THE FUTURE OF THE UNITED STATES CLIMATE POLICY IS DIGITAL

How Digital Tools and Platforms can Revolutionize U.S. Climate Policy

Digital Climate Alliance

THE FUTURE OF THE UNITED STATES CLIMATE POLICY IS DIGITAL

How Digital Tools and Platforms can Revolutionize U.S. Climate Policy

As more and more companies are leveraging digital tools and platforms to reduce climate impacts, improve energy and water efficiency and resiliency, and promote further innovation across our nation's critical infrastructure, there needs to be a concerted voice coordinating these efforts and advocating for the increased use of digital technologies as solutions to addressing the climate crisis. The Digital Climate Alliance is a coalition of companies developing and utilizing digital technologies to reduce their environmental impacts for themselves and for their customers. The Digital Climate Alliance's goal is to promote digital tools and platforms to enable 21st-century solutions, solving climate, water, and energy challenges that impact economic development, business growth, social well-being, and ecosystem health.

The United States' decision to rejoin the Paris Agreement puts the country firmly on a path towards decarbonizing sectors of the U.S. economy. While key policies surrounding the Paris Agreement and domestic activities still need to be enacted, digital technologies will play a vital role in accelerating decarbonization. This paper provides policy recommendations highlighting opportunities to leverage digital tools and platforms to address the climate crisis.

The Digital Climate Alliance
Autodesk, Enel, Intel, Johnson Controls, Nautilus Data Technologies, Schneider Electric, Trane Technologies, Xpansiv, Water Foundry

Digital Climate Alliance

TABLE OF CONTENTS

EXECUTIVE SUMMARY

I. *Digital Technologies Promote Economic Opportunities, Advance Innovation, and Accelerate Decarbonization*

As the Federal government advances ambitious goals to tackle the climate crisis and associated impacts to critical resources including water, now is the time to utilize digital technologies, including artificial intelligence (AI) and machine learning, blockchain technologies, crowdsourcing platforms, data analytics, the internet of things (IoT), and software and systems. Additionally, as the Federal government utilizes these digital tools and platforms as essential tools within our Federal climate policy, it is paramount that both the Federal government and private industry use robust safeguards to protect both the infrastructure and data from malfeasant actors. Not only are these digital technologies an important economic driver for the United States, but they also drive innovation. Our government, industries, and businesses need to harness these digital technologies to accelerate environmental progress, advance decarbonization, and unleash solutions to address the current and projected risk posed by climate change.

II. *Digital Technologies will Enable Data-Driven, High-Quality Sustainable Information*

As more businesses commit to reaching net-zero by 2050, companies will need high-quality, data-driven sustainability information that aligns upstream and downstream emissions with decarbonization goals. Companies will need to invest in digital innovations in the measurement, reporting, and verification sector (Digital MRV) to quantify emissions-reduction technologies, systems, and solutions across their business activities. Through utilizing Digital MRV, companies can ensure their sustainability data is transparent, trustworthy, and transactable, positioning them to effectively transition to low-carbon business models and markets.

III. *Utilizing Digital Technologies to Scale Sensors and Software, Standardized Metrics, Enable Supply Chain Data Transparency and Interoperability, and Eliminate Silos*

As we look to unleash markets, including increasing United States export opportunities, spur innovation, and accelerate decarbonization, now is the time to embrace digitalization for sustainability, including:

- scaling sensors, software, and analytics;
- standardizing metrics;
- enabling supply chain data transparency and interoperability; and
- eliminating silos to accelerate adoption.

IV. *Digital Technologies Are a Key Enabler to a Sustainable Economy*

Major sectors of the United States' economy—buildings, infrastructure, including water infrastructure, industrial, data center, and transportation sectors—are undergoing a digital transformation. Crosscutting digital tools and platforms are already being deployed to successfully analyze, optimize, and monetize this data in new ways, affording tremendous opportunity to address the climate crisis within these sectors.

V. *A Way Forward: Utilizing Digital Technologies to Address the Climate Crisis*

While American businesses and consumers are demanding a new market paradigm that encourages both economic competitiveness and sustainability, governments and policymakers play a critical role in accelerating this transformation and addressing the urgent climate crisis.

The document provides recommendations to the Biden Administration, the 117th Congress, and the private sector highlighting opportunities to leverage digital technology to address the climate crisis.

A. Policy Recommendations: Executive Branch

1. Continue to advance the United States' leadership role, both domestically and internationally, to address the climate crisis, including:
    a. Prioritizing digitalization in conjunction with ambitious National Determined Contributions to meet the goals of the Paris Agreement;
        i. Digital tools and platforms should be utilized to better identify, measure, and track greenhouse gas emissions to ensure actions are aligned with commitments;
    b. Supporting the Administration's formation of a climate team to execute a whole of government approach to solving the climate crisis; and
    c. Recommending that the Administration incorporate and leverage the voice and subject-matter expertise of the information technology industry when formulating solutions at both the domestic and international levels.
        i. Consider concrete ways of soliciting input on these issues through a business advisory panel or roundtable, and the Digital Climate Alliance is ready to provide recommendations and subject-matter expertise as a resource to strengthen solutions and their implementation.
2. Accelerate the Federal government's digital transformation and integrate systemic efficiency goals, including:
    a. Exploring opportunities to leverage the interconnectedness of digital tools and platforms, IoT-enabled software and analytics, and AI where applicable, to maximize efficiencies and decarbonization goals; and
    b. Prioritizing incorporating digital tools and platforms in buildings, both during planned new construction and retrofits, to reduce carbon emissions, including:

i. Developing Federal guidelines for measuring and reporting embodied carbon for construction materials; and

ii. Establishing Federal programs to incentivize or accelerate investments for the utilization of Building Information Modeling (BIM) and Building Energy Modeling (BEM) for new construction, including public, commercial, and residential buildings.

3. Establish an interagency working group, including the DOE, the Department of Homeland Security, and the Intelligence Community, working together to identify and mitigate threats to the electric grid that are inherent as the United States expands digital tools and platforms and modernizes the electric grid.

B. Policy Recommendations: Legislative Branch

1. Modernize and digitize U.S. infrastructure to accelerate decarbonization and strengthen resilience, including:
   a. Promoting the use of digital tools and platforms to design, construct, and operate smarter infrastructure that is more efficient, resilient, and sustainable;
   b. Closing the digital divide by injecting needed capital for broadband infrastructure in underserved areas of the country;
   c. Modernizing the nation's electric grid and water infrastructure utilizing smart, secure, and advanced software and hardware to design, construct, and operate to improve service and reduce waste, chemicals, and carbon use; and
   d. Modernizing the design, construction, and operation of buildings, including through Building Information Modeling (BIM) and Building Energy Modeling (BEM), to reduce operational and embodied carbon of the built environment.
2. Incentivize smart/advanced manufacturing to maintain the United States' competitive and technological advantage, advance workforce development to support the jobs of the future, all while enabling the United States to meet targets for net-zero emissions, including:
   a. Creating accessible and simplified Federal programs, loans, or incentives to upgrade, modernize, and invest in smart/advanced American manufacturing and workforce development; and
   b. Developing an "Accelerating Smart Manufacturing" public-private task force or advisory panel.
3. Direct the Federal government, working with the private sector, to develop a plan to fully inventory and assess digital climate solutions, including the standardization of both climate disclosure protocols and interoperability of data formats, specifically detailing the efforts of the Federal government and the private sector to promote the utilization of crosscutting digital tools and platforms.

C. Policy Recommendations: Private Sector, including the Technology Industry

1. Encourage the private sector in both the United States and globally to accelerate efforts to enhance sustainability and leverage technology and digital solutions to establish and achieve bold targets for decarbonization and resilience.
2. Develop new and strengthen existing public-private partnerships to accelerate the digital transformation, supporting decarbonization goals within key sectors of the U.S. economy.
3. Develop innovative financing models to advance the United States' emission reduction and decarbonization goals.

VI. Conclusion

The current public policy and regulatory frameworks have not kept up with technological advancements that will also help us address the climate crisis. As the United States and the world seek to accelerate decarbonization, digital tools and platforms will spur an efficient, resilient, and sustainable economy.

DIGITAL TECHNOLOGIES PROMOTE ECONOMIC OPPORTUNITIES, ADVANCE INNOVATION, AND ACCELERATE DECARBONIZATION

Throughout its history, the United States experienced revolutions driven by technology and innovation. Today, trends around decentralization, connectivity, and automation are enabling another transformation: a new era of digitalization. Every day, American innovators, entrepreneurs, and businesses are developing groundbreaking technologies to solve our country's most challenging problems. As the Federal government advances ambitious goals to tackle the climate crisis, now is the time to utilize existing digital tools and platforms, while continuing to innovate and develop the next generation of digital technologies, to accelerate environmental progress, advance decarbonization efforts, and unleash solutions to address the risk posed by climate change.

Unlike many energy and environmental technological innovations of past decades, emerging digital innovations are crosscutting digital tools and platforms that can be applied to the built environment to solve a myriad of challenges. They include:

- artificial intelligence (AI) and machine learning that enable increased automation;
- satellite data acquisition and analytics that enable enhanced visibility and insights into business operations;
- blockchain technologies that enable secure, decentralized, peer-to-peer transactions;
- crowdsourcing platforms that enable creative finance mechanisms and expose consumer preferences;
- the internet of things (IoT), which connects smart appliances, electronics, mobile devices, and sensors and enables them to communicate across a network; and
- software and systems that enable new business models for energy services.

