vhb viewpoints

The Energy Revolution & Climate Change:

How the AEC Industry Is Addressing a Generational Challenge

Transition. Evolve. Transform.

Contents

The world is experiencing an energy revolution in response to climate change. Climate disruption is one of the biggest threats to humanity. It is not solely an environmental or energy problem, but a monumental, shared challenge with impacts and implications spanning markets, sectors, industries, geographies and demographics. It requires a big picture, shared solution—and the AEC industry plays a critical role in shaping the response.

Understanding the impacts and implications of climate change on our environment, communities, businesses, and clients, the AEC industry serves as both educator and innovator. Through our work we demonstrate what a transition to a clean and green future looks like, from multimodal transport to renewable energy to climate positive buildings—and why it is important to make changes now. Our knowledge, experience, and guidance are crucial to helping our clients and communities anticipate emerging opportunities, identify potential risks, and develop innovative solutions to mitigate those risks.

Climate Consequences

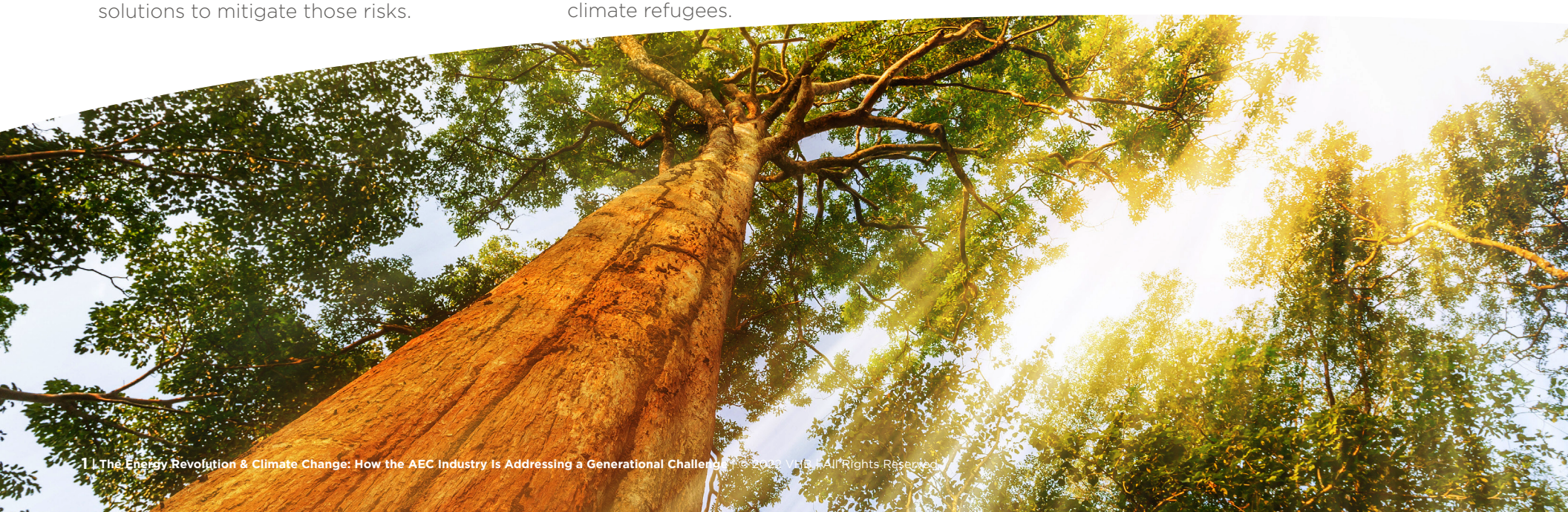
Since the pre-industrial period, CO_2 emissions have increased by approximately 50 percent, with the built environment responsible for a large portion of emissions. We need to cut greenhouse gas (GHG) emissions by implementing changes NOW, or we will face irreversible consequences, including:

Rising average air temperatures will reach a point of no return, making entire regions uninhabitable, forcing population shifts, and—in some cases—resulting in climate refugees.

Significant sea level rise will lead to coastal damage due to severe flooding, with many cities completely under water.

Perpetual drought will result in significant water restrictions and more frequent wildfires, leading to long-term public health problems.

Extreme weather events, including increased precipitation and storm surge, will leave communities devastated and, in some instances, unable to recover.



Key Terms & Definitions

Net Zero: Reducing GHG emissions and confirming that remaining emission sources are balanced by GHG absorption methods.

Decarbonization: The process of reducing or replacing systems that produce CO_2 emissions with technologies that create less or no GHG. More simply, the reduction of carbon.

Climate Positive/Net Negative: When an entity's GHG removals exceed its emissions and the removals are "like-for-like," defined as when a GHG emission and its corresponding sink/removal have the same warming impact in terms of timescale and duration. This claim must be tied to a specific time period.

GHG Reduction vs. Removal: Reduction occurs by replacing emission-producing equipment or practices with those that produce fewer or none, like switching from fossil fuels to renewable energy. A removal actively takes GHGs out of the atmosphere (e.g., planting new trees).

Addressing Climate Justice

Air pollution, extreme heat, and water scarcity all negatively impact human and environmental health. Collectively, these effects are referred to as climate change, but the issue is more than just environmental. Hurricanes, tornadoes, flooding, and wildfires manifest physical results, but there are also societal and economic impacts resulting from climate change—especially for vulnerable populations.

Different populations experience varying social, economic, and public health impacts, with disadvantaged communities bearing the brunt of climate change impacts. These impacts are not created equal, nor are the responses and policies that are put into place to combat a changing climate.

