# Energy Internet: A Review

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**Abstract**: Energy crisis coupled with the increasing rate of carbon emissions into the atmosphere have plagued humanity today. Energy Internet, A new complex power generation, distribution, and management system comprising of latest innovations in the field of Power generation and Information Technology called Energy Internet has been discussed in this paper. This paper talks about the basic concept of Energy Internet. A few functional requirements of the EI infrastructure have been briefly presented in this article. The concept of Energy router and its functions, Smart meters and its functions have been briefly discussed. This paper also highlights the security and privacy issues that arise because of the complexity of the system. This new energy Infrastructure will function with the help of distributed energy resources comprising mostly of renewable energy resources to help humanity combat the effects of global warming and reduce the carbon footprint

**Index Terms**: Carbon emissions, Distributed energy System, Energy Internet, Privacy, Renewable Energy Resources, Smart Meter, Security.

## I. INTRODUCTION

With a significant focus and effort directed towards a greener and cleaner future, the need for a change in the way we generate, distribute and utilize our energy resources arises [1]. Energy Internet is a new developing form of energy system. Today's energy-intensive economies that sometimes face energy shortages are now actively aiming for a greener and a sustainable future due to the alarming increase in global warming, and an exponential increase in demand for energy due to which a new better and efficient form of energy system was needed. Energy Internet plays a significant part in the future of achieving safe, efficient, green energy to help reduce the effects of global warming [2]. A massive change in the way we generate, distribute and utilize energy is anticipated in Energy Internet [3]. For the year 2014-2015, the total energy consumption was 5,920 petajoules and the total generation was 16,711 petajoules in Australia, the majority of which was generated by Black Coal (73.5%), Brown Coal (4.1%), Natural Gas (15.6%), Oil And NGL (4.2%), LPG (0.5%) which accounts for 97.9% Market share. All of these fuels are Non-Renewable and polluting fuels. This heavy dependence on fossil fuels will eventually lead to a major energy crisis in the near future, the reason being that most of the oil and natural gas which get imported from politically volatile regions, also the fuel source is an exhaustible resource which is being consumed at an alarming rate[4]. Increased use of renewable energy resources can help prevent a major energy crisis. For the year 2014-2015 the generation by renewable energy sources accounts for only 2.1% of the total market share. Energy Internet uses a distributed generation system coupled with transfer of data between the consumers and producers in real time to optimize the overall efficiency [5]. This paper talks about the overview of Energy Internet, providing information about technology requirements, Infrastructure requirements, and other critical research areas.

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## II. LITERATURE REVIEW

During the second industrial revolution, the invention of electric power generation and related technologies have been under constant research and development [6]. At the very beginning stages of energy generation, the knowledge and technical availability at the time were insufficient. During this period the production and utilization of energy were shallow and this was achieved with the help of small-scale local power generators, which supplied power only to the localized area. The next major overhaul came during the period of centralized energy production were in large-scale thermal power plants generated electricity and distributed that via high power transmission wires to a large geographical area. At this stage, energy generation and distribution became an important sector for the development of the economy. This method of energy generation was economical and cheap but the effect of pollution by burning coal was never given any serious thought [7]. In the 20$^{th}$ century, our traditional electric grids were a vast and a complex system. The technology is very mature and infrastructure is highly interconnected [5]. This type of system utilizes central generating power stations at various locations to deliver power to a majority of a population via high capacity power transmission lines. The reason for utilizing such a method was the use of fossil fuels on a large scale was an economical process wherein the generation and operation costs could be kept minimal while providing low-cost electricity to all consumers. Since customers are highly distributed over a large geographical area, a highly sophisticated and complex transmission and distribution system are needed to ensure that every customer gets energy as and when they require it. This being the case, the need arises for a large infrastructure to meet the demand. Most often this infrastructure is highly regulated and our understanding of such complex and important systems is quite low due to which we are unable to regulate this sector efficiently. There is often a compromise between reliability and efficiency and in most cases the former is given more importance [8] But as always, one cannot guarantee 100% reliability of the system. On February 8$^{th}$, 2016, there was a major power outage in South Australia that occurred due to storm damage to the electricity transmission infrastructure, which crippled the entire state, which resulted in severe economic losses to the state. This event was considered a once in a 50-year event. The cause of each event may be different but the consequences will remain the same. Investing more capital on transmission and distribution will provide a short-term solution, but this solution is not economically viable as there is a continuous increase in the demand for energy and over the course of a few years the problems will resurface again. As the widespread use of fossil fuels began to grow, it is very evident now that continued use of fossil fuels wound neither is economical nor environmentally viable. It's a well-established fact that the use of fossil fuels is the main contributor to Global climate change adding to this, the fuels which are used to generate electricity, are non-renewable resources and the global fuel reserve is rapidly declining which in the near future will see the costs of these fuels soaring very high making them uneconomical to use to the generation of energy [9]. To combat the rising threat to the global climate and to reduce our dependency on fossil fuels the switch must take place from conventional energy sources (Non-Renewable) to non-conventional energy sources (Renewable) [10]. With major research and development of renewable energy generation such as solar (Solar PV, CSP), wind energy, Geothermal energy, hydro energy, Tidal energy, etc., made it possible to have different generating systems and collectively generate energy. This method of energy generation is known as distributed energy generation [11]. The next change for the energy sector will come with the advent of smart and connected distributed energy generation, transmission, and utilization. To efficiently provide energy as demand arises, the advancement in two critical engineering fields shines the way. The First being, Developing more efficient forms of generation of electricity by using renewable energy resources and the second being the rapid advances and developments in the field Information and communication technologies. Today these two diverse technologies are beginning to merge to usher in a new era which will change the way power is generated, transmitted and used [12]. Energy Internet combines these two technologies to provide clean, green energy efficiently to a wide geographical area minimizing and optimizing the generation, transmission and utilization of energy. But at Present the existing infrastructure cannot be upgraded as the present technology including millions of electric meters, miles of Transmission lines are just passive devices, which transmit electricity or receive it. They are unable to have a two-way communication. Furthermore, the technology to effectively store electricity is still in its infant stages of research and development.

