# Electricity Transition

## Achieving the Implausible with Advanced Technology, Investment Capital, and a Sense of Optimism

T&DWorld

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## INTRODUCTION

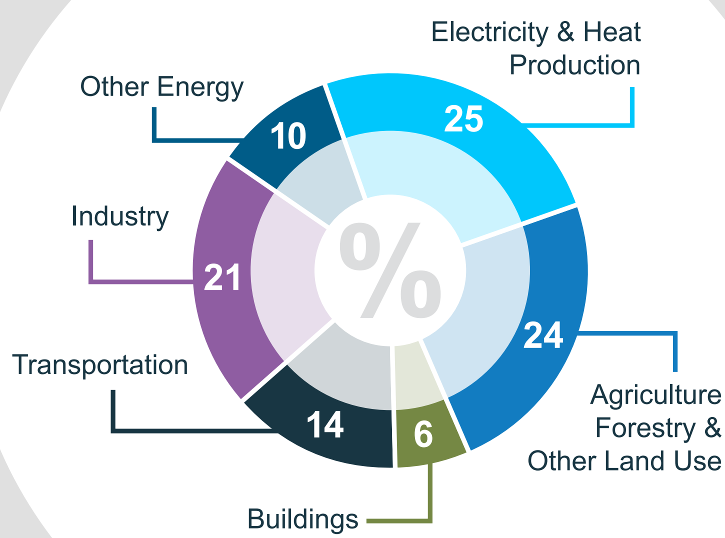
The world could use a healthy dose of F. Scott Fitzgerald as we collectively strive to stem and reverse global climate change. The author of ***The Great Gatsby*** accentuated both the harsh realities of stagnation and the rewarding possibilities of innovation. In his view, we must decide which direction to go.

Driven by the continued reliance on fossil fuels, we should not underestimate the challenge of turning around a global energy ecosystem, now 150 years in the making, nor should we be intimidated by the size and scope of the current climate challenge. If we want to achieve the improbable, even the implausible, then there is no time to waste.

The world's leading energy companies have an enormous amount of talent working on decarbonizing the planet. Decarbonization is particularly critical for the electricity and heat production industries and transportation sectors, which together account for more than half of global greenhouse gas emissions (see Figure 1).[1] While there are similar transition efforts at oil and gas companies, the focus of this article is on decarbonizing the electricity industry.

FIGURE 1

*Global Greehouse Gas Emmisions by Economic Sectors*




[1] www.epa.gov/ghgemissions/global-greenhouse-gas-emissions-data, U.S. Environmental Protection Agency (October 26, 2021).

