

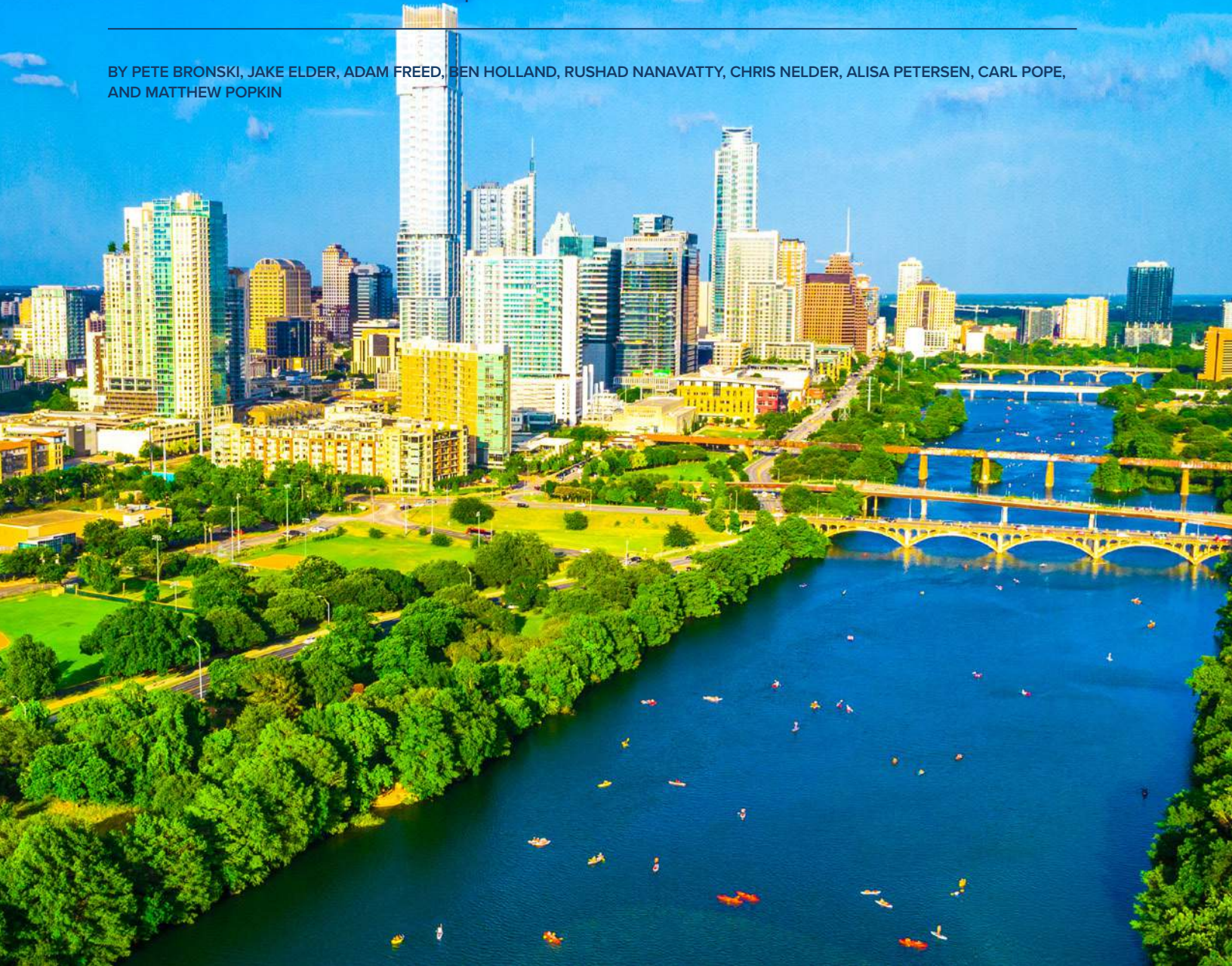


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COMING BACK STRONGER

A City-Driven Infrastructure Agenda for a Cleaner,
More Resilient, More Equitable America

BY PETE BRONSKI, JAKE ELDER, ADAM FREED, BEN HOLLAND, RUSHAD NANAVATTY, CHRIS NELDER, ALISA PETERSEN, CARL POPE,
AND MATTHEW POPKIN



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AUTHORS & ACKNOWLEDGMENTS

AUTHORS

Pete Bronski (Inflection Point Agency), Jake Elder (Bloomberg Associates), Adam Freed (Bloomberg Associates), Ben Holland, Rushad Nanavatty, Chris Nelder, Alisa Petersen, Carl Pope (Inside Straight Strategies), and Matthew Popkin

** Authors listed alphabetically.*

All authors from Rocky Mountain Institute unless otherwise noted.

ACKNOWLEDGMENTS

The authors would like to thank the following for their support in writing this report:

Kelly Shultz, Bloomberg Philanthropies
Kelan Stoy, UrbanFootprint
Jason Hercules, UrbanFootprint
Johanna Partin, Carbon-Neutral Cities Alliance

CONTACTS

Alisa Petersen, apetersen@rmi.org
Rushad Nanavatty, rnanavatty@rmi.org
Kelly Shultz, kellys@bloomberg.org

SUGGESTED CITATION

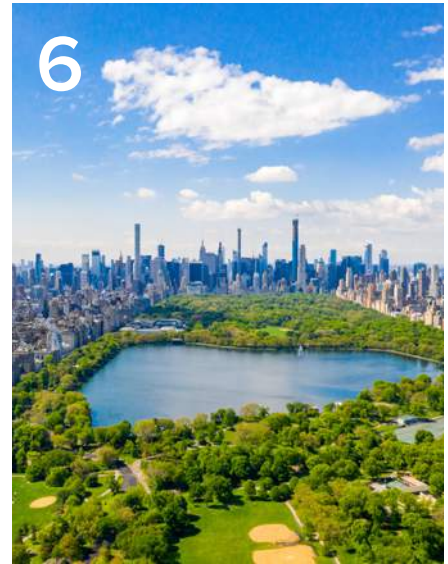
Pete Bronski, Jake Elder, Adam Freed, Ben Holland, Rushad Nanavatty, Chris Nelder, Alisa Petersen, Carl Pope, and Matthew Popkin, *Coming Back Stronger: A City-Driven Infrastructure Agenda for a Cleaner, More Resilient, More Equitable America*, Bloomberg Philanthropies and Rocky Mountain Institute, 2020, <https://rmi.org/insight/coming-back-stronger>

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EXECUTIVE SUMMARY



EXECUTIVE SUMMARY

America is in a moment of transition. To recover from the human tragedy and economic crisis induced by the COVID-19 pandemic, we need our federal, state, and local governments working in concert to build back a stronger America—one that is more inclusive, more resilient, and aligned with a pathway that keeps global warming to under 1.5°C.

While we need a large infusion of federal spending along with state and federal policy change, cities need to play a key role in contextualizing, designing, and delivering these projects. This report offers ideas across six sectors, highlighting city success stories for each.

1. ACCESS AND MOBILITY:

Infrastructure spending should reclaim automotive space and funding for people, transit, and mobility alternatives, while also accelerating vehicle electrification.

2. BUILDINGS:

Infrastructure spending should be focused on rebuilding America's schools, affordable housing, and commercial buildings through a national buildings upgrade effort that delivers deep retrofits for existing building stock along with efficient, all-electric, grid-interactive new construction.

3. POWER:

Infrastructure spending should be focused on retiring our remaining coal power and deploying clean energy portfolios, enabled and accelerated by grid upgrades and regulatory reform—in the service of ensuring our electricity is affordable, clean, and reliable.

4. BROADBAND:

Infrastructure spending should be focused on expanding affordable, widespread broadband access via competition and municipal or public-private partnership (P3) programs.

5. WATER:

Infrastructure projects should be focused on providing clean drinking water for all Americans while managing both drought and flood risk by upgrading our water distribution infrastructure (including lead service line replacement), sewage treatment improvements, a national water conservation program, and green stormwater infrastructure.