Climate justice principles recommend addressing inequities head on through long-term mitigation and adaptation strategies, including investment in community-based energy solutions. Learn more about implementing an equitable and inclusive approach to combatting climate change.

The next 10 to 25 years are critical to developing and executing GHG reduction policies and commitments. To avoid major irreparable harm to the planet, we should attempt to limit global temperature rise to 1.5 degrees Celsius above pre-industrial levels.

We must drive major change—now.

The year 2050, just one generation away, marks an important milestone in achieving carbon reductions necessary to keep the global climate stable. Beginning in the late 1700s, the net global effect of human activities has been a continual increase in greenhouse gas concentrations. The AEC industry has the opportunity to reverse the trend of human-caused emissions increases. From implementation of green technologies to deliver more sustainable infrastructure solutions, to the use of data to monitor, quantify, and reduce emissions, our industry is elevating focus and accountability around this urgent issue—and working together to identify implementable strategies.

Protecting Coastlines & Transforming Communities: Ohio Creek Watershed

To protect its Chesterfield Heights neighborhood, the City of Norfolk, Virginia, partnered with VHB to develop coastal defense strategies, including earthen berms, tide gates, floodwalls, and 2,000 linear feet of living shoreline. The city's resiliency strategy also included raising roadways to make them operational during heavy rainfall events, replacing old infrastructure to hold more rainfall, and designing multi-use trails and athletic fields to create a sense of community. Elements such as lighting, educational signage, and sidewalk improvements were also incorporated. This project, recently featured in *Engineering News-Record*, improved not only flooding, but the overall quality of life for the community through economic vitality, public health, safety, and expanded connectivity and accessibility. As one of the largest populations at risk for sea level rise in the U.S., this strategic resiliency project will transform the Chesterfield Heights Historic District and Grandy Village neighborhoods. Learn more about how this project is protecting coastlines and transforming communities.

The Importance of Partnerships

The Infrastructure Investment and Jobs Act (IIJA) provides a total of $1.2T, with an emphasis on infrastructure investments focused on sustainability, resiliency, and equity. The Inflation Reduction Act (IRA) builds on IIJA with $369B of additional climate and energy funding over the next decade. However, federal funding alone will never be enough to solve the climate crisis. **An issue as large as climate change requires private investment and partnerships to achieve net zero carbon emissions by 2050.** The AEC industry is primed to lead the way in exploration and implementation of innovative spending and funding options, including public-private partnerships.

AEC Industry's Key Role

VHB's role in helping clients address their carbon reduction or other climate targets will have lasting benefits within communities as we seek to balance development and infrastructure needs with environmental stewardship. Over the next few years, the AEC industry will need to understand our clients' vulnerabilities to climate change, as well as provide guidance and solutions to help them mitigate future climate impacts, mostly through reducing their GHG emissions.

Having a technical understanding of climate change, including future projections, as well as being able to accurately account for GHG emissions, are two fundamental principles for AEC industry firms to advance if we are going to usher clients into a clean energy future.

As an industry, our ability to research, analyze, and model potential climate scenarios is what allows us to more accurately anticipate, mitigate, and adapt—and is critical to providing guidance to our clients and creating a resilient future that will benefit communities for generations to come.

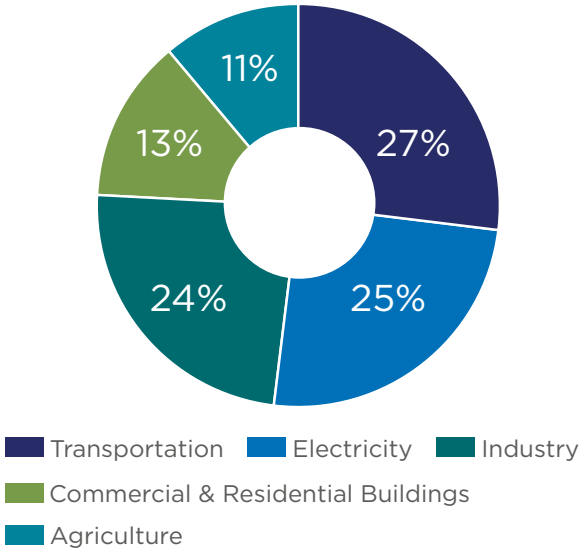
> **"Technology and creative, innovative ideas will continue to play a critical role as we integrate progressive, sustainable, equitable solutions that spur economic development and reimagine the built environment—for a more resilient tomorrow."**
>
> **—Mike Carragher** | *VHB President & CEO*

Transition: A Phased Approach to Decarbonization

Through innovation and implementation of responsible solutions, the AEC industry is addressing the climate crisis as a global priority. The world we live in is rapidly evolving, and it is important to both implement changes where we can, and also prepare for inevitable future changes. **Mitigation and adaptation must work in concert.** While mitigation involves looking for ways to limit climate change—such as greater use of renewable energy and electric vehicles—adaptation finds ways to prepare for change, such as implementing resilient shoreline design to address sea level rise. We need to mitigate and adapt, and the steps we take today will help to plan for a more sustainable and resilient tomorrow—but change will not come overnight.

