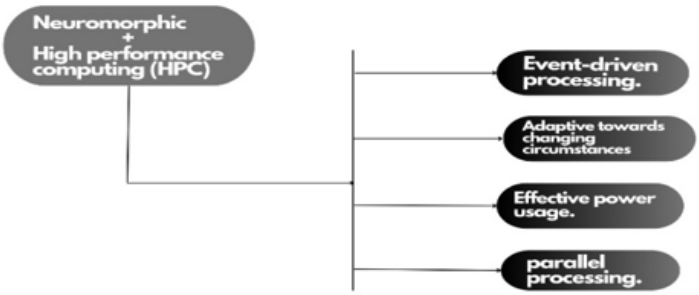
JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

# Revolutionizing AI and Sustainable Energy: The Intersection of Neuromorphic Computing, Renewable Energy, and High-Performance Computing

***A. S. Satvika, B. Aarekh Verma, [1] Ankit Mishra[2]***

1. Department of Computer Science Engineering, Amity University Chhattisgarh, Raipur, C.G - 493225, India 1, surampudisatvika2005@gmail.com
2. Department of Electrical and Electronics Engineering, Amity University Chhattisgarh, Raipur, C.G - 493225, India 2.

Artificial intelligence and sustainable energy solutions are advanced by neuromorphic computing, renewable energy, and high-performance computing. High-performance computers can tackle complex computational tasks that need a lot of processing power. Green energy technology uses renewable energy to mitigate climate change, while neuromorphic computing mimics the human brain to develop energy-efficient computers. Energy production, storage, and consumption might be revolutionised by their synergy, paving the way for a more sustainable future. Using neuromorphic computing, renewable energy, and HPC technologies, we are tackling global energy efficiency problems. With memristor technology, this combination might revolutionise AI and advance robotics, cognitive computing, and machine learning. Organic neuromorphic sensors, inspired by the human nervous system, are flexible, biocompatible, and suitable for wearable, implanted applications. They can gather data at the network's periphery, allowing HPC systems to quickly analyse it. This enables decisions to be made more quickly and with more information. Light, pressure, and temperature are all converted by these sensors into electrical impulses, which are then processed by neuromorphic circuits in the same way that the brain does. Because of their high energy efficiency and sensitivity, they are an ideal choice for applications that need accurate environmental monitoring or real-time health tracking, as well as for wireless devices that are powered by batteries. These areas may include Through the analysis of real-time data, high-performance computing (HPC) technology that is powered by neuromorphic components has the potential to tackle the problem of green energy variability, optimise energy networks, and reduce the use of fossil fuels. To monitoring the quality of products in real time, neuromorphic sensors are something that the manufacturing sector absolutely needs. Neuromorphic sensors are required to be installed in their respective manufacturing processes. It is possible that high-performance computer analysis might minimise waste by spotting potential problems at an earlier stage.




**Advantages of Neuromorphic Computing and High-Performance Computing**

**Figure1**

## 1. Introduction.

Three cutting-edge disciplines that are revolutionizing our approach to artificial intelligence and sustainable energy solutions are neuromorphic computing, green energy technology and High-Performance Computing. Green energy technology seeks to harness renewable energy sources to counteract climate change, whereas neuromorphic computing creates energy-efficient computer systems by modelling and HPC involves using supercomputers or computer clusters to solve complex computational problems at high speed. Given that neuromorphic computing and HPC may maximize the effectiveness and responsiveness of renewable energy systems, the synergy between these three fields is encouraging [1]. This collaboration has the power to completely transform the way we produce, store, and use energy, which will eventually result in a more ecologically friendly and sustainable future. We are making great progress in tackling the urgent worldwide concerns of energy efficiency by fusing the concepts of neuromorphic computing and HPC with today's renewable energy technology. By allowing more energy-efficient, real-time, and brain-like computing systems, this collaboration between neuromorphic computing, HPC and memristor technology has the potential to completely transform artificial intelligence (AI) and pave the way for developments in fields like machine learning, robotics, and cognitive computing [2]. The future of computers and artificial intelligence is expected to be shaped by this amazing fusion of science and technology.