6. NATURAL SYSTEMS:

Infrastructure projects should be focused on protecting and enhancing natural systems ("green infrastructure"), both buffering and serving as an alternative to human-made systems ("grey infrastructure"), while ensuring that every American has access to green space.

Investing in "future-proof" American infrastructure can create much-needed jobs and economic recovery, help confront our massive social inequalities, accelerate the clean energy transition, and prepare our communities to withstand the climate instability that we are already experiencing. Cities drive innovation, are highly effective channels for economic stimulus and infrastructure spending, and have a more intimate understanding of people's needs than any other level of government. Their role is key.

INTRODUCTION



INTRODUCTION

CONTEXT

For months, America’s policymakers have been discussing the prospect of a national rebuilding project. Enhancing the nation’s infrastructure is an issue that enjoys a rare degree of bipartisan support—at least notionally. This report shows how cities—**home to four out of every five Americans**—can anchor a long-term national rebuilding project, taking inspiration from what these cities are already doing.¹

Not only are we dealing with an economic crisis in which **7.9% of the US population is unemployed** six months into the pandemic, we are also living on a destabilized planet. We are pushing our **planetary boundaries** to the breaking point and have entered a world of **stochastic risk** and **tipping points**. When every national intelligence assessment warns of a pandemic and where 1,000-year storms become annual events, there are no more “black swans.”

While infrastructure projects can and will create new jobs to support recovery, we also recognize that we remain in the middle of a pandemic. The primary focus of any new spending should be relief: helping support those that have temporarily lost their livelihoods.

ACHIEVING RESULTS WITH INFRASTRUCTURE

Given that context, it is critical to define both (a) what we mean by “infrastructure,” and (b) the goals of infrastructure spending.

Definition:

At its core, infrastructure encompasses the systems that enable our society and economy to function. Too often, that translates into siloed projects for discrete, public, physical assets: roads, bridges, information and communications networks, airports, and rail lines. A better definition would also include:

- buildings (e.g., housing, commercial buildings, **public buildings**),
- natural systems, which provide a range of vital services and underpin human-made infrastructure, and
- the physical relationship and interactions between different infrastructure systems (which affects how each individual system functions).

Goals:

We need to rebuild an economy that looks fundamentally different than the one we were trying to decarbonize before the COVID-19 pandemic: one that is more competitive, more resilient, more equitable, and less likely to break the planet. We have only a decade to keep global warming to a maximum of 1.5°C above pre-industrial levels, beyond which **even half a degree will significantly worsen** the risk of drought, floods, water availability, extreme heat, and poverty. For the United States, this implies reducing emissions by roughly 50% relative to 2005 levels by 2030, on the way toward net-zero emissions by 2050.

While we are *not* on track for these targets, **America’s Pledge analysis** shows that it is still possible with ambitious state, city, and business action, alongside a resumption of federal leadership in 2021. An unprecedented level of economic recovery spending gives the United States the ability to “future-proof” America’s infrastructure. Failure to do so will risk American lives, our landscapes, and our economy.

¹ For simplicity’s sake, we use the term “cities” in this report to mean any kind of local government authority: cities, towns, counties, etc. The solutions within apply to many of these entities.

THE ROLE OF CITIES

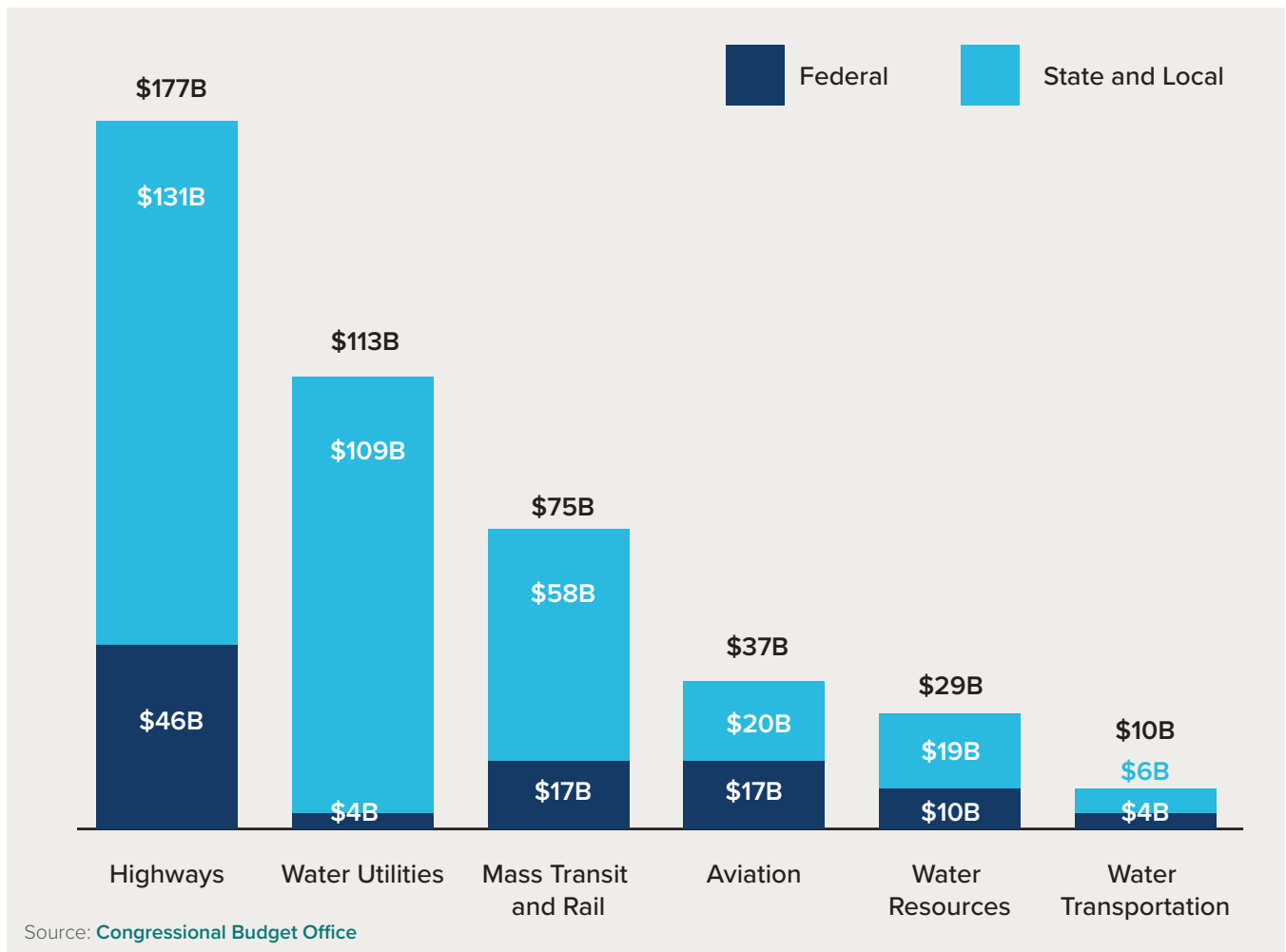
Cities drive innovation.

America differs from most other industrialized countries in the extent to which it **relies on local and state spending** to meet infrastructure needs. While most European countries fund most of their infrastructure development at the national level, only **25% of US public infrastructure funding** comes from the federal government.

American cities (as this report shows) are often willing to experiment, question assumptions, and take risks—to the benefit of other local governments and the country as a whole. If states are the “laboratories of democracy,” cities are the workshops.

EXHIBIT 1

Local and Federal Public Spending on Transportation and Water Infrastructure in Billions of 2017 Dollars



Stimulus spending is uniquely effective when directed through cities.

Cities are more responsible for direct service provision and more responsive to citizens' needs than any other branch of government. Because of this proximity to people and projects, cities can ensure that infrastructure funding is informed by local context. Additionally, cities can deliver the most bang for the buck by pairing investment with thoughtful policies at the city level. Decades of underinvestment in cities have also left them with a significant backlog of infrastructure needs that their leaders could quickly address if given the resources.