Digitalization is a Significant Economic Driver

Digitalization is a significant economic driver – spurring growth and job creation throughout the global economy. Digital tools and platforms are creating a generation of smart infrastructure and enabling more predictive asset management to strengthen efficiency and resilience. We need to utilize these innovations to grow key economic sectors within the United States, including buildings, infrastructure, data centers, industrial, and transportation sectors.

According to the Organisation for Economic Co-operation and Development (OECD), "Effective use of digital tools is increasingly essential for small and medium-sized enterprises to improve business processes, innovate, scale up and internationalise." (OECD, 2020). However, in the most recent United Nations E-Government Survey, the United States ranks 9th in the United Nations E-Government Development Index – behind the Republic of Korea, Australia, New Zealand, and five European countries. (Department of Economic and Social Affairs, 2020). We must do better. To accelerate progress, the United States should seek to close the digital divide and invest to build out the nation's digital infrastructure.

Over the coming decade, digital tools and platforms will significantly transform the economy. Information technologies such as advanced mobile communications (5G), cloud and edge computing, IoT, data analytics, AI, and blockchain will fundamentally alter the building and construction, banking, agriculture, manufacturing, and energy sectors across the globe.

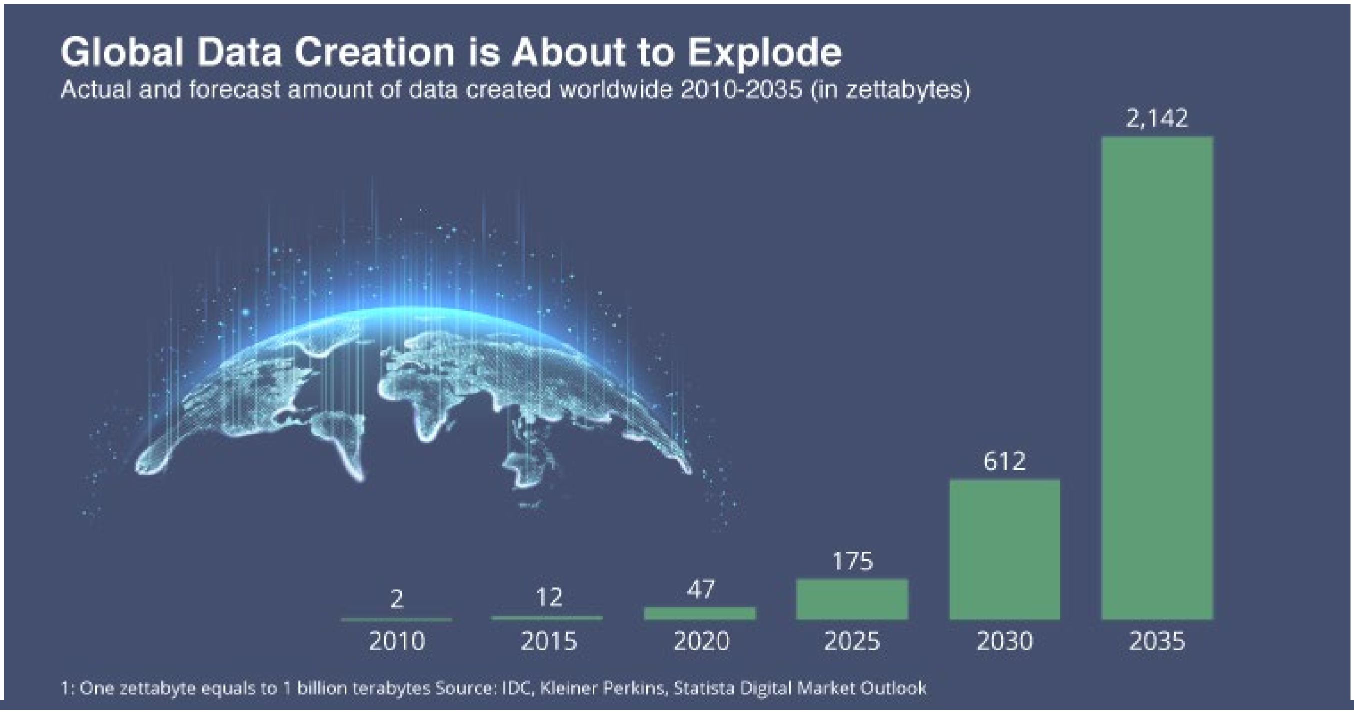
Digitalization is Innovation and More Can be Done

The rise of the internet and digitalization was the biggest driver of economy-wide, systems change in our lifetime, resulting in transformational change in social relationships, global connectivity, science, communications, politics, and governance. (EC-MAP, 2018).

Across key industry sectors in the United States, information and communications technologies are intersecting in a variety of ways, including through data collection, data analytics, and real-time communications networks. Moreover, advances in computing and machine learning enabled advanced functionality to be embedded within industry delivery systems and distribution networks. (EC-MAP, 2018).

While most people are familiar with Moore's Law, which describes exponential improvements in computing power, similar dramatic trends are also observed when looking at many modern technologies (e.g., DNA sequencing, LED lights, computing power, data storage, and wireless data transfer). According to the McKinsey Global Institute, 98% of the U.S. economy is already impacted by digitalization. Moreover, rapid adoption of clean energy technologies will also create jobs, while driving efficiency improvements in the built environment, electrifying end-uses through equipment manufacturing and installation, and upgrading the electric infrastructure. However, for high performance systems such as AI or machine learning to thrive, a digital infrastructure must be in place to facilitate the data computation. For example, the common data center is not equipped to handle this type of computing with the average rack density being 8.2 kilowatt (kW) per rack (AFCOM State of the Data Center Report, 2020), while an AI application requires more than 30 kW per rack. As more data centers turn to liquid cooling to enable this digital advancement, potable water and energy resources are tapped.

- Energy: Several models predict that data center energy usage could engulf over 10% of the global electricity supply by 2030 if left unchecked. (McNerney, 2019). Such growth would indicate similar increases for both greenhouse gas emissions and e-waste produced.

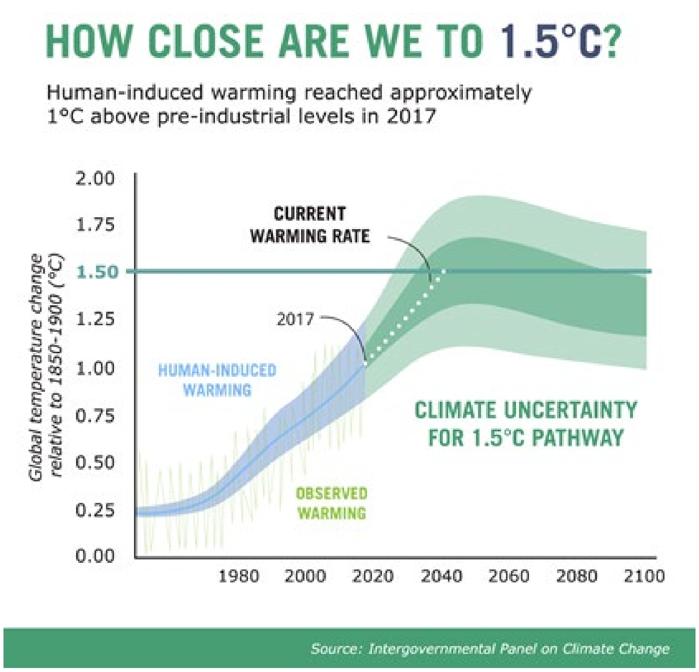


- Water: According to the United Nations, demand for fresh water globally will exceed available supplies by 40% by 2030. (UNEP, 2016). For data centers, which typically use up to 8 million gallons of water per year per megawatt (MW) (Tenuta, 2019), water scarcity threatens future growth and operational reliability.

Water-cooling systems for data centers, however, are available that do not consume public drinking water, or use water treatment chemicals and chemical refrigerants that are potent greenhouse gases and ozone depleting substances.

To Address Climate Change, the United States Needs to Embrace Digital Technologies

There is a pathway to creating an efficient, resilient, and decarbonized economy. Since the creation of the Intergovernmental Panel on Climate Change (IPCC) in 1988, climate science made tremendous progress in understanding human impacts on the climate. Since the beginning of the 20th century, global temperatures increased by approximately 1-degree Celsius and it is widely acknowledged that human-induced greenhouse gas emissions are the key root cause of this rapid change in global climate.



NAUTILUS® DATA TECHNOLOGIES

Nautilus Data Technologies created the world's most environmentally innovative water-cooled data center design, setting a new standard for efficiency, sustainability, and global scalability. The patented TRUE™ ("Total Resource Usage Effectiveness") cooling closed water loop technology integrates proven maritime and industrial water-cooling systems with next-generation data center infrastructure to mark a new era of performance for the data center industry.

In 2020, Nautilus commissioned its first commercial data center in Stockton, California, validating water-cooling superiority for data centers. The system enables high-density computing at more than 100kW a rack, opening the door to wide-scale availability of more powerful high-performance computing applications using AI and machine learning. Compared to the traditionally cooled data center, it is possible to achieve up to 70% increase in cooling efficiency and 30% more net energy efficiency. The system also maintains a 1.15 power usage effectiveness every day of the year. The technology trims carbon emissions by 30% and offers a 100% reduction in water consumption, with zero pollution from ozone-depleting refrigerants or chemicals and no harm to terrestrial and aquatic biodiversity.

