Paper	Challenges
40	The main contemporary challenge involves such an energy sector transformation which will prevent climate change and will ensure the sustainable development of the global economy. However, this requires solving a large number of sub-problems in areas such as legislation, energy distribution, democracy, and cybersecurity.
41	Some challenges relate to the devices themselves and include the need to assure higher performance of the Smart Connected Products (SCP) produced through PE-related technologies, as well as assuring that the power supply and power consumption are optimized for their long-term use. Moreover, since these SCP are intended to be retrieving large amounts of personal data, its management and security will also play a role in the long-term acceptance of these devices by the public. Another concern is the lack of manufacturing standardization and regulation that is inherent to such recent technologies. Skilled workers in the field of PE, capable of implementing such manufacturing standards and creating/obeying regulations are also in demand.
42	Although IoT provides various solutions for smart grid (SG) management and the Internet of Energy as a peer-to-peer network, it also brings vulnerabilities. These are mainly security issues, which can undermine the system's reliability. Continuous growth in the number of prosumers in the grid make them an important part in energy trading. All energy trading parties are involved in trading (producers, prosumers and consumers), which requires reliable and secure transactions in a more and more decentralized system. As smart grid (SG) systems are based on IoT technology, they are prone to its vulnerabilities. IoT devices, in general, have limited power; many of them are battery powered, which leads to battery development to extend their life.
43	Furthermore, intelligent energy trading can solve the energy transaction problem and maximize the economic return, with accurate forecasting on renewable electricity, demand consumption, dynamic state of energy storage, and interaction learning between prosumer bidding actions and market responses.
44	Realizing the potential of large-scale bio-based manufacturing requires substantial strategic investments, especially in infrastructure.
45	There are a number of challenges associated with the implementation of peer-to-peer energy trading at the customer level: Reliable Platforms, Regulatory framework, Attaining technical requirements, Policies and Protocols ,Roles and Responsibilities, Security and Privacy, Scalability and Cost, Social Acceptance, Overhead management.
46	The energy storage management system plays an important role in modern electric systems; the influence of energy storage needs to be considered while solving the OPF problem; thus, new advanced methodologies need to be adopted to cope with the challenge.
47	In an IoT ecosystem, most of the work is carried out by fully automated and autonomous devices, thus reducing the need for human interference and causing job losses in the long run. The second challenge is related to the technical limitations of the IoT, such as lack of connectivity, network bandwidth and latency, power supply, response time, battery efficiency, incompatibility of IoT systems with current farm operations, heterogeneity of data and devices, and interoperability. The third challenge includes privacy and ethical issues, including the absence of privacy protections in agricultural systems, lack of accountability, and regulatory measures associated with data processing and analysis. The fourth challenge concerns the organizational barriers to IoT deployment, such as reluctance to adopt IoT technologies, share farm data, bureaucratic processes and paperwork and culture.
48	The PMS/EMS should ensure the economic benefits of the consumers and suppliers. In addition, the PCS topologies should be flexible enough for future expansion. The priority control for multi-functional ESS stacking will generate more financial revenues for the ESS owners. The simplified models of AI should be developed for PCS of ESS to improve the reliability and reduce the computation cost.
49	The studies demonstrate that digital technology perspectives for social development and wellbeing should target the following three areas: employment and job markets, education, and healthcare.
50	This sustainable energy challenge is of the utmost importance in meeting basic human needs, improving quality of lives, and avoiding contributing to further climate catastrophes. However, revealed, energy efficiency may not be the silver bullet for all energy sustainability needs. There is a need to enable more renewable energy in smart cities. This is critical as the forecasts are for the future of urban mobility being electric, hence there is investment needed for clean energy fed electromobility.
51	There is a lack of a data-driven framework that enables the use of AI and allows for a robust and comprehensive evaluation of AI methods for making effective decisions about which SDGs should be prioritized in terms of AI use. AI models vary in their effectiveness in achieving the 17 SDGs and present us with different challenges: For example, DL can be used in healthcare (cf. SDG 3) with high prediction accuracy, but given the lack of explainability and causability, as well as concerns about patient–physician relationships, data security, and privacy. AI models are only moderately effective, have redundant or negative effects, or may lead to (data) problems.