Examining historical examples of recovery spending—dating back to the Great Depression—Christina Romer, chair of President Obama's Council of Economic Advisers, **said** “the money given to state and local governments to ease their budget problems appears to have been particularly effective for job creation in the near term.”

City action can be significantly enhanced if the state and federal government are pulling in the same direction.

While city-led infrastructure projects are the primary focus of this report, city governments cannot do it alone. As the World Resources Institute points out in its *New Climate Federalism* working paper, “the task of decarbonizing the US economy is too big for any one level of government to tackle alone... each level [of government] has distinct roles and capabilities that, when combined, can lead to the best outcomes.”

We need a strong federal role where especially large investments are required, where expertise is limited at the state and local level, and where the need for a national standard outweighs the benefits of local variation and experimentation. We need a stronger state or city role when local variations (demographic, topographic, or climatic)

are of critical concern, where engagement with local communities is especially important, and where local governments have expertise and capacity.

Among the principles articulated in the *New Climate Federalism* paper:

“Preemption should be rare. Actions by the federal government should enable and not impede more ambitious actions by state and local government... Likewise, state governments should enable and not impede more ambitious action by local governments.”

“[We need] federal standards that are sufficiently ambitious to address the climate challenge, while preserving the ability of state and local governments to take more ambitious action and adopt compliance strategies that reflect local and regional conditions.”

Cognizant of this need to harness the unique strengths of each level of government, we have highlighted areas where state or federal policy change could help supercharge city-led action.

DRAWING INSPIRATION FROM OTHER COUNTRIES

While the CARES Act has not provided direct stimulus support to local governments or clean infrastructure **beyond some funding for public transit**, other countries are starting to show leadership.

The UK spent **£2 billion for cycling, bus-only, and pedestrian infrastructure**. Italy increased subsidies for household rooftop solar and storage installations from 50% to 110% and building renovation projects from 65% to 110%. **China's stimulus plan includes increased funding** for electric vehicles (EVs) and EV

charging infrastructure, which it expects will support a five-fold increase in EVs in the next five years. The European Commission has announced funding for home energy efficiency and **a Just Transition Fund**. The United States can similarly use clean infrastructure to create jobs, increase resilience, enhance the health of our people, and decarbonize our economy.



THE CONTENTS OF THIS REPORT

Through city-led clean infrastructure projects, we can rebuild a healthier, safer, greener, and more-resilient America. This report covers six sectors and highlights city success stories within each. Through clean infrastructure, we can build an America where:

1. **ACCESS AND MOBILITY:** People have equitable, convenient physical access to jobs and essential services.
City example: Seattle’s holistic transportation strategy has emphasized walking, cycling, and public transit improvements alongside electric vehicle (EV) infrastructure buildout and the electrification of its own vehicle fleet.
2. **BUILDINGS:** Our homes, schools, and commercial buildings are affordable, resilient, healthy, and climate friendly.
City examples: Boulder’s efficiency standards for rentals policy and program resulted in upgrades to 32% of its residential housing and lower utility bills for renters.
City example: Atlanta’s Better Buildings Challenge led to almost 15% of commercial space voluntarily committing to a 20% reduction in water and energy by 2020.
3. **POWER:** Electricity is affordable, clean, and reliable.
City example: Cincinnati contracted a 100-megawatt solar array for its city facilities and residents that included a significant local economic development component.
4. **BROADBAND:** The power of the online world is available to every family in every zip code.
City example: San Jose’s broadband strategy combines municipal leadership and public-private telecom partnerships to advance digital inclusion.
5. **WATER:** Every American has access to clean and affordable drinking water and all communities are resilient to floods and droughts.
City example: Newark is replacing all the lead service lines in its drinking water system with copper pipes in less than three years, improving the quality and safety of water for all residents.
6. **NATURAL SYSTEMS:** Every American has access to green space, with our natural systems buffering and enhancing our human-made infrastructure.
City example: Denver significantly expanded equitable access to urban parks and forestry through building new downtown parks, growing its urban forest, and ensuring equitable access to recreation space.

CROSS-CUTTING CASE STUDY ON URBAN

LAND-USE: Portland’s land-use policies increase the supply of affordable housing, enable people to live close to transit and jobs, and enhance resilience.

This report summarizes infrastructure projects and policies that are critical for building city infrastructure, supporting economic growth and recovery, protecting public health, and achieving our climate goals.

1

ACCESS AND MOBILITY



ACCESS AND MOBILITY

THE BIG IDEA

Reclaim automotive space and funding for people, transit, and mobility alternatives, while also accelerating vehicle electrification.

WHY BUSINESS AS USUAL IS NOT ENOUGH

Since the mid-20th century, transportation policies and practices in America have consistently prioritized automobiles, especially single-occupancy passenger vehicles. While not without some benefit (to the car and fossil fuel industries, for example) it has arguably come with a much more significant economic, social, and environmental cost.

The average American household **spends 16% of its income on transportation**, 93% of which is spent on personal vehicles—the biggest expenditure after housing. From 1982 to 2015, while the US population grew by 38%, the total land “consumed” in America grew 60% (from 72 to 115 million acres). Most of this was sprawl—and for every 1% increase in land consumed, vehicle miles traveled (VMT) increased by 1.6%. That sprawl also results in emissions from converting natural systems into settlements: **80 million tons** of carbon dioxide-equivalent (tCO₂e) emissions per year—more than 10% of the magnitude of America’s net land sink.

Auto-centric federal and state transportation funding that reinforces American car culture inordinately favors highways, which garner **more than 70% of all land transportation** funding. Much of this is applied to expanding highways or building new roads in the name of alleviating traffic congestion. This is a false promise. Road expansions are typically quickly overwhelmed by “induced demand.” If you widen a road, more people will start driving on it. Even though highway expansions have outstripped urban population growth over the past 30 years, traffic delays are actually up **144%**. And each new light-duty vehicle

on the road also means an **additional 15 tCO₂e from manufacturing**, equivalent to about three years of emissions from an average gas-fueled vehicle.

America’s car-centric approach to transportation is also a major equity issue. Black Americans are less likely to own a car and thus **four times more likely to commute by public transit** than White Americans. Lower-income households and communities of color are much more likely to live near highways without benefiting from increased access and mobility but suffering from their proximity to vehicle pollution. Black and Hispanic Americans are exposed to **63% and 56% more pollution than they create**.

HOW TO DO BETTER

Comprehensive transportation infrastructure reform is needed in two complementary arenas: a) to reclaim space and funding previously dedicated to automobiles for people, public transit, and mobility alternatives, and b) to electrify the vehicles on our roadways, including passenger cars, other light-duty vehicles, buses, and municipal fleets.

Reclaim Automobile Space and Funding

A movement is underway across the country to reclaim auto-dominated spaces for people and alternative modes of transportation (e.g., transit priority lanes, sidewalk expansions, and bike lanes). However, these efforts have largely been relegated to popular urban centers with pre-existing, latent demand for walkable environments, high-quality transit, and bike infrastructure. There remains tremendous potential to activate neighborhoods surrounding urban cores—and even the exurbs.

INVESTMENTS

Reform federal transportation funding, rebalancing investment toward public transit and active modes of transportation. Congress recently passed a year-long extension of the *Fixing America’s Surface Transportation (FAST) Act*, which was set to expire on September 30. Instead of rebalancing funding for our transportation system, the extension has **80%** going to roads and interstate highways with just 17% going to public transit and 2% to active transportation.

The extension gives transportation advocates a year to define critical policies and investments, and to cultivate support for overhauling our federal funding strategy. Such an overhaul should fund transit and active transportation at an equal level to highways. Funding should also prioritize **“complete streets”**—streets designed and operated to enable safe access for all users including bicyclists and pedestrians—over the speed of personal vehicles.