The built environment is responsible for a large portion of GHG emissions in the U.S., a significant amount of which comes from electricity, construction, building operation, and the energy required to transport building materials. **The AEC industry plays a key role in advancing these markets and will lead the way in helping to develop and implement viable, incremental solutions.** In June 2021, the canton of Geneva, Switzerland, released an ambitious framework to achieve carbon neutrality for the canton by 2050—including slashing its carbon footprint by 60 percent over the next 10 years. The plan, which includes both direct and indirect emissions, may serve as a model for other geo-political entities. Decarbonization is a monumental challenge, but every small change contributes to the bigger picture and transformation.

Sources of U.S. Greenhouse Gas Emissions



Source: USEPA

> **"Climate adaptation and resiliency means developing and implementing innovative strategies to protect our environment, our infrastructure, and our communities."**
>
> **—Meredith Avery |** *VHB Managing Director, MA Environmental*

More Efficient Transportation Systems

Transportation keeps our economy and communities moving. Departments of Transportation (DOTs) and transportation agencies across the country are focused on designing resilient infrastructure that will withstand the impacts of climate change—and they are prioritizing getting the U.S. on a path toward zero emissions. The IIJA includes reauthorization of the surface transportation program for the next five years, funding that can be invested in electric vehicle charging infrastructure, removal of diesel buses, and integration of solar-powered transit stations.

> **"Alternate modes of travel, including e-mobility, transit, and active transportation, help reduce greenhouse gas emissions, improving both environmental and human health."**
>
> **—Ryan Prime |** *VHB Sustainability Practice Leader*

A Cleaner Way to Improve Mobility: Electric Vehicle Charging Stations

As electric vehicle options become widespread across the U.S., VHB is helping to meet the demand for fast-charging stations that are powered by 100 percent renewable energy. As one example, VHB is providing site and civil engineering, landscape architecture, zoning, and permitting to support the infrastructure for charging station locations across Georgia, Florida, Virginia, and North Carolina. These stations are strategically located along major interstates and near shopping centers to provide convenient, reliable access for powering vehicles. Learn more about VHB's work on these charging stations.

Strategies for More Efficient Transportation Systems

Electric Vehicles (EVs)

Fleet conversion to electric, for both commercial and personal vehicles, will have a major impact on America's energy grid. While EV-only manufacturing may one day be the norm, building the infrastructure to support this transition is a necessary first step.

The IIJA has identified $7.5B to build EV charging infrastructure nationwide and accelerate the adoption of EVs to address the climate crisis, which will push many state and local governments to think about sustainability in a more practical, real-world way.

As we plan for this transformation, we must consider where stations will have the most positive and equitable impact, how we can maximize land development to provide a safe and inviting driver experience, and what the next evolution of vehicles might look like.

Learn more about electric vehicles and infrastructure needs.

Greener Transit

Diesel-powered trains and buses are incrementally transitioning to electric or other alternatives.

The creation of the Clean School Bus Program will replace the current fleet with low or zero emission school buses—nearly $5B over five years.

Metrolink became the first passenger rail agency in the U.S. powered by renewable fuel—made of recycled natural fats and vegetable oils.

Compressed natural gas (CNG), produced by compressing natural gas (methane) to less than one percent of its typical volume, is an energy alternative being evaluated as another viable option for fleet conversion.

From bus stops and shelters to full-scale stations, transit agencies are using solar power to operate lights, charging ports, and digital signage—reducing emissions and saving money.

Last year, NJ Transit unveiled its first solar powered bus shelter to help advance sustainability goals identified in its 10-Year Strategic Plan. Leveraging natural power sources, like the sun, provides equitable opportunities for transit in remote areas without access to electricity.

Healthier Mobility

Community needs are evolving. Residents, visitors, and commuters desire multimodal transportation, including active options such as biking and walking. Complex downtown networks are significantly expanded by the inclusion of separated bike lanes, complete street design, and new and upgraded sidewalks. For example, Tel Aviv is building micromobility infrastructure to support an increasing number of e-scooters and bikes on congested city streets, part of the vision to transform the city into a car-free, pollution-free metropolis of the future. Active and alternative options play a critical role in transportation networks, providing vital connections and more equitable and sustainable solutions.

Diverse Energy Solutions

Getting energy to all customers—reliably, efficiently, and affordably—is a priority for energy providers. However, we are in a period of energy transition. While the world is still dependent on fossil fuels, there is a clear progression toward renewables and cleaner energy generation. The IIJA addresses the climate crisis with the largest investment in American history in clean energy technologies and our nation's electric grid. The U.S. Department of Energy will manage more than $60B in funds to deliver a more equitable, clean energy future. Additionally, the IRA includes new and expanded incentives for renewable and clean energy investments.

> **"Today's energy discussion is about diversity, resiliency, and sustainability. We are experiencing an energy transformation and clean energy revolution in response to climate change. Integrated, innovative energy solutions, including long-term renewable options and short-term transition options—like natural gas—will be necessary to reach decarbonization goals."**
>
> **—Kris Dramby |** *VHB Energy Market Leader*

Embracing Renewable Energy: Revolution Wind

Revolution Wind Farm, a 704-megawatt offshore wind farm project planned for federal waters off the coast of Rhode Island, will provide enough clean, renewable energy to power more than 350,000 homes in Rhode Island (400 MW) and Connecticut (304 MW). As a trusted partner to Ørsted and Eversource, VHB leads a team in managing offshore and onshore project components, leveraging our local experience and relationships to navigate a challenging regulatory environment to obtain permits and allow construction to advance on schedule. This massive renewable energy project is leading the way in offshore wind development in the U.S. Learn more about how VHB is helping RI and CT reach ambitious clean energy goals through our work on Revolution Wind.