52	Although there are various dispersed research and development incentives for AI in the energy sector run by different actors, a holistic top-down approach is needed, with energy being one of the sectors targeted by the Indian AI Strategy. Actions such as the National Smart Grid Mission or the Smart Cities and Infrastructure or India Energy Dashboards should be commended; a more comprehensive attitude is needed, as India's energy sector, including electricity, faces numerous challenges such as data collection and communication with energy customers

53	As a "trust-machine" or "confidence machine", blockchain can facilitate coordination and communication. Yet, for this to happen, trustworthy information, adequate rules, accountability, conflict resolution and voting mechanisms, as well as, adaptiveness in overall participants need to be in place
54	Integrating BC requires expensive technological infrastructure upgrades to deal with huge amounts of data and perform fast, high-security trading. Privacy and security issues are still plaguing BC technology in most applications, creating a barrier to BC adoption. Moreover, the pricing structure in BC lacks an appropriate local market design, and more intensive research is required to overcome this problem and standardize the structure.
55	(i)The BC in different SG systems needs efficient cryptographic schemes(ii)BC network required penalty and incentive mechanisms(iii)Advance privacy, security, and data communication exchanges(iv)The BC-based SG system is required to keep penalty/reward policies(v)Interoperability limitation among the SG process(vi)Game theory, cognitive modeling, and deep learning need to add a standard processing technique for benchmark and validation(vii)SG energy sources required optimal allocation(viii)Renewable/storage energy system required communication and advance metering for integration with SG, control, and monitoring(ix)Energy management systems are required considering the burden and computational complexity to design and implement(x)SG required more focus to handle uncertainty: source intermittency, weather condition, electric vehicle/plug-in-electric vehicle driving pattern, impulsive human behavior during the load connection, and disconnection.
1	However, energy-ICT may also bring with it adverse effects against SDGs, such as increased energy consumption, the generation of more carbon emissions, cyber-attack vulnerability, the enabling of unfair competition, etc.
56	The problem is not Bitcoin or the blockchain technology but the way they can cryptographically operate. As evoked earlier, some potential solutions exist; however, these solutions are still ill-defined; not well diffused yet or do not offer the same guarantees in terms of transparency and security than the proof-of-work based systems.
57	Special attention should be paid to implications of inequal data access that can result in digital poverty and hence increase inequalities instead of reducing the gap. Cybersecurity of strongly interconnected systems through the cloud should be reinforced
58	Utility-scale hybrid wind–solar PV power plants, when assessing their potential, they present higher needs in terms of input data, as they are forced to consider both spatial and temporal variations to evaluate their techno-economic viability, as well as other common inputs such as economic, social or environmental data.
59	Speaking about the suggestions on how to deal with challenges of 5G networks in demand-response renewable energy grids, such major challenges as infrastructure issues, security issues, reliability, and economic challenges should be considered by the relevant stakeholders and policy-makers.
60	We also discussed some of the remarkable challenges faced by the proper implementation of DL-based IIoT that include the complexity and selection of specific DL algorithms, preprocessing, and data labeling.
61	Although the blockchain technology can be applied as a useful option for the SGs, the security issues should be carefully investigated to reduce the probability of fraud and manipulation and improve the reliability and trustworthiness of the smart grids.
62	As far as the policy implications are concerned, it becomes apparent that the country needs to embark on a path of digitalization in energy industry and increase the share of renewables in its energy mix. All of these constitute serious challenges for the Russian energy sector as well as the problems of energy efficiency and energy saving in Russian business enterprises that need to be tackled by the politicians and business stakeholders.