The IPCC models demonstrate that human-induced emissions should be zeroed by 2050 in order to hold a reasonable chance to remain within a 1.5-degree Celsius increase, which is often considered the safety line or the line below which impacts on biodiversity and weather would remain contained (IPCC, 2014; 2018).

The necessary transition to a sustainable economy should not come at the expense of the U.S. economy and living standards. Rather, this is an opportunity to redefine progress through innovation. If we are serious about addressing the climate crisis, we should utilize digital tools and platforms to accelerate decarbonization and grow the United States' economy.

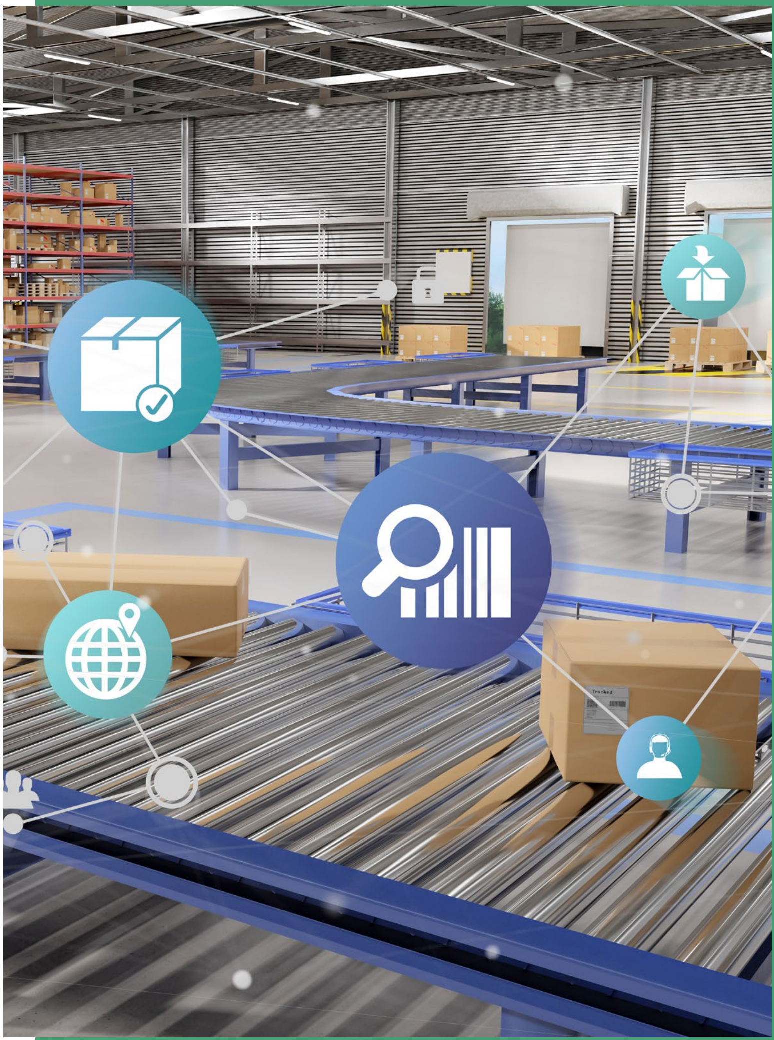
DIGITAL TECHNOLOGIES WILL ENABLE DATA-DRIVEN, HIGH-QUALITY SUSTAINABLE INFORMATION

As more businesses commit to achieving environmental sustainability goals for carbon emissions, energy, water, and waste, there is a critical need to develop real-time data to quantify and report impacts. When it comes to carbon emissions accounting, companies need high-quality, data-driven sustainability information to align upstream and downstream emissions with their decarbonization goals.

Moreover, sustainability data can be used for a variety of practices including:

- measuring commercial risk and opportunities for products, commodities, and investments;
- increasing environmental, social, and governance (ESG) accountability and standardization;
- creating more informed consumer markets to serve the growing market demand for products with fewer climate impacts;
- allowing sectors and businesses to set actionable net-zero targets; and
- helping investors evaluate companies' climate risk profiles, including their emissions, and align investment decisions to transition to a net-zero economy.

Evaluating a business's carbon footprint and measuring emissions reductions across its entire supply chain is complex. To evaluate their performance against their stated net-zero targets, companies need real-time information, which is traceable and verified from end-to-end. Digital tools and platforms enable the processing of staggering amounts of data, coming from sources along the business value chain, allowing businesses to monitor Scope 1, 2, and 3 emissions. Scope 1 emissions are "direct emissions from owned or controlled sources", Scope 2 emissions are "indirect emissions from the purchase of electricity, steam, heat, or cooling", and Scope 3 emissions are "all indirect emissions (not included in Scope 2) that occur in the value chain of the reporting company, including both upstream and downstream emissions." (EC-MAP, 2020). As such, leveraging digitalization is the only way for companies to track their environmental performance and impact (i.e., footprint and handprint, respectively).



Digital hardware and software tools, including aerial platforms for imagery, sensors for data (e.g., LIDAR), edge computing, and cloud-based platforms, help to collect and process environmental data about raw materials, products, and supply chains. Once the data is collected, the next step is to turn this data into meaningful information that will allow investors, consumers, and conscientious buyers to place a value on sustainability metrics. Digitized data on sustainability is essential for products to remain relevant and viable, and for businesses to have a significant impact in the future.

Furthermore, it is imperative for companies to invest in digital innovations in the measurement, reporting, and verification sector (Digital MRV) to quantify emissions-reduction technologies, systems, and solutions across their business activities. (EC-MAP, 2020). As a solution to integrate climate change strategies and commitment, combined with digital tools and platforms, Digital MRV delivers:

- low-carbon supply chains, carbon credit projects, green procurement, products, and technologies;
- transparent data for better policy decisions;
- reduced transaction costs for ecosystem services markets; and
- quality sustainability information for investors to minimize risk.

The Necessity for Sustainability Data that is Transparent, Trustworthy, and Transactable

Ultimately, businesses will require digital tools and platforms that provide high-quality sustainability data that is transparent, trustworthy, and transactable to be best positioned to transition to low-carbon business models and markets.

The Carbon Handprint

Across the globe, policies are being implemented to simultaneously reduce emissions, grow the economy, and improve living conditions for billions of people. These initiatives (e.g., electrification with clean energy, industrial and building emissions reductions and energy management, and reduction in transport emissions) will all rely heavily on information and communication (ICT) technologies. Investments made by businesses in advanced ICT technologies can help all economic sectors achieve a lower carbon footprint. The concept of applying digitalization to enable emissions reduction is termed the "handprint" or the enabling power of the ICT sector to reduce other industries' carbon, energy, and/or climate footprint.

While there is a growing interest in the market to redefine the environmental performance of products and commodities to reflect the downshift in carbon emissions, unfortunately, the current data available to meet that interest is characterized by a lack of visibility along the supply chain of an environmental product or commodity. As such, transparency will enable innovation in business models, technologies, and operational processes.

Even as digital tools and platforms are emerging to collect data and revealing the environmental impacts of products, the data must also be trustworthy. For example, within the business community, the fewer assumptions businesses must make regarding the integrity of the data, the more reliably it can be transmitted and used to make investment decisions. As such, the ability to independently verify or audit the sustainability data for products using standardized metrics will ensure greater credibility for all stakeholders involved.

Research shows that there is an increase in overall demand for sustainable and low and zero emissions products by investors and consumers. (BlackRock 2020 Global Sustainable Investing Survey, 2020). To meet this demand and capture these economic opportunities, businesses need data that can be compared across similar products and have a consistent market value (i.e., businesses need the data to make the environmental attribute of the product or commodity transactable in the market) and leveraged into transactable market-based solutions, like credits or tokens. Once data is transparent and trustworthy, businesses and consumers will have more opportunities to benefit from their investment decisions, whether that's utilizing electric cars, promoting responsibly-sourced natural gas or clean energy sources, or optimizing construction and buildings.

Xpansiv

Xpansiv is a data-refinery company that is creating a global commodity marketplace through ESG-inclusive energy and carbon products and price information. These Intelligent Commodities™ bring transparency and liquidity to markets, empowering participants to value energy, carbon, and water to meet new sustainability challenges.

Xpansiv processes real-time commodity production data using AI-enabled systems to create what the company calls "Digital Feedstock," a secure digital asset that contains an accurate, verified profile of the life cycle environmental characteristics of a given commodity. The company leverages the power of remote sensing, digital monitoring, deep learning, and a distributed ledger platform (i.e., blockchain technologies) to reveal the specific environmental attributes (such as GHG intensity, water use, and land disturbance) that differentiate a low-carbon commodity from a higher polluting alternative. This allows investors to differentiate between clean and dirty commodities and transact the environmental attributes of the products in the market.

UTILIZING DIGITAL TECHNOLOGIES TO SCALE SENSORS AND SOFTWARE, STANDARDIZED METRICS, ENABLE SUPPLY CHAIN DATA TRANSPARENCY AND INTEROPERABILITY, AND ELIMINATE SILOS

As we look to unleash markets, spur innovation, and accelerate decarbonization, now is the time to embrace digitalization for sustainability, including:

- scaling sensors, software, and analytics;
- standardizing metrics;
- enabling supply chain data transparency and interoperability; and
- eliminating silos to accelerate adoption.