By combining HPC with neuromorphic computing and renewable energy, we unlock a powerful synergy that has the potential to transform the world of computing. The brain-inspired algorithms and architectures of neuromorphic computing can significantly boost the performance of HPC systems, enabling them to carry out numerous calculations while consuming minimal energy. This convergence is especially advantageous for applications in machine learning and artificial intelligence, as neuromorphic systems are capable of processing data in a manner that closely resembles the workings of the human brain. As a result, learning processes become quicker and more efficient, paving the way for groundbreaking advancements in technology. When these two technologies are combined,

It is possible to design computing systems that are both ecologically and energy-conscious [3].

The alliance of Neuromorphic Computing, HPC and renewable energy holds immense potential across various domains:

- Improved Computational Efficiency: The incorporation of neuromorphic computing into HPC systems improves computational efficiency through the optimization of energy consumption and computational performance, resulting in faster and more energy-saving computations.
- Innovation and Scalability: By adopting this comprehensive approach, we encourage the development of new ideas in AI, ML, scientific simulations, and data analytics, while also guaranteeing the ability to handle larger workloads and maintaining a dependable computing environment [4-6].
- Embrace Sustainable Computing: Using renewable energy sources to power high-performance computing infrastructures not only reduces carbon footprints (Carbon footprints measure greenhouse gases from human activities, guiding efforts to reduce emissions.) but also contributes to sustainability, aligning with worldwide initiatives to combat climate change.

Neuromorphic computing systems can decrease reliance on fossil fuels and decrease their carbon footprint by utilizing sustainable energy sources such as solar or wind power. This aligns with sustainability goals and the concept of Green AI. These systems imitate the structure and functionality of the human brain, efficiently processing information in parallel. However, incorporating sustainable energy sources into their infrastructure can significantly diminish environmental impact. Solar panels or wind turbines can generate electricity for the necessary high-performance computing infrastructure without depleting resources or emitting greenhouse gases. This approach not only addresses environmental concerns but also allows for the application of advanced AI algorithms in various fields. By minimizing environmental impact, researchers can focus on developing innovative solutions without guilt or negative consequences. Overall, integrating sustainable energy sources into neuromorphic computing systems is a crucial step towards achieving Green AI objectives, reducing energy consumption and carbon footprint, and advancing the understanding and resolution of complex issues [7-9].

## 2. Analytical Section

Spiking Neural Network (SNN): -

A Spiking Neural Network (SNN) is an artificial neural network that emulates the structure and functionalities of real neurons in the brain. Unlike conventional neural networks that rely on continuous values, SNNs utilize discrete spikes or waves of activity to transmit data packets.

SNNs are highly proficient in handling sensory data and various forms of pattern recognition. These tasks require intricate physical information processing capabilities [10].

Neuroscience Concepts and Hardware: -

Artificial intelligence algorithms fall short of replicating the intricate complexity of the human brain. Not only do they exhibit unpredictable memory behaviors and leakage, but they also struggle with oscillating and synchronizing spikes. By integrating signals from various sources into multi-function slots, we can establish autonomous development zones. The biological synapse is not solely composed of analog weight; it encompasses additional elements. As a result of transmitting only a small portion of the inputs they receive, certain synapses can exhibit significant inefficiency. The adoption of neural energy products is poised to increase due to the myriad benefits they provide. If materials and the accompanying physical processes can be utilized to realize these ideas while keeping energy costs extremely low, the potential they hold is immense. The primary emphasis in this field lies in the application of the exponential association between transistor leakage current and voltage. Over the past decade, an increasing array of physical setups have been utilized to investigate intriguing characteristics of synapses and neurons [11].