## III. ENERGY INTERNET

### A. CONCEPT

Energy Internet refers to the upgrading and automating the Electricity sector. This allows the Production, Transmission, and utilization of energy efficiently and with minimal wastage of resources. Energy Internet represents an opportunity to usher the aging electricity sector into a new era of digitization, reliability, and efficiency. The Fusion of Information and communication technology with the energy sector will allow for two-way communication between the producers and consumers. Energy Internet utilizes a distributed energy generation system and just like the internet; Energy Internet will consist of controls, computers, automation, data transfer all working in real time to respond to any situation without the intervention of humans to quickly adapt with changing demand hence providing an unmatched optimization of power usage [13]. To Employ Energy Internet for widespread use, we should consider a few important aspects.

#### 1. Smart Energy Management

One of the major challenges faced is the storage of electricity, and without any economic alternatives the storage of electricity becomes a hurdle, but this issue can be addressed practically. Many argue that with the help of real-time information sharing it is possible to create a virtual buffer between consumers and producers [8, 14]. Even though we physically cannot store substantial quantity electricity, we can create a virtual buffer with the help of demand-side management strategy, which is constructed upon the practices of dynamic data, which is collected. With the emergence of intelligent meters that support two-way communication, the system can automatically schedule the use of electricity of every customer connected to Energy Internet Grid. Based on the real-time prices of electricity, customers can make a smart decision. Once implemented customers will not power up energy-hungry appliances at will. Instead, they would make an informed decision after balancing the costs and benefits. Tasks such as doing the laundry can be scheduled at night when the energy available is high and the costs are low [14]. The cost of electricity is floating in real time based on the demand and supply and the technical capabilities of the system to handle the transfer of resources, which in turn translates to higher the demand the higher the costs incurred by the customer. This system is analogous to the access control system widely used for the transfer of data via Internet. Thus, from a customer point, with the implementation of dynamic scheduling and smart metering, the electricity is stored virtually on the grid before the customer utilizes it. This automation of scheduling is possible by software agents who act on behalf of their clients [8]. The main technical challenge that the software has to deal with is the anticipation capability, which is a challenge, as humans tend to be the most irrational beings. The software agents must be able to predict the client's day-to-day activities to schedule the consumption of electricity efficiently. In 1999 the consortium for the Intelligent Management of the Electric Power Grid (CIMEG) developed several prediction models to forecast the demand taking into account various cases [2]. By forecasting or anticipating the energy demand, the system can optimize the production automatically.

