LITERATURE REVIEW

2.1 He Yan et al. (2007), This paper discussed about green manufacturing and green manufacturing process planning. The factors considered and optimization of power and storage in case of different databases like tool database. There is lack of software tools to implement green metrics, they classified the database storage into three layers, database layer, user layer and application layer, mostly green can be implemented on application layer, by optimizing models of process routing, minimizing the noise in the data and power optimization. Model selection process based on the types of application also has significant impact.

2.2 Ankita Atrey et al. (2012), author in this paper talks about green cloud computing and starts with carbon issues due to electronic devices, global warning, they studied existing work and found various metrics like PUE (power usage efficiency), CUE (carbon usage efficiency), WAU (water usage efficiency), ERF (energy reuse factor), DCiE (data centre infrastructure efficiency), DCP (data center productivity), CPE (compute power efficiency), GEC (green energy coefficient), SWaP (space wattage and performance etc.) and also they proposed integrated green cloud architecture.

2.3 Kashif Bilal (2012) This paper green data centre network challenges and opportunities author first discussed about the environmental impacts in data centre. Also said the for data access from different location network bandwidth is going to be a big issue. Two types of architecture models are explained here, namely switch based and hybrid models. Data centre issues potentials and solutions as well as green networking are also discussed. They concluded by saying much attention should be given to improve the efficiency of the data centre.

2.4 Nurul A. Emran (2012) This paper has given information about storage space optimization. author suggested having green data centre which has less carbon emission compared to normal data centre, mentioned about optimizing the data base space by using compression tools s relational table level, apply repeated values removal technique, space optimization in storage is the primary concern. Proposes a space optimization technique called ‘proxy based approach’, do space optimization through database schema modification, the authors they used the proxies for the attribute substitutes other attributes, also did implementation options of proxy map with tables. The author concluded by suggesting advanced proxy algorithm.
2.5 Yichao Jin et al, (2012), This paper author discussed about the impact of server virtualization in the data centre and they analysed how the virtualization is supporting energy usage in different workload. Author also mentioned about various standards used in electronic product usage and by the analysis found that server architecture will be updated to save energy, and virtual server consume more power than physical ones. Energy overhead on virtual server solely depends on hypervisor used, multi core scheduling algorithm should be incorporated Also author compared the capacity of type1 and type2 hypervisors and suggested saving the power using closing he background activities running in system.

2.6 Nithin Singh Chauhan and Ashutosh Saxena (2013), authors discussed about the impact of global warming through IT, organization are asking to have clean energy resources, author also discussed about, green house frame work, need of service level agreements and software’s and their categories, cloud infrastructure, virtualization, various facilities in data centre. Authors also propose cloud web service delivery model.

2.7 Sauro Pierucci and Jiri J. Klems (2013), worldwide the Data centre (DC) responsible for enormous global electricity usage due to the intake of electricity. In the cooling systems we can minimize the DC cost by using a Direct Free Cooling (DFC) system which uses outside air to directly cool the information technology (IT). However this approach involves the risk to introduce outdoor aerosol which can become electrically conductive if the surrounding air reaches the aerosol Deliquescence Relative Humidity (DRH), thus damaging electronic equipment. Author also discussed about a study aimed to increase DC energy efficiency, whilst at the same time preventing aerosol corrosion. Energy consumption of the DC. A potential energy savings of 60% was estimated compared to a traditional.

2.8 Shalabh Agarwal et al, (2013), this paper discussed about the need of going eco-friendly based environment. Also author highlights the sources of carbon emission such as, nuclear power plan, burning of coal etc., and suggested the need of collaboration of staff and students to bring eco-friendly measures, use of ICT in education so that minimize face to face communication and have paperless document, and to increase green in education mentioned about college management like, application online, exam, admission, feedback, attendance etc. Online computing reduces e-waste and save electricity.