63	Brazil needs to find ways to grow its generation capacity, keeping and possibly increasing its share of renewables. Given the difficulties to build new large HPPs with reservoirs, and the intermittence of wind and solar power, huge investments in the modernization of the power grid will be required. Both the complexity and the costs of such endeavor are so huge that it seems unlikely it could be addressed by the state alone, in the old verticalized and centralized model of the nationalist period
64	How to use blockchain technology to enhance energy transactions, and how to improve the security of the energy Internet and the security of the energy blockchain technology itself will be the second research hotspot.
65	In summary, it seems that Distributed Energy Resources (DERs), microgrids, and particularly Electric Vehicles (EVs) and Charging Facility Units (CFUs) will be emergent actors of the electricity grid, and from the Distribution System Operator (DSOs') perspective, there will be challenges on the grid, such as the short-term peak load management problem and grid capacity concerns owing to the quick charging technology and instant energy production changes. However, the security, privacy, scalability, and transaction speed of BC technologies in the energy sector are other concerns.
66	Due to the high-level penetration of informatics and communication infrastructure, which exposes the network to security vulnerabilities, the presented study has highlighted the potential sources of threats, the type of cyber-attacks, and the mathematical models that can be used to describe the attacks.
67	The negative consequences are visible or will be visible in the reduction of jobs because the digital transformation will result in the middleman becoming redundant
68	In smart grids, stakeholders currently work with data management techniques that are unique and customised to their own goals, thereby posing challenges for grid-wide integration and deployment.

69	Due to the complexity of the emerging smart grid and its significant status for public order (critical infrastructure), experts expect higher risks to cyber-attacks, which include conventional attacks like DoS (Denial of Service) attacks, replay attacks, or false data injection.
71-70	smart factories need to be sustainable and renewable in terms of energy pattern (electric system industry). Furthermore, the United Nations Industrial Development Organization (UNIDO) has set the relevancy of industry 4.0 and sustainability in the global Sustainable Development Goals (SDG 7 and 9) that digital industrial development should support the growth of industrial sustainable energy. This has pointed towards the evolution of new energy concept known as energy 4.0. A number of disruptive technologies, however, have received very few applications in these selected industries.
71	However, in order to achieve sustainable manufacturing, several challenges still need to be overcome according to existing research, such as the implementation of life cycle analysis, enhancement of maintenance and supply chain management, reduction of environmental impacts, implementation of I4.0 technology frame works, proper use of circular economy concepts, real-time data processing and security. energy resource management, maintenance schedule optimization and others. The literature evidently reveals the lack of methods to assess and evaluate the implementation and effects of I4.0 in companies as well as in sustainability dimensions. This might occur because the concept seems to be immature. Consequently, industries commonly fail to plan an appropriate implementation of I4.0 technologies and it makes difficulties for decision-makers to integrate I4.0 initiatives with sustainable practices.
72	The main challenges are business models, value creation networks, equipment, the human factor, organization of smart factories, sustainable processes and product development and products lifecycles. Negative impacts are often the opposite of positive impacts (cost reduction vs. cost increasing, etc.) and are often a barrier to the introduction of green processes and new technologies in manufacturing.
73	We discuss some of the challenges of applying IoT in the energy sector, including challenge of identifying objects, big data management, connectivity issues and uncertainty, integration of subsystems, security and privacy, energy requirements of IoT systems, standardization, and architectural design.
74	Another critical aspect is the effective demand-side management and the successful integration of different RES technologies into the NZEB concept, to be able to transform buildings from energy users to energy producers.
75	Energy efficiency is also a major challenge, there is a need to motivate and involve citizens in reducing the energy intensity in order to achieve energy efficiency and, thus, a sustainable growth. In the domestic sphere of the SCs, the integration of ICTs may be energetically unsustainable and not available for all the citizens. This stresses the importance of considering the energy consumption when introducing ICTs in the SCs. From the smart micro-grids perspective, Yoldasx et al. identify two main challenges: regulation, which prevent the proper usage of micro-grids, and technical challenges. For the later, they distinguish the following issues: (1) operation, (2) components and compatibility, (3) integration of renewable generation and (4) protection.