Logic Gates: -

In digital electronics, logic gates are key elements that carry out operations on binary data. Within neuromorphic computing, which seeks to imitate the human brain's functions, logic gates are essential for modeling neural processes. In the realm of neuromorphic computing, Spiking Neural Nets (SNN) adopt an alternative paradigm, establishing the fundamental principles. Nevertheless, intriguing parallels and potential synergies can be observed between logic gates and neuromorphic computing [12].

Employing spiking neurons, event-driven processing, and synaptic plasticity, neuromorphic computing offers an alternative computing paradigm that mimics the computational abilities of the human brain. It deviates from traditional logic gates and instead focuses on emulating brain-inspired computation.

### 2.1. Applications of Logic Gates in neuromorphic computing: -

1) In the realm of neuron modelling, logic gates are employed to construct behavioural models for artificial neurons. By examining the firing patterns, a basic logic gate can generate an output (size) if the number of inputs exceeds certain limitations.
2) To achieve spike coding and decoding, the utilization of logic gates is paramount. These gates facilitate the conversion of digital signals to signals and vice versa, enabling the processing of sensory input and the seamless integration of neuromorphic technology with conventional digital system
3) By employing logic gates, we can shed light on the intricate workings of synaptic plasticity rules, particularly Spike-Time-Dependent Plasticity (STDP). This allows us to grasp the precise manner in which synaptic weights adapt based on the timing of neuronal spikes.

4) In pattern recognition tasks, logic gates are essential for deciphering spiking patterns, allowing the system to identify complex patterns and draw conclusions from them.
5) When it comes to performing tasks or calculations in neuromorphic systems, the utilization of logic gates proves to be highly effective in building intricate combinational and sequential logic circuits.

### 2.2. High Performance Computing: -

The immense computational power of supercomputers is transforming our approach to complex problems through High-Performance Computing (HPC). These high-speed machines can process massive amounts of data in a fraction of the time it would take a traditional computer. As a result, they have become indispensable tools for researchers, scientists, and engineers working on projects that involve intensive calculations and simulations. With HPC, tasks that used to require weeks or even months to finish can now be completed within a matter of hours. This accelerated pace of work fosters faster innovation and advancements across a wide range of fields [13].

Plus-Points of HPC: -

- HPC systems utilize numerous processors running simultaneously to carry out complex calculations, while traditional computing usually depends on a single processor completing tasks one after the other.
- HPC excels at handling extensive and intricate calculations at a significantly faster and more effective rate compared to conventional computing systems. What might require weeks or months on a standard system can be finished within hours or even minutes using HPC technology.
- HPC systems possess excellent scalability, enabling them to manage a growing number of processors and computing nodes to meet the requirements of the application.
- HPC systems play a vital role in scientific research and engineering applications due to their ability to deliver highly accurate simulations and calculations.
- High-Performance Computing (HPC) utilizes parallel processing to break down computations into smaller tasks that can be executed at the same time, ultimately boosting the system's total throughput.
- HPC systems are designed to optimize resources, ensuring the efficient utilization of available computing resources to maximize their value.

Working of HPC: -

High-Performance Computing (HPC) is a cutting-edge technology that harnesses the power of parallel processing to achieve outstanding performance. HPC systems consist of interconnected clusters of nodes, each equipped with multiple CPUs or GPUs, working together seamlessly to tackle computational tasks simultaneously. This collaboration leads to a remarkable acceleration in processing speed. The presence of high-speed networking is essential as it enables rapid data exchange between nodes, ensuring smooth system operation. HPC utilizes advanced algorithms and specialized software to efficiently distribute and manage workloads across processors. Additionally, optimized storage solutions are implemented to handle extensive data requirements without compromising performance. Resource management plays a crucial role in maximizing the system's capabilities, ensuring that each component operates at its peak efficiency. With these elements combined, HPC becomes an invaluable asset in various scientific and industrial domains, capable of addressing computationally intensive tasks with ease [14].

