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Guest Editorial

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This issue of *IEEE Power & Energy Magazine* focuses on smart cities and smart villages.

As a result of advanced information and communications technology and its deep integration with the electric power industry, smart energy forms a solid foundation to build smart cities. Smart energy uses energy more efficiently through improved design and advanced technologies along with the adaptation of clean renewable resources to generate electricity, heat, and power transportation. Electricity consumption is a true reflection of the socio-economic health of a city. Data convergence and energy infrastructures enable a better life for the citizens in smart cities and create a sustainable lifestyle for the eco-aware 21st-century citizen. However, these transitions and transformations bring numerous challenges and opportunities at industrial, academic, and policy levels. The availability, reliability, and sustainability of clean electricity are critical for modern living. Operation and management of electric transportation and health services will depend heavily on smart energy.

Smart Cities

IEEE Smart Cities initiatives bring together a broad array of technical societies and organizations to advance state-of-the-art smart city technologies to benefit society and set the global standard by serving as a neutral broker of information amongst industry, academic, and government stakeholders. The IEEE efforts identify and further develop technical best practices across several functional domains within the context of urban infrastructure systems (i.e., sensors and intelligent electronic devices, communication networks and cyber security, systems integration, intelligence and data analytics, and management and control platforms). Smart cities rely on widely distributed smart devices to monitor the city environment in real-time, collect information for intelligent decision-making, and facilitate various services to improve the quality of city life.

The goals behind a smart city include the following:

- Minimize the demand for resources
- Promote a low-carbon economy
- Enhance city efficiency
- Promote business productivity
- Improve the quality of living
- Enhance climatic resilience

Combine all these items and smart cities can develop. Cities operating affordably and sustainably need more sophisticated control and management systems to ensure their business

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objectives can be achieved. The development and application of new technologies are also accelerated in this new city environment as decision-makers and city planners seek to improve their effectiveness and efficiency. A distributed network of smart sensor nodes and data centers that store and share sensor data make up the smart city infrastructure. The digital and wireless technologies, all part of the smart city concept, are specifically designed to help citizens and make the city safe by bringing together strengths in energy, transportation, health, and education. Smart cities have the potential to radically change the way people live by making daily life more convenient, efficient, and less stressful. The authors in this issue provide coverage of these topics and their roles in building smart cities.

Smart Villages

As a counterpart to smart cities, IEEE Smart Village (ISV) initiatives address the lack of opportunity in rural parts of the world. This lack forces rural-urban migration that increases problems faced by smart cities as the unreached population grows. Deeply personal narratives focus on the human aspect of "advancing technology for humanity" in underserved rural communities.

ISV has its roots in the humanitarian urges of two IEEE members, Ray Larsen a nuclear physicist from IEEE Nuclear and Plasma Sciences Society and Robin Podmore a power engineer from the Power & Energy Society In the aftermath of a 2011 earthquake in Haiti, they deployed solar-based systems to bring light to devastated rural communities. From the start, their vision was to plant self-sustaining enterprises to outlast the actions of a few well-meaning outsiders. ISV has grown to seed enterprises in four continents, and its approach has expanded into the productive use of renewable energy while tapping the expertise of multiple IEEE societies.

As a humanitarian seed fund, ISV supports local entrepreneurs and mentors and monitors them to prove technology/business models. With these launch vehicles, ISV supports enterprises' growth by attracting funds from other sources. ISV encourages enterprises to start small with a vision of going large. Its objective is to improve living standards through mechanization, yet leapfrog the use of fossil fuels. It works with knowledge from local entrepreneurs to deploy advanced technologies to electrify rural economies. ISV has also grown its governance structure. Starting with IEEE Power & Energy Society and IEEE Nuclear and Plasma Sciences Society, it is now under the oversight of 14 IEEE societies and the IEEE Foundation.

The four-part smart village articles start with a foundation of technology and include the personal stories of the entrepreneurs who are at the forefront of ISV's operations. These stories show how to deploy advanced technologies in circumstances of social, political, supply chain, education, market access, financing, and other challenges.