76	There are a range of intrinsic and implicit costs and business challenges that SSA entrepreneurs need to address to create frontier markets. These include difficulties in hiring talent, building consumer awareness, and investor interest in new products and services; poor and costly infrastructure; weak IP enforcement and quality assurance systems and policy and regulatory environments that favor incumbent firms or hinder new technologies.
77	However, high-quality input data for the determination of energy demand is limited and difficult to be accessed. It is important to invest some effort in the improvement of the quality, standardization and availability of the necessary databases.
78	The practical implementation of the SG still have a long way to go with numerous technical and socio-economic challenges, such as the consumer's awareness, advance and efficient control scheme, efficient dynamic optimization techniques, efficient storage devices, management of EVs penetartions, reliable communication infrastructure, an intelligently optimize SG consumer energy managment, facilitate and manage the prosumers activities, precise weather forecasting techniques, and other social, security and privacy issues.
79	Security is a challenging issue since the on-going smart grid systems facing increasing vulnerabilities as more and more automation, remote monitoring/controlling and supervision entities are interconnected.
80	Since the main goal of EDT technology for the process industries is to reduce costs, energy, and emissions, a careful balance needs to be maintained to keep the computational requirements including the power, energy and emissions expended from operating EDT sufficiently low. For instance, contemporary deep learning algorithms are viewed as highly energy intensive, which is also exacerbated by the dramatically increasing network transmission volumes of the site and site-edge IoT data they would rely on. If computational requirements increases significantly, a trade-off may arise between the marginal benefit derived and the power consumed.
81	There are two primary issues when implementing the AI to the operations of power systems: First, when the historical data is too less to train an accurate AI model, how to guarantee the model accuracy and avoid the issues of over/under fitting presents a challenge. Second, how to ensure that controlling decisions yielded by the AI models align with the physical constraints of power systems presents another challenge
82	In contrast, realizing the DRG infrastructure using ZigBee PRO technology has some shortcomings such as interference, small memory, low processing capability, longer transmission time, and others which are highlighted and resolved based on previous reviews.
83	Blockchain technologies can be disruptive for energy companies and face a large variety of challenges to achieve market penetration, including legal, regulatory and competition barriers. Additional research initiatives, trials, projects and collaborations will show if the technology can reach its full potential, prove its commercial viability and finally be adopted in the mainstream.

84	Restrictions or regulations creating high transaction costs for harvesting renewable energy by prosumers should be avoided and existing ones abandoned. Most of these concern first forcibly defining distributed generated power as a commodity, and then treating it as such, e.g. by taxing the electricity within the distributed systems. Government regulation should focus on real public values, such as safety standards for devices, on maintaining justice in processes and distributive outcomes, and safeguarding ecosystem impact.
85	Capital costs, availability and flexibility remain important issues for integrating renewable energy sources into 4GDH systems and necessitate careful design and resource assessment.
86	In particular, Decentralization and Digitalization for power systems show many common enabling technologies due to the need of connection and communication between decentralized generators, load aggregates and storage systems. In this context, it is worth to underline the main role played by ICT and automation both in buildings and in the power grid [96–107]. In particular, the next challenges in this field will be the definition of: Universal protocols and technologies for communication and control in virtual utilities and smart transmission systems; A common technical and regulatory framework overpassing the current differences between the IEC and ANSI/IEEE approaches.
87	Delivery of utility services on a pay-as-you-go basis integrated with mobile payments is a successful example of it, as many start-ups have developed their concept in the last five years. With an impactful potential in their hands, they struggle to get funded and crash into countries' adverse regulatory frameworks. One of the biggest problems about PAYG solar home systems is a misleading perception of this technology: the distorted view that DC systems provide a "second-class energy" is largely spread among the policy-makers.
