoption cloud in the sector public And private Keep going increased . However, understanding about his contribution to sustainability environment Still limited . In fact , the implementation of cost-effective data center energy , virtualization server , and integration energy renewable can strengthening the green economy agenda .

Study This aim For study the role of cloud technology in efficiency energy And carbon emission reduction , as well as How its integration can support development strategies sustainable . With approach qualitative descriptive study This expected give contribution theoretical And practical in designing policy digital Which friendly environment in the era transformation digital .

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2. Review Library

a. Energy Efficiency through Cloud Technology

Cloud technology contribute on efficiency energy through virtualization , consolidation server , and management burden Work Which smart . Modern data centers use technique such as dynamic voltage scaling, workload migration, and usage

source energy renewable For reduce consumption power . Cloud computing allows utilization source Power in a way elastic , so that avoid overprovisioning and increase efficiency operational .

b. Emission Reduction through Technology Cloud

Cloud computing play a role in carbon emission reduction with reduce need device hard local And centralize process computing in the data center more efficient . Practice like use energy renewable , optimization cooling , and monitoring footsteps carbon through the emissions calculator has become standard in green cloud computing . Large companies like Google and Microsoft have show significant emission reduction through migration to the cloud .

c. Green Economy Perspective in Adoption of Cloud Technology

Green economy emphasize economic growth that low carbon , efficient source power , and inclusive . In context cloud computing , adoption of this technology support green economy principles through subtraction cost energy , increase efficiency operational , and subtraction waste electronics . Green cloud computing is becoming an important strategy for organizations that want to transform digitally at once guard sustainability environment.

3. Proposed Method

Study This use approach qualitative descriptive with method studies literature. The data source comes from from:

- Journal scientific international (Scopus, Springer, Elsevier)
- Report institution international (IEA, UNEP, World Bank)
- Case study company cloud providers (Google, Microsoft, AWS)

Analysis done with approach content thematic for identify pattern cloud computing's contribution to efficiency energy and reduction emissions, as well as its relevance with principle economy green.

4. Results and Discussion

a. Efficiency Energy through Cloud Computing

Studies by Accenture (2020)[1] show that company Which migrate to the cloud public experience subtraction consumption energy up to 65–84%. Migration from traditional IT infrastructure to the cloud computing allows consolidation source power, virtualization, and management burden Work Which more efficient. Virtualization technology And management burden Work dynamic allows use source Power Which more optimal compared to server local .

b. Carbon Emission Reduction

According to AWS report (2022) cloud- [2]based data centers that use energy renewable can reduce emission carbon up to 88%. Study*[3]* show that digitalization, including cloud, in a No direct lower GHG emissions through improvement consumption energy renewable. In No direct, digitalization push adoption energy renewable and practice business sustainable, such as smart grid and e-governance.

c. Green Economy Perspective

Cloud computing supports principle economy green through efficiency source power, reduction waste electronics, and savings cost operational. Cloud adoption also drives more innovative business models sustainable, such as green supply chain and smart government. Cloud also opens opportunity business model innovation green, like service digital- based and economical energy and low carbon.

5. Comparison

a. Comparison with Condition Latest (2025)

1. Green Cloud Adoption is Increasingly Widespread

Provider big such as AWS, Google Cloud, and Microsoft Azure have integrate energy renewable and efficiency of AI in their data centers. Strategies such as carbon-aware workload shifting and liquid cooling are becoming standard new.

2. Digitalization And Energy Renewable Integrated

Siemens [4]and Lincoln International [5]Report show that digitalization push decentralization energy and adoption energy clean. Cloud technology plays a role in smart grid, management energy, and predictions burden.

3. Challenge Sustainability Cloud

Although efficiency increase, data growth and request cloud Also increase consumption energy. Tech Research Online Article questioning is green cloud real sustainable or just a branding strategy.

4. Policy And Regulation Support Transition Green

The IEA reported that policy energy green in the sector electricity And transportation push adoption of digital technology And cloud For efficiency system [6].

b. Contribution Study

1. Strength

- Provide framework theoretical Which connect cloud computing with a green economy .
- Highlighting potential efficiency energy And emission reduction conceptual .
- Merge literature international and studies case technology .

2. Limitations

- Does not include empirical data local (for example sector Indonesian public).
- Not yet discussed challenge cloud sustainability such as rebound effect and footprint carbon No direct .
- Not yet integrated aspect policies , regulations , and incentives green .

c. Opportunity Development

- Add mediation analysis such as in studies Dimian et al. (2025) for test connection digitalization → energy renewable → emissions.[3]
- primary data from agencies government or company cloud local .
- Develop model conceptual Which combining technology, policy , and organizational behavior

6. Conclusion

Cloud technology own potential big in support efficiency energy And reducing carbon emissions , making it pillar important in the green economy strategy . To maximize benefit this , is required policy Which push adoption cloud based energy renewable , especially in the sector public And industry energy intensive research advanced recommended For study impact empirical cloud computing in context local , such as institution government in Indonesia.

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