2.9. Shantanu Ray et al, (2013), this article gives brief about the impact of carbon emission and the importance of sustainability in software development methodologies. The available methods
SCRUM, Extreme programming and Sprint helps in minimizing the problems related to the efficiency and flexibility. The normal software methodology based on Non virtual product life cycle. Maintenance in software has to be minimized by using longer life time software author then suggested visualization of server and use natural resources for energy consumption for the software and monitor the energy difference through normal energy and adaptation of sustainable natural energy. The frame work require for the development such as specification, meeting should be maintained. The other distribution phase, usage phase lso maintain sustainability and they also proposed a tool OGSA-DAI-used in university of Edinburgh to enhance optimization.

2.10. Shehia Afzal et.al, (2013), This paper gives information about reducing the energy used by the organization by using cloud storages SDLC should be made energy efficient, the finding of the study suggest that both functional and non-functional requirements include performance, security, portability availability, usability. The design phase include classification of data, architecture and interface design., Advanced level encryption algorithm consume less energy than the data encryption standard (DES). In case of implementation loop and branching statement consume more energy, Enhance energy consumption during information transmission, the software maintenance include technology changes also in cloud the data we are storing should be green too.

2.11. Tommi Makela and Sakari Luukkainen (2013), authors mentioned that cloud computing and green computing plays major role in data storage, cloud computing offers IT resources s service, private cloud and hybrid cloud are outsourced so less burden in managing things, green computing has no value as the cloud providers are not having energy efficient software tools to measure the metrics of green efficiency of hardware software network and storage, the only incentive is low cost and the author mentioned about a study by Microsoft with small, medium and large group, the fact that, when working on large group the percentage of carbon footprint is lesser by 30% and for lesser groups the carbon footprint is 90% lesser in cloud compared to on premise working.

2.12. Aditi Mahajan and Anita Ganapati (2014), Conducted a study on energy efficiency techniques on cloud computing like dynamic voltage and frequency scaling (DVFS), VM consolidation, Resource-Throttling and dynamic component De-activation (DCD). Also proposed three real time cloud service schemes lowest-DVS, d-Advanced-DVS and ADAPTIVE-DVS. trough studies they
also found that cloud consumes huge energy and contributing overwhelming operation cost and also has impact on environment due to carbon emissions.

2.13. *Chenlei Zhang and Abram Hindle* (2014), authors gives information of power consumption by using green miners software, green missing data sets. Mentioned a concrete body to research power application in mobile devices, studied about windows mobile based power models elens to find the energy consumption of mobile. But how to reduce energy using mobile was not mentioned in the model. Organization of data sets and how to trace the data sets were generated by two open source applications, in this application each data sets is in CSV format and each row in the file represent the data of the application system. Proposed methodology which can choose and build multiple version of software product, develop test case and run the software.

2.14. *Renuka M. Dhanwate and Vaishali B. Bhagath* (2014), performed a review on improving the energy efficiency on Android using cloud based services. Given information about offloading the information of mobile device in cloud. Also classified the publication into two domain research paper and report and further subdivided into review, improvement in the existing technology and new design minimize the environmental impact perspective of cloud service provider. Author also performed a review on total number of paper published in the field of cloud and found that tremendous increase in publication is there. Concluded by saying they have collected the information for the research from the existing research papers.

2.15. *Sonu Choudhary* (2014), author made a survey on green computing techniques. Started with highlighting the concerns of huge energy consumption by cloud and mentioned the advantages of green computing like reduction or CO2, disposal of products, saving energy and money, recycling the products, prevent the health of human being. The green computing approaches mentioned are product longevity, data centre design software optimization, power management, material recycling, telecommuting etc. Data centre local techniques include virtualization. Author concluded by saying research should be made to control power consumption in the data centre.

2.16. *Abhishek Singh and Priyanka Upadhyay* (2015), This paper explores the emergent need of virtualization in green data centre and proposes green data centre architecture on virtualization environment. Discussed about the components of virtualization environment like service delivery module, virtualization environment data protection module, service orchestration module, energy efficient module, power and cooling component management modules and its working.
Information about data centre physical construction component management module which support the data centre to save energy and to minimize the carbon emission also mentioned. The methods suggested include there constant gap in pillow and brushes of the discharge side, remove floor grills from the area where cooling is not required, remove obstacles below the floor and minimize the cold air flow to the server. The challenges in the virtualization environment can be reduced by energy proposed hardware design, power management in the virtualization environment and by energy efficient resource management.