88	That there are still the following problems in the construction of REI: (1) The energy consumption structure is unreasonable. Energy consumption models, such as ''fuelwood + coal" model and ''fuelwood + electricity" model, vary from region to region because of the imbalance development among regions. (2) Energy poverty still exists in part of rural areas. (3) Rural energy transformation is affected by farmers' economic income. (4) The stability and reliability of power supply in rural power grids are not high. (5) The level of electrification and the degree of energy cleanliness in rural areas is low. (6) The distribution of rural loads is relatively scattered. (7) The development speed of renewable energy in rural areas is slow. (8) The state subsidy policy is unreasonable. (9) The rural internet is backward.
89	The key challenges regarding the grid-connected micro-grid involve immature national grid, frequency instability, proper controlling of power converter stages, implementation of smart energy infrastructure, deficiency of high-speed communication lines, cost of battery energy storage system, natural vulnerability, the complexity of demand-side management, cybersecurity, lack of protective relays, regulatory challenges, and policy related to microgrid business policy.
90	In spite of the abundance of renewable energy resources, Africa is still undergoing a phase of serious crises because still they couldn't be able to tap its huge capital of renewable energy. The factors are lacking in the use of appropriate required technology and due to the dearth of contribution from agencies (who are real stakeholders, especially in the private sector). The huge dependence on forest wood and improper use of wood resources needs to be penalties like an increase in desertification.
91	Increased attractiveness for rural villages makes smart transformations in rural areas a necessity for developing sustainable Smart Villages. This is why it is so important that the idea of Smart Villages is integrated as part of the current rural development policies. Another conclusion we can draw is related to the funding problem of Smart Villages
92	We present here a few challenges that should be taken into consideration while implementing the proposed architecture: ▪LoRa technology is limited in terms of its data rate. So, it may affect communication during emergencies, where fast data communication is normally desired. ▪Grid connection and control in the microgrid network need to be developed in a robust manner as they may affect the entire power network.
93	Overall, the benefits, strategies, barriers, and challenges of global power grid connectivity are as follows: • Despite the regional power trade (economic, environmental, and technical benefits), cross-border connectivity is plagued by issues such as regulations, policies, standards, investment, and energy security. • Apart from the technical, political, and financial considerations, cross-border trade has implementation obstacles involving land acquisition and environmental clearance. • Transnational grid interconnection ensures reliable, affordable, and sustainable energy supply.
94	Although smart grids provide a broad range of opportunities for power sector reform in Nepal, several technical and socioeconomic challenges may make their implementation difficult. These issues can be addressed if the GoN and NEA jointly adopt policies and strategies that promote their development. The results of existing smart grid initiatives like the Kathmandu Valley Smart Metering Project, on the other hand, can offer insight into how its development will proceed in Nepal.
95	One of the main challenges of decarbonizing an energy system is integrating non-dispatchable resources that are generating power intermittently and then transmitting that electricity from a decentralized location via a grid that was designed for a one-directional flow of energy.
96	The MGT industry currently faces new challenges of increasing operational flexibility, reducing operating costs, and improving reliability and availability while mitigating environmental impact. The main concern when it comes to distributed generation is the ability to maintain performance and high availability while minimizing the operation and maintenance costs.

97	The real-time implementation of big data analytics in a smart grid along with efficient protocols will lead to challenges and issues in the future. Scalability, achieving a satisfactory and efficient method, data protection, reliable performance of the algorithm under unfavourable conditions and knowledge of artificial intelligence tools by the operators are certain constraints in achieving a sustainable future.
98	In conclusion, we believe that blockchain technology may not (itself) radically transform the energy sector and this is related to various limitations highlighted in this paper (grid reliability and security issues, energy consumption issues, regulatory risk, as well as its inherent levels of technological uncertainty for firms). The key reason however is related to the complexity of managing properly the grid (e.g. grid reliability and stability in heavily decentralized power exchange configurations).