The United States should be the Leader in Digital Innovation

The United States is home to the first innovation ecosystem and is the world leader in emerging technologies, specifically digital tools and platforms. However, in recent years, the United States has fallen behind other nations in the UN's E-Government Survey, which is designed to provide a snapshot of country trends and relative rankings of e-government development in the implementation of the Sustainable Development Goals. As the United States is re-asserting itself to be the leader addressing the climate crisis, we need to re-establish its competitive edge and continue to invent and export digital technologies. Moreover, digital technologies will not only help the United States address the risks posed by

Intel is a world-leading manufacturer of semiconductors that power the vast majority of the world's personal computers and data centers. In addition, it is an innovation leader in Internet of Things (IoT), Artificial Intelligence (AI), electricity grid modernization technologies, and other digital solutions.

Intel, working with its partners at Dell and VM Ware, has developed a technology solution known as "micro data center for substations." It transforms the traditional electrical grid substations into flexible infrastructure which makes it easy for utilities to deploy applications at the edge. Utilities are facing increased customer demand for clean energy derived from renewable resources. The challenges associated with meeting this demand include: greater penetration of distributed energy resources; increasing penetration of electric vehicles (EVs); increasing electricity demand from data centers; and the intermittent nature of renewable energy sources. We have found that the best way to meet these challenges is to build an intelligent edge computing capability using data-centric technologies. This entails separating hardware from application software; deploying standardized hardware; and employing virtualization technologies to run multiple applications. The benefits of utility implementation of this technology include more flexible and scalable compute infrastructure; improved reliability, safety, and security; and reduced operations and maintenance costs.

climate change, but they will also open doors for economic growth in the clean energy sector and create jobs.

The United States Should Utilize Digital Technologies to Develop Standardization of Metrics and Promote Interoperability of Supply Chain Systems

In the United States and across the globe, the speed and complexity of digitalization often outpaces our current understanding of legal and regulatory frameworks and policymakers' ability to respond to and anticipate its developments. At the same time, highly regulated industries possess limited understanding of the most appropriate means to harness and utilize digital platforms as a tool to drive decarbonization. If digitalization is going to enable a sustainable economy, complex governance issues will require standardization of both climate disclosure protocols and of specifications of data formats. We need to create an interoperable network of emissions data across the supply chains for all sectors. (Girard, 2020).

Digital Technologies will Eliminate Silos in the Market to Accelerate Adoption

Existing duplication and redundancy within both the market and Federal government create inefficiencies and delays policy implementation. This results in wasteful spending, dilution of dedicated resources, and confusion between participants and decision makers, as well as beneficiaries and external stakeholders. In the private sector, there is a demand for standardized carbon accounting, however, silos exist between the different sectors and methodologies. Digital tools and platforms should be utilized to eliminate these silos, increase comparability and reliability of data measures, and promote interoperability of the platforms.

Smart Grid Technologies

Standards provide a level playing field for industry and help build trust between participants in supply chains. They serve as a "handshake" between various components of systems and allow for interoperability. In the early 2000s, concepts for a "smart grid" began to emerge, but there were no standards for power plants, meters, buildings, vehicles, and other devices and systems to communicate with the grid. Without standards, smart grid technologies were at risk of becoming prematurely obsolete or being implemented without necessary security features.

In 2007, Congress directed the National Institute of Standards and Technology (NIST) to coordinate development of a framework and standards to achieve interoperability of smart grid devices and systems. In 2010, NIST published a "Framework and Roadmap for Smart Grid Interoperability," including a "reference model"—a tool for defining and developing architectures for systems and subsystems within the smart grid and ensuring interoperability and cybersecurity.

Today, the NIST Smart Grid Interoperability Panel (SGIP) maintains a catalog of standards and provides an open process for stakeholders to interact and accelerate standards harmonization and advance the interoperability of smart grid devices and systems. As of December 2020, 88 million smart meters have been deployed in the United States, representing 57% of all electric meters.

Source: Department of Energy Office of Electricity (DOE-OE). (2019). Recovery Act: Standards and Interoperability. Standards Interoperability.

DIGITAL TECHNOLOGIES ARE A KEY ENABLER TO A SUSTAINABLE ECONOMY

Major sectors of the United States' economy—buildings, infrastructure, including water infrastructure, data center, industrial, and transportation sectors—are undergoing a digital transformation. In recent years, ubiquitous connectivity, inexpensive data storage, and faster networks for data transmission have led to exponential growth in data. Crosscutting digital tools and platforms are already being deployed to analyze, optimize, and monetize this data in new ways, affording tremendous opportunity to address the climate crisis within these sectors.

Digital Technologies Accelerate Decarbonization by Enabling Smarter Buildings

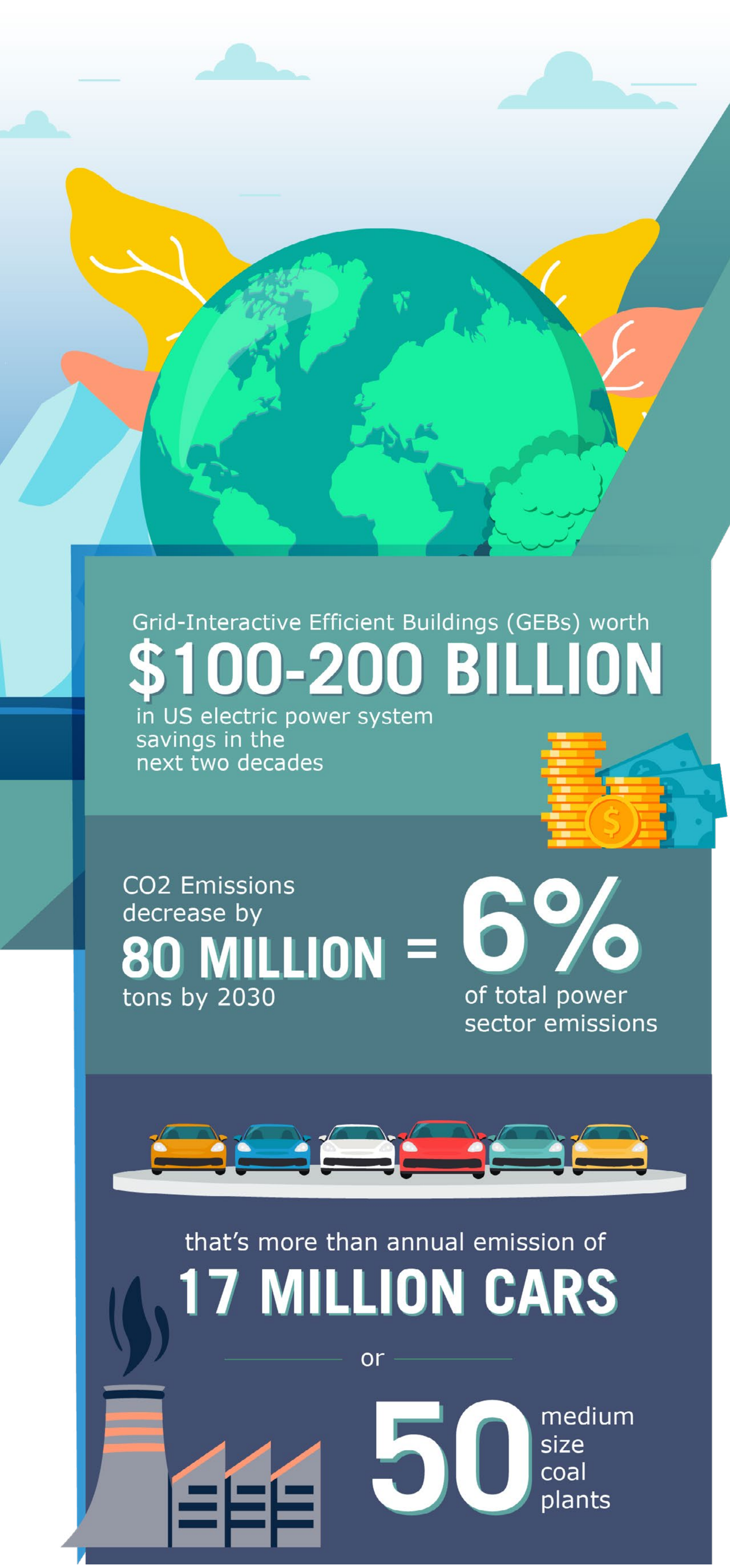
In buildings, several studies demonstrated that the deployment of digital controls could typically bring 20-30% efficiency in residential and up to 50% efficiency in commercial buildings, primarily due to granular and real-time control of energy use by partitioning time and space use. The simple deployment of smart thermostats in households could help save 15-50% of energy use. Deploying smart thermostats also result in paybacks generally lower than 5 years, compared to traditional passive efficiency measures which range from 10 to 30 years, because they are much less intrusive (Energy 3.0, 2013; EU Buildup, 2017; International Energy Agency, 2012). This was confirmed by a recent report from the International Energy Agency (2017) which, accounting for conservative adoption rates, estimated that globally, the deployment of digital controls could help save 10% of total energy demand in buildings by 2040.

Schneider Electric

Schneider Electric drives digital transformation by integrating world-leading process and energy technologies to realize the full efficiency and sustainability opportunities for businesses. Schneider uses an open, interoperable, IoT-enabled system architecture and platform called EcoStruxure to leverage advancements in IoT, mobility, sensing, cloud, analytics, and cybersecurity.