2.17. Arif sari and Murat Akkaya(2015) spoke about security and optimization challenges of green data centre .first gives information about green computing and mentioned the four ways energy consumption can be minimized., green use in process, design and disposal .described about the organization of data centre team and data centre infrastructure design .Various techniques for energy optimization in the data centre they suggested are cooling methods, energy efficient server and security models like access control, information classification, data encryption, intelligent video surveillance by using SIPORT technology to be incorporated in the data centre and concluded by saying there should be depth search in case of cooling systems.

2.18. Birgit Penzenstadler(2014), explains about Infusing green and about green requirement engineering and provide a background work of, how to have sustainable requirement engineering. Also discussed about requirement types and the various dimensions of sustainability. Proposed a model for green requirement engineering, also find different sustainable Stake holders and conducted an analysis of sustainable goals of car sharing case study a kind of resource pooling to save energy. Also logical constrains in implementing the methodology also studied. Risk management and environmental sustainability also studied.

2.19. Coral Calero and Mario Piattini(2015) authors said sustainability in software development , starts from, hardware , software , information and communication technology, information systems, business process reengineering etc. Suggested have to move on from sustainability to more green IT , by giving natural energy sources to the data centre rather than using the electricity generated due to coal. Mentioned about minimizing carbon emission also using cloud, recycling e-waste, power management, storage optimization, thin clients etc.. by developing green software which consume less energy. They suggested the whole software development work should go green in future.
2.20. **Herald Munzel and Aphn e.V. (2015)**, authors tries to give insight about the ethics principles and code of ethics from the professional associations, they further discussed about the three approaches of normative ethics namely virtue ethics, deontological and teleological ethics. Virtues like courage and integrity are the key idea of the ethics, other virtue named is cardinal virtue to today’s concern of sustainability development like, equity, moderation insight and courage. The virtue of understanding of complex coherences includes human being, nature and culture courage which help people to leave the known path and dare to think out of box. Also they gave information about (IEEE-Computer Science code of ethics, German information society code of ethics(GI) and British computer society(BCS).these ethics lead to motivate oneself and feel responsible outcomes associated with one’s profession

2.21. **IMRAN GHANI et.al, (2015)** This paper is a study of around 68 research papers based on the energy consumption in the data centre, by analysing parameters of metrics such as power usage efficiency (PUE), data centre infrastructure efficiency, carbon usage effectiveness. Also mentioned about IT Equipment utilization, for the data centre productivity and water usage effectiveness. Various energy saving techniques for servers such as dynamic power management, Dynamic voltage and frequency scaling (DVFS), also energy saving solution for network usage, adaptive link rate (ALR), virtual network embedding, sleep mode and green routing are also discussed. study states that DVFS decrease the adaptation of energy of parallel task administration.

2.22. **Ishrat Unnisa (2015)**, given message that green computing should start from the initial stage from designing the operating systems and disposing the e-waste in efficient manner and so that green initiatives can begin from the first phase of software development, shortcoming of the green software can be increased. Also replacement of CRT with Led Plays the major role, the various power hardware, virtualization and cloud computing, use of recycling, safety and healthy environment is possible with proper green computing.

2.23. **Pragya and Manjeeth Gupta (2015)**, this paper mentioned about efficient scheduling algorithm in green clouds computing, they tried virtual migration using green cloud simulator using different scheduling techniques like first fit, Monte Carlo and round robin. used Green cloud simulator, it will investigate workload distribution in different environment with packet level simulation of connections in the data centre through research paper they studied that energy
efficient cloud can be achieve by a) energy efficient hardware b) energy efficient resource scheduling algorithm, network infrastructure in cloud, energy efficient cloud servers.

2.24. IRNE MONOTAS et.al, (2016), Authors stated Green software development is a growing need, there are many software development initiatives like GREENS, etc. authors also conducted interview with the professionals from Microsoft, google, IBM and different software organization about the knowledge of saving energy in all the phases of software engineering like, analysis, design, coding, implementation and testing. They also conducted, the formal interview with 467 people, further brainstormed and analysed and come to the conclusion that most of the engineers are not aware of how to save the energy. Still the developers require more practice in developing software with green energy efficiency.