Advantages of GPU in HPC: -

In addition to parallel processing capabilities, GPUs offer various programming frameworks like CUDA and OpenCL that enhance their usefulness in HPC. These frameworks provide tools for developers to efficiently utilize GPU power for optimized algorithms and applications.

Furthermore, GPUs are versatile and can be used for scientific simulations, machine learning, data analytics, and more. They excel at handling large amounts of data and complex calculations quickly, making them invaluable in various fields [15].

Another advantage of GPUs in HPC is their ability to work alongside CPUs, improving overall system performance through heterogeneous computing. Cloud-based GPU instances have also made it easier for organizations to access GPU resources without costly hardware investments, democratizing high-performance computing capabilities.

In conclusion, GPUs have transformed high-performance computing with their specialized architecture for parallel processing. Their efficiency, scalability, and continuous technological advancements make them essential in modern HPC infrastructure, promising even greater performance gains and expanded applications in the future [16].

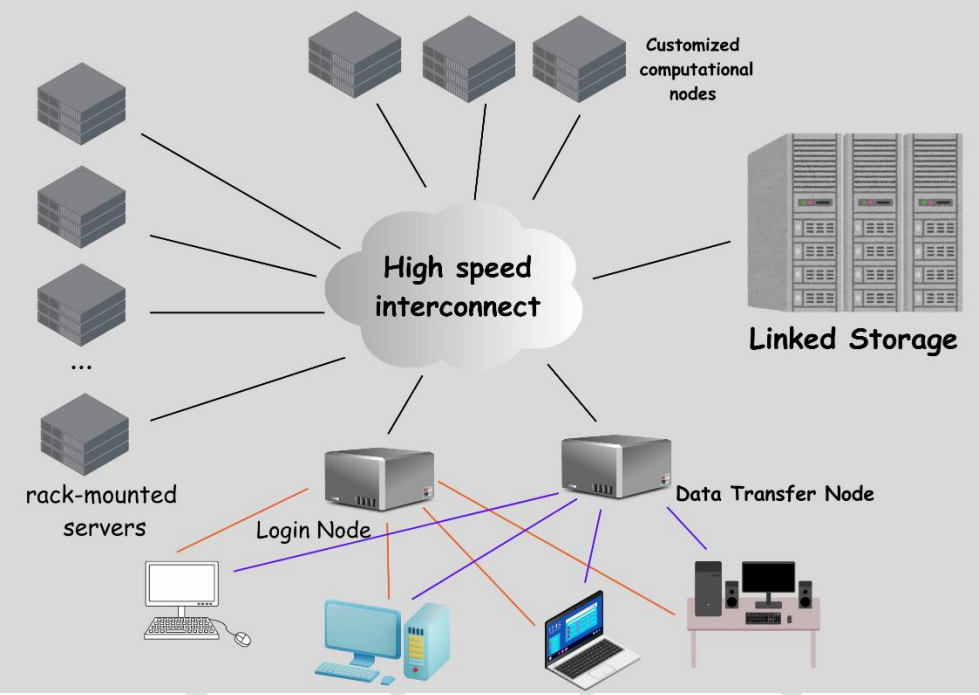



Fig. Mechanism of High-Performance Computing

## 3. Organic Neuromorphic HPC Blended Sensors

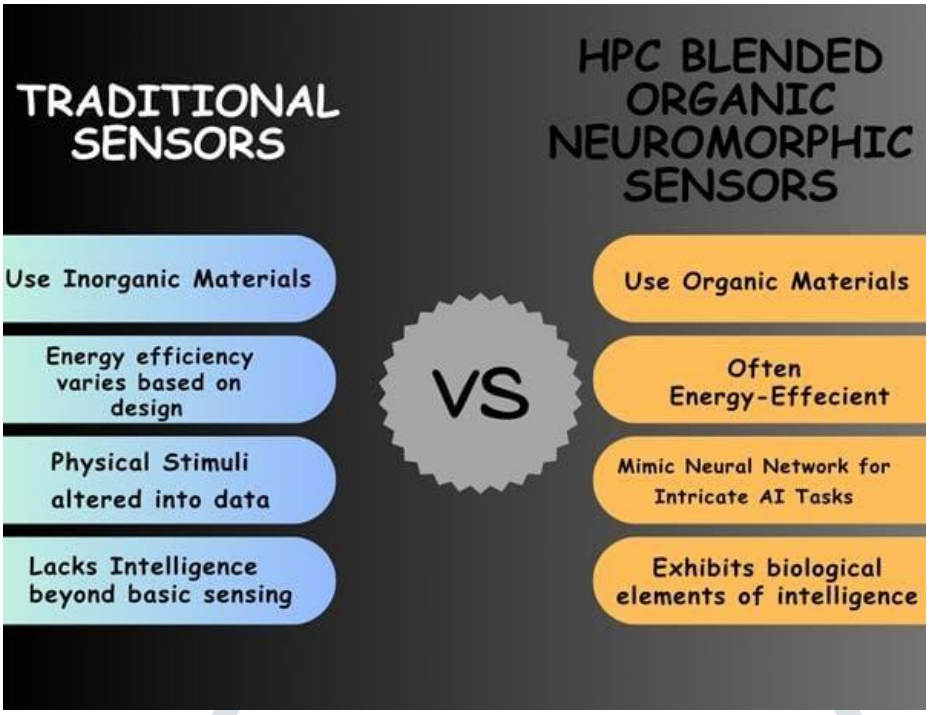
By incorporating high-performance computing (HPC) capabilities into organic neuromorphic sensors, researchers and developers can significantly improve the overall functionality and efficiency of these sensors. HPC technology enables these sensors to handle massive amounts of data in real time, allowing for faster processing speeds and more accurate results.

Furthermore, the integration of HPC capabilities allows organic neuromorphic sensors to scale up their performance to meet the demands of various applications. Whether it be in the fields of artificial intelligence, robotics, or healthcare, these sensors can now handle complex algorithms and tasks with ease, making them more versatile and adaptable to different scenarios [17].