Schneider worked with Boston Scientific, a global developer and manufacturer of medical devices, to help achieve its goals of creating a more sustainable corporate campus and reducing energy waste for its new 645,00 square foot headquarters. By leveraging digital tools such as EcoStruxure Building Advisor and Buildings Operation software, Boston Scientific could receive in-depth analytics about its footprint.

With the ability to monitor over 9,000 data points, harness advanced algorithms, and track trends, Boston Scientific could discern when energy could be saved, and receive actionable insights and specific recommendations to achieve its strategic goals. Within the first year of its implementation, the recommendations given by EcoStruxure Building Advisor enabled the company to achieve a 160,000-kWh reduction in its energy use and shrink its carbon footprint by 114 metric tons of CO_2.



Looking ahead, grid-interactive efficient buildings (GEBs), energy efficient buildings with smart technologies characterized by the active use of distributed energy resources (DERs), will be able to optimize energy use for grid services, occupant needs and preferences, and cost reductions in a continuous and integrated way. In doing so, GEBs can play a key role in promoting greater affordability, resilience, environmental performance, and reliability across the U.S. electric power system.

A recent report by the U.S. Department of Energy (DOE) states that "[O]ver the next two decades, national adoption of GEBs could be worth between $100–200 billion in U.S. electric power system cost savings. By reducing and shifting the timing of electricity consumption, GEBs could decrease CO_2 emissions by 80 million tons per year by 2030, or 6% of total power sector CO_2 emissions. That is more than the annual emissions of 50 medium-sized coal plants, or 17 million cars." (Building Technologies Office, DOE-EERE, 2021).

Currently, however, existing technical and market barriers along the GEB value chain are preventing customers from realizing these benefits. To overcome existing challenges related to interoperability and cybersecurity concerns, technological advancements are needed. Spurred by digital tools and platforms, these advancements will also provide deeper and more reliable load impacts.

To advance adoption of technologies utilized in GEBs, including harnessing their decarbonization potential, consumers will need to familiarize themselves with participation incentives, mitigate against perceived risks (e.g., complexity), and address insufficient participation incentive levels. (Building Technologies Office, DOE-EERE, 2021). Additionally, for utilities and other entities that are responsible for operationalizing the

Johnson Controls is a global digital solutions company with a leading portfolio of building products, technologies, software, and services to make buildings smarter. These buildings are embedded with more safety, comfort, and efficiency features, and are, ultimately, more sustainable.

In partnership with Stanford Energy System Innovations, Johnson Controls developed a new Central Energy Facility designed to meet the heating and cooling needs for Stanford University's campus. Johnson Controls delivered a customized engineered heat-recovery system and developed a predictive control software system to optimize cost and energy-use throughout the facility. The plant utilizes high-efficiency chillers and heat pumps, thermal storage, and is controlled by OpenBlue Central Utility Plant – a digital solution that utilizes AI to optimize equipment and ensure heating and cooling loads are met as efficiently as possible.

The use of model predictive controls sets a forward-looking heating and cooling plan and leverages over 1,200 variables including energy prices, load forecasts, and equipment capabilities. The Central Energy Facility will help Stanford slash GHG emissions by 68%, reduce water consumption by 15%, and save $420 million in utility costs over 35 years.

technology benefits, including reducing system costs and emissions, regulatory officials should provide certainty, allowing these stakeholders to consider GEBs as an alternative to other resource investments. As the United States seeks to accelerate decarbonization in the buildings sector, policymakers and regulators need to be aware and understand the potential of GEB advancements.

Digital Technologies Change the Way Business is Conducted for Infrastructure

"Infrastructure is ALL of the physical systems that a community or a country needs in order to operate. That is a lot more than roads, streets, and bridges." (J. Gordon Arbuckle, 2025 Law and Policy, LLC). While digital tools and platforms can significantly improve how physical systems are built and operated, they also play an important role in modernizing and decarbonizing buildings, roads, bridges, rail and transit, water infrastructure, data centers, and the electrical grid.

Looking at the water infrastructure sector, current trends are also shifting towards digitalization. Deployment of big data and digital solutions are enabling more cost effective and smarter management of water supplies and aging infrastructure. Furthermore, a widespread digital transformation of the water sector ("digital water") is imperative to its efficiency, sustainability, and ultimately, long-term financial and operational resilience. (National Municipal Stormwater Alliance, 2021).

Digital water enables real-time insight into the quality and performance of a water system's assets, allowing utilities and communities to make informed decisions about when to invest in infrastructure and extend the life of a water asset. (National Municipal Stormwater Alliance, 2021). Through utilizing digital water solutions, including algorithmic and insitu leak detection, asset management platforms, and augmented and virtual reality, utilities and communities benefit from preventive and predictive maintenance capabilities that reduce unexpected costs and prevent downtime of critical assets, helping utilities become more resilient. (Sarni, et.al, 2019).

Data can also enable more effective customer engagement, education, and communications. Robust and transparent communication with consumers not only helps justify utility actions (e.g., new investment, rate increases, system failure responses), but also promotes customer engagement related to their own actions. As a society, we are accustomed to instantaneous information; digital water creates instantaneous information on water usage, such as notifying customers of running toilets, unusually excessive usage, and tailored ways for a household to conserve. (National Municipal Stormwater Alliance, 2021).

Being deployed across multiple sectors, the digital twin is a concept that represents an IoT process, equipment, system, or other industrial assets digitally. It provides an accurate representation of the physical asset, which helps identify problems and allows managers to optimize a process before its execution. Digital twinning reveals the internal functions of the machines allowing for enhanced upkeep. Additionally, digital twins allow for the enhanced monitoring of inaccessible devices in remote locations such as wind turbines or pipelines situated under the roads.

Today, companies are using digital twin capabilities in a variety of ways. In the automotive and aircraft sectors, digital twins are becoming essential tools to optimize entire manufacturing value chains and design new products. In the energy sector, oil field service operators are capturing and analyzing massive amounts of data that is used to build digital models, which guide drilling efforts in real-time. Lastly, in a remarkable feat of smart-city management, Singapore uses a detailed virtual model of itself in urban planning, maintenance, and disaster readiness projects. In 2020, the digital twin market was valued at $3.1 billion and is anticipated to grow to $48.2 billion over the next five years. (EC-MAP, 2020).

When it comes to the power sector, the deployment of digital tools and platforms could help save 5% of generation and transmission and distribution (T&D) operating costs and extend the lifetime of infrastructures by around 5 years. (International Energy Agency, 2017).

AUTODESK

Autodesk, Inc. is a global leader in design and makes software for architecture, engineering, construction, media and entertainment, and manufacturing industries. Their software and services harness emerging technologies—such as additive manufacturing (3D printing), artificial intelligence, generative design, industrialized construction, and robotics—that give companies and individuals the power to work more quickly, effectively, and sustainably through the entire project lifecycle.

The Norwegian Public Roads Administration authority is using the Autodesk Forge platform to help them achieve a smart transport and modern road construction system for a $500 million transport project in southern Norway. The construction, design, and engineering comprised of roads, tunnels, and bridges spanning 19 kilometers, which meant multiple streams of data that had to be coordinated with the project managers and workers.

Using these creative application programming interface (API) capabilities helped the project team aggregate the data and enable interoperability across the project's platform. Forge enabled the construction design team to achieve their ambitious goal of a 20% carbon emissions reduction, in comparison to a conventional road project.

Water Foundry is proving a First-of-Its-Kind Digital Watershed™ Project to Address Impacts to Climate Change on The Colorado River Basin.

Reduced availability of clean drinking water around the globe is arguably the biggest issue of our time. As extreme weather events increase and groundwater is “mined”, quality and quantity become intrinsically related in a cycle of decline.

The Colorado River Basin is a prime example of the trajectory of clean water scarcity in the United States. When the River’s water was allocated in 1922, it was one of the wettest years on record. The watershed now faces the impacts of increasing demand for water and climate change.

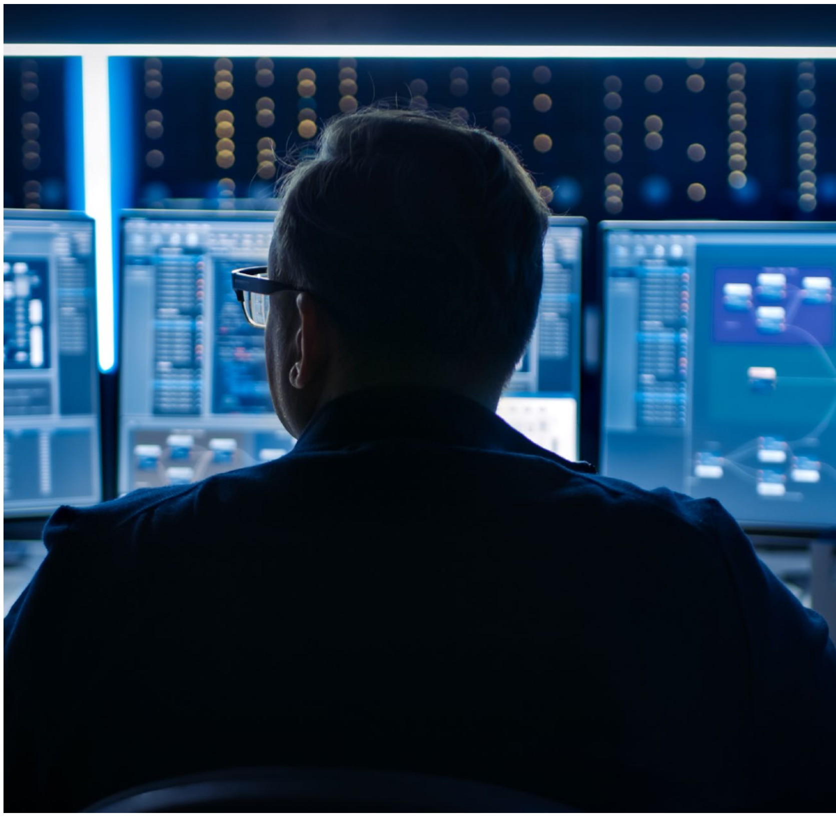
The Water Foundry and True Elements are tackling the problem by way of a first-of-its-kind intelligent data and forecasting solution. We believe the solution is found in creating a digital twin (the business eco-system affected by water) and a network approach to address increasing demand for water and the impacts of climate change.