Implement a “fix it first” policy for highway funding. Infrastructure investments should prioritize maintenance and repair of existing roads before road expansions. These investments in new roads not only redirect funds away from much needed repair and maintenance, they also increase the amount of funding needed for this in the future. Every new lane-mile of road costs approximately **\$24,000 per year** to preserve in a state of good repair. Further, investing in new roads reinforces the systemic bias against investing in urban and inner suburbs, and in investing public funds to subsidize auto-dependent sprawl.

Invest in transit-supportive street space allocation. Public transit excels only when prioritized. Public transit ridership is directly tied to frequency, which in turn is directly connected to the space we allocate to buses or trains. Reallocating traffic lanes for buses or light rail enables congestion-free commuting for high volumes of passengers.

For example, a simple bus priority lane can move

40–80 people per bus every 10–15 minutes—sailing by general car traffic. Plus, every \$1 invested in public transportation **creates \$4 of economic activity** in the community and **70% more jobs per dollar** than new or expanded roads. By helping more people gather in the same places, public transit also enables the clustering of jobs—which raises wages and economic productivity over time. Researchers at **UC Berkeley** have calculated that this hidden economic value could be worth anywhere from \$1.5 million to \$1.8 billion a year, depending on the size of the city.

Invest in street retrofits that prioritize pedestrians, cyclists, and micro-mobility. Protected lanes for these uses will dramatically improve the convenience, safety, and speed of using bicycles, e-bikes, and scooters as true commuting options. For example, protected bike lanes reduced fatal crash rates by **more than 60% in Seattle and 38% in Chicago**. Further, most cities across the country suffer from a gross undersupply of sidewalks—arguably the most overlooked and effective mobility solution, **particularly for disadvantaged and transit-dependent communities.**

POLICIES

Ditch level of service as the guiding metric for transportation planning and real estate development. Outside of California, nearly every American city continues to use the antiquated metric of **level of service (LOS)** for judging the performance of a street. LOS assumes an amount of automobile trip generation for every development, typically resulting in street widenings, increased parking, and other measures that prioritize cars and free-flowing traffic. By this metric, buses carrying 40-plus passengers are treated the same as single-passenger vehicles, and pedestrians are considered an impediment to alleviating congestion.

Instead, states and cities should follow California’s **policy** and mandate that state and city transportation planning prioritize VMT reduction as the chief guiding metric. Alternatively, **“passenger miles traveled”** is an emerging metric that accounts for distance traveled by each passenger, which better accounts for ride sharing. Selecting either of these metrics over LOS will stem the tide of unnecessary road and highway expansions that directly reduce the viability of walking, biking, and transit.

Define a strategy, regulatory, and funding framework for transit and mobility services. Cities should pursue the concept of “Universal Basic Mobility” or a holistic strategy for making mobility alternatives ubiquitous and accessible to all. In particular, cities can support and complement public transportation by providing critical first- and last-mile connections. While some cities have struggled to manage and integrate micro-mobility services, such as dockless scooters, e-bikes, and traditional bikeshare, others are embracing the role that these mobility alternatives can play in enhancing the convenience and accessibility of public transit and non-automobile commuting. Cities have the power and influence to establish strategies and regulations to ensure mutually beneficial operation of public transit and alternative mobility services.

End exclusionary land-use and zoning practices and build the “right housing in the right places” to help address a nationwide housing crisis while simultaneously reducing transportation emissions and increasing the tax base in cities. Regressive regulations like detached single-family zoning, minimum parking and lot-size requirements, height restrictions, and prohibitions on accessory dwelling units currently prevent neighborhoods from adding housing and adapting to evolving demands.

In addition, cities should allow for mixed-use development, to ensure that people can live in close proximity to critical services. By creating “15-minute neighborhoods,” where people can walk to the most

basic of needs, cities can reverse a tide in which suburbs have cannibalized tax revenue for years and burdened cities with unrecoverable debts associated with highway and public utility (e.g., water) expansions.

Establish a nationwide interoperable transit and mobility data standard that enables seamless trip-planning, reservations, and payment across modes, including bus, rail, micro-mobility, carsharing, and other emerging mobility services. Though there is a patchwork of efforts to create open market standards for public transit, the industry has yet to agree upon a fare standard that would enable users to ride and pay across transit agencies, modes, and trip-planning apps. Likewise, private mobility services have developed their own unique data standards that are largely inaccessible through transit and third-party apps. Creating open standards will improve the convenience and increase the use of alternatives to personal vehicles.

Eliminate Tailpipe Emissions through Vehicle Electrification

According to **America’s Pledge**, staying within a 1.5°C climate scenario will not only require reducing vehicles miles traveled significantly, but also require new light-duty vehicle sales to be almost 70% electric by 2030. Currently, about 2% of sales are electric. Tens of millions of new light-duty cars and trucks as well as heavy-duty vehicles will also need supporting charging infrastructure: a 30–54-fold increase in our current number of “level 2” chargers and a 20–36-fold in the number of fast chargers.

INVESTMENTS

Invest in municipal fleet electrification. Cities have a near-term opportunity to “walk the talk” on vehicle electrification by converting their own fleets to electric vehicles (EVs). Austin committed to procuring **330 EVs by 2020**, which it projects will save the city 3.5 million over 10 years from reduced fuel and maintenance costs. By increasing understanding around the challenges and best practices for fleet electrification,

the experience of local governments can serve to both inform policy and encourage similar efforts with corporate and municipal fleets.

Invest in public transit/bus electrification. Many cities and states are establishing mandates to electrify public transit and school buses. Though these buses contribute less than 1% of transportation emissions, there are significant benefits associated with electrifying this sector. This is due to the number of people they move, their potential to provide grid services, and the fact that they are typically owned and operated by agencies with a public mission (city transit agencies and school districts).

School buses are uniquely interesting as potential grid and resilience assets (both during and after their operating life) because of the predictability of their operations combined with significant downtime. Dominion Energy is supporting Virginia school districts to replace **50 diesel school buses with electric school buses by 2020**, with a plan to expand to 1,000 by 2025, and replace all diesel buses by 2030. These buses will include vehicle-to-grid technology allowing them to support the regional electricity system by storing and injecting energy into the power grid when not in use.

With increased ridership, these benefits will only grow. However, bus electrification mandates will require extensive and costly utility and charging infrastructure upgrades and garage retrofits. As there are few dedicated e-bus assembly lines, bus manufacturing has not reached the point where it is achieving real economies of scale. Therefore, costs cannot yet be borne by transit agencies or school districts alone. By financing this transition, the federal government could play a **crucial role** in defraying these costs and de-risk these investments. This support is essential at a time when transit systems are already struggling to maintain and fund existing service levels.

POLICY/REFORM

Streamline permitting for charging infrastructure.

Reducing “soft costs” will be critical to faster deployment of EV charging infrastructure. Hassles associated with permitting and siting mean that a charging station in one location can **cost twice as much** as an identical one in a different location. By streamlining zoning regulations and permitting, cities can enable and incent installations by businesses, developers, utilities, and private charging infrastructure players. Federal guidance or a federal standard—the EV charging equivalent of NREL’s SolarAPP for rooftop solar installations—could be critically helpful. (More on SolarAPP in *Power* section.)

Establish EV-ready building codes. Cities can require that all new commercial and residential buildings and parking lots include power supply stub-outs for EV chargers, so that workplaces, multi-unit dwellings, and single-family homes can all be equipped with level 2 chargers quickly and cheaply. This is the fastest and lowest-cost way to enable ubiquitous, equitable deployment of charging infrastructure.

Reform utility business models and regulation.

Variation in pricing and rules for EV charging significantly hampers deployment of charging infrastructure; charging costs range from **zero to the equivalent of over \$3 per gallon**. And demand charges, levied at times of high electricity load, can often ruin the business case of chargers.

