BUILTWORLDS INSIGHTS

Thinking Smarter: The Next Step in City Infrastructure

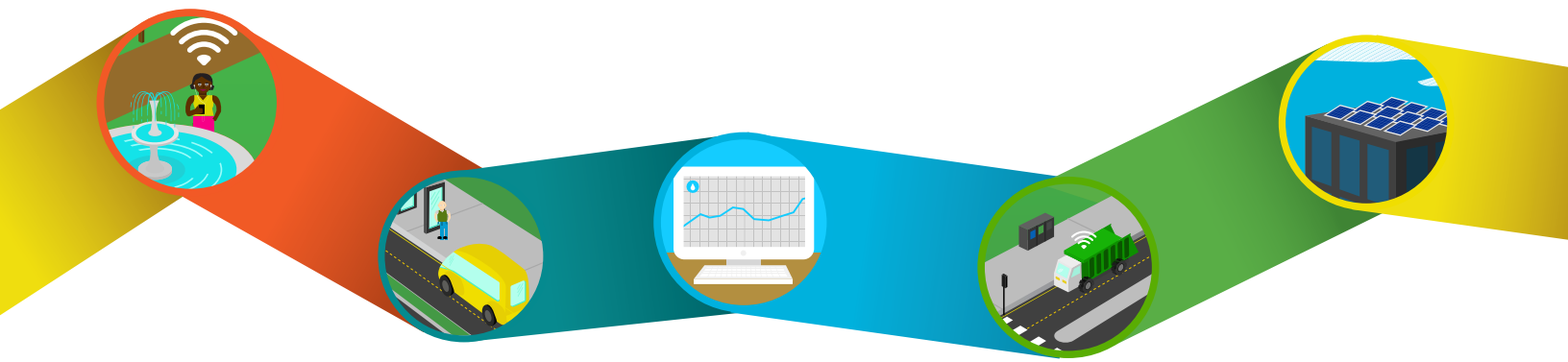
INTRODUCTION

Connectivity, shared space, cultural exchange, economic opportunity – the core values of urban living are long-standing and have shaped the way people interact with cities for millennia. Today, we find ourselves at the crest of a tidal wave of urbanization. With more and more people seeking out shared experiences and moving to urban areas every year, cities have become increasingly pressured to grow without sacrificing what it means to live and work in a cultural and economic hub.

Today, **55% of the global population lives in urban areas,** and that number is projected to reach **nearly 70% by 2050.**[1]

As a result, the demand for high quality and easily-accessible **communication, mobility, water, waste, and energy** infrastructure services continues to increase. Meeting this demand in cities that are already faced with scarce resources has proven to be quite the challenge, and one that has highlighted flaws in our existing infrastructure network.

Not only are we reaching the capacity of that network, but it is becoming difficult to maintain. Infrastructure failures contaminate our daily news with stories of bridges collapsing and city-wide power outages. It is clear that the time has come to view our infrastructure through a new lens and incorporate the technology available today to make our lives safer and more sustainable.