Tracking data from every drop of water and what happens to it on the path from raindrop to faucet and back, we can score and forecast water quality down to the neighborhood block and look at solutions for the watershed as a system, rather than simply an individual problem.

There is also significant potential to optimize the utilization of energy assets. The integration of electrified loads (i.e., heat pumps and electric vehicles (EVs)) and decentralized supply (i.e., rooftop solar and batteries) at the building or factory level (i.e., microgrids or grid-interactive efficient buildings) have the potential to provide momentous flexibility, including promoting systemic efficiency, to the entire energy system (World Economic Forum, 2020a, 2020b), which is enabled by real-time control capabilities, supported by pervasive digital tools and platforms. The International Energy Agency (2017) estimated that up to 20% of electricity demand could become eligible to demand response mechanisms by 2040, a likely conservative figure, impacting the way current power infrastructures are designed and their cost.

Digital Technologies Spur Growth in the Industrial Sector

Advancements in digital tools and platforms would also benefit the industrial sector.



Specifically, utilizing better process controls could help reach an average of 7% energy efficiency with paybacks below 4 years and above 10% including all feasible measures. (International Energy Agency, 2017; Climate Works, 2012).

McKinsey's Global Institute predicts that IoT will have an economic impact of around $11 trillion by the end of 2025. (2019 State of IoT Report, Particle, 2019). Specifically, the growing demand for automation, centralized monitoring, and predictive maintenance are leading the IoT technology most prominently in the manufacturing industry.

Additionally, the Industrial IoT (IIoT) market is expected to reach $263.4 billion by 2027. (Meticulous Research, 2020). The growing trend of Industry 4.0, otherwise known as the Fourth Industrial Revolution, is the current automation of manufacturing and industrial abilities through the application of smart technologies. Across the globe, Industry 4.0 enabled IIoT to become an integral part of the business process, where data is a key asset, and analytics is a necessity in the connected sphere of products. Moreover, the IIoT can help gather new information, offer insights into business-critical processes, and act upon issues in real-time—this is extremely valuable for the industrial marketplace. Thus, the IIoT is widely used in automation, optimization, and achievement of tactical or strategic goals in the competitive industrial sector.

Rising investments for IIoT-enabled projects, which led to the extensive adoption of various components, services, and connectivity modules, are a key driving factor for the IIoT solutions' dominance in the market in recent years. Looking ahead, this segment is expected to witness a high growth rate owing to the consistent engagement of the industrial sector in improving efficiency, reducing costs, and increasing the Overall Equipment Effectiveness (OEE) through better access to information from real-time solutions.

enel

Enel is a renewable energy leader and innovator in the United States and Canada, helping companies and consumers find value in sustainability. Through Enel Green Power, Enel X, and their Global Trading divisions, they provide a full spectrum of energy services to businesses, utilities, municipalities, and other commercial energy users. Using drones and big data analytics, Enel supports innovative diagnostics of renewable plants cross applied with advanced digital technologies.

From Enel Green Power's Innovation Lab in Catania comes ARP (Autonomous Robot Platform for renewable plants), a robotic system that uses a self-driving land rover, equipped with a self-driving drone base, that helps to identify irregularities in photovoltaic modules before they can cause failures or inefficiencies. This allows for a significant reduction in inspection times for large-scale renewable plants, going from 200 days using conventional methods to just 13 days while saving on maintenance costs. This enhanced capability guarantees greater autonomy, higher resolution and efficiency to monitor the performance of a solar PV system.

Besides making valuable information available to plant managers, Enel's predictive maintenance network also deploys sensors, IoT, artificial intelligence and other robots to perform inspection missions to guarantee the rapid and safe development of renewable energy.

Digital Technologies Promote Increased Efficiency in the Transportation Sector

In the transportation sector, beyond electrification, digital tools and platforms will dramatically improve optimization. The International Energy Agency (2017) estimates that the deployment of digital technologies could enable as much as 40% savings on energy demand, by the combination of vehicle automation, the deployment of multimodal transportation systems, and transport as a service (TaaS). This would affect both private transportation as well as on freight transport. Moreover, transportation must go beyond being an enabler of the digital economy to itself harnessing the power of technology.

The think tank RethinkX (2017) estimates that rapid deployment of TaaS could reduce costs of transportation by 3-10 times by 2030 in the United States, leading to a sharp reduction of vehicles on the road and thereby reducing emissions.

Today, trends around decentralization, connectivity, and automation are transforming transportation—including how governments build and finance infrastructure and how consumers access it for mobility. The market for intelligent transportation systems in the United States nearly doubled between 2012 and 2017 and is on pace to more than triple by 2022. (EC-MAP, 2018). Moreover, Strategy Analytics projects that autonomous vehicles will be a $2 trillion industry in the United States by 2050 (Marshall, 2017), while McKinsey & Company projects that storing, organizing, and analyzing data from cars will be a $750 million market by 2030. (EC-MAP, 2018).

The dominant transportation systems in use today rely on inventions born during the industrial revolution. As WRI research shows, new digital tools and platforms are beginning to change this, creating entirely new business models and disrupting the market. (Canales et al., 2017). In many cities, it is possible to request a taxi or shared car with the push of a button. Commuters

TRANE TECHNOLOGIES™

Trane Technologies is global-climate innovator that aims to bring efficient and sustainable climate innovations to buildings, homes, and transportation. Trane Technologies provides holistic system-level improvements and operational monitoring and support to drive continuous energy efficiency.

For example, Trane helped lead the renovation of a 1.5M square foot mixed-use development called the Crosstown Concourse in Memphis, TN. Built in 1927, it had been vacant for over 20 years. Trane provided a custom-designed high efficiency HVAC system with controls and smart meters throughout to drive energy efficiency gains. For ongoing support, the Trane Tracer© Ensemble™ cloud-based building management system optimizes daily operations and troubleshoots issues in an automated real-time way to deliver further operational sustainability gains.

As of 2017, this is the largest and oldest LEED Platinum Adaptive Reuse Building on the planet. As the tenant occupancy rate increases, the absolute building energy consumption has been decreasing by 3-6% year over year. The building automation system is a catalyst for new levels of efficiency even as the rentable space on the property becomes more occupied and complex.

can switch seamlessly from buses to trains to trams and back again. Bicycles can be found on every corner, unlocked remotely, and keyed to your phone. And sometime soon, autonomous cars will join the fray, perhaps even delivering goods to your front door. Collectively these “new mobility” services are radically reshaping the transport landscape.

In both passenger and freight transport, digital platforms are improving efficiency by providing new ways to match supply and demand. New platforms to share and dispatch freight trucks more efficiently are significantly reducing empty backhauling, for example.

Autonomous vehicles are smarter and lighter, promising the potential for better efficiency, fewer vehicles on the road and a sharp reduction in crashes. Smartphone alert systems and apps to report incidents and educate transportation users and providers are presenting new solutions to old problems.

Similarly, open data is allowing many to see comprehensively what transporation options are available to them, evaluate those choices, and make informed decisions. Looking ahead, smart digital solutions need to be a core element of any sustainable mobility strategy.

A WAY FORWARD: UTILIZING DIGITAL TECHNOLOGIES TO ADDRESS THE CLIMATE CRISIS

The current public policy and regulatory frameworks have not kept up with American businesses' technological advancements—advancements that will also help us address the climate crisis. While American businesses and consumers are demanding a new paradigm that encourages both economic competitiveness and sustainability, governments and policymakers play a critical role in accelerating the utilization of digital tools and platforms and addressing the urgent climate crisis.

While policymakers face the extreme challenge of tackling the climate crisis simultaneously while recovering from the COVID pandemic, many solutions involving digital technology could work together to benefit economic recovery, competitiveness, national security, and decarbonization efforts. The following recommendations to the Biden Administration and 117th Congress focus on opportunities to leverage digital technology to address the climate crisis.

As we seek to utilize digital tools and platforms as essential tools within our Federal climate policy, it is paramount that both the Federal government and private industry use robust safeguards to protect both the infrastructure and data from malfeasant actors.