2.25. Jaspreet Kaur and Amritpal Kaur (2016), authors in this paper describes the energy efficient resource allocation for load balancing in the heterogeneous system through decision making procedure in the data centre. Large amount of server are used in organization like IBM and Microsoft. authors also mentioned the advantage of using EHEROS over HEROS which uses binary search algorithm for task scheduling on distributed infrastructures. The resources include computing, memory, storage and networking. also given information about three tire architecture, core network, aggregate network and access level network, the aggregate layer will support content switching, load balancing.

2.26. Mohan Kumar and M. Anand Kumar (2016) on considering the requirement of green in information technology, tools to estimate and calculate the green competence of the database are used. in order to ensure that they describe code optimization algorithm to find maximum optimization by minimizing unwanted read and write. Another algorithm related to CPU and algorithm related to memory are also given. The experimental evaluation of energy consumption and CPU utilization also is calculated. CPU consumption, transactional ability of the system, average queue extent and average reply time. through these parameter analysis they aimed diminishing carbon usage.

2.27. Nader Nadar(2016). This paper suggested implementing energy efficiency framework in cloud computing. Initially author studied various research paper and understand the complications in environment due to carbon emission and performed research on analysing various metrics like power usage efficiency, data centre infrastructure efficiency, data centre productivity. Virtual
machine implementation used to minimize energy and strongly proposed the need of emergent need of framework of integrated cloud nd data centre framework. They concluded by saying new integrated framework should be adapted in early basis.

2.28. **Pooja Subash Patil and Jyoti Kharrade (2016)** this paper discussed about the necessity of green computing in smaller and larger data centre to minimizing the carbon emission in the data centre enhance green competence by recycling and reuse and also focussed on green technologies green data centre virtualization ,green cloud and power optimization green tool is used to save energy consumption, modular deployment ,intelligent power distribution monitoring system, advanced cooling technology. By virtualization can minimize downtime by migrating virtual machine from the physical server, dynamically balance workload increase the ability of server groups to share resources and other method for green computing power optimization by having energy efficient CPU.

2.29. **Umma Khatuna Jannat(2016)**, author explores that requirement engineer can use the option of adopting green methodologies for developing software .Green elicitation encourage the use of reusable design framework patterns only when it is clear that it can save power and increase quality. Green it information can be collected from different data bases such us IEEE,,ACM, Springer link, Google scholar , whiley etc. conduct green interview ,use paperless form, also the Virtual meeting will reduce CPU usage, reduce transportations. Optimize the resource utilization, minimize e-waste. In data analysis part, focus on paperless work, to meet non-functional requirement using minimum resources etc. and lower the hardware by virtualization systems.

2.30. **Xibo Jin et.al,(2016)**, Author stared by discussing the issues in data centre environment due to power and mentioned about data centre techniques like energy efficiency ,thermal control ,resource management and green metrics, and worked on various algorithm by increasing the speed in single and multiprocessor .then highlighted about the challenges and research issues in data centre management techniques like ,virtualization, data centre traffic engineering, Remote energy access and temperature and thermal control methods are also discussed and concluded with the future directions.

2.31. **Eric Brewer et.al,(2017)**. the growing need of storage of data is increasing ,the innovations should be there on disk storage. Social networking sites, you tube video itself occupy bulk storage,. Five key metrics they suggested ,high speed I/O s per second, higher capacity in GB,
lower latency, low total cost ownership. Each disk should have read and write caches, so that data can be accessed fast. Profiling data and management of profile, security of data, special design to increase the hard disk capacity also mentioned.

2.32. Hayri Acar et al. (2017), this paper highlights about how with software we can minimize power consumption. Proposed a model (TEEC) to check and verify the power consumed by CPU, Memory, Disk etc. They did various research approaches like validation research, evaluation research and solution research. Formulas are used to estimate energy of CPU at the architecture level, running process, source code, also a suggested solution about estimate power without giving information about the source code, in memory virtual energy counters. Described DRAM architecture in order to operate power for disk. Told about simulation based mathematical timing model for disk to monitor power consumption.