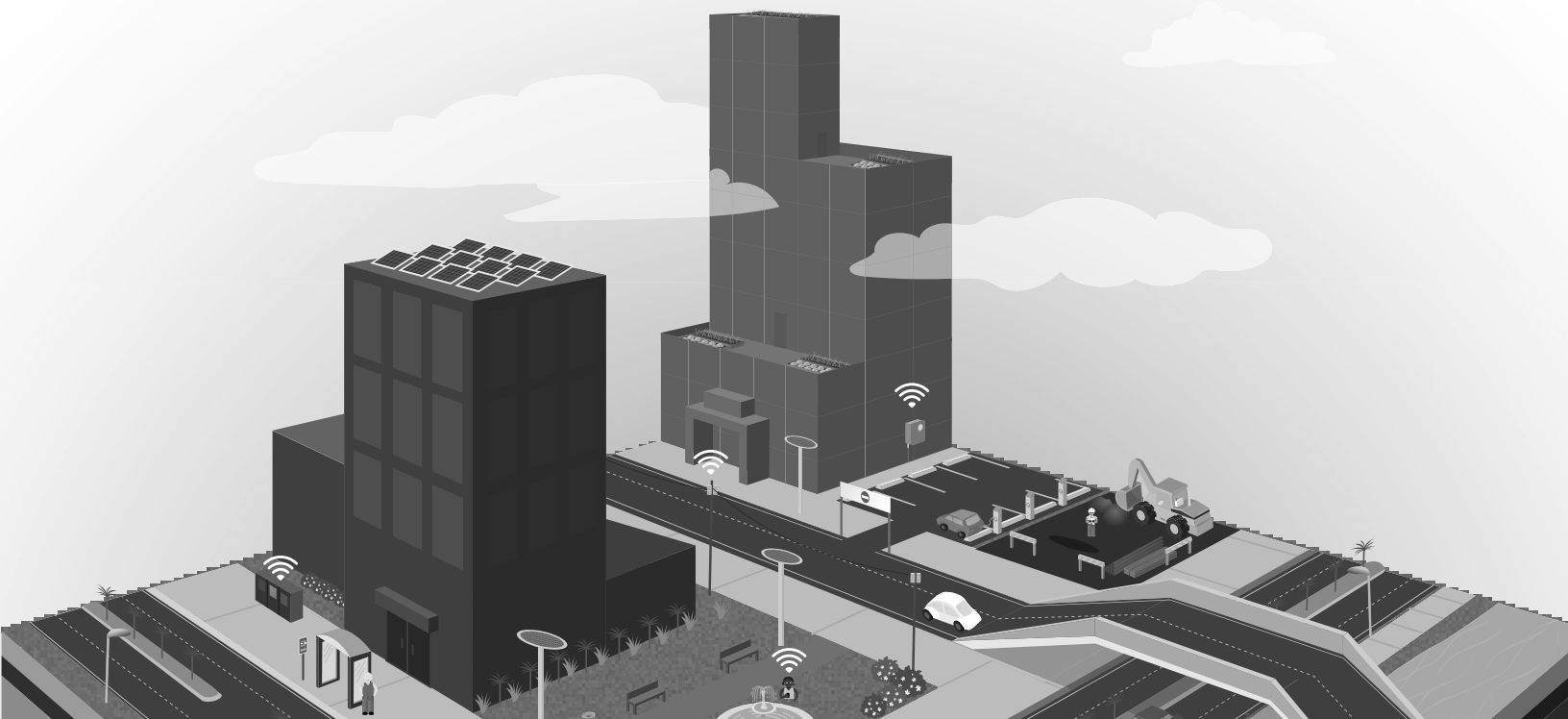


THE SMART CITY MOVEMENT

In 2018, the United States faces a $106 billion gap between actual and needed investment in infrastructure. On our current trajectory, that gap is projected to nearly double by 2040.[2] How are the built, urban planning, and technology industries collaborating to bridge that gap? In nearly every corner of the world, the **smart city movement** is charging full-steam ahead, poised to solve the challenges associated with widespread and rapid urbanization. Thought leaders, technological innovators, urban planners, and other key players have come up with exciting and cost-effective ways to maximize existing infrastructure investments. Their vision? **A collaborative network** of people, institutions, technology, infrastructure, and information that touches every facet of urban life.

With so many new applications for emerging technology in urban systems, it can feel overwhelming to picture what the cities of the (not so distant) future will actually look like. From fleets of autonomous vehicles maneuvering across highways, to underground high-speed railway networks that take you across the country in hours, to free public WiFi, and new park systems enabling independent energy production, the future smart city has endless possibility and thrilling potential.

Let's take a look at how developments in smart infrastructure have used information and technology to connect urban assets, and explore the vast implications of this trend on the built industry.