Policy Recommendations: Executive Branch

1. Continue to advance the United States' leadership role, both domestically and internationally, to address the climate crisis, including:
    a. Prioritizing digitalization in conjunction with ambitious National Determined Contributions to meet the goals of the Paris Agreement;
        i. Digital tools and platforms should be utilized to better identify, measure, and track greenhouse gas emissions to ensure actions are aligned with commitments;
    b. Supporting the Administration's formation of a climate team to execute a whole of government approach to solving the climate crisis; and
    c. Recommending that the Administration incorporate and leverage the voice and subject-matter expertise of the information technology industry when formulating solutions at both the domestic and international levels.
        i. Consider concrete ways of soliciting input on these issues through a business advisory panel or roundtable, and the Digital Climate Alliance is ready to provide recommendations and subject-matter expertise as a resource to strengthen solutions and their implementation.
2. Accelerate the Federal government's digital transformation and integrate systemic efficiency goals, including:
    a. Exploring opportunities to leverage the interconnectedness of digital tools and platforms, IoT-enabled software and analytics, and AI where applicable, to maximize efficiencies and decarbonization goals; and
    b. Prioritizing incorporating digital tools and platforms in buildings, both during planned new construction and retrofits, to reduce carbon emissions, including:
        i. Developing Federal guidelines for measuring and reporting embodied carbon for construction materials; and

ii. Establishing Federal programs to incentivize or accelerate investments for the utilization of Building Information Modeling (BIM) and Building Energy Modeling (BEM) for new construction, including public, commercial, and residential buildings.

3. Establish an interagency working group, including the DOE, the Department of Homeland Security, and the Intelligence Community, working together to identify and mitigate threats to the electric grid that are inherent as the United States expands digital tools and platforms and modernizes the electric grid.

Policy Recommendations: Legislative Branch

1. Modernize and digitize U.S. infrastructure to accelerate decarbonization and strengthen resilience, including:
   a. Promoting the use of digital tools and platforms to design, construct, and operate smarter infrastructure that is more efficient, resilient, and sustainable;
   b. Closing the digital divide by injecting needed capital for broadband infrastructure in underserved areas of the country;
   c. Modernizing the nation's electric grid and water infrastructure utilizing smart, secure, and advanced software and hardware to design, construct, and operate to improve service and reduce waste, chemicals, and carbon use; and
   d. Modernizing the design, construction, and operation of buildings, including through Building Information Modeling (BIM) and Building Energy Modeling (BEM), to reduce operational and embodied carbon of the built environment.
2. Incentivize smart/advanced manufacturing to maintain the United States' competitive and technological advantage, advance workforce development to support the jobs of the future, all while enabling the United States to meet targets for net-zero emissions, including:
   a. Creating accessible and simplified Federal programs, loans, or incentives to upgrade, modernize, and invest in smart/advanced American manufacturing and workforce development; and
   b. Developing an "Accelerating Smart Manufacturing" public-private task force or advisory panel.
3. Direct the Federal government, working with the private sector, to develop a plan to fully inventory and assess digital climate solutions, including the standardization of both climate disclosure protocols and interoperability of data formats, specifically detailing the efforts of the Federal government and the private sector to promote the utilization of crosscutting digital tools and platforms.

Policy Recommendations: Private Sector, including the Technology Industry

1. Encourage the private sector in both the United States and globally to accelerate efforts to enhance sustainability and leverage technology and digital solutions to establish and achieve bold targets for decarbonization and resilience.
2. Develop new and strengthen existing public-private partnerships to accelerate the digital transformation, supporting decarbonization goals within key sectors of the U.S. economy.
3. Develop innovative financing models to advance the United States' emission reduction and decarbonization goals.

THE FUTURE OF THE UNITED STATES' CLIMATE POLICY IS DIGITAL

The speed of technological innovation in the United States, including advancements in digital tools and platforms, challenge existing regulatory frameworks and public policy.

As the United States and the world races toward net-zero, digital technologies will prove critical to enabling the innovations that will drive a more efficient, resilient, and decarbonized economy.

Moreover, digital tools and platforms will also secure America's energy future, reduce energy costs for businesses, and grow the economy.

Now is the time to embrace digital technologies for sustainability as they will allow us to scale sensors, software, and analytics, which along with standardization of metrics and the development of supply chain transparency and interoperability, will eliminate silos to accelerate adoption.

REFERENCES

1. AFCOM. (2020). (rep.). State of the Data Center Report - March 2020. Retrieved from https://www.afcom.com/Public/Member_Resources/Learning_Center/Research/Public/Resource_Center/Researchs_Public.aspx

2. BlackRock. (2020). (rep.). Sustainability goes mainstream 2020 Global Sustainable Investing Survey. https://www.blackrock.com/corporate/literature/publication/blackrock-sustainability-survey.pdf

3. Building Technologies Office. (2021). A National Roadmap for Grid-Interactive Efficient Buildings. U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy. https://gebroadmap.lbl.gov/A%20National%20Roadmap%20for%20GEBs%20%E2%80%93%20Final_20210517.pdf

4. Canales, D., Bouton, S., Trimble, E., Thayne, J., Da Silva, L., Shastry, S., Knupfer, S., Powell, M. (2017). Connected Urban Growth: Public-Private Collaborations for Transforming Urban Mobility. Coalition for Urban Transitions. Retrieved from http://newclimateeconomy.report/workingpapers/wp-content/uploads/sites/5/2017/11/NCE2017_CUT_UrbanMobility_02012018.pdf

5. Climate Works. (2012). Industrial Energy Efficiency Data Analysis Project. https://www.climateworksaustralia.org/resource/industrial-energy-efficiency-data-analysis-project-ieeda/

6. Department of Economic and Social Affairs, U.N. (2020). United Nations E-Government Surveys: 2020 Digital Government in the Decade of Action for Sustainable Development. Table 2.2 Countries in the Americas with the highest EGDI values (Page 46). https://publicadministration.un.org/egovkb/Portals/egovkb/Documents/un/2020-Survey/2020 UN E-Government Survey (Full Report).pdf

7. Department of Energy Office of Electricity (DOE-OE). (2019). Recovery Act: Standards and Interoperability. Standards Interoperability. https://www.smartgrid.gov/recovery_act/overview/standards_interoperability.html

8. Energy Consumer Market Alignment Project (EC-MAP). (2018). New Policy for an Era of Energy Digitalization: Transportation. https://ec-map.org/wp-content/uploads/2018/07/transportation-whitepaper.pdf

9. Energy Consumer Market Alignment Project (EC-MAP). (2020) The Role of Digitalization in Driving Demand for Industrial Decarbonization. https://static1.squarespace.com/static/5e544feb1567935b2bf69451/t/5e6aa41743c8037cd94b3e9d/1584047154017/Industrial-Sector-White-Paper_WEB.pdf

10. Energie 3.0. (2013). Débat sur la transition énergétique : les solutions concrètes de la filière éco-électrique. http://www.efficacite-electrique.fr/2013/01/transition-energetique-eco-

electrique/

11. EU Build up. (2017). Optimising the energy use of technical building systems. https://www.buildup.eu/en/practices/publications/optimising-energy-use-technical-building-systems-0

12. Girard, M. (2020). Data Standards Task Force for Digital Cooperation. https://www.cigionline.org/publications/data-standards-task-force-digital-cooperation/

13. International Energy Agency. (2012). Building Shell and Thermal Insulation. IEA Publishing. License: www.iea.org/t&c. https://iea-etsap.org/E-TechDS/PDF/R01_Building%20shell-thermal%20insulation%20FINAL_GSOK.pdf

14. International Energy Agency. (2017). Digitalisation and Energy 2017. IEA Publishing. License: www.iea.org/t&c. https://www.iea.org/digital/

15. Intergovernmental Panel on Climate Change (IPCC). (2014). Climate change 2014 synthesis report. https://www.ipcc.ch/site/assets/uploads/2018/05/SYR_AR5_FINAL_full_wcover.pdf

16. Intergovernmental Panel on Climate Change (IPCC). (2018). Global Warming 1.5 degrees. https://www.ipcc.ch/sr15/

17. MarketsandMarkets. (2020). (rep.). Digital Twin Market by Technology, Type (Product, Process, and System), Application (predictive maintenance, and others), Industry (Aerospace & Defense, Automotive & Transportation, Healthcare, and others), and Geography - Global Forecast to 2026. https://www.marketsandmarkets.com/PressReleases/digital-twin.asp

18. Marshall, A. (2018). Robocars Could Add $7 Trillion to the Global Economy. Wired. https://www.wired.com/2017/06/impact-of-autonomous-vehicles/

19. McKinsey. (2009). Unlocking Energy Efficiency in the US economy. https://www.mckinsey.com/~/media/mckinsey/dotcom/client_service/epng/pdfs/unlocking%20energy%20efficiency/us_energy_efficiency_exc_summary.ashx

20. McNerney, M. (2019, April 19). The Data Center Dilemma: Is Our Data Destroying the Environment? Data Center Knowledge. Retrieved from https://www.datacenterknowledge.com/industry-perspectives/data-center-dilemma-our-data-destroying-environment

21. Meticulous Market Research Pvt. Ltd. (2020). Industrial IoT (IIoT) Market to Reach $263.4 Billion by 2027, Growing at a CAGR of 16.7% From 2020 With COVID-19 Impact. GlobeNewswire News Room. https://www.globenewswire.com/news-release/2020/12/07/2140283/0/en/Industrial-IoT-IIoT-Market-to-Reach-263-4-Billion-by-2027-Growing-at-a-CAGR-of-16-7-From-2020-With-COVID-19-Impact-Meticulous-Research-Analysis.html

22. National Municipal Stormwater Alliance. (2021). The Agriculture and MS4 Sectors: A Digital Revolution. http://nationalstormwateralliance.org/wp-content/uploads/2021/06/NMSA_AgMS4DigitalReport_April2021_FINAL.pdf