Strategies for Diverse Energy Solutions

Onshore & Offshore Wind

Wind-generated energy is entering an age of greater certainty, with advancements in technology allowing more infrastructure to be built with increased energy generation potential. While land-based wind turbines are quite large, they are dwarfed by offshore wind turbines. GE's new Haliade-X 14 MW turbine stands 260 meters tall and has a rotational diameter of 220 meters—two full football fields. A 1,500 MW offshore wind farm would have 100 of these turbines installed a mile apart, situated about 20 miles offshore, and be able to power 750,000 homes thanks to the sustained high winds that far out at sea (which exceed those on land). There is vast potential in the wind industry—and more opportunity than what is currently being captured—but also challenges, including:

- Supply chain issues associated with component manufacturing
- Limited land in ports for offshore storage and construction staging
- Feasibility of transporting parts due to size of turbines
- Outdated transportation infrastructure connecting ports and municipalities
- Shifting federal, state, and local regulations

Learn more about VHB's commitment to a clean energy future and partnership in advancing offshore wind development.

Natural Gas

Fossil fuel use will slowly decline over time, but the world is not ready to run solely on renewables—the infrastructure simply is not there. According to the U.S. Energy Information Administration, natural gas emits almost 50 percent less carbon dioxide than coal. And while natural gas utilization needs to be significantly reduced or removed within the 2050 to 2070 timeframe, all projections of energy use between now and 2050 recognize its "carbon-better" status and anticipate increased use through 2040, followed by a slow shift away. Natural gas will continue to be part of diverse energy options and play a key role during the transition to net zero. It is a necessary strategy and part of the big picture solution. The IIJA includes funding for repair and rehabilitation of natural gas assets to make certain this transition is safe and sustainable.

Battery Energy Storage

As states across the country continue to push toward carbon-free initiatives, and solar and wind become more prominent as part of renewable energy initiatives, the topic of power storage is at the forefront of conversation. How will we capture the excess clean energy generated from offshore wind and solar farms? How and where will we store this excess power during times of lower sunshine and diminished wind? **Left unresolved, storage limitations create a barrier to running the electric grid efficiently on renewables, hindering states' ability to meet clean energy targets.**

Naturally occurring circumstances, such as weather patterns or time of day, can create difficulties in meeting power demands when using clean energy. It is not only essential to have a place to store excess energy and have it readily available to offset these occasions, but it also adds economic value to the sourced energy, allowing for further production. An efficient storage system enables the continual transition away from fossil fuels. There are multiple options to consider, including thermal energy, pumped hydropower, and hydrogen energy.

Watch this video to learn more about how utility customers and the electric grid benefit from residential battery storage.

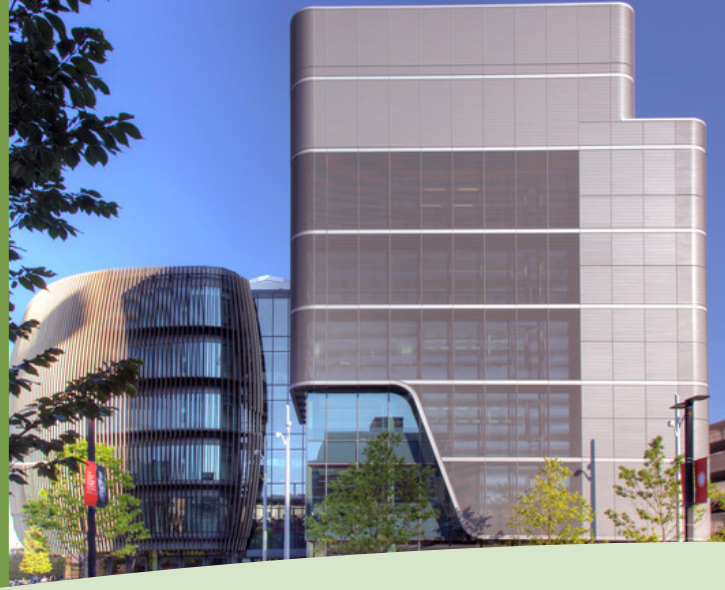
New & Renewed Spaces & Places

Continued investment in healthy community and sustainable design, along with green building technologies, are needed to bring more solutions to the climate crisis. Green buildings and technologies, through planning and design, construction, and operation, promote energy efficiency. This approach reduces negative climate impacts—and often creates positive impacts on the natural environment. Additionally, repositioning distressed or underutilized assets, such as decommissioned energy plants, can result in more renewed spaces and places with greater value and more sustainable infrastructure.

> **“Green space, including parks, plazas, and trails, promotes positive impacts on our natural resources and human well-being.”**
>
> **—Ryan Prime** | *VHB Sustainability Practice Leader*

A Roadmap to Carbon Neutrality: Northeastern University Climate Justice Action Plan (CJAP)

As a long-time partner of Northeastern, VHB is working with the University to expand their sustainability and resiliency planning. The CJAP is a community-driven initiative and will recommend a roadmap to achieve carbon neutrality at Northeastern. Focus areas include energy consumption and sourcing, transportation, climate resiliency, and the University's ability to affect change through its strengths in academia and research. With a focus on social, environmental, and economic justice, the CJAP will recognize the University's comparative role in its contributions to the climate crisis, the disproportionate impact of climate disruptions on marginalized populations—and their capacity to adapt—and the transformative change necessary to address historic inequities and achieve equitable outcomes. Learn more about this project.