BUILTWORLDS
INSIGHTS

$3.7 TRILLION

of investment in **infrastructure alone** is needed ***every year*** from now until 2035 **to keep pace with projected growth.**[3]

COMMUNICATION

THE PROBLEM

One of the main structural challenges in large cities is the **lack of communication** between infrastructure operators and the physical infrastructure itself. For cities to thrive and grow, we need to be able to monitor the condition of roads, bridges, water mains, and energy grids. Relying on a system of manual, in-person checks and balances to do so has simply become an outdated and infeasible practice. The aim of the smart city is to turn the siloed, disconnected cogs of our infrastructure network into a humming, well-oiled machine.

THE SOLUTION

CONNECTIVITY AND THE INTERNET OF THINGS

Connectivity is the backbone of the smart city. The Internet of Things (IoT) refers to a network of intelligent devices that constantly collects and relays information about how its individual pieces interact. From road sensors that monitor traffic patterns to water meters that identify leaks and bursts, **the value of the city IoT network lies within the insights gained from real-time data**. City planners, technology manufacturers, developers, and even citizens all rely on data to shape project selection, design, and day-to-day decision-making. In a city where transportation systems, water infrastructure, and other key services interact with the people who use them, everything becomes more efficient, productive, and cost-effective.

This exchange of information is made possible by over-arching software platforms that collect and store data, facilitate communication between nodes on the network, and turn raw data into actionable insights and strategies. **Bridging the digital and the physical**, IoT platforms are the central "command centers" of Smart Cities, addressing the productivity loss resulting from poor communication and cooperation across urban service sectors.

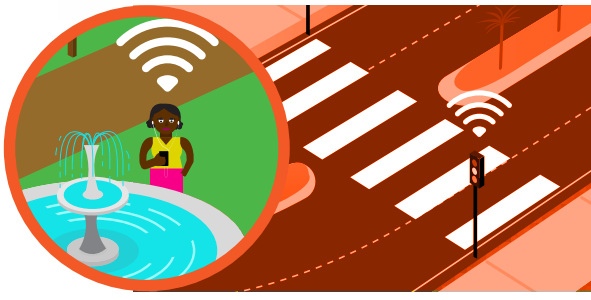
> **"Building new, innovative solutions requires multi-party collaboration** to make the most of new technology and big data opportunities."
>
> – Brenna Berman, Executive Director, City Tech Collaborative

SOLUTION SPOTLIGHT:

Verizon

In an exciting and ambitious public-private partnership, Verizon is working with the City of Sacramento to upgrade the city's infrastructure with a range of IoT solutions. Verizon's smart cities program aims to create connected, safe, and tech-forward communities, and offers solutions in lighting, video, traffic management, parking, and digital communications. They are bringing free WiFi to public parks, managing congestion with advanced signal controls and remote monitoring sensors, installing digital kiosks that include features such as security, wayfinding, and notice boards, among others. With partnerships in cities all over the globe, Verizon's IoT technology is propelling the smart city movement.

> "This partnership will serve as a critical step in upgrading our city's infrastructure to support the newest and best technology and the economic growth that comes with that technology."
>
> – Darrell Steinberg, Mayor of Sacramento



What does this mean for the built industry? In order to make city-scale IoT work, we need to upgrade our physical infrastructure network. Street lights, waste bins, water systems and roads must be retrofitted with sensors, meters, and other smart devices. Data centers and microgrids need to be built. Automated public and private vehicles need to be manufactured on a large scale. In short, we must lift our cities out of the 20th century and make them more flexible, adaptable, and tech-forward. The technology behind smart city solutions is already here, **now it's time to start making it work for us.**

MOBILITY

THE PROBLEM

Transportation is one of the most vital aspects of urban life. The ability to quickly and efficiently move people and goods to their destinations plays a large role in economic development, whether it be getting people to work on time or delivering shipments from manufacturers to retailers. In either case, one of the most frustrating parts of city living is sitting in traffic. Congestion on urban roads often feels inescapable, and in many ways it is.