99	From the discussed techniques and series IV games, engineers, technologists, and professionals can get a hint of how series IV tool is useful for RES planning, and in accordance with a few of the discussed advantages from the highlighted studies deliberated in this article, it can be inferred that by incorporating advanced IV tools, risk of failure in the comprehensive RES system design can be avoided. Considering the current work done, there is still a need for the software package and the future recommendation is to develop an IVseries game (after careful mathematical modeling and with game engine) that can support the design engineer in planning the project constraints by optimizing the cost and energy efficiency, thereby seeing the energy needs of the public sector.
100	Scope implementation issues are hampering the implementation of SG 2.0 and the demand for an intelligent enterprise-based information system. Demand-management issues arise from squatter tenants, building characteristics, needs, regulatory constraints, power grid dynamics, operational requirements and market constraints. Due to costs, lack of system support, advanced technology and logistical difficulties, these systems are still hypothetical.
101	The development phase is risky and expensive for the energy communities. As Vernay et al. (2020) emphasize, several projects have not yet been implemented because the ECs faced difficulties with financing this stage.
102	However, there is serious concern that anti-islanding functionality can work adequately with current limited islanding detection methods. Similar problems occur when DSOs cannot apply their desired power control at the PCC because SMG is supposed to be an independent identity. This issue is interwoven with market conditions and regulatory issues. For instance and as discussed in Sections 6 and 3.1, although hierarchical controllers have been developed and perform for MG, this controlling strategy is still unable to address DSO concerns about handling the provided active power (i.e., to determine who the potential buyer is). And there is also a lack of regulations for reactive power trading in most countries. The present study found that the main problems for market actors are rooted in the fact that they are not motivated to invest in SMGs because this novel concept comes with many uncertainties and perceived risks. Moreover, social acceptance of SMGs among local communities and end users suffer from a multidimensional problem between technology structures, regulations and institutions.
5	However, the early evidence suggests that policymaking worldwide is focused on short-term, seemingly quicker solutions, such as supporting the incumbent energy industry in the post-pandemic era to save the economy and looking for new fossil fuel supply routes for enhancing energy security following the war. Governments are more focused on energy security in the short-term, relying on low-hanging but risky alternatives, such as looking for new routes of fossil fuel supply, nuclear extensions, or coal revival.
103	Following this, the article discussed the integration of IoT for energy generation transmission, distribution, and consumption. In which, the article addressed the energy generation from renewable energy sources (wind, solar, and thermal) that are prioritized for implementation to minimize carbon emissions. Resource generation management: realizing the output status of the generators, transformers, tap changers, and electrical status of transmission lines including perturbations; and improper monitoring of energy consumption in the domestic and other areas are the problems identified in the four sub-systems of energy.
104	But, as smart contracts gain wider adoption in commercial energy projects, the security and verifiability of smart contract code is an aspect that needs to be considered. Another key challenge that smart contracts in energy face are scalability and questions of energy use. So far, most smart contract projects in the energy sector have been relatively small scale, and/or implemented on a private blockchain (as opposed to, e.g. deployment on the public Ethereum blockchain, which requires considerable gas payments). Third, a very important issue — also highlighted in Section 4.10 of the paper is that smart contracts are not particularly ''smart" in themselves, in the sense of having embedded Artificial Intelligence/machine learning capabilities. This is both due to the computational cost of executing complex code on a distributed public blockchain, but also because smart contract programming languages are often restricted, due to computational and security reasons.
105	Digitalization of energy systems, e.g. through smart grids important to renewable electricity utilization, may as such improve resilience from traditional weather and technical failure threats, but it also introduces new vulnerabilities to cyberattacks. Major differences between the internet and smart grids limit the applicability of existing cybersecurity solutions to the energy sector. Other structural energy system changes will likely bring new threats, which call for updating the threat landscape for expected system development scenarios.
106	Although data-driven technologies play a key role at all stages of the production of food and feed in agri-food systems of the future, none of this can happen without enough energy and water from farm to fork. Being clean and sustainable the energy used in agriculture, not chemically polluted of the water is vital to access to fresh water and clean energy everyone, and for a better reconstructing in the aftermath of the COVID-19 pandemic.