#### 2. Managing Uncertainties with the help of Elastic Pricing

The other essential element for Energy Internet is dealing with Pricing. Since the data used is forecasted data or predicted data, the accuracy of these data is a major concern. This uncertainty may reach unaccepted levels when all the prediction data is summed up. To get around this problem, Elastic Pricing is used. Price Elasticity is used to characterize the ability of a consumer to change when the price of electricity changes. As in the case of Information and communication technology, which uses a feedback system to control a process based on measurements, which are fed back to the control system. Similarly, a feedback loop between the consumers and producers will help reduce the forecasting error and this system will adapt accordingly depending on the situation. The best feedback technique is provided by price elasticity. An efficient price elasticity model can provide an estimate on the consumer's willingness to purchase electricity at a given price. With the help of this tool producers and consumers would be able to perform a dynamic negotiations and achieve a well-choreographed balance between the generation of electricity and consumption of electricity [15].

### B. INFRASTRUCTURE

The present infrastructure of the Energy sector is a product of years of research and development and rapid urbanization and infrastructure developments in various parts of the world. In the

21st century, the energy sector has been influenced majorly by economic growth; government policies all of these factors are unique to each utility company. Despite this, the basic topology of the entire system has remained unchanged since the beginning. In the present system, the centralized power plants are at the top of the chain to ensure power generation to meet consumers demand at various levels of the economy. The major drawback of this system is that the system is essentially a one-way street where the generators have no real-time information about the consumer's actual consumption. To overcome this issue, the entire grid is over-engineered to function even at the maximum anticipated peak demands and such occurrence is a rare phenomenon, which leaves the system inefficient. Adding to the woes, the unprecedented increase in demand is further compounded by low investments has dramatically reduced the system stability [16]. It's a well-established fact that more than 90% of all power outages are caused due to disruptions in the distribution system [17]. The following sections will give brief information about certain key components and requirements for the infrastructure of Energy Internet.

**1. Smart Meter**

This is one of the most fundamental requirements of Energy Internet. With the smart meter installed, the interactions between consumers and producers will occur at a very high rate. Real-time data about the consumer's usage will be transmitted to the generators and based on the load requirements; the utility companies can adjust prices or increase or decrease production accordingly. This requires each consumer to have a smart meter installed and each smart meter would have a unique and addressable identifier and a two-way data transfer capability inbuilt in them.

**2. Forecasting Ability**

Since the ability to correctly and accurately forecast the consumers demand is crucial to Energy Internet, much of the focus is directed towards this issue. As mentioned earlier, since Energy Internet relies more on distributed energy, and coupled with the fact that we do not have a reliable large-scale energy storage, a "virtual storage" has to be implemented [2]. With the emergence of smart meter and further development of machine learning and artificial intelligence, it will be possible to program the consumer's energy consumption pattern into the smart meter. This meter will then become an intelligent agent, which has a unique ID, which represents the consumer on the energy Internet. This intelligent or smart meter is equipped with the ability to forecast the demand of the consumer based on data collected. Apart from the ability to forecast the demand, the smart meter will also be able to receive the pricing information in real time from the utility provider. When the price is acceptable, the smart meter then places the order on behalf of the consumer acting on behalf of the consumer. After the utility provider has accepted the order, this quantity of energy can be viewed as a guaranteed energy, which is purchased but has not been utilized by the consumer. This creates a virtual storage or virtual buffer. This system of pre-ordering is a critical process in the Energy Internet [14]. The U.S. Department of Defense (DOD) and Electric Power Research Institute (EPRI) funded the Consortium for the Intelligent Management of the Electric Power Grid (CIMEG) to develop intelligent approaches to defend power systems against potential cyber threats [2, 8]. The research team at CIMEG was led by Purdue University and the team also included various researchers from University of Tennessee, Fisk University, and Exelon. The team developed and advanced an anticipatory control system where the system can anticipate potential threats and make changes to prevent any threat, which can bring down the integrity of the system. The technical difficulty of defining the over all health of the power system was overcome by using a bottom-up approach. A demand-based system, consisting of all consumers in an area make up what is called LAG (Local Area Grid). Each LAG is charged with the responsibility and authority to maintain its health by restricting or regulating the power consumption of its members based on demand and supply. The Entire grid of Energy Internet is made up of many different LAGS'. Once all the LAG's have achieved stability and security, the whole grid will achieve security as well. Smart meters will play an important role to ensure that the LAG's and subsequently the entire grid stays healthy by monitoring and forecasting loads of individual consumers and taking preventive measures to ensure that the system does not fail. CIMEG developed a Prototype of a system called Transmission Entities with Learning Capabilities and on-line self-healing (TELOS) which was tested and implemented in Exelon and Argonne National Laboratory [18]. The main aim of CIMEG was to create and develop a platform to manage the power grid in a smart and efficient way. The real-time interactions between customers and suppliers with the help of smart meters, which have forecasting ability, will form a new intelligent human-centered automated infrastructure.