From 1980 to 2016, annual miles travelled by American drivers increased by 108%, while the amount of driveable lane miles **only grew by 10%.**[4]

As the number of cars on the road increases and the road network runs out of space to expand, the negative side effects of high auto-dependence have become apparent. **In 2017, the average U.S. commuter spent 42 hours idling in traffic, costing the country roughly $305 billion.**[5] The transportation sector is also one of the largest sources of carbon emissions, disproportionately contributing to poor air quality and climate change in urban areas. The pressure that transportation places on cities may feel significant, but new technology is already helping to relieve it.

THE SOLUTION

SMART ROADS

In many ways, the road network is the unsung hero of the city. Every member of an urban community relies on roads, no matter their status as a vehicle owner. Public buses, ride sharing, and bicycling all thrive when our roads are properly maintained and in tune with the latest technological advancements. Sensors and cameras allow us to monitor traffic patterns and road conditions, and better address congestion. Solar and piezoelectric arrays are turning roads into assets for decentralized renewable energy generation. We are more equipped than ever before, and our roads are reaching a turning point where they can begin working with us.

SOLUTION SPOTLIGHT: Valerann

In Tel Aviv, a stretch of the Ayalon Highway has acted as the test bed for a network of smart road studs connected by a cloud-based software platform since June 2018. Created by Israeli start-up Valerann, this comprehensive road monitoring system is generating a stream of real-time data used by local drivers, road operators, planners, and policy-makers. Replacing existing reflective studs, the new smart studs are equipped with sensors and lights that enable two-way feedback between drivers and operators. Information about traffic patterns, automobile crashes, and road conditions is transmitted using IoT technology, and the studs can in-turn flash to warn drivers of any hazards on the road. With intuitive data management software, their platform makes it easy to draw valuable insight from raw road data. Valerann's Smart Road System is now expanding its testing, globally.

"By having a live stream of continuous data about everything that is happening on the road, road operators and planners can make better operational decisions and create a much safer environment for all road users."

– Gabriel Jacobson, CEO, Valerann

Traffic control and road-monitoring systems consist of a network of sensors alongside a cloud-based IoT platform, and are used to collect and spread real-time information about traffic patterns and road conditions. Remotely monitoring travel behavior and the condition of our roads makes it much easier to address road hazards. Ultimately, having sensing technology on all of our cities' roads will allow city planners to manage congestion, decrease travel times, reduce the amount of excess carbon emissions from cars, and alleviate the collective headache of city traffic jams.

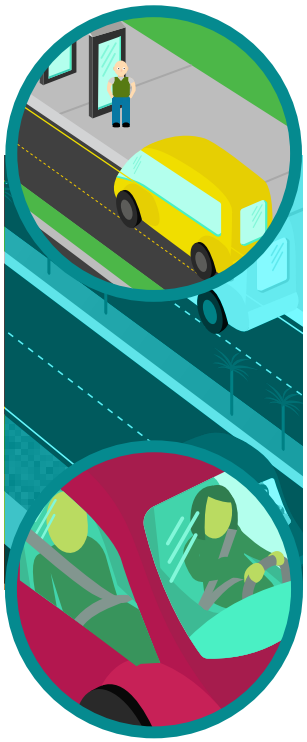
MOBILITY

In addition to using sensors for remote monitoring, roads are becoming smarter by sourcing renewable energy for cities. **Solar roadways** are being installed across the globe, testing the notion that our existing road network can be leveraged for clean energy generation. As photovoltaic panels become more affordable and durable they become an exciting opportunity to turn roads into productive assets. Going beyond solar power, **piezoelectric sensor arrays** generate electricity from the vibrations of moving traffic. The benefits of projects like these extend far beyond localized renewable energy; the technology makes it possible to charge electric vehicles on-the-go, heat roadways to manage heavy snowfall, and safely guide drivers and emergency crews with illuminated lane markings in case of emergency. The smart city movement has us thinking of roads as much more than just paved surfaces.