Overview of the Issue

This issue provides a glimpse into the many exciting smart city projects happening around the world with a focus on energy and power systems. The authors not only share their technical knowledge about opportunities and challenges but also the lessons learned from actual implementations. In each article, they discuss what is needed to move concepts forward.

This issue begins with "Smart City Energy Technology in the Face of COVID-19" by Vijay Vittal, Nirmal Nair, and Farnoosh Rahmatian. It examines critical smart city infrastructure

components like electricity supply, transportation, and telecommunication in the face of a pandemic like COVID-19. The electricity infrastructure is a critical component of any smart city infrastructure and significantly impacts other systems like transportation, communication, and water delivery and treatment.

The second article, "Challenges and Opportunities for Smart Grids to Revolutionize Chinese Cities" by Loi Lei Lai and Hao-Tian Zhang, shows three real-life smart energy projects and how they could improve the quality of life in those cities. It also discusses potential challenges and opportunities based on the experience from these projects. The huge concern in increased greenhouse gas emissions, a need to achieve net-zero by 2050, and revising laws and regulations lead to the need for sustainable and clean energy to reduce energy demand and improve energy efficiency.

The third article, "A Tale of Smart Cities: How Cooperation between Utilities and Communities Is Essential to Building Smart Cities" comes from Emily Kean, Daniel Kushner, Aleksi Paaso, Richard Fioravanti, and Veronika Rabl. The article shows that across the world, policymakers at every level are developing and executing plans to meet decarbonization and resilience goals for their residents. City leaders are looking for best practices to support the increased deployment of clean energy generation. Integrating beneficial electrification can mitigate the effects of climate change and reduce the emissions that affect public health, especially in vulnerable communities.

The smart village section begins with an article by Paras Loomba and Jaideep Bansal, "Electricity and Livelihood in Remote India." This article tracks the deployment of microgrids in the far northern mountains of India, beyond the grid. In an innovative conversion of adversity to opportunity, eco-tourists fund and deploy these systems. Now, they have added home stays, astro-tourism. and other income-generating opportunities for more than 160 villages above 10,000 feet elevation.

The next four articles are a series titled "Smart Village Voices in Africa." In "Part 1 – System of Systems Approach to Zero Poverty," Robin Podmore, Ray Larsen, John Nelson, and Rajan Kapur use the Multi-dimensional Poverty Index to frame solving poverty as a multi-domain optimization problem. The problem is solved using off-grid electricity for small scale farming and processing. The goal is for farmers and village workers to receive 80% of the retail price of the sold goods. These global commercial transactions are personalized so the buyers know the story of the women that grew and processed the products.

"Part 2 – Village Entrepreneurs in Nigeria" interviews two mini grid entrepreneurs in Nigeria. They decribe their motivation for starting their companies, system configurations deployed, impacts on their communities and lessons learned.

"Part 3 – Electrification of Villages in Cameroon" describes the initial deployment of ISV SunBlazers (a photovoltaic system coupled with batteries) that has grown to a U.S. Trade and Development Agency-supported study for minigrid deployment in more than 700 villages. This has also facilitated the deployment of a local network that supports tele-education and e-commerce with the goal to increase agricultural productivity.

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The final article, "Part 4 – Gemstones to Electric Infrastructure in Zambia" is a unique story of capturing lost opportunities to generate income and grow infrastructure underpinned by solar microgrids. Set in the mining region of Zambia, an opportunity is being created where raw gemstones are cut and polished locally in secure container-based buildings to provide maximum benefit to the local communities.

This set of articles shows how rural communities can be empowered by deploying microgrids, supplemented by electrical machinery, internet of things technology, telecommunication, and other productive uses of electricity. By electrifying rural economies, societies can improve livelihood opportunities in rural areas by reducing dependence on fossil fuels, stanching rural-urban migration, and assisting smart cities in meeting their objectives.

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