23. Organisation for Economic Co-operation and Development (OECD). (2020). OECD Digital Economy Outlook 2020, Chapter 1. Going digital: An integrated approach to policy in the digital age. OECD Publishing, Paris. https://www.oecd-ilibrary.org/sites/bb167041-en/1/3/1/index.html?itemId=/content/publication/bb167041-en&_csp_=509e10cb8ea8559b6f9cc53015e8814d&itemIGO=oecd&itemContentType=book

24. Particle Industries (2019). 2019 State of IoT Report. Retrieved from https://cdn2.hubspot.net/hubfs/2833873/White%20Papers/Particle-IoT-Survey.pdf

25. RethinkX. (2017). Rethinking Transportation. https://www.rethinkx.com/transportation

26. Sarni, et.al. (2019). Digital Water: Industry Leaders Chart the Transformation Journey. https://iwa-network.org/wp-content/uploads/2019/06/IWA_2019_Digital_Water_Report.pdf

27. Tenuta, E. (2019). (rep.). Water Scarcity Could Put Your Data Center at Risk. UptimeInstitute - Research. Retrieved from https://www.google.com/l?sa=t&rct=j&q=&esrc=s&source=web&cd=&cad=rja&uact=8&ved=2ahUKEwjkuqL1ybrxAhWIW8oKHUxaC9gQFjABegQIBhAD&url=https%3A%2F%2Fwww.ecolab.com%2F-%2Fmedia%2FWiden%2FNalco-Water%2FWater%2FR-2009_Water_Scarcity_Could_Put_Your_Data_Center_at_Risk_pdf.pdf&usg=AOvVaw1PoYMWr545KFl2KDucqVuv

28. United Nations Environment Programme (UNEP). (2016, March 21). Half the World to Face Severe Water Stress by 2030 unless Water Use is "Decoupled" from Economic Growth, Says International Resource Panel. Retrieved from https://www.unep.org/news-and-stories/press-release/half-world-face-severe-water-stress-2030-unless-water-use-decoupled

29. World Economic Forum. (2020a). Net Zero Carbon cities. https://www.weforum.org/reports/net-zero-carbon-cities-an-integrated-approach

30. World Economic Forum. (2020b). System Value. https://www.weforum.org/projects/system-value

APPENDIX A: DIGITAL GLOSSARY

What is the Digital Climate Alliance (DCA)?

The DCA is a unique coalition made up of prominent global companies, teaming up with the purpose of informing and inserting into public policy the important role that digitalization plays as a critical catalyst for climate solutions.

What is the DCA Digital Glossary?

The DCA Digital Glossary provides definitions for digital infrastructure terms that are important to know when discussing the different facets of digitalization. Understanding the vocabulary will help elucidate the potential of digital mechanisms and its alignment with climate policy.

- ☐ AI
- ☐ Big Data
- ☐ Blockchain
- ☐ Cloud Computing
- ☐ Crowdsourcing
- ☐ Data Centers
- ☐ Digital Economy
- ☐ Digital Infrastructure
- ☐ Digital MRV
- ☐ Digital Supply Chain
- ☐ Digital Twin
- ☐ Edge Computing
- ☐ GitHub Repository
- ☐ Horizontal Integration
- ☐ Industry 4.0
- ☐ Internet of Things (IoT)
- ☐ Interoperability
- ☐ Predictive Analysis
- ☐ Machine Learning
- ☐ Sharing Economy
- ☐ Smart Manufacturing
- ☐ Vertical integration
- ☐ 5G

AI

Definition: Artificial Intelligence (AI) is a human intelligence simulation in computers designed to undertake tasks such as decision-making and problem-solving, for the purpose of solving complex issues.

Helpful Resource: 1:40 min. Qualcomm video explaining AI and various examples, like autonomous vehicles and AI in medicine.

Big Data

Definition: Big data is a simplified term used to describe large amounts of data that is collected. This data is used to help aid in better decision making and creating efficient business models, for example.

Helpful Resource: 3½ min. video explaining Big Data, examples of its use, and some of its strengths and weaknesses.

Blockchain

Definition: Blockchain is a digital database of information and transactions that are safely stored for transparent usage by associated groups and are strengthened to block hacking and cheating of the system.

Helpful Resource: 6 min. Simply Explained video explaining blockchain, how it works, and its uses.

Cloud Computing

Definition: Cloud computing is the use of the internet to deliver a variety of services, such as data storage, networking, and multiple communication processes.

Helpful Resource: 3 min. Amazon video explaining cloud computing and several applications in the real-world.

Crowdsourcing

Definition: Crowdsourcing is the use of the internet to gather people for enlistment of a particular service or project, for the purpose of gathering perspectives and information.

Helpful Resource: 5 min. NBC News Learn video explaining the science behind crowdsourcing and how it helps solve complex problems.

Data Centers

Definition: Data centers are facilities that stores, processes, and shares data, centralizing a specific organization's digital operations.

Helpful Resource: 0:38-1:11 Google Cloud Tech video explaining a data center.

Digital Economy

Definition: Digital economy refers to the innumerable economic activities that are based on digital technology and computing tools. For example, the use of Amazon to shop and sell items.

Helpful Resource: 1 min. Gig Economist video explaining digital economy and the synonymous terms related to it (i.e., internet economy).

Digital Infrastructure

Definition: Digital infrastructure is the foundation provided by digital technology and tools for an entity's (nation, city, state, region, organization) information technology operations.

Helpful Resource: Autodesk blog post explaining infrastructure digitalization, its purpose, and application.

Digital MRV

Definition: Digital measurement, reporting, and verification (MRV) summarizes the technology and data management tools that calculate, communicate, and validate results in real-time.

Helpful Resource: EC-MAP Digital MRV Page.

Digital Supply Chain

Definition: A digital supply chain is like any regular supply chain but is comprised of digital mediums used to supply a specific product or service, previously supplied in a physical form.

Helpful Resource: 4½ min. strategy and video explaining digital supply chain, why it is needed, and a practical example.

Digital Twin

Definition: A Digital twin is a virtual model of a particular service, product, or process used to analyze and monitor changes and problems.

Helpful Resource: 2 min. Geospatial World video explaining digital twin and its various applications.

Edge Computing

Definition: Edge computing is the method of obtaining, processing, and evaluating a collection of data at the source or near where it was created, for example sensors, phones, and laptops.

Helpful Resource: 3 min. IDG TECHtalk video explaining edge computing and examples of applications and processes.

GitHub Repository

Definition: A GitHub repository contains all the project files as well as a history of revisions for each file, for a specific user. The repository allows you to manage project work and collaborate with one another, as they can be shared or owned individually. Repositories can be used to ask and answer questions, collect user feedback, organize tasks, amongst other functions.

Helpful Resource:

Glossary of all GitHub related terms

1½ min. GitKraken video explaining Git Repository (0:00-0:36) and how to add and use it.

Horizontal Integration

Definition: Horizontal integration is when a business acquires another business that is in the same industry and is at the same stage of the supply chain.

Helpful Resource: Investopedia Page with video explainer.

Industry 4.0

Definition: Industry 4.0 – otherwise known as the Fourth Industrial Revolution – is the current automation of manufacturing and industrial abilities through the application of smart technologies, for example, AI and blockchain.

Helpful Resource: 2 min. University of Derby, UK video explaining Industry 4.0 and its real-world application.

Internet of Things (IoT)

Definition: The Internet of Things (IoT) is a concept that describes the interconnectivity and communication between various digital networks and devices – including smart meters, sensors, satellites, and other electronics – for the generation, collection, and exchange of data and information.

Helpful Resource: 3½ min. edureka! video explaining IoT, how it works, and real-world applications and uses.

Interoperability

Definition: Interoperability is the capability that computer systems and software have that allows them to exchange and use information.

Helpful Resource: 3½ min. video explaining interoperability in action in Europe during the Covid-19 crisis.

Predictive Analysis

Definition: Predictive analysis is the use of data, statistics, and various machine-learning mechanisms to predict future results and identify likelihoods.

Helpful Resource: 1min. Accenture video explaining predictive analysis and its uses.

Machine Learning

Definition: Machine learning is an example of an AI application that allows for computer systems to self-learn from acquired data and apply the findings without the need for human involvement.

Helpful Resource: 5½ min. Google Cloud Tech video explaining machine learning, its uses, and the prognosis of its application.

Sharing Economy

Definition: Sharing economy is a specific economic model that describes peer-to-peer (P2P) activities related to purchasing, selling, and sharing access to various goods and services; often provided in an online format.

Helpful Resource: 3 min. Google Cloud Tech video explaining shared economy and providing real-world applications, from small start-ups to larger operations like Airbnb.

Smart Manufacturing

Definition: Smart manufacturing is the use of technology-based approaches and tools in the production process – including the usage of internet-linked machinery – to optimize and increase productivity and meet real time demands and needs in supply.

Helpful Resource: Almost 3 min. Department of Energy video explaining the applications of smart manufacturing in the United States and how it makes energy production more efficient.

Vertical Integration

Definition: Vertical integration is when one business acquires another business that handles parts of the supply chain that are either before or after the acquiring business's stage of operations.

Helpful Resource: Investopedia Page with video explainer.

5G

Definition: 5G is the more efficient evolution of previous 4G networks, incorporating faster speeds and higher capacities for connecting devices – whether through IoT, AI, or other digital avenues.

Helpful Resource: 5 min. CNET video explaining 5G, what it can do, and how it is applied in various situations (i.e., vehicles and home ownership).