2.33. Junaid Shuja et al. (2017), The emerging technologies cloud computing, big data and internet of things (IOT) consumes lot of energy as well as carbon emission (Green House Gas) which can lead to global warming, depletion of ozone layer, high disease rates. They said that green mobile computing is increased because of the usage of the mobile phones, they frequently trigger sensor (GPS). Another concept discussed about using RFID tags and tags readers in the form of microchips, the unique ID in the tag, which contain context data of entities they are attached, they trigger information flow by transmitting signal. Active tag use on board power battery and passive harvest energy from the signal of readers both consume energy and emit carbon, as the material is non degradable.

2.34. Laur-Diana Radu (2017) performed a literature survey on cloud computing in existing literature and to find out the key issues researched and applied in data centre, discussed about cloud computing, and made a comparative study on the research papers in international databases like web of science, ACM digital library, IEEE computer society, Scopus and science direct, after that author found cloud computing status and trends based on various categories like, algorithm, architecture, framework general issues, models and methods in terms of energy efficiency, resource management, operational costs and CO2 emissions.

2.35. Renu Bala and Jasdeep Mann (2017), authors mentioned about green computing using energy efficient task allocation strategy in cloud environment. Cloud is also service provider, large amount of data stored in the cloud is called big data. Proposed a new power saving algorithm for
carbon footprint. The steps are initialize the cloud sim simulator, create multiple heterogeneous virtual machines, multiple clouds and divide them into three zones, set the cloud in descending order using max-min scheduling algorithm, sort virtual machines, run in different operating mode (high, medium and low). Computer the total power consumed, total waiting time and average time for all cloudlets and chart to be prepared to display all results.

2.36. **Richardo Bianchini et.al, (2017)**, highlights the need of using public, private and hybrid cloud and need of virtualization in cloud. More than thousands of server in the data centre require data centre infrastructure and management Tools (DCIM) to monitor and control the load efficiency and power efficiency in the data centre. Author also mentioned about converting data centre and network into virtualization environment and mapping physical resources with virtual resources. For AC they suggested classify the aisles into three types, cold hot and superhot to manage the energy in sustainable manner.

2.37. **Shailesh Saxena and Ankur Kumar (2017)** made an analytical study on green computing environment. Discussed about the need and importance of cloud computing. The infrastructure of cloud is explained properly. Various related work about the cloud computing is studied and found the areas of power efficiency advantages like diversity economics of scale, flexibility and enabling structural change. Mentioned about the need of green cloud framework, virtual machine scheduling and management also described, further concluded by saying green computing is not only destroying the existing computers but also to implement new concepts like green cloud.

2.38. **Blesson Varghese (2018)**, author discussed a next generation cloud computing impacts the two tire architecture of the cloud will be three tire architecture more. Security and energy sustainability will be the major area to look at in the cloud computing. The data centre architecture is used for connecting people and device. Architecture should support emerging applications like big data and Internet of Things. Distributed cloud infrastructure will play a major role in future.

2.39. **Onkar Aswale et.al, (2018)**, this paper survey on green cloud computing data centre authors has stated about the green data centre and its operating and capital expenditure (capex). They given the components of data centre server, switch and internetwork types as well as two tire and three tire architecture of the data centre. The testing and predictions of measuring the performance metrics and energy efficiency in the data centre can be measured by using cloud simulators. The exiting
Simulators available are cloud Sim, cloud analyst, Green cloud, Network Cloud Sim, EMU SIM, GroudSim, and DCsim

2.40. Sara DIOUANI and Hicham MEDROMI (2018), gave information about energy aware and dynamic resource management in data centre, author studied various research about cloud computing. Also mentioned about dynamic energy aware solution for energy management such as virtual machine migration, setting for the physical machines and considering virtual machines and its work offload. Author concluded by suggesting to implement efficient scheduling algorithm while respecting the defined service level agreements and enhance the data centre efficiency.