Strategies for New & Renewed Spaces & Places

Geo-exchange

Higher education institutions are increasingly developing energy master plans, including infrastructure to support resilient energy systems, such as combined heat and power (CHP) or geo-exchange systems for heating and cooling. Geo-exchange uses the ground as a renewable energy source. During warm months, heat is removed from buildings and stored in the ground. During cold months, the heat is "exchanged" back into the building to provide heat. This process offsets energy demands and aids institutions in meeting GHG reduction targets. Learn more about how geo-exchange works and how Princeton University is advancing this technology across campus.

Healthy Buildings & Green Infrastructure

As the race to address climate change accelerates, many building owners are finding ways to integrate design elements that support occupant health while increasing climate resiliency. Rooftop gardens promote health and well-being via access to green space while also providing reductions in stormwater runoff and lowering the amount of solar heat transferred to the building interior. This single design element provides multiple benefits—for both humans and the environment. Another example is the strategic location of windows to not only minimize heat gain and reduce energy consumption but increase occupant comfort by aligning with humans' natural circadian rhythms. King Open/Cambridge Street Upper Schools and Community Complex in Massachusetts incorporates geothermal wells and great expanses of photovoltaics on all of the roof real estate.

Low-Carbon Concrete

Embodied carbon refers to the GHG emissions from manufacturing, transporting, and installing materials or products. Cement, a component of concrete, is one of the most carbon intensive materials to produce, making concrete one of the largest contributors to climate change in the built environment. Lowering embodied carbon in concrete will help reduce environmental impacts of the anticipated surge in new infrastructure. Emerging technologies, including ByFusion, can act as cement substitutes. Some, like CarbonCure, capture CO_2 from large industrial emitters and sequester it indefinitely in concrete, improving the concrete's compressive strength. Researchers at the University of Illinois at Urbana-Champaign are using an artificial intelligence model to create concrete mixes with lower embodied carbon emissions.

Our world moves in incremental change- and behavior-management steps. **The journey to net zero will require a significant amount of time to accomplish—and a phased approach to be successful.** Strategically phasing out diesel-powered vehicles with hybrid, electric, and active transportation options, as well as implementing short-term, carbon-better solutions such as natural gas, are necessary incremental steps to reaching larger decarbonization goals. Concurrently, we must enact policy and regulations, as well as strengthen and expand our existing infrastructure, as we work together toward a cleaner future. In the fight against climate change, transformation cannot occur without transition.

Evolve: Innovative Solutions to Reduce Emissions

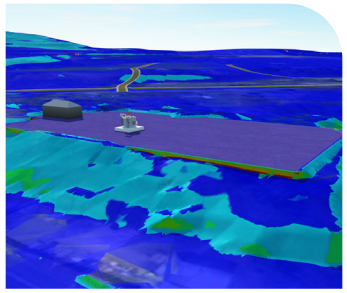
As countries, cities, and companies set climate goals, data and technology will play an important part in achieving net zero and supporting the clean energy revolution. To be sustainable, we need information. To be informed, we need data, which continues to become more readily available. **How that data is harnessed and applied in new and innovative ways to make informed decisions is key to addressing complex, shared challenges such as climate change**. The cost to address climate issues is immense. Leveraging technology will be critical to monitoring, quantifying, and reducing emissions in the quest to meet decarbonization goals—and increasing quality of life along the way. **Technology-enabled solutions that may play a role in this evolution include:**

Autonomous Vehicles

Autonomous vehicles, sometimes called self-driving cars, continue to evolve. From personal vehicles to transit and shuttles to long-haul trucks, autonomous vehicles are changing the shape of transportation. Even pizza delivery is testing self-driving options. AVs can have positive environmental impacts by decreasing accidents, reducing congestion, and therefore decreasing emissions. In addition to improved safety, AVs also increase equitable mobility for elderly and disabled travelers. Listen to this podcast to learn more about how cities are responding to major innovations in transportation technology by integrating autonomous vehicle infrastructure.

Smart LED Lighting

The "streetlight of the future" uses the Internet of Things (IoT) and GIS technology to turn older, high-pressure, sodium-lit streetlights into efficient, interconnected LED lighting networks across communities. These streetlights are not only budget and energy savers, but can become precisely managed and monitored networks, with future-focused technology built in. The new LEDs have a more uniform, less-harsh distribution of light and significantly reduce CO_2 emissions and energy consumption—up to 75 percent in some cities. Optional smart "nodes" enable the lights with additional public safety, environmental reporting, and communication abilities. Learn more about VHB's work retrofitting 100+ New England cities with smart-ready LED streetlights.



Model-Based Design (MBD)

MBD is a collaborative design process that uses a virtual representation of intelligent and connected data to guide design decisions. Electrical substations will play a critical role in the power grid's transition to clean energy, and using MBD during the development process allows for a broader assessment of a substation's sustainability priorities. The innovative use of MBD and GIS data can illustrate in three dimensions what a proposed project will mean from an environmental, social, and economic standpoint. Implementing MBD during the conceptual phase of an electrical substation project is an inherently sustainable and technology-enabled approach, with significant benefits to both energy clients and communities. Learn more about sustainable substation design using a model-based design approach.