Overall, the integration of HPC capabilities into organic neuromorphic sensors opens up a world of possibilities for advancements in technology and innovation. With enhanced computational power, scalability, and performance, these sensors can revolutionize the way we interact with and utilize technology in our daily lives.

### 3.1. Distinctive attributes and perks: -

- Organic neuromorphic sensors, mimicking the human brain, efficiently process information, making them ideal for wearable devices, IoT, and battery-powered autonomous systems. They enable parallel processing and adaptive learning, making them valuable in healthcare, robotics, environmental monitoring, and smart agriculture.
- Advanced machine learning algorithms and artificial intelligence techniques enable sensors to learn from data patterns, adjust responses, and enhance accuracy and reliability over time. This continuous analysis identifies trends, adjusts responses, and adapts to changing conditions without manual calibration, enhancing decision-making and outcomes in various fields.
- Organic sensors provide a versatile and powerful tool for a wide range of industries and applications, such as monitoring vital signs and detecting diseases, optimizing crop growth and pest control in agriculture, detecting objects and navigating in robotics, and tracking fitness and monitoring health in wearable technology.
- Organic materials are biocompatible and ideal for biomedical applications, wearable devices, and human-machine interfaces. They are crucial for implants, tissue engineering, wearable devices, and human-machine interfaces, offering long-term functionality, comfort, and flexibility, while minimizing biological system harm.




## 4. Conceptual Approach

Organic Neuromorphic HPC Blended Sensors for Battery Charging and Management System.

Organic Neuromorphic HPC blended sensors require battery charging and management for integrating energy storage components such as rechargeable batteries or supercapacitors. These components are essential for storing harvested energy from different sources, maintaining sensor operation, and aiding in data collection for quality control purposes.