**3. Energy Router**

The other key component for Energy Internet is Energy Routers. Since, Energy Internet will have a distributed energy generation method encompassing on the use of renewable energy resources, the effective management of supply and demand are managed by energy routers [4]. The main function of energy routers is to dynamically adjust the energy distribution in the grid [3]. The revolutionary energy management system in Energy Internet, energy is mostly generated by using renewable sources in a distributed energy generation system as mentioned above and a significant proportion portion of the grid users are acting as both producers and consumers [19]. This dual role of users is seen as the same as those who use Internet because; every Internet user sends and receives data. In Energy Internet, every user who is connected to the grid will be able to buy and sell energy. Since the flow of Information and energy is both ways, this system has got the name Energy Internet. In the case of an Internet user, data packets play a vital role in transmitting information, similarly in Energy Internet; Energy routers are required to manage the transmission and distribution of electricity [3]. Energy router is used extensively in the grid and based on their location; they serve a variety of different purposes. As the energy router bridges all energy sources and users, it should guarantee that the power quality is consistent. The energy router should also require to monitor the change of supply and load in real time, and make changes to dynamically to adapt to ever-changing situations [5]. At the user level, the energy router is located at the end of the grid and these are connected directly to the customers. In this system, users use the energy router to construct a LAG which the router hosts. Every user then with the help of intelligent meters communicates with the energy router for all the energy requirements. The system consists of a plug and play interface. Once the user has connected to the LAG, a user can use the energy routers to make service request, to receive status updates and to terminate services. AT the Grid level, there are two connection modes for the energy routers, which are grid-tie mode and islanding mode. In the grid tie mode, the LAG's are connected to the router and all the Energy and information flows through the energy router. In grid-tie mode, the energy router functions as a flow regulator making changes in response to the demand and supply in the grid. In the islanding mode, the energy router disengages itself from the microgrid in the case of emergency ensuring the rest of the grid does not collapse [2]. The other important use for energy router is to provide a platform for implementation of intelligent network management. Distributed energy resources, in some cases, may not be able to support the LAG, due to high demand. In such cases, energy router should be able to connect to the neighboring LAG and draw energy to maintain the demand and supply without causing a local area Blackout.