THE SOLUTION

COLLABORATIVE TRANSIT

There are many ways to get around in a city, and **the ability to choose** between public transit, personal vehicles, rideshare, walking, and bicycling is one of the huge draws of city living. That choice is shaped by infrastructure, with each transport mode offering its own unique set of advantages and challenges. With new real-world applications for technology, the landscape of urban transportation has begun to change dramatically and people's preferred modes of transport have shifted.



Bus and train services are valuable assets for cities in the ongoing struggle to manage congestion and carbon emissions. Despite this, auto-dependence and car ownership has risen over time, and public transit ridership has steadily declined in most cities. To steer people back toward mass transit, municipal transit agencies have partnered with rideshare providers like **Lyft** and are helping to **connect people to their local train and bus lines**. In the spirit of **public-private partnership** and a more equitable transport landscape, cities are working to incorporate modern forms of transportation in unison with public transit.

WATER

THE PROBLEM

Reliable access to clean water is crucial to a healthy urban ecosystem. While our cities grow, the demand for clean water surges. As such, water infrastructure has risen to the forefront of city planning conversations in recent years. Yet, the majority of the United States' one million miles of water pipes are outdated and slowly deteriorating. America's network of pipes was laid in the early-to-mid 20th century, approaching the end of its lifespan. As leaks, bursts, and contamination become more common, cities are struggling to provide clean water to their steadily growing populations. The implications of aging water infrastructure are significant. Not only are operators of major utilities losing money and struggling to maintain their pipes and reservoirs, but **water quality is worsening** and the price of water is on a slow but relentless rise.

In 2017,
6 billion gallons of treated water were lost per day
to aging infrastructure in the United States.[6]

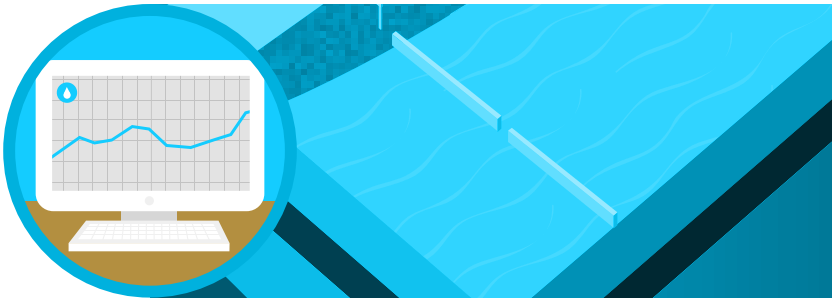
Additionally, severe weather events are often volatile affairs, placing more stress than ever on city stormwater infrastructure. Increased rain volumes and impervious man-made surfaces have made the risk of flooding, sewer overflows, and pollution of water sources evermore apparent. The amount of investment needed to update the entire water network is untenable in the short-term, so new solutions to maximize existing assets are required. How can the smart city of the future re-imagine the way we **collect, transport, and consume** our most precious and basic resource?

THE SOLUTION

METERS, SENSORS, AND REAL-TIME INFORMATION

One of the biggest challenges in repairing aging pipes to prevent costly water loss has been our limited ability to monitor them. By equipping water infrastructure with **smart sensors and meters** and connecting those to a **central data management platform**, water utilities are able to diagnose weak points in physical assets and address them before they become larger, more costly problems. Smart meters are also able to monitor the quality of water flowing through the pipes to identify the source of contamination. While water metering technology is not particularly new, the devices traditionally had to be checked manually, resulting in expensive labor costs for utility providers. With the rising price of water, municipalities are now turning to smart meters to save on costs and maximize productivity.

Companies like **Badger Meter** and **Valor Water Analytics** offer a range of cloud-based smart devices and software platforms that have already been implemented and proven on large scales across the country. These solutions rely on the remote collection of real-time data and advanced analytics to determine how to better manage infrastructure stock, allowing cities to scale-up their **Advanced Metering Infrastructure (AMI)** like never before. In a truly smart city we can communicate with everything, even the water pipes.