Workflow of Battery Charging and Management System: -

Energy Harvesting: Organic Neuromorphic HPC integrated sensors can harness energy from the environment through sources like light, vibrations, and temperature differences. The collected energy is typically in the form of electrical power, with varying magnitudes depending on the method and environmental conditions [18].

Energy Storage Components: Rechargeable batteries, especially lithium-ion ones, are commonly used in organic neuromorphic HPC blended sensors for energy storage due to their high energy density, long cycle life, and compatibility with sensor electronics. Supercapacitors can also be used in sensor designs, providing fast energy bursts and high-power capabilities.

Battery Charging Process: After energy collection, the sensor's energy management system converts the electrical energy for the rechargeable battery or supercapacitor. Charging algorithms and control circuitry optimize battery health, prevent overcharging, and maximize energy storage efficiency. Organic Neuromorphic sensors may use efficient charging strategies like trickle charging during low-energy harvest and rapid charging during high-energy harvest to maintain optimal energy levels [19].

Energy Management and Discharge: Sensors use stored energy from batteries or supercapacitors to power electronics for data collection, processing, communication, and memory while in operation for quality control. Energy management algorithms optimize power distribution, apply power-saving techniques, and control discharge to ensure uninterrupted sensor operation for continuous data collection and quality monitoring.

Power Back and Redundancy: Redundant energy storage systems in sensor designs provide fault tolerance and backup power for critical quality control applications, ensuring continuous operation during energy shortages or disruptions. Energy management strategies such as failover mechanisms, automatic switchover to backup power, and real-time energy monitoring address power supply issues [20].

Monitoring and Maintenance: Organic Neuromorphic HPC sensors monitor energy levels, battery health indicators, and supercapacitor performance in real-time. Maintenance tasks include assessing battery health, adjusting charging algorithms, and updating firmware to enhance energy storage efficiency, prolong battery lifespan, and increase system reliability.

To summarize, the charging and management of batteries in Organic Neuromorphic HPC blended sensors play a crucial role in maintaining uninterrupted sensor operation, independent energy supply, and efficient data

collection for quality control purposes. These sensors utilize effective energy storage technologies, smart charging algorithms, and strong energy management strategies to guarantee reliable and sustainable performance in industrial settings.

## 5. Results and Discussion: -

Important Characteristics of Battery Charging and Management Systems: -

- Organic neuromorphic sensors frequently function with restricted power resources, necessitating a highly energy-efficient charging and management system to optimize the sensor's runtime on a single charge.
- The ability to charge quickly is crucial in order to minimize the sensor system's downtime. Utilizing advanced charging technologies such as quick charge or fast charge can greatly decrease the time needed to recharge the batteries.
- To safeguard the batteries from overcharging and prevent a decrease in their lifespan, it is crucial to have accurate regulation of voltage and current. The utilization of voltage and current sensors and regulators aids in maintaining the ideal charging conditions.
- It is crucial to monitor the temperature while charging, especially for organic materials that can be affected by heat. Temperature sensors help prevent the charging process from going beyond safe thermal thresholds.
- Accurate monitoring of the State of Charge (SoC) enables real-time updates on the battery's remaining capacity. This crucial information is necessary for optimizing the sensor's performance and predicting when recharging is required.
- Evaluate the long-term reliability and performance of batteries by monitoring battery health parameters, including cycle count, internal resistance, and impedance, consistently.
- Safety features like overvoltage protection, overcurrent protection, and short-circuit protection are in place to safeguard the batteries and maintain safe charging operations.
- Intelligent charging algorithms have the ability to adjust and optimize the charging process for specific types of organic batteries used in neuromorphic sensors, making them adaptable to different battery chemistries.
- By integrating with the sensor platform's power management system, power allocation can be coordinated between the sensor, processor, and other components, leading to enhanced overall system efficiency.
- The charging and management system needs to be scalable to handle different power requirements and battery configurations. Flexibility in charging protocols and interfaces will increase compatibility with various sensor designs.