Leveraging Technology for a More Sustainable Community: Orlando Future-Ready City Master Plan

The City of Orlando is regarded as an early adopter of innovations in technology and sustainability that benefit its residents and communities. The city has set an ambitious goal to be one of America's new Future-Ready cities by incorporating smart city technologies. As prime consultant, VHB is a valued partner and trusted advisor to the city, developing the master plan and now managing programs that leverage technology to create more sustainable and equitable results. The city's tablet and hot spot lending library, as well as picnic tables outfitted with solar panels, help to bridge the digital divide. Their food recovery program uses technology to connect restaurants and businesses that have surplus food with shelters and food pantries. The Advanced Air Mobility (AAM) Transportation Plan, created with support from an exclusive aero-research partnership with NASA and VHB, will evaluate anticipated transportation, economic, environmental and community impacts at a regional scale. Learn more about Orlando Future-Ready.

Smart Transportation Networks

Integration of technologies that support smart transportation can reduce or eliminate GHG emissions by decreasing congestion and vehicle idle times. Optimization of signal systems and timings via digital sensors; increased use of electric, connected, and autonomous vehicles; and improved efficiency for connecting mass transportation and mode-choice options are all examples of smart transportation that help to lower traffic congestion and emissions.

Advanced Air Mobility

Emerging air mobility options, including electric vertical take-off and landing (eVTOL) technologies and air taxi "vertiports" are expanding transportation options for commuters and communities. Drones are being used to deliver cargo and medical supplies. This innovative transport of people and goods, operating at lower altitudes and powered by carbon-better systems, will improve accessibility and help to relieve roadway congestion. Listen to this podcast to learn more about the future of AAM, including the partnership between the City of Orlando, VHB, and NASA.

Green Hydrogen

Produced by splitting water molecules into hydrogen and oxygen via electrolysis using clean energy, green hydrogen leverages technology to produce clean power for a variety of sectors, from manufacturing to transportation. With its only byproduct being water, green hydrogen will be critical in reducing the carbon footprint of aviation and shipping, which require high energy densities that currently only hydrocarbons can provide. The U.S. Department of Energy's Loan Programs Office recently awarded $500M toward one of the biggest proposed green hydrogen projects in the country.

Renewable Natural Gas (RNG)

Previously not cost-effective, RNG—methane from an agricultural operation, landfill, or sewage treatment plant—is now becoming financially viable. Also called anaerobic digestion, RNG presents an interesting alternative in the waste-to-energy space. The U.S. Environmental Protection Agency defines it as a process through which bacteria break down organic matter, such as animal manure, wastewater biosolids, and food wastes in the absence of oxygen. The resulting biogas can be processed into RNG or transportation fuels.

> **"The AEC industry is experiencing continual and rapid technological advancements. Leveraging the ability to collect and analyze data is an asset to consultants, clients, partners, and communities as we address the climate crisis through innovation."**
>
> **—Steve Anderson |** *VHB Technology Enablement Service Leader*

Digital Twin Technologies

This innovation serves as the bridge between the physical and digital worlds, using sensors to collect data about physical structures—and even entire cities. Digital twins can be used to facilitate scenario planning and enhance real-time decision-making using a virtual environment. The technology can help planning and design teams—as well as owners and operators—cut carbon emissions of new construction, test effectiveness of various measures against sea level rise, and determine how infrastructure improvements will impact the natural environment. Virtual Singapore, a dynamic 3D city model and collaborative data platform, will enable users from different sectors to develop sophisticated tools and applications for testing concepts and services, planning and decision-making, and research on technologies to solve emerging and complex challenges.

Listen to this podcast to learn more about how communities are using digital twins to simulate virtual, data-informed representations of their neighborhoods and infrastructure to enhance decision-making, innovation, and resilience.

Carbon Capture

Carbon capture and storage (CCS) is technology that involves capturing CO_2 from industrial processes, transporting it, and storing it deep underground. Norway's Project Longship is one of the first projects in the world to develop the infrastructure to permanently store significant amounts of carbon beneath the North Sea. Long term, CCS prevents CO_2 from contributing to the greenhouse effect and could be refined into alternative fuels in the future. Other carbon removal options include using nature as a carbon "sponge" and pulling CO_2 from the air using machines or carbon vacuums such as the Orca in Iceland, the world's first and largest climate positive direct air capture and storage plant. Similar to CCS, carbon sequestration secures CO_2 prior to it entering the earth's atmosphere. Biological carbon sequestration uses vegetation, soils, and oceans to store CO_2. Geological sequestration stores CO_2 in underground, porous rocks via injection. This process is still being researched but holds promise for future widespread adoption.

Smart Communities: Intelligent Solutions Can Have Significant Impacts on the Future

Smart communities are intentional about harnessing new and existing technologies that align with community values to plan for a better tomorrow. By using a people-first, holistic approach, smart communities elevate innovation to improve quality of life, sustainability, resiliency, and equity—while having a positive impact on the environment and helping to address climate issues.

As we brace for climate change impacts, one of the biggest challenges that smart communities need to be prepared for is population migration. Within the U.S., we'll see climate refugees relocating to the Northeast and Midwest from the West and Southwest due to drought, smoke, fire, and extreme heat, while residents in the Southeast may be forced to relocate due to extreme heat and rising sea levels. However, the impact is even more extreme globally, with more than 200 million climate refugees expected to flee their homes by 2050. This results in a need for affordable and energy efficient housing, multimodal transportation options, and employment opportunities.

Another concern facing communities is food insecurity. The global agriculture markets are currently stressed, food prices continue to increase, and the production and transportation of food demands large energy resources. Growing and sourcing local food will become more important than ever, and keeping those food costs down and accessible to lower income communities will be critical.

Planning for resilient energy storage is also essential. Some sources of renewable energy, such as wind and solar power, are subject to weather conditions. Capturing and storing energy during peak periods for later use is a critical part of running an efficient renewable grid. Additionally, many households may not be able to afford solar panels or generators to keep the air conditioners and refrigerators running during power outages.