### C. SECURITY

Energy internet uses communication and information technologies and with machine learning capabilities provide better situational awareness in real time to the users connected to the grid [20, 21]. With the help of intelligent meters and energy routers, load shedding can be implemented to ensure that the peak demand is flattened, which eliminates the requirement to bring additional peak demand generation plants online. [22]. With the forecasting ability and machine learning capabilities, the system can perform predictive analysis, which estimates the amount of electricity generated from different resources and at what times and based on this information, the grid automatically keeps the power balanced. The results analyzed from pilot projects in California and Washington show a 10% reduction in peak demand because of the demand management and smart scheduling of appliances [20]. To establish Energy Internet, widespread communication, data transfer must take place in real time between all the grid components all while maintaining the reliability of the system. Since much of the system comprises of personal data transfer and communication between the components, the security of the system becomes a grave concern. Security of any system has always been a never-ending game of intellects, where hackers are constantly trying to find vulnerability in the system and try to exploit it while the developers are trying to ensure that there is no vulnerability. The weakness in the system may allow hackers to infiltrate the system, obtain users sensitive data, gain access to control software and alter load conditions to create havoc [23, 24]. If the energy Internet is breached by unwanted cyber attacks, the repercussions can range from economic shutdown to controlling individuals electricity. While Energy Internet is the way to ensure sustainability, it also provides a platform to antisocial elements to disrupt day-to-day life and cause chaos. Energy Internet will connect every house and building providing potential attackers sensitive data. Since the system relies heavily on real-time data transfer between components, The system will be exposed to a wide range of cyber threats [25]. The infrastructure of Energy Internet is very large and complex which makes it nearly impossible to ensure the security of every single component. The system needs to connect to different system right from different generation facilities, distribution facilities, and end users. With such complexity, many new vulnerabilities are introduced in the system [26]. The complex control, forecasting ability, and the pricing algorithm, which are built into the system, further increase the chances of vulnerability in the system. Much research is being directed towards the security of Energy Internet [22, 27] and various guidelines have been published. In such a complex system, a potential cyber attack can plunge entire economies into chaos. The vulnerabilities in the system can range from an individual using a shunt to bypass the smart meter to collecting data of the masses by breaking into the system. While dealing with physical and IT infrastructure, A new term called cyber-physical security was introduced by Yilin Mo et al. in 2012 [22]. Much of the sensitive private data travels through public networks; hence the need for securing the data becomes extremely important. This can be accomplished by establishing and using secure channels for communication and data transfers [28]. Smart meters are one of the critical infrastructure in energy Internet, but they are the most attractive target for malicious attacks. This is due to the fact the weakness in the system can easily be monetized. If the smart meter is compromised, the hackers would be able to fabricate false readings, manipulate the price of energy [29]. Back during the early days of cable television, signal hijacking kits were sold throughout the united states and in huge volumes despite 30 years of investment into signal theft prevention, this issue plagues the entertainment industry even today. Smart meter being a key component, it is not hard to assume a day when we would be able to purchase smart meter hack kits online. In the United States consumer fraud in the electrical grid isn't a new problem. Current approximations indicate that as much as $6 billion is lost every year by fraud. In July 2010, the first-ever control system malware called Stuxnet was discovered. Stuxnet was targeting SCADA system [30]. More than 100 centrifuges in a nuclear power plant was attacked and damaged by Stuxnet in 2010 [1]. Apart from Stuxnet, Havex was another malware which was a serious threat to the entire European grid [31]. Due to the complexity of Energy Internet, Pure cybersecurity approaches are inadequate to guarantee the security of the system because pure cybersecurity does not account for the physical system, thereby it does not defend the system from physical attacks for example, shunt connectors can be placed in parallel with a meter to bypass it and cause energy theft. History has shown that cybersecurity is not 100% effective. With the Increase in the use of remote management and control of cyber-physical system, the security and privacy play an important and crucial part in the system because the ease of remote management can be exploited by terrorists or hackers for malicious intent all from the comfort of their respective homes. The infrastructure of Energy Internet requires security for the physical infrastructure as well as the IT infrastructure, which greatly complicates the security requirements; this increased complexity of the system also facilitates abundant prospects for misuse. More focus and energy should be directed towards research and development of certain security measures such as secure data transmission, physical intrusion detection, eavesdropping prevention and falsified data detection [32].

### D. Privacy

Since the beginning, the main objectives of the grid have been reliability and integrity. But with the advent of Energy Internet, safeguarding the privacy of the users becomes a critical issue, since the backbone of the system works on users data collection and transmission. Electricity use patterns could disclose an individual's habits including the time he spends at his residence and the time he stays away from his residence. Further analysis of data could even reveal what kind of devices that are being used by an individual, entertainment habits and sleeping habits [33]. Much of this information can be collected by a compromising the smart meter [34]. Thus, smart meters have inadvertent consequences for the privacy of the user [35]. An experiment conducted on a private residence where the smart meter was installed showed that personal information could be easily estimated with a high degree of accuracy. The experiment showcased that with minimal effort; personal activities of the individual could easily be estimated with a high degree of accuracy. The experiment also determined the types of appliances which were used in the house based on the data collected from smart meter [36]. A distributed incremental data aggregation approach were in data aggregation was performed on all smart meters. The user's privacy was protected by homomorphic encryption of the data transmitted [37]. It's a well-known act that with the introduction of any new technology, one should have performed detailed risk analysis and put forward the findings and overcome these essential privacy weaknesses in the system [38].