## Reimagining the Electricity Business

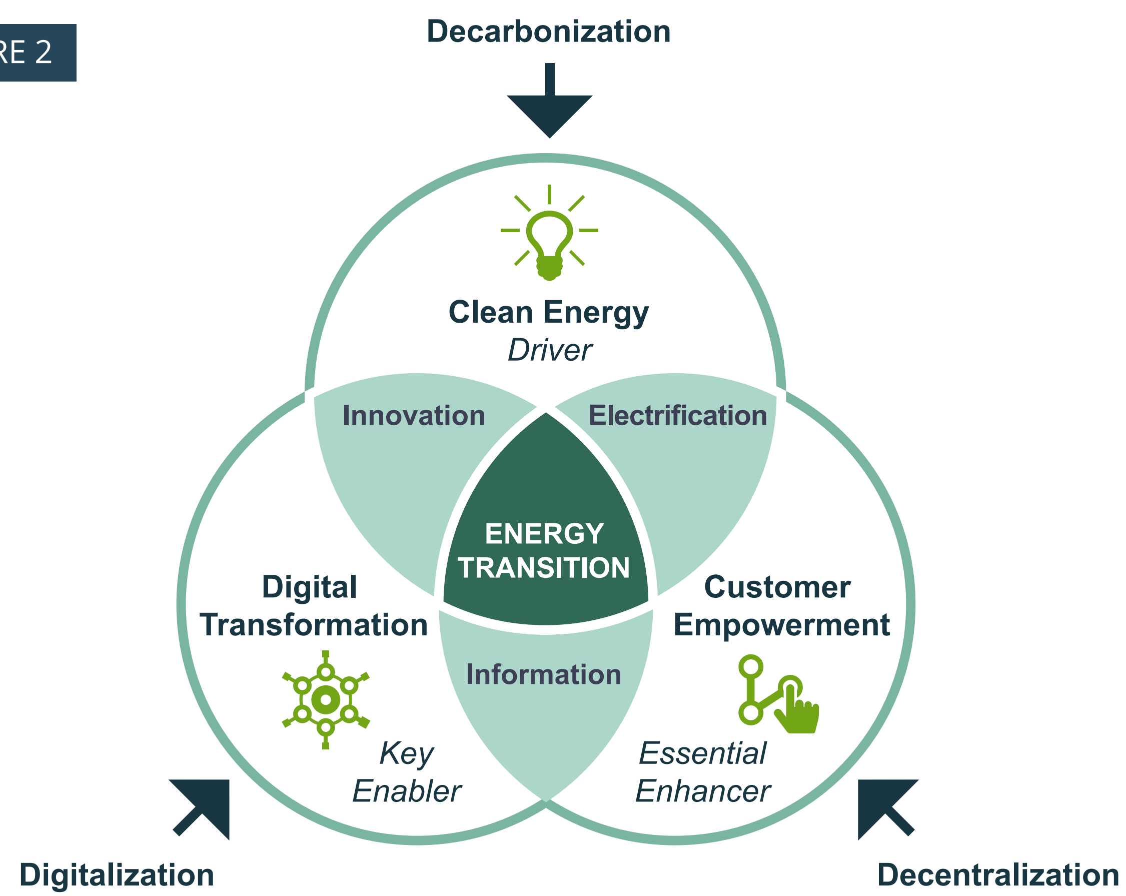
The world's largest and most innovative electric companies are working to decarbonize their operations to help usher in a cleaner, greener, and healthier future. Intel is both prepared and privileged to support these companies by providing technology that lowers carbon emissions, improves efficiency and reduces waste, and advances grid modernization.

The recently concluded U.N. Conference of the Parties (COP26) in Glasgow, Scotland, highlighted that while there is progress for transitioning the electric power industry, there is still much to do. All parts of the electricity business—generation, transmission, distribution, and behind-the-meter power generation at customer sites—are changing, driven by advancements in policy and technology.

Figure 2 represents how the intersection of decarbonization—from renewable generation and digitalization of the grid, along with decentralized decision-making—can guide the energy ecosystem's transition to a cleaner, more reliable, and brighter future.

Intel and its electric power partners are active in all aspects of this transformation. At a broad level, solution strategies include enhanced computerization, secure connectivity, and storage at the edge of the grid, enabling advanced digitalization that provides greater visibility, insight, and faster decision-making. Pursuing digital transformation will require investments to replace closed proprietary systems with open, interoperable systems, enabling innovation, enhanced competitiveness, and increased business value.