THE SOLUTION

REMOTE STORMWATER MONITORING AND CONTROL

The pressure that stormwater puts on cities is significant. In the same way that replacing all water pipes is expensive and infeasible, building additional basins and sewer pipes to capture overflow and prevent flooding is not always a realistic solution. In cities that are particularly at-risk of heavy rain and severe weather events, the smart city movement has come up with ways to **leverage existing stormwater infrastructure** and make it more productive and efficient.

With **remote monitoring and control** technology from **Opti** and other industry leaders, cities can now drain their stormwater basins in the days leading up to heavy storms, leaving enough room to accommodate new stormwater. As a result, heavy flooding and property damage is largely avoided, saving time and money on costly repairs while improving public safety. Moving forward, using smart sensing technology alongside green infrastructure will make it easier and more cost-effective to manage the stress of heavy storms.

WASTE

THE PROBLEM

As hubs of concentrated population, cities generate a lot of waste. Waste management is often left out of cities and infrastructure conversations, but that does not change the fact that it is equally as important as the rest of our infrastructure network. The problem is that as cities grow, they continue to **rely on inefficient manual waste collection**. It is common for cities to resist fully embracing sustainable practices like recycling and waste-to-energy conversion due to their often costly impact on budgets, limiting productivity and efficiency.

53% of the 258 million tons of solid waste generated in the United States each year ends up in landfills, while **only 34% is recycled and 13% is converted into energy.**[7]

THE SOLUTION

WASTE MONITORING AND ROUTE OPTIMIZATION

As with other sectors we have touched on in this report, waste management service providers are increasingly turning toward data-driven, IoT-based solutions to fit into the smart city landscape. With products coming to market allow collectors to monitor waste bin levels using sensors, encourage sustainable behavior with more accessible recycling options, and optimize garbage truck routing, the opportunity to cut costs, increase productivity, and transform city waste practices is upon us.

Comprehensive waste management platforms that rely on **sensor technology to remotely monitor bin fullness** and notify operators when they need to be emptied are reducing the amount of time and money spent manually collecting waste on a regular schedule and avoiding overflowing bins. Not only does this lower costs, but it also results in more attractive, clean, and environmentally-friendly public spaces.

SmartBin and others are also revolutionizing the way garbage truck fleets move, with information from IoT sensors guiding efficient routing. Relating back to the smart mobility goals of reducing congestion and emissions, solutions like this are making more room on city roads for public and personal vehicles, and reducing fuel costs. With more developments to waste infrastructure on the way, cities are quickly becoming cleaner, healthier, and less wasteful.

SOLUTION SPOTLIGHT: Bigbelly

Times Square's 500,000 daily pedestrians generate 15,300 pounds of waste everyday. To make sure that it all gets discarded properly and on time, the city partnered with Massachusetts-based technology leader Bigbelly. Their 197 smart waste and recycling stations prompt users to separate waste by type, and with a solar-powered compactor the bins hold 5 times as much as a traditional sidewalk bin. The new smart bins also come equipped with sensors, allowing them to be remotely checked for fullness to avoid wasting money on manual checks. As a result, 40% of Times Square waste is now properly recycled and 50% less time is spent collecting waste.

ENERGY

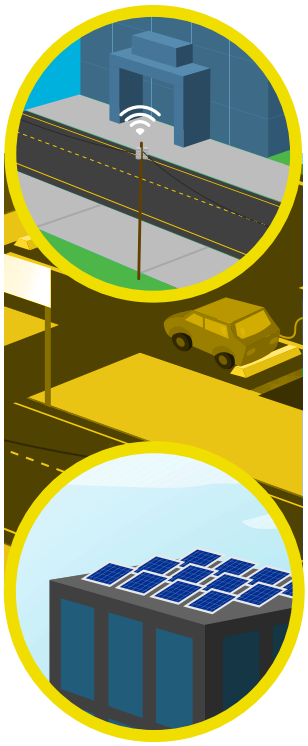
THE PROBLEM

Energy provision in the United States is characterized by outdated, centralized grid infrastructure and a heavy reliance on fossil fuels. A wide-reaching and impressive feat of engineering, the electrical grid is now nearing the end of its life span. While we continue to ask more from the grid than what it was designed to provide, it has become less reliable and resilient. With critical infrastructure and operations relying on constant, uninterrupted power supply, and with mounting environmental concerns over fossil fuel use, it is clear that we need to finally bring our energy infrastructure into the 21st century.