We need nationwide alignment on utility rate structures and electricity market rules in order to provide utilities and private charging infrastructure companies with greater certainty—both over charging costs and over potential revenue streams from utilizing EV batteries as grid assets. This could build on the momentum of the recent **FERC Order 2222**, designed to help distributed energy resources (DERs) compete on a level playing field in organized capacity, energy, and ancillary services markets.

MOBILITY CASE STUDY: SEATTLE, WA

With a goal of reducing transportation emissions 50% by 2030, the City of Seattle has undertaken what is arguably the most comprehensive strategy for reducing transportation emissions of any city in America. Seattle's strategy prioritizes efforts to increase the mode-share of transit, walking, and biking, as well as a commitment to vehicle electrification.

Seattle's efforts to enhance pedestrian, cycling, and transit initiatives have made it one of the best cities for living and working without a car. The city's success with these initiatives has led to a **significant drop** in drive-alone rates, with walking and transit seeing large increases. In the past five years, Seattleites and the City of Seattle have advanced policies and strategies to fund significant expansions to the transit system and bike network. Instead of expanding highway infrastructure, Seattle has improved service coverage and frequency. In 2016, Seattleites approved Sound Transit 3, which increased the sales tax to generate \$54 billion in funding for a massive expansion of its existing light-rail network—connecting a vast portion of the population to transit. According to the UrbanFootprint analysis shown in Exhibit 2, this will increase the population living within a 10-minute walk of the light rail from 119,000 to 174,000.

Relatedly, there are two additional, quickly developing technologies that will address range limitations. The first—hydrogen fuel cell electric drive for heavy- and medium-duty trucks and buses—is well understood and appears to be near full market launch. The benefits relative to battery electric drive are reduced weight and extended range. Hydrogen drive technology is gaining momentum for over-the-road use cases, but it will not come without challenges because it requires new fueling infrastructure—the same barrier as compressed natural gas and battery electric before it. The second is solid-state battery technology, which is well underway in the lab. It promises lightweight and high-density energy storage and could see market viability by the end of the decade.

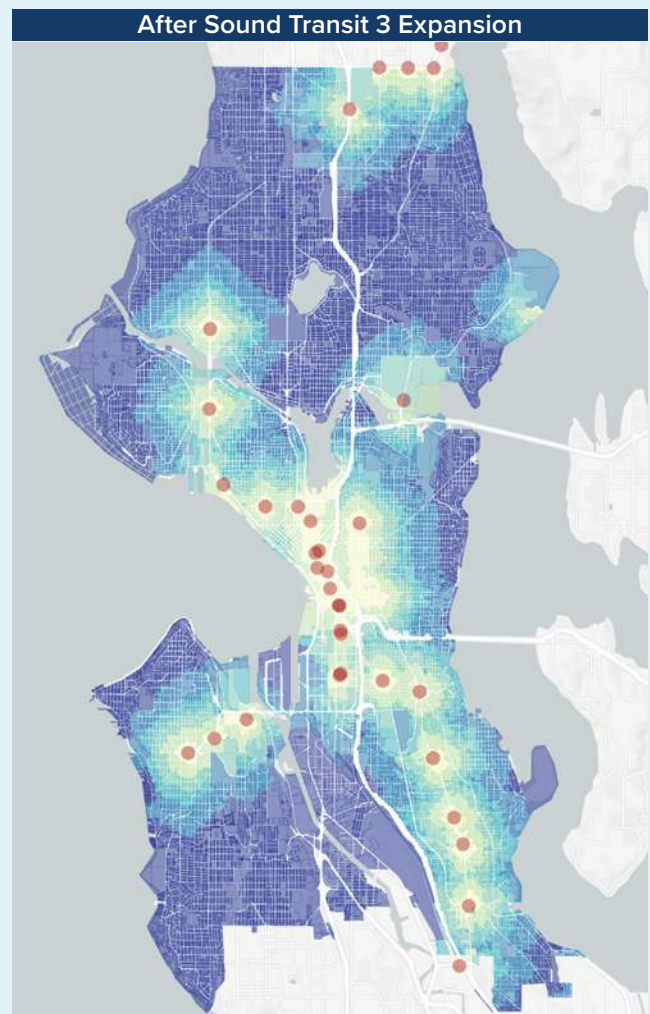
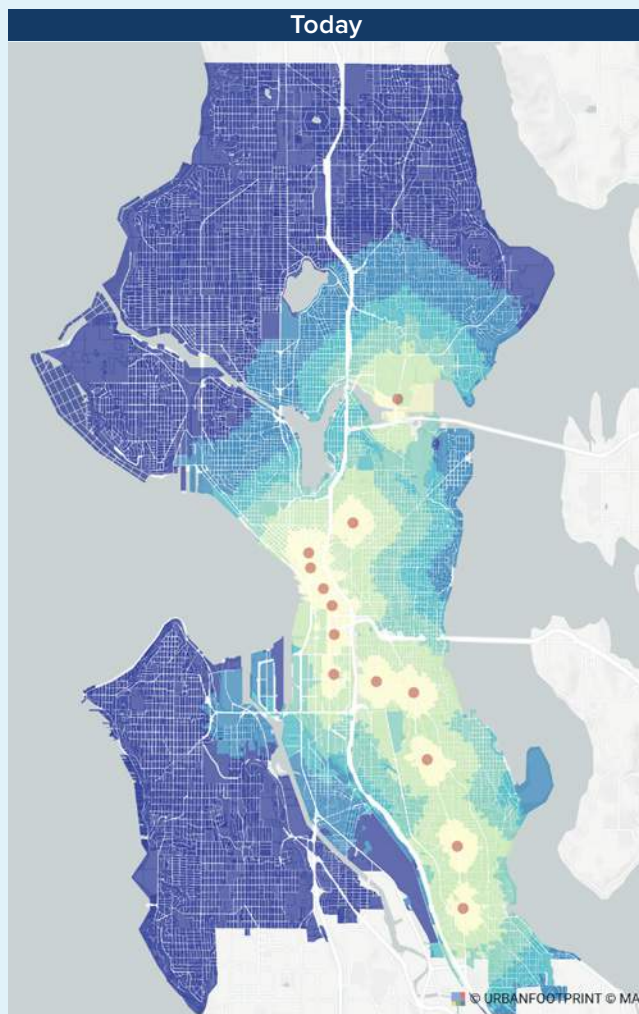
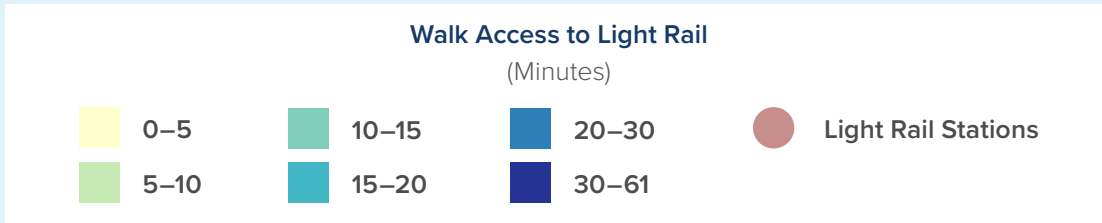
Seattle has also closely tied its transit and mobility planning to policies and practices aimed at increasing the availability of affordable housing. For the Sound Transit 3 expansion, affordable housing played a critical enabling role. Ahead of the 2016 election, the Washington State legislature adopted legislation requiring that Sound Transit prioritize equitable transit-oriented development (TOD) at key locations along light-rail lines. Specifically, **the plan** requires that Sound Transit allocate 80% of its surplus property suitable for housing to developers that agree to make 80% of the units affordable to families making 80% or less of the area median income.

With 90% of the city's electricity coming from clean hydroelectric power, Seattle is one of the cleanest places in the country to own and operate an electric vehicle. Since the arrival of mass-market electric vehicles in 2009, the City of Seattle has supported the expansion of charging infrastructure and committed to electrifying its fleet. The City already has 200 EVs with plans to grow the fleet. Likewise, Seattle transit agency, King County Metro, has committed to electrifying all of its buses by 2040, making it one of the most-progressive agencies in the country

As a result, the chorus is growing to electrify medium- and heavy-duty vehicles of all types. Given that bus electrification leads this vehicle segment with near-term commitments, funding for demonstration projects at scale should be the priority. Scaled demonstrations prove out the technology, create the solutions that address deployment challenges, and will help usher in electrification of truck fleets.