FIGURE 2

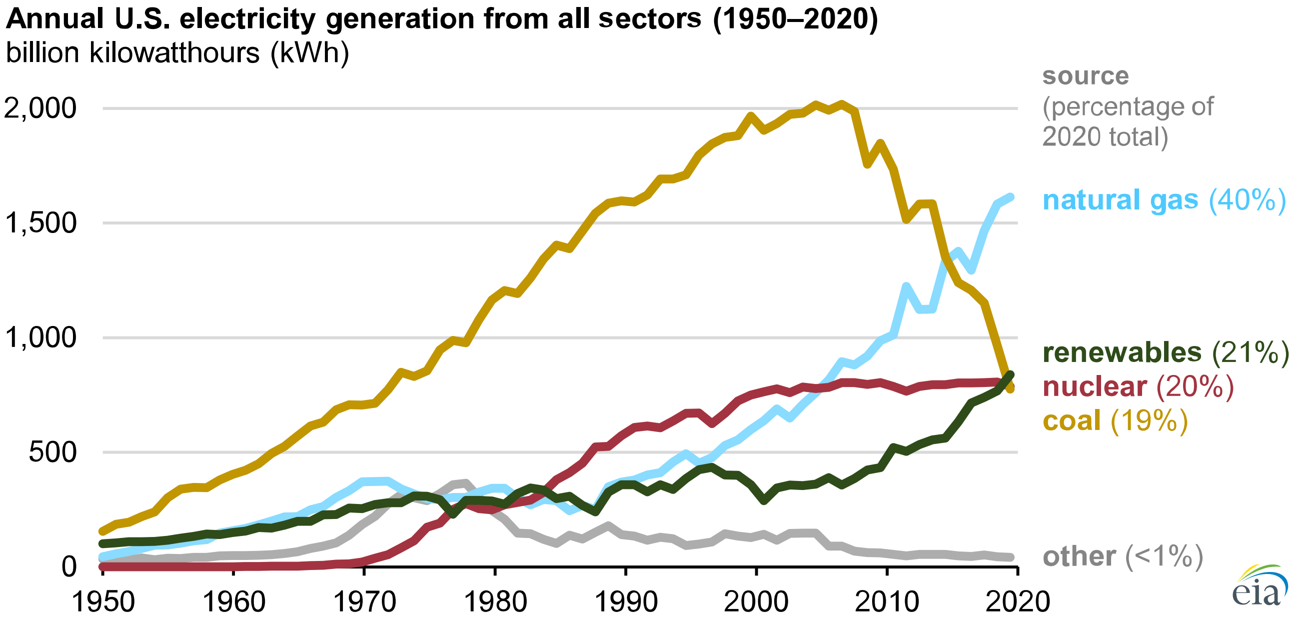


## The Greening of Generation

In the U.S., electric utilities and power developers have ceased building coal-fired power plants in favor of a combination of interim gas-fired plants and renewable energy platforms like wind and solar. Stakeholders are also sharply cutting back on gas-fired power plants in favor of a more dominant renewable energy portfolio.

In 2020, renewables (including hydroelectric generation) accounted for about 21% of all electricity consumed in the U.S., second only to natural gas, according to the U.S. Energy Information Administration (see Figure 3).[2] From 2022 to 2026, approximately 88% of the planned electric generation projects in the U.S. are slated to be

FIGURE 3




*Renewables are the Second-largest Source of Electricity in the U.S., U.S. Energy Information Administration*

[2] Renewables became the second-most prevalent U.S. electricity source in 2020, U.S. Energy Information Administration (July 28, 2021).

renewable energy, primarily sun and wind.[3] The "dash to gas" of a decade ago has slowed dramatically as the economics of renewable energy have improved, in large part by leveraging state and federal tax credits. The recent actions of state utility regulators, for instance, suggest that they are wary of supporting gas-fired power plants amid rising concerns over climate change.

While the "rush to renewables" for developed countries continues, much of the developing world still embraces coal-based energy, often because it's locally available, plentiful, and inexpensive. According to the COP26 summit, decarbonizing the electricity supply in the developing world is linked to the developed world's willingness to financially support the developing world's shift away from coal toward low-carbon fuels, like natural gas, and no-carbon fuels, like solar and wind.

Fortunately, investors are playing an increased and constructive role in decarbonization efforts worldwide. By the end of 2020, major banks, insurance companies, and asset managers of pension, mutual, and private equity funds (with roughly $100 trillion in portfolio value), were directing capital toward more environmentally "responsible" investments. This capital is expected to grow as other major investors put climate change at the heart of their $130 trillion of assets under management.[4]

It's clear the movement to decarbonize electric generation is well under way and gaining momentum. For instance, while small in percentage, Distributed Energy Resources (DERs) such as rooftop solar power or community renewable-energy parks are helping to drive the energy transition forward by demonstrating how "decentralization" can empower customers to make cleaner energy choices.

[3] Britt Burt and Brock Ramey, U.S. Power Industry Outlook 2022, *Turbomachinery International Handbook 2022*.

[4] Simon Jessop and Andrea Shalal, COP26 coalition worth $130 trillion vows to put climate at heart of finance, Reuters (November 3, 2021).(July 28, 2021).

## Flattening and Greening the Grid

While an amazing feat for its time, yesterday's electrical grid was a unidirectional schema generating and delivering power from central power stations to homes and businesses. Today, the electric grid is being transformed into a dynamic, bidirectional electric superhighway where electrons flow from a wide variety of power sources to homes and businesses and back again.

In the decades leading up to this transition, utility executives focused on modernizing an aging infrastructure. Today they have identified integrating renewable generation into the grid as their top concern, according to a recent survey of utility executives from Black & Veatch.[5]

Many utility executives are still in an early stage of understanding how integrating DERs will impact the distribution grid. The Black & Veatch study suggests that many grid stakeholders are in an intense period of learning about how DERs fit into the future electric landscape.