THE SOLUTION

DECENTRALIZED, RENEWABLE ENERGY

Microgrid technology has introduced an exciting alternative to centralized energy provision. Instead of generating energy from a large-scale, collective source and distributing it through a central grid, the microgrid encourages **local generation and distribution**. By generating energy on-site, infrastructure operators, large manufacturing facilities, hospitals, schools, and other critical services eliminate the risk of losing power when the grid goes down. As solar, wind, and other renewable sources of energy become more prevalent and cost-effective, many institutions can now afford to build their own microgrids. From a city perspective, imagine a grid made up of many microgrids. With the ability for microgrid operators to sell extra energy back to the central grid, we can increase collaboration across city stakeholders and make a large-scale push for renewable power.



THE CONCLUSION

Information lies at the heart of the smart city. With 55% of our global headcount populating urban areas and enormous infrastructure spending gaps plaguing our cities, we have reached a turning point. The population influx into cities is only going to keep growing, but so are the advancements making it more manageable. With data guiding design, construction, and operation, the built industry can use technology and the Internet of Things to revolutionize infrastructure. The set of solutions emerging from smart cities is vast and diverse and includes: cloud-based data management in **communication**, smart roads and optimized transit in **mobility**, smart metering and remote control capability in **water,** bin management and efficient routing in **waste**, and decentralized, renewable grid technology in **energy**, among others.

In order for cities to implement these solutions on a large scale, the built industry will play the largest role. It's time to put as much innovation into our infrastructure as we do the rest of our lives, the future of our cities is counting on it.

References: [1] United Nations, Department of Economic and Social Affairs Population Division, World Urbanization Prospects 2018, [2] Global Infrastructure Hub, Infrastructure Outlook: Forecasting Infrastructure Investment Needs and Gaps, [3] Bridging infrastructure gaps: Has the world made progress? McKinsey Global Institute, 2017, [4] Federal Highway Administration, Policy and Government Affairs Office of Highway Policy Information, Chart VMT-422: Highway Statistics 2016, [5] Traffic's Mind-Boggling Economic Toll, City Lab, [6] American Society of Civil Engineers (ASCE), 2017 Infrastructure Report Card: Drinking Water, [7] American Society of Civil Engineers (ASCE), 2017 Infrastructure Report Card: Solid Waste,

BUILTWORLDS
INSIGHTS

It's our mission to make sure our community stays at the vanguard of the built industry with easy access to the most relevant research and opportunities to understand and test the latest technologies. BuiltWorlds Insights is how we make cutting-edge R&D a little less scary and far less time-consuming.

Get involved with BuiltWorlds Insights and you can sponsor a research report that directly address your company's needs, test out new technologies on your job site, hear from industry thought leaders in the comfort of your office and highlight your emerging tech solution within the BuiltWorlds community.

**All Spotlights represent sponsored content*

For more info about how to get involved with Insights, email
partnerships@builtworlds.com

A Network. Not a Trade Publication.

BuiltWorlds is the premier global network fueling the conversation on emerging technology and new approaches in buildings and infrastructure. Our community of the industry's leading companies, hottest startups, and most respected thought leaders is united by a common interest: Driving innovation in the built world.

Through our groundbreaking events, data-driven research, member network, and original written and video content, BuiltWorlds is providing the tools, knowledge, inspiration, and connections to grow careers, companies, and the industry.

To learn more about how to get involved with BuiltWorlds,
visit our **Network homepage.**