Uses of Battery Charging and Management Systems: -

i. Activating the sensors: The main objective of a battery charging system is to supply power to the organic neuromorphic sensor, enabling it to operate continuously without the need for external power sources. This enhances the sensor's portability and versatility.
ii. Allowing for Self-Governing Operation: With the help of a reliable battery management system, organic neuromorphic sensors can operate autonomously, without the need for constant tethering to a power outlet. This independence is crucial for applications that require mobility or deployment in remote locations.
iii. Increasing Operational Period: Efficient charging and management systems play a key role in enhancing the sensor's runtime on a single charge. This is particularly crucial for applications that involve continuous monitoring or data collection over extended periods.
iv. Boosting Power Optimization: Battery management systems are key in ensuring that power is used efficiently in sensors by distributing power effectively to different components, ultimately improving energy efficiency.
v. Techniques for Supporting Energy Harvesting: Battery management systems not only rely on traditional charging methods from external power sources but also have the capability to utilize energy-harvesting techniques. These techniques involve capturing ambient energy like solar power or kinetic energy to recharge the battery and extend operational uptime.

vi. Maintaining Reliable Execution: By closely monitoring and regulating voltage, current, temperature, and state of charge, these systems play a crucial role in maintaining reliable performance and protecting the sensor from potential damage due to overcharging, overheating, or other electrical issues.

vii. Promoting Efficient Deployment: Versatile organic neuromorphic sensors with portable design and fast-charging capabilities are ideal for quick deployment in a range of settings such as field research, monitoring systems, healthcare applications, and IoT devices.

viii. Elevating User Experience: It is made possible through the implementation of a well-crafted battery management system. This system offers users real-time updates on battery status, estimated runtime, and charging progress, empowering them to effectively plan and manage their sensor usage.

ix. Achieving Scalability: Experience the benefits of our scalable battery charging and management systems, which can effortlessly handle batteries with varying capacities and configurations. This scalability guarantees compatibility with evolving sensor designs and empowers you to make upgrades or customizations tailored to your specific application requirements.

x. Encouraging Energy-Efficient Computing: The primary goal of organic neuromorphic sensor design is to enable energy-efficient computing, and the battery management system plays a crucial role in aligning power delivery with computational demands. This alignment is instrumental in optimizing energy usage and supporting sustainable computing practices.

## 6. Conclusion: -

The intersection of green energy technology, neuromorphic computing, and high-performance computing (HPC) marks the beginning of a new era of innovation with profound implications for sustainability and technological progress. Neuromorphic computing, drawing inspiration from the neural networks of the brain, introduces energy-efficient architectures that seamlessly blend with renewable energy sources from green technology. These systems excel in pattern recognition, sensory processing, and adaptive learning, making them well-suited for applications in artificial intelligence (AI), robotics, and cognitive computing. Green energy technology, utilizing renewable sources such as solar and wind power, diminishes dependence on fossil fuels and lessens environmental impact. HPC, with its vast computational capabilities, enables intricate simulations and data analytics essential for optimizing renewable energy systems and grid integration strategies. The combined force of these technologies transforms energy generation, storage, and utilization by enhancing energy efficiency, effectively harnessing renewable energy, and assisting in infrastructure design and optimization. This partnership extends its transformative influence beyond energy to fields like AI, robotics, and cognitive computing, unlocking fresh opportunities for sustainable and autonomous technologies. As this convergence advances, it represents a significant stride towards a more intelligent, sustainable, and eco-friendly future, where intelligence, sustainability, and technological innovation converge for the betterment of humanity and the planet.