Intel has been working on a first-of-its-kind micro-data center solution for the existing infrastructure that will create a smarter grid that more readily adapts to changing energy demands. Intel's concept introduces artificial intelligence (AI) and data-driven technologies into the current system, "flattening the grid" and allowing the market to determine the highest and best energy source, regardless of its physical

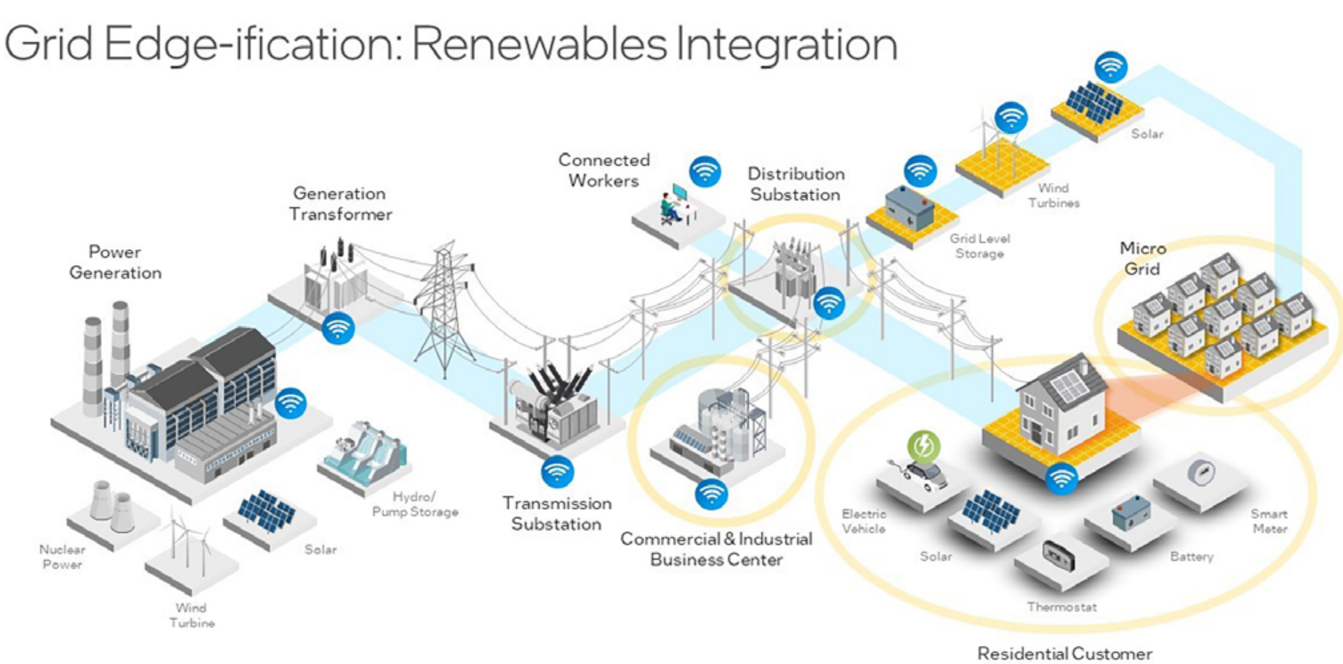
[5] Black & Veatch, 2021 Electric Report (November 2021).

location on the grid (see Figure 4). A flattened grid enables the integration of 100% clean, renewable, and intermittent energy into real-time energy markets.

A flattened grid will facilitate a grid-connection strategy that effectively integrates the cleanest and most cost-effective DERs with ever-greater amounts of utility-scale renewable generation. For instance, DERs and battery energy storage systems (BESS) could be leveraged in a flattened grid future (such as when a wildfire or tornado takes down a transmission line or when local demand exceeds the designed capacities of substations). Flattening the grid will not be easy and includes overcoming challenges with retrofitting, upgrading, updating, and future-proofing substations. For example, existing substations use numerous legacy devices and application-specific hardware and firmware, limiting the systems' interoperability. Instead, fixed-function, proprietary legacy devices need to be replaced by a commercial non-proprietary interoperable software platform that supports various new applications. Additionally, hardware may need to be upgraded once the firmware is upgraded.