> **"The convergence of the digital realm and the physical environment creates many new opportunities as well as unforeseen challenges. Smart community programs provide a roadmap for engaging the public and establishing focus areas where innovation and new technologies can have an immediate impact in making places more sustainable, equitable, and resilient."**
>
> **—Curt Ostrodka** | *VHB Director of Smart Communities*

Steps to Address Climate Change Using a Smart Community Approach

Identify Needs—Vulnerable communities are most impacted by near-term environmental hazards. These residents are typically underrepresented in planning decisions, have limited political power, and may lack resources to be self-resilient. These stakeholders should be included in the public engagement process.

Leverage Technology—Using technology to examine different disruptors (e.g., natural disasters) and stressors (e.g., traffic congestion) allows for data analysis to make informed decisions and recommend appropriate actions.

Implement Solutions—Data-informed and technology-enabled solutions are nearly always components of a smart community, but how those components are adopted has become a differentiator in whether smart cities succeed. At its core, a smart community improves quality of life for citizens by providing efficient government services and private-sector partnerships.

Leveraging Technology to Make Our Communities Future-Ready

Each community has its own definition of "smart" because each community has unique challenges and culture. Smart communities can address the issue of climate change in many ways. Right now, there is huge opportunity to transform how we use energy by leveraging data and technology. Smart communities explore the use of innovation and new technologies to plan for a better tomorrow. By analyzing data and utilizing the appropriate technology-enabled solutions specific to each community, responses will better align with needs and values. Big cities, suburbs, and rural townships all benefit from interconnected technology-driven initiatives that prioritize collaboration, such as:

- Adding **solar panels** to reduce reliance on grid electricity
- Providing **energy microgrid backups** to withstand power outages
- Incorporating **residential battery storage** so that wind and solar power can be used at any time
- Utilizing **geo-exchange technology** to phase out non-renewable energy dependence
- Using **augmented reality and digital twin technology** to discover information on neighborhood needs
- Incorporating **smart LED streetlights** to reduce energy and increase safety
- Striving for **building certification such as LEED** to decrease maintenance costs, produce less waste, and improve indoor air quality
- Improving **mass transportation connectivity** to lower traffic congestion and emissions
- Providing **EV charging stations** at public parks, retail destinations, and multifamily residential areas for convenient, reliable access
- Designing **walkable and bikeable communities** for more economically equitable transportation

Future-focused, smart communities are interconnected and co-created via partnerships between residents, businesses, and government. VHB's approach to smart community building is people-centric and purposeful, and we strive to implement guidelines that prioritize innovations in technology and data-informed decision-making. The communities we partner with in implementing smart solutions will be sustainable and thrive as healthy, environmentally-friendly, and economically and socially vibrant destinations for generations to come. Learn more about the 10 foundational elements of smart communities in this digital animation.

Transform: Investment & Partnerships for a Cleaner Future

In fall 2021, the 26th annual Conference of the Parties convened in Glasgow, Scotland, with more than 190 world leaders participating to address the issue of climate change. There is hope that this example of collaboration will also apply to state and local initiatives and will send a strong signal to governments, the public sector, private investors, and consultants to work together for a common purpose.

The AEC industry has a pivotal role in redefining the future. We are educators as well as innovators. Education can encourage people to change their attitudes and behavior; it also helps them to make informed decisions. Clients turn to us for our knowledge, experience, and guidance. As trusted advisors, we will help our clients navigate both challenges and opportunities associated with climate issues—and partner with them to create a cleaner and greener future.

> **"Innovation is the practical development and implementation of forward-thinking solutions that improve efficiency, enhance value, and embrace change."**
>
> **—Dave Mulholland |** *VHB Chief Technology Officer*

Challenges & Potential Solutions

Social & Economic Issues

Climate change brings with it the challenge of unequal distribution of impacts and climate readiness. Environmental issues are intertwined with social and economic ones. While climate change is a global challenge, there are certain communities hit first and worst by environmental issues—typically disadvantaged communities. We must consider the following:

- What happens to families who can't afford to move from a neighborhood hit by extreme weather or natural disaster?
- Who will be able to finance sustainable innovations such as rooftop solar panels?
- Will new development make neighborhoods less affordable?

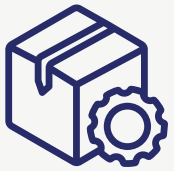
As we make changes in response to climate change, we have a responsibility to mitigate the harm to disadvantaged communities that will otherwise see the worst impacts. **Technology can help paint a clearer picture of impacts on typically underserved areas. A holistic approach that considers environmental, social, and economic issues is critically important to our role in the AEC industry—and to the solutions we provide for the infrastructure that supports our communities.** We must transition from industrial multinational use of fossil fuels and invest in community-based energy solutions, ones that engage all stakeholders—including the public—from the onset. Learn more about how social equity is at the heart of smart, future-focused community design and VHB's commitment to equity in the built environment.