EXHIBIT 2

Walk Access to Seattle’s Light Rail System a) Today and b) After Sound Transit 3 Expansion



The maps show the current and future build-outs of Seattle’s light-rail system and the walkable access each transit stop provides. Left: Sound Transit 2, which was completed in 2009 and runs from the Seattle-Tacoma International Airport to the University of Washington. Right: Sound Transit 3, the future build-out of the light rail system, which was approved by Seattle voters in 2016 and will be complete in 2035. Not pictured is Seattle’s extensive bus system, which provides high-quality transit throughout the city.

Source: UrbanFootprint and RMI analysis



BUILDINGS

THE BIG IDEA

Rebuild America's schools, affordable housing, and commercial buildings through a national buildings upgrade effort that results in highly efficient, all-electric new construction and deep retrofits for existing building stock.

WHY BUSINESS AS USUAL IS NOT ENOUGH

In order to stay within a 1.5°C climate scenario in 2030, buildings need to swiftly move toward becoming highly efficient and all-electric. **America's Pledge analysis** shows that this requires average annual efficiency improvements of 2%, all-electric new buildings, and electrification of existing fossil gas-based heating equipment and appliances at the end of life. Energy efficiency and grid-integrated technologies (e.g., smart thermostats, heat pumps) are necessary precursors to support cost-effective electrification that minimizes buildout of a larger grid to support this new electric load.

These efforts must target America's existing commercial and residential building stock as much or more than new buildings. **Two-thirds of the buildings standing today will still be around in 2050**, necessitating deep retrofits that significantly cut energy use for existing buildings. Finally, **embodied carbon is responsible for 28% of building sector emissions**, so developing low-embodied-carbon building materials such as cement and steel will be crucial too.

Overhauling America's building stock is also a serious human health and equity issue. Indoor air pollution from burning fossil fuels in residential and commercial buildings (e.g., for space heating, hot water, cooking) causes more premature deaths (**over 28,000 per year**) in the United States than any other sector.

The location of our housing exposes tens of millions of American families to risk from natural disasters. The

number of houses built at the wildfire-prone wildland/urban interface (WUI) grew from **31 million in 1990 to 43 million in 2010**, a more than 30% increase in a 20-year span. Meanwhile, over **16% of US properties** are at risk of flooding within the next 30 years, while in **eight coastal states**, housing is being developed at faster rates in flood-risk zones than in safer locations. Flooding disproportionately impacts low-income and historically disadvantaged communities; for example, **in Chicago 87% of flood damage insurance claims** are paid in communities of color.

Affordable housing represents a particularly acute infrastructure need. The United States has **only 36 affordable housing units** for every 100 very-low-income renters in need. Additionally, **31 million households** suffer severe energy burdens (i.e., pay more than 10% of their incomes in energy bills). Energy burden rates are **43% higher** for Black households than for non-Hispanic White households.

Finally, America's building crisis also extends to our schools. The federal government supports just **0.2% of capital costs for schools, with states providing 18% and local governments the remaining 82%**. More than **50% of schools** require improvements to reach "good" condition, according to ASCE's 2017 *Infrastructure Report Card*. Since property tax revenue funds most local schools, investment in schools is directly tied to the wealth of its surrounding community, again bringing equity to the fore.

HOW TO DO BETTER

INVESTMENTS

Finance a national retrofit program that emphasizes workforce training. We need a federally financed, city-run program to spur deep retrofits of the nation’s commercial and residential building stock. These more ambitious, deep retrofits are often cheaper than shallower retrofits because they enable us to **“tunnel through the cost barrier”** and downsize or eliminate expensive heating, ventilation, and air-conditioning (HVAC) systems. These retrofits should prioritize affordable and low-income housing and small businesses, where utility bill savings could reduce energy insecurity and increase profits respectively.

Further federal investment in the **Weatherization Assistance Program (WAP), Community Development Block Grant, and Energy Efficiency and Conservation Block Grant programs** would all help spur more efficient building upgrades. These retrofits should also prioritize disaster mitigation upgrades for buildings in disaster prone areas. A significantly higher share of **FEMA’s Hazard Mitigation Assistance Grants** should go to state and local government, based on their share of disaster relief costs. States currently receive only 6% of this funding.

Having the workforce in place to implement the deep building improvement projects needed to meet our climate goals is a critical need. A national retrofit program can help close the building industry’s severe knowledge gap, particularly around beneficial electrification and zero-emissions design strategies. Creating these job opportunities would support a **“just transition”** away from fossil fuels (see the *Power* section for more on this topic). Energy efficiency projects create almost **three times as many jobs** as fossil fuels for every dollar spent. Workforce development programs are not one-size-fits-all, and since cities better understand what types of building retrofit work

and training are needed in their communities, they are best positioned to run these programs.

Invest in research and development of new building technologies and materials. We need new and innovative ways to retrofit buildings, such as the **REALIZE** program, which combines high-performance technologies with off-site prefabrication techniques that deliver breakthroughs in productivity—alongside more robust worker protection. Additionally, while cold-climate heat pumps have significantly improved in effectiveness and efficiency thanks to **US Department of Energy-funded R&D**, more work is needed to ensure every community can electrify its building stock without performance concerns.

By leveraging public sector procurement, we can also help establish the United States as the global leader in low- and negative-carbon building materials—like concrete produced through lower-emissions processes that can **store carbon for a century, need less water, and result in a stronger product**. A material that holds promise is **“mass timber”**—engineered, prefabricated structural wood components—which is already being used for **corporate campuses, entire waterfront districts, and buildings more than 30 stories tall**. We would need to be careful to ensure this comes from **carefully managed forests** in the lower 48 (which could reduce wildfire risk as a co-benefit) and not old growth rainforest in Alaska, Asia, Canada, and South America. If we can, life-cycle analysis suggests that buildings using this material instead of reinforced concrete would achieve a **greater than 25% reduction** in global warming potential.

Revitalize abandoned properties. Many cities have abandoned properties that are focal points for crime, urban decay, and environmental degradation—and can spur waves of disinvestment in cities. Infrastructure

funding could be used to reinvest and recover these abandoned properties using the best practices highlighted in the *New Building Codes* section. These revitalized properties can create new affordable housing in cities with lower total cost of ownership due to significantly lower utility bills.

Baltimore’s **Vacants to Value** program is a successful city-run program that revitalizes vacant properties. The program helps make rehabilitated properties affordable by providing down payment assistance, enabling families to build wealth through homeownership, and keeping the total cost of ownership low by ensuring high energy efficiency. Abandoned properties without market demand can instead be demolished and turned into community green space (see the *Natural Systems* section for more on this).

Bulk purchase fuel-switching infrastructure. Many homes do not have large enough electrical panels to support fuel-switching to electrification. Like **solarize campaigns where cities support bulk procurement of solar panels**, cities could facilitate bulk procurement of equipment such as electric panels and high-efficiency heat pumps for affordable housing units and low-income homeowners. Beyond supporting beneficial electrification, electrical panel upgrades can help prevent electrical fires, reduce power surges, and may reduce homeowner insurance costs.

Add resilience to public school buildings. Federal funding should be focused first in poorer districts and/or low-performing buildings to prevent funds from disproportionately going to more affluent communities that might otherwise be first in line. School upgrades should follow best practices highlighted in the *Policies* section.

Schools are also a good candidate to be turned into **resilience hubs** since they have deep ties to the community, have gyms and auditoriums for people to gather, and are often thought of as

“secondary critical loads.” This includes installing solar and battery systems (including those of electric school buses) that enable school buildings to remain powered during grid outages. A notable side-benefit would be the unique opportunities for schoolchildren to learn about clean technologies.