In sum, utility operations have layers of applications that have been added over time and do not always work cohesively. Adding to that challenge is that the "internet of everything" generates an enormous volume of valuable data that must be captured, stored, and analyzed for making business decisions and sustaining complex network operations. This marked increase in the need for analytics portends there will also be an increased reliance on AI and machine learning (ML).

FIGURE 4 *Intel's vision to "flatten the grid."*




Potential: Substations and microgrids as places to site new functionality and services

## Extracting Business Value from Big Data

Intel maintains its close partnerships with utility clients defining a standards-based, open, interoperable, and secure architecture that addresses both the technical and business challenges of this energy transition. In response to insights gained, Intel is developing software-defined technology that consolidates a multitude of applications into a single platform. This vital process will also help integrate new workloads, like clean energy resources distributed at the edge of the grid.

This platform design includes AI-enabled decision-making to sense and learn optimal load balancing across a distributed set of intermittent, clean energy resources. Further, taking a virtualized/containerized approach ensures that the applications remain isolated and secure.

This platform reduces capital costs by avoiding waste and distributing energy in the most efficient way possible. It also reduces operating costs by offering insight into each substation and supporting predictive maintenance. Major utilities worldwide are testing these incorporated Intel-based technologies as they plan to integrate more green energy into the grid while enhancing reliability and facilitating the integration of DERs, like rooftop solar cells and panels.

## A Case in Point for Digitizing the Grid

Intel also continues to work with Southern California Edison (SCE) to implement virtualization technology at one of its substations.

**"California is at the forefront of addressing climate change and air pollution. Electric utilities have an important role in realizing the state's goal of reducing greenhouse gas emissions by 40% below 1990 levels by 2030. To achieve this new energy paradigm, we at SCE are working to modernize and strengthen the grid. The technology we're deploying today, such as automated devices and grid hardware, will make our grid stronger and more capable of withstanding disruptions on the system. We're harnessing the power of data, analytics, and machine virtualization to explore new approaches to make our grid safer and more reliable for our customers."**

*— Phil Herrington, Prior Senior Vice President, Transmission & Distribution, SCE*

For SCE, realizing a transformed grid that enables improved performance and reliability demands taking a vital first step to replace closed, proprietary systems with open systems that can address the inherent inefficiencies of the legacy electric grid.

Looking ahead to when systems are open and interoperable, SCE will no longer be forced to stockpile replacement equipment from different vendors. Advancements in the automation of the electric system also will create safer working conditions by reducing the instances when employees come in direct contact with high-voltage equipment. Further, advanced technology provides SCE with better situational intelligence into the health of its network, enabling officials to make predictive maintenance decisions rather than dealing with disruptive and costly failure scenarios.

## Guiding the Grid Transition

Digital technology, decarbonization, and decentralization of energy sources are three trends that are inextricably linked as defining features of the transition to a greener, more sustainable outlook for humankind. Intel sees these trends playing out in the various segments of the electricity business, including power generation, transmission and distribution, and consumers—both commercial and residential.

For electricity companies, this means making multibillion-dollar investments to support the electrification of society. For instance, Intel has been reducing carbon emissions with solutions that lower electric usage at data centers. In these centers and facilities, hundreds of computer servers are clustered into a single "farm," producing significant amounts of heat that must be dissipated with costly air conditioning. Here, Intel's solutions include deploying next-generation low-heat chips and servers that significantly cut the costs of cooling.

For private industry, advanced energy technologies are essential for improving grid reliability and resiliency in a highly digitized economy. Using the transportation sector as an example, Intel has focused on delivering advanced computing in support of transportation system applications using new and emerging technologies (such as 5G, AI, and autonomous vehicles), as well as advanced Internet of Things (IoT) sensors and data collection technologies.

At the customer level, microgrids, solar, energy storage systems, and electric vehicles (EVs) are proliferating, enabling consumers to exert greater control over their energy choices. This trend is accelerating, driven by federal incentives, state laws and rules, and the growing importance of electric reliability and resilience.

Intel believes that as all electricity stakeholders advance together, infrastructure digitization must be ready on all fronts, like being "EV ready," as today's decisions will persist long into the future. So, it seems appropriate to close with an old adage that "A journey of 1,000 miles begins with a single step." Intel is proud to be a part of such a monumental and meaningful journey.