Regulations & Permitting

Clean energy projects are desired, and the need to build supporting infrastructure is understood. However, these projects are being denied permits and unable to advance, even in states with bold and progressive Renewable Portfolio Standards. Regulations and policies are needed to allow projects to be permitted, designed, and built with allocated schedules and minimal risk. This will also help streamline the siting process, which can be a big stumbling block due to the need to reach consensus with various stakeholders. If projects are unable to cross the finish line, states will be in danger of not meeting clean energy goals and we won't reach net zero. **Consultants with a broad knowledge of the regulatory environment, latest policies and trends, as well as stakeholder concerns, will help clients and communities navigate complex and dynamic requirements and move projects forward.**

Funding

In addition to government funding, major investment partnerships will be needed to fund a global energy transition. The 2021 Intergovernmental Panel on Climate Change report spurred some of the largest financial institutions in the world—many not known for progressive action around climate change—to embrace net zero targets. It is important for the global finance industry to engage not only with the companies they own but also policy makers and the consultant community. As project demands and industry standards continue to evolve, clients and owners are increasingly turning to alternative delivery, including public-private partnerships (P3s) between the government and private sector, to deliver projects. **Consultants who understand and have worked on both sides of the table are in a unique position to bridge the gap between the public- and private-sector—and facilitate these partnerships to help advance projects.**



Supply Chain & Construction Costs

The ongoing COVID-19 pandemic, as well as the war in Ukraine, are having longstanding effects on global and domestic supply chains. Large infrastructure projects, especially those with Buy America requirements, are impacted by domestic supply chain issues. Building materials, including concrete and steel, are in high demand but low supply—resulting in escalating costs and project delays. Offering tax incentives for material providers could be one approach to help increase domestic production. Another way to mitigate escalating construction costs is to closely monitor budgets beginning at the earliest project stages. **Alternative delivery allows for shared risk between owners and contractors, as well as for early participation from contractors and greater collaboration between design and construction.** Clients are beginning to implement progressive design-build delivery, which allows cost commitment to be delayed until the majority of design is complete. This shortens the time between budget identification and spending, allowing for less chance of inflation. Watch this video to learn more about design-build and collaboration for better project outcomes.

> **"VHB is committed to integrating sustainability throughout our internal operations and business practices. We leverage data and technology to enable us to measure our footprint and take action, helping contribute to climate solutions and a cleaner, greener future."**
>
> **—Andrew White |** *VHB Corporate Sustainability Director*

Infrastructure

In a warmer world, more evaporation occurs—and what goes up, must come down. America's infrastructure is old and not designed for these new precipitation conditions. Rehabilitation and repair projects are necessary to modernize infrastructure and make it more resilient. Additionally, as we transition to greater use of electric and hybrid vehicles, renewable power sources, and cleaner, greener construction, existing infrastructure must also transition to support this change. The IIJA is accelerating investments in the future of our communities, with a longer-term view, a more aggressive spend, and multi-year approach to deliver overdue investments to support our nation's critical infrastructure—roads, bridges, railways, airports, ports, waterways, water, sewage, broadband, EV charging infrastructure, and power grid renewal. **This unprecedented, once-in-a-generation investment is an opportunity for the AEC industry to support our clients in developing the critical infrastructure that will lay the foundation for economic growth—and create more sustainable, resilient, equitable communities.**

> **"As a generational company founded on stewardship, VHB recognizes our important role in addressing the climate crisis. It will take all of us—government, municipalities, agencies, consultants, private companies, communities, and individuals—to transition, evolve, and transform to a cleaner and greener future."**
>
> **—Mike Carragher |** *VHB President & CEO*

Unlocking Development Potential: GreenCity Ecodistrict

A 204-acre abandoned corporate campus is being transformed into a sustainable and resilient community called GreenCity, in Henrico County, Virginia. VHB worked alongside Green City Partners, LLC, to prepare the master development plan and provide recommendations for future infrastructure. The vision for the property as an ecodistrict integrates sustainability, with social equity and resiliency at the forefront of its standards. The future of GreenCity will include mixed income housing, forested areas and parks, buildings designed to interact with the environment, and a multimodal transportation network designed for walkability and connectivity. A 17,000-seat arena with flexible seating configurations will be constructed using green best practices. This $2.3B investment will result in a dynamic mixed-use ecodistrict that will attract new businesses, create jobs, and generate millions in tax revenue for the community. Learn more about GreenCity.

Conclusion

VHB understands that innovation, strategic thinking, data and technology, and partnerships continue to play a key role in the built environment—and in the transformation to a clean energy future.

Technology-enabled consulting is at the forefront of VHB's approach to solving our clients' and communities' most complex challenges, including climate issues. Smarter, more efficient, and equitable transportation networks bring accessibility and connectivity to all travelers through multimodal and data-informed options. Renewable energy sources help to reduce dependence on fossil fuels and lower GHG emissions. Vulnerability assessments that leverage data and analytics allow communities to plan for more sustainable and resilient infrastructure options.

While innovation and technology can help achieve net zero, it is important to understand that net zero is not the final solution or end game—it is the mid-game. In the years after net zero is achieved, we need to strive for net negative carbon emissions, capturing carbon via forests and direct air capture. **Everyone has a role to play, and partnerships are key.** Government, private entities, companies, investors, and civil society need to align with the target to limit global temperature rise to 1.5°C and achieve net zero emissions by 2050, as well as interim targets.

The AEC industry must continue to follow the IIJA and IRA; maintain future-focused, strategic conversations around opportunities to create more sustainable, resilient, and equitable communities; and consider creation of synergies between public agencies and private entities that will lead to strategic investments and accelerate economic development.

Now more than ever, partnerships and collaboration will be critical to achieving our nation's goals and transforming the built environment. Ultimately, by working together, we can create a cleaner, greener, healthier future for everyone.

Connect with VHB to share insights on embracing the clean energy revolution and addressing the climate crisis through transition, evolution, and transformation.

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