Invest in resilient, safe, efficient affordable housing.

To address the affordable housing crisis, more federal funding could be placed in the Low-Income Housing Tax Credit (LIHTC), which subsidizes the acquisition, construction, and rehabilitation of affordable rental housing. The LIHTC currently supports construction or rehabilitation of **about 110,000 affordable rental units each year**, but with a national shortage of more than **7.2 million affordable and available homes**, we need a lot more funding to meet this need.

Any new affordable housing should prioritize location-efficiency and minimizing exposure to disaster risk (i.e., building this housing close to economic opportunity and essential services rather than on the wildland-urban interface or in flood zones). For low-income families, the ability to live near good public transportation translates into improved access to healthcare, education, employment opportunities, and **reduced commuting costs** (see the *Mobility Case Study: Seattle, WA* for an example). The implication for reduced VMT and vehicle emissions—and by extension climate—are equally significant. Addressing California’s affordable housing crisis with transit-oriented urban infill will mean **35% lower VMT** than if it were to place this housing in the suburbs.

Finally, any new affordable housing should be all-electric, and highly efficient, to minimize both health risk and energy burden. These could be made a requirement to access LIHTC. Cities play a key role in supporting these types of requirements since they understand their local building typology and climate best. Boston, for example, recently announced \$30 million in funding to support new or renovate old affordable housing and required that all new affordable

housing construction **funded by the City must meet carbon-neutral performance standards**. To support this requirement, it **released its first zero-carbon affordable housing design standards**, tailored to the city's climate, portfolio, density, and resilience goals.

POLICIES

Strengthen building codes for new construction.

Newly constructed buildings, both residential and commercial, can and should be built to zero-emissions standards—or they will lock in inefficient operations and associated emissions for decades. Building energy codes are often set at the state level, but some cities can develop stricter energy codes or work with their states to develop stricter codes.

New building codes should include an explicit all-electric requirement, a low-embodied-carbon materials requirement, EV-ready parking spaces (where parking spaces are included), demand flexibility standards for certain equipment and appliances, and either require on-site solar or that buildings be solar-ready. Cities in **California have been leaders** in either requiring all-electric new construction (e.g., **Cupertino**), or explicitly banning gas or propane plumbing in new buildings (e.g., **San Mateo County**).

Building codes should also be updated to effectively protect against extreme weather, wildfires, and other climate-induced disasters. This may mean adding storm-safe windows and roofing, building higher above the floodplain, choosing **fire-resistant building materials**, using reflective coatings to reduce temperatures, or building homes with additional insulation so they can remain comfortable during critical **hours of safety** in extreme cold weather. For example, after Hurricane Harvey, **Houston enhanced building codes** to require that all new and redeveloped structures be elevated higher than previously required. As a result, each newly developed or redeveloped home is expected to mitigate upward of \$50,000 in rebuilding costs from potential future flooding.

Set building performance standards. These policies require existing buildings to meet certain energy or emissions performance thresholds. These thresholds ratchet up over time to drive emissions reductions and can be designed in ways to accelerate electrification as the local power supply becomes cleaner. Building performance standards would be most effective when paired with clean electricity standards or carbon pricing policies to accelerate electrification and improve retrofit economics.

The City of Boulder successfully implemented a program that required upgrades for residential rental properties, resulting in **32% of rental buildings being upgraded** (see the *Buildings Case Study: Boulder, CO* for more detail) and other cities are now pursuing rental efficiency standards. **Washington, D.C., New York City, and St. Louis** all recently passed building performance standards for their existing commercial and multifamily buildings.

Embrace up-zoning and infill development (i.e., change zoning to promote density, transit access, and mixed uses). This creates opportunities for new affordable housing and builds housing closer to transportation and jobs, reducing auto-dependent sprawl, preserving open space, and ensuring denser development in areas of lower wildfire and flood risk. Up-zoning to allow for accessory dwelling units can also be an important anti-displacement strategy by providing people with an additional revenue stream that enables them to stay in their homes. Cities that have successfully implemented these policies include **Minneapolis, Seattle, and Portland** (see the *Cross-Cutting Case Study: Portland, OR* for more benefits of up-zoning).

RESIDENTIAL BUILDINGS CASE STUDY: BOULDER, CO

Boulder, CO, was one of the first cities to adopt minimum efficiency standards for housing rentals, a policy the city named **SmartRegs**. The policy applied to more than 22,000 residential properties, more than half of Boulder's housing stock. It was adopted in 2010 with compliance required by the end of 2018.

When Boulder first passed this law in 2010, the concept of beneficial electrification wasn't as well known, so the efficiency standard did not promote electrification. Boulder has since **become a leader** in developing policy, markets, and financial mechanisms to facilitate a rapid transition from natural gas appliances to all-electric alternatives, and has updated the standard to promote electrification.

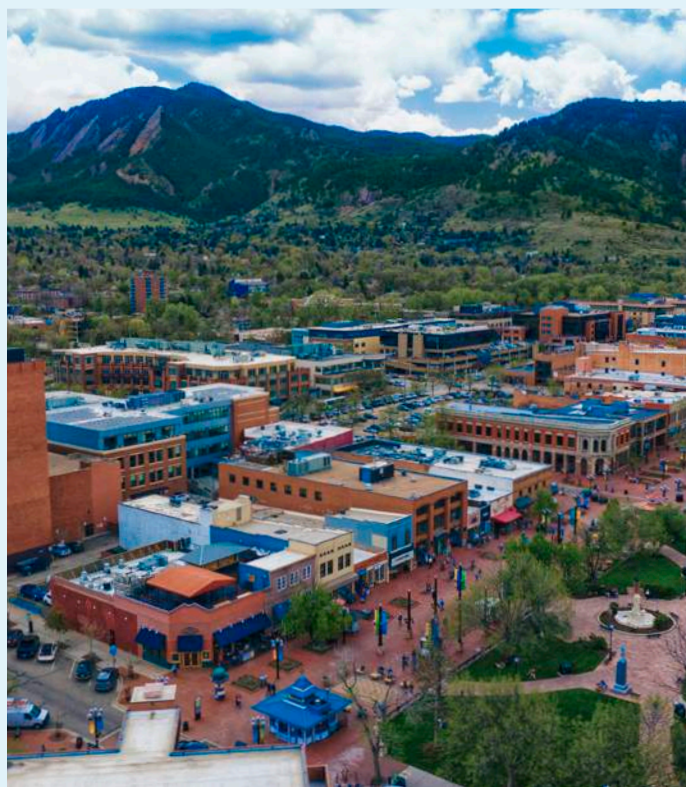
All long-term licensed rental properties are required to be SmartRegs-compliant before they receive their rental licenses. If a rental property failed to meet the requisite efficiency standards by December 31, 2018, the property owner would not receive his or her rental license or their existing rental license would expire until efficiency upgrades were performed to make the rental property SmartRegs-compliant.

The City of Boulder worked with Boulder Area Rental Housing Association members, energy efficiency professionals, and other stakeholders to define the minimum efficiency standards that would be achievable while balancing the burden for property owners. City staff time focused on implementing the program was funded through the fees added to rental license fees collected from noncompliant rentals. This also further incented early adoption.

In parallel, Boulder County created the **EnergySmart program**, which was key to the City of Boulder's SmartRegs policy success. It offers technical assistance, helps scheduling contractors for energy efficiency improvements, and offers incentives above and beyond those offered by the utility. The

EnergySmart program also supports energy efficiency efforts for commercial buildings. Boulder County and its partners received a **\$25 million BetterBuildings grant** from the US Department of Energy under the American Recovery and Reinvestment Act in the summer of 2010 as seed funding for this program.

The SmartRegs policy paired with the EnergySmart program spurred a significant number of rental renovations that likely wouldn't have occurred otherwise. In 2019, 99% of rentals were SmartRegs-compliant, with **32% of rental units undergoing upgrades** to get there. This had a related equity benefit: renters tend to be lower-income than homeowners and have higher energy burdens, and it is far more difficult to get landlords to update rental properties due to the split incentive issue (i.e., landlords paying the cost of energy-efficiency upgrades but tenants reaping the benefits of lower utility bills).