## References

1) Ankit Mishra, High-efficiency perovskite – nanowire-based organic-inorganic solar cell, International Journal of Emerging Trends in Engineering and Development, Issue 8, Vol.2, February- March 2018

2) Ankit Mishra, Ashutosh Choudhary, Modeling of Co2 Gas Detector Using Comsol Multiphysics, International Journal of Scientific Research and Reviews, IJSRR, 8(1) Jan. – Mar. 2019

3) Ankit Mishra, SICKLE CELL ANEMIA USING IMAGE DISSECTION TECHNIQUE, Issue 9, Vol.1 (January 2019)

4) Ankit Mishra, Simulation Study on Organic Solar Cell consist of SWCNT in presence of Stone Wall Defect, Volume 8, Issue 6, June-2017

5) Ankit Mishra, Ashutosh Choudhary, Sameera Khan, Gagan Jain, Simulation study on Stone wales defect in Si-Nanowire based Graphene-lithium-ion batteries, Volume 6, Issue 2 April 2018

6) Ankit Mishra, Creative Approach of HR in Cooperates Industries, Volume 8, Issue 4 April 2020

7) Ankit Mishra, Suniti Purbey REVIEW PAPER ON APTAMERS FOR CANCER DIAGNOSIS, Special Issues May 2019

8) Dr.Brijesh Khandelwal, Ashutosh Choudhary, Ankit Mishra, Realizing the Internet of NanoThings:-A Review, Issue 8, Vol.3 (April- May 2018)

9) Ashutosh Choudhary, Suniti Choudhary, Ankit Mishra, Review on Fault Tolerance in Wireless Sensor Network, Volume 182 – No. 45, March 2019

10) Tushar, Priyanshu Patel, Aniket Sharma, and Ankit Mishra ROZGAAR: ANDROID APP FOR FREELANCING, Issue 10, Vol.6 (Oct-Nov 2020)

11) Tushar, Aniket Sharma, Ankit Mishra, Cryptographic Algorithm For Enhancing Data Security: A Theoretical Approach, Vol. 10 Issue 03, March-2021

12) Om Chaturvedi, Milan Maurya, Ankit Mishra, 5G NETWORK, GENERATIONS, AND CHALLENGES, 30 June 2021.

13) Paritosh Banchhor, Durgesh Sahu, Ankit Mishra, Mohammed Bakhtawar Ahmed, A Systematic Review on Blockchain Security Attacks, Challenges, and Issues, Vol. 10 Issue 04, April-2021.

14) Ankit Mishra, Ashutosh Choudhary, THEORETICAL APPROACH TO STUDY THE POWER OUTAGES IN ELECTRICAL SYSTEM, Issue: 4 Year: April 2021

15) Bandi Pavan Kumar, Khushideep Gupta, Dr. Poonam Mishra, Ankit Mishra," A REVIEW PAPER ON ORGANIC SENSOR AND ITS APPLICATION IN COMMERCIAL MARKET" Volume 9, Issue 6 June 2021

16) Dr. Poonam Mishra, Ankit Mishra," A SYSTEMATIC INVESTIGATION OF IMAGE PROCESSING ALGORITHMS" Volume: 05 Issue: 07 July – 2021

17) Ashutosh kumar Choudhary, Suniti Purbey, Ankit Mishra," FOG COMPUTING, APPLICATIONS, SECURITY AND CHALLENGES: - A SURVEY" Volume: 9 Issue: 5 Year: May 2021

18) Nazarene Mustoor, Riya Patro, Ankit Mishra, Suniti Purbey," A REVIEW ON ZIGBEE TECHNOLOGY IN INTERNET OF THINGS (IOT) AND ITS APPLICATIONS" 9 Issue: 5 Year: May 2021

19) Ankit Mishra," COMMUNICATION AND ITS EFFECTIVE ROLE IN ORGANIZATION" Volume: 9 Issue: 6 Year: June 2021

20) Roshan Bishi, Raj Mallick, Ankit Mishra," A REVIEW ON QUANTUM COMPUTER – THE HORIZON OF LIMITS" International Journal of Scientific Research in Engineering and Management,Volume: 05 Issue: 07 | July – 2021