## IV. ISSUES

Much of the discussion above primarily focused on the issues concerning the security and privacy of Energy Internet. This section talks briefly about other issues such as data utilization issues, Regulatory issues and consumer issues. With Energy Internet's core built on data collection and utilization, this becomes an important and strategic resource for the utility company. The availability and use of such data in utility sector is quite low, but with the advent of Energy Internet, Utility companies can use the data to improve the efficiency of energy production. A few issues concerning data are the data processing and secure storage, the quality and reliability of data, data security and privacy and finally data sharing [39]. In most developing countries in the world, the electricity production remains a monopolistic, having only one producer [40]. Much of the prices (peak demand & off-peak demand) are set by regulators to ensure that the customers don't pay too much for energy and to ensure that the utility companies don't make supernormal profits. This being the case, to promote a sustainable development of the new system, the regulators play a crucial role. Since Energy Internet relies on a distributed power generation method, the regulations and policies that were used previously would not apply to the new system. Regulators must draw up new regulations and policies to ensure that producers and consumers are not being exploited. Over the past 10 years, there has been a burst of advancements in the field of Information technology. Today's consumers are smart consumers as they can clearly make well-informed decisions because of the amount of information available to them. The consumers today, with the extensive use of smartphones and social media, are becoming more interconnected. The behavior and characteristic of a consumer are ever changing depending on the social status. In this new era, the price is no more an important factor that affects the consumer's energy utilization. Understanding other factors such as habits, social comparisons of a consumer play a significant role [41].

## V. Other Projects and Research

The following section gives a brief description of major projects relating to smart grid around the world. In Rome, The implementation of the smart metering management began in 2004. The project aimed to improve the energy efficiency [42]. In the United States, American Transmission Company researched to build fiber optics communication networks to raise the capability of phasor management network across the US transmission system. Austin energy deployed the smart grid 1.0 in the year 2003 followed by the deployment of smart grid in the year 2008 with the main aim to improve customer service by offering web-based management of consumer appliances and remote control of appliances[43]. The American Electric Power Company researched to enhance the ease of integrating small energy resources into the microgrid in the year 2006 [44]. The EPRI is conducting research, which aims at creating a new electric power infrastructure called IntelliGrid. At present, IntelliGrid consists of five main projects, which are IntelliGrid architecture, simulation, and modeling, communication systems for Energy Internet infrastructure, process monitoring system and consumer portal [45]. The Pacific Gas and electric company as a part of the statewide effort upgraded the electricity infrastructure with automated metering system which ensured that the consumers use less energy [46]. Bonneville Power Administration conducted research, which aimed at validating new smart grid technologies, providing two-way communication between the interconnected systems, studying the cost benefits of the new system and improving the security and privacy of the system [47]. SmartGridCity was a pilot technology, which explored the smart-grid tools in a real-world setting. The goals of this project were to determine the energy management and conservation tools consumers preferred. The project also explored different technologies, which could boost the power delivery while reducing the carbon emissions, and lastly the project explored the possibilities of rolling out promising Smart Grid components on a large scale [48]. In the European Union, Kema Nederland BV is developing and testing a high-speed narrow-band power line with communication capability. GDF Suez along with eight European energy utility providers, conducted research to address the technical and non-technical challenges faced to implement distributed energy generation in Europe [49, 50]. Tianjin Electric Power Company which is based in Singapore conducted a pilot project which aimed to build a smart power supply network with a 220kV and a 110kV transmission grid [51].

## VI. Conclusion

This paper showcased the concept of Energy Internet and a few critical components required for the implementation of Energy Internet. The two-way communications between the consumer and producers create a new human-centered dynamic system. The sustainability and existence of humans on this earth mainly depends on Energy resources and how we exploit it. Energy Internet has revolutionized the idea of integrating the power industry with the Information technology. Creating the Smart Network for the future is one of the best solutions to the growing energy crisis and growing pollution problem the world faces today. Rapid advances in the field of Information technology and the use of large-scale renewable energy has paved the way for Energy Internet. The electricity sector around the world is undergoing rapid changes regarding technology improvements. To successfully implement Energy Internet in real world requires further research and development. The ever-increasing costs of electricity and the growing demand for energy and the threat of catastrophic climate changes are the key motivators for the research and development of Energy Internet. Future research should be concentrated on the security and privacy of the data. Since, the core working of Energy Internet heavily relies on data analytics, as any malicious attacks on this could crash an entire grid plunging cities or even an entire country into darkness and chaos. Further research should also be conducted into developing newer methods to effectively and efficiently forecast the demand of individual consumers based on their consumption patterns. With the successful Implementation of Energy Internet in the real world, Humankind can tackle the ever-growing problem of global warming and energy crisis by using distributed energy generation systems, which comprises mostly of renewable energy resources to ensure a clean and green future.

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