COMMERCIAL BUILDINGS CASE STUDY: ATLANTA, GA

Atlanta was one of three first-mover cities, along with Seattle and Los Angeles, selected to join the Better Buildings Challenge developed by the DOE in 2011. The goal of this challenge was to help building owners and managers to reduce their energy consumption by 20% by 2020. Atlanta was the **first city** to add the goal of reducing water consumption by 20% as well, spurring other cities to follow. The Atlanta Better Buildings Challenge (ABBC) is a public/private partnership that includes the City of Atlanta, DOE, the General Services Administration, the Georgia Environmental Finance Authority, and Invest Atlanta alongside a number of **private sector partners**.

When building owners opt into the program, they are committing to meet the 20% reduction goal. In return, they are given a comprehensive assessment of their property that identifies opportunities to improve energy and water efficiency, training courses to **help them access project financing**, and positive **public recognition**. By the end of the program, **475 buildings** committed to the Atlanta Better Buildings Challenge, representing about **15% of the commercial space in the city**, far exceeding the **initial 2 million square foot goal**. The challenge **spans many building types**, with the most square footage coming from office buildings, then parking garages, and then school buildings.

Atlanta announced in 2019 that it had met the challenge ahead of schedule, achieving significant energy savings (**319 gigawatt-hours annually**) and water savings (**34.3 million gallons annually**), resulting in an estimated **\$24.5 million** in direct savings. These water savings are particularly impactful because Atlanta is rapidly growing and relies on surface water, which means **conservation is critical** to maintain the resource. These building improvement projects also resulted in **\$52 million** added to the regional economy and created or preserved **654 local jobs**.

Providing access to financing was key to the program's success. Invest Atlanta, the City's economic development authority, **created a program** to give building owners grants to fund the cost of significant energy efficiency projects. The City used a competitive process to identify projects with the greatest potential to improve the economic vitality and competitiveness of Downtown Atlanta. Beyond these grants, ABBC helped partners to take advantage of DOE programs, utility rebates, and matching grants.



3

POWER



POWER

THE BIG IDEA

Decarbonize and modernize the power grid by accelerating coal power plant retirements and deploying clean energy portfolios, enabled and accelerated by grid upgrades and regulatory reform.

WHY BUSINESS AS USUAL IS NOT ENOUGH

In order to stay within a 1.5°C climate scenario, electricity-sector emissions must decline rapidly. According to analysis by **America's Pledge**, this requires closing almost all coal plants, limiting the construction of any new “unabated” gas plants (i.e., gas plants without carbon-capturing technology), and moving to over 75% clean electricity generation nationwide by 2030. These changes need to happen in conjunction with massive end-use electrification, which will grow demand for electricity. For example, electrifying all transportation and all space heating and water heating in the United States by 2050 would require an additional 3,700 terawatt-hours (TWh) of annual generation, **an increase of 89% over 2019**.

To meet these goals, we need to build solar and wind generation capacity at a rate faster than the gas build of the early 2000s or nuclear build in the 1970s. We will need similar increases in the power grid's capacity to handle this electricity—both transmission capacity to “ship” clean electrons from large-scale renewable generation to load centers and distribution capacity to accommodate end-use electrification and local power sources. We also need the grid interactivity and flexibility from end-users: buildings, vehicles, and industrial equipment.

The DOE's **National Transmission Grid Study** made clear that without dramatic upgrades over the next decade, **the nation's transmission system will fall short** of the reliability standards our economy requires. And without new transmission or flexibility investment to alleviate congestion, many new renewable energy projects cannot proceed. This will

slow power-sector decarbonization and already exacts a significant economic price: the DOE estimates that **grid congestion costs totaled \$4.8 billion** in 2016, ultimately meaning higher electricity bills for customers.

Power-sector emissions also impact health and lives both through climate change and through ambient air pollution, which causes **90,000–360,000 premature deaths annually** in the United States. This pollution often crosses state boundaries, making it an issue of federal concern. Black Americans are **more than 20% more likely** to die prematurely as a result of air pollution exposure than the average American.

Finally, as the frequency and severity of natural disasters increases, resilience has come to the forefront. The power grid needs to move away from conventional hub-and-spoke architecture and increase the share of DERs, including microgrids. Microgrids in California **proved their value** during 2019's Public Safety Power Shutoff events, by keeping the power on for critical facilities (e.g., gas stations and grocery stores) when parts of the transmission grid had to be powered down to prevent it from sparking wildfires.

The pandemic has also exposed new vulnerabilities in the power sector—and strengthened the reliability argument for clean energy resources. Wind turbines, solar panels, and batteries typically controlled by secure remote computers keep producing, storing, and dispatching electrons while social distancing **compromises safety** and forces shutdowns of **fuel-reliant and maintenance-hungry fossil fuel power plants**.

HOW TO DO BETTER

What follows is not a comprehensive blueprint for decarbonizing what some have called “the most complicated machine in the world.” Rather, it is a list of actions that can help accelerate cities’ own efforts to speed electricity system decarbonization, bring clean energy benefits to disadvantaged communities, and enhance resilience.

City Actions

Undertake large-sale procurement of renewable power via power purchase agreements. Cities with municipal utilities, or in states that allow retail choice, can buy power directly from utility-scale solar, wind, and storage projects through power purchase agreements (PPAs). As the cost of renewables continues its rapid decline (utility-scale **solar costs have fallen 82% and wind costs have fallen 39% since 2010**), these deals often mean lower-cost energy and downward pressure on electricity costs for all of the city’s ratepayers, in addition to reducing the city’s emissions footprint. **Cincinnati, Los Angeles, Houston, Philadelphia, and Washington, D.C.**, all offer particularly instructive examples. **Chicago** is in the middle of a transaction that will uniquely elevate equity and local economic development considerations.

Even cities without retail electricity choice have options. They can work with their utility to develop “green tariff” products (**Charlotte’s** is a great example). They can also sign “virtual” PPAs to provide financial backing to renewable energy projects in any of the country’s wholesale electricity markets, enabling cities to support renewables development wherever they assess it will have the greatest impact, a popular model for **corporate clean energy procurement**. Over the past five years, the large-scale municipal renewables procurement market has grown rapidly, with cities bringing **9,200 megawatts (MW) of new renewable energy on line** using these methods.

Form community choice aggregation (CCA) programs to enable even larger renewables deals.

CCAs entail aggregating the electricity demand of all or most of the city’s residents, businesses, and municipal accounts. By addressing community-wide load instead of just serving electricity demand for municipal operations, and by pushing the decarbonization agenda more quickly than the host utility would otherwise, CCAs can help cities dramatically increase their impact on the electricity system. They usually offer a 100% clean energy option to customers—a rarity for most utilities.

Marin Clean Energy (MCE), founded in 2010 as the first CCA in California, now procures cleaner power than the host utility for more than one million residents and businesses. MCE has used its market power to spend \$1.6 billion building 677 MW of new renewable power projects in California. Cincinnati recently procured **65 MW of renewable energy for its CCA** program from the same solar farm that it procured 35 MW for its municipal load, reducing the cost of both procurements through economies of scale. CCAs are **currently authorized** in California, Illinois, Ohio, Massachusetts, New Jersey, New York, and Rhode Island, with many other states considering legislation to authorize them.

Develop solarize programs to expand access to residential solar. Local governments can rapidly increase residential solar adoption by partnering with community organizations and financial institutions to enable community members to access a bulk solar discount from a vetted and community-selected installer(s) in one streamlined process. Solarize campaigns can also be tailored to accelerate solar adoption in communities of color and/or lower-income communities if they can directly address the barriers facing these communities. This includes addressing outreach barriers by utilizing community-based communications and communicators, financial barriers by partnering with mission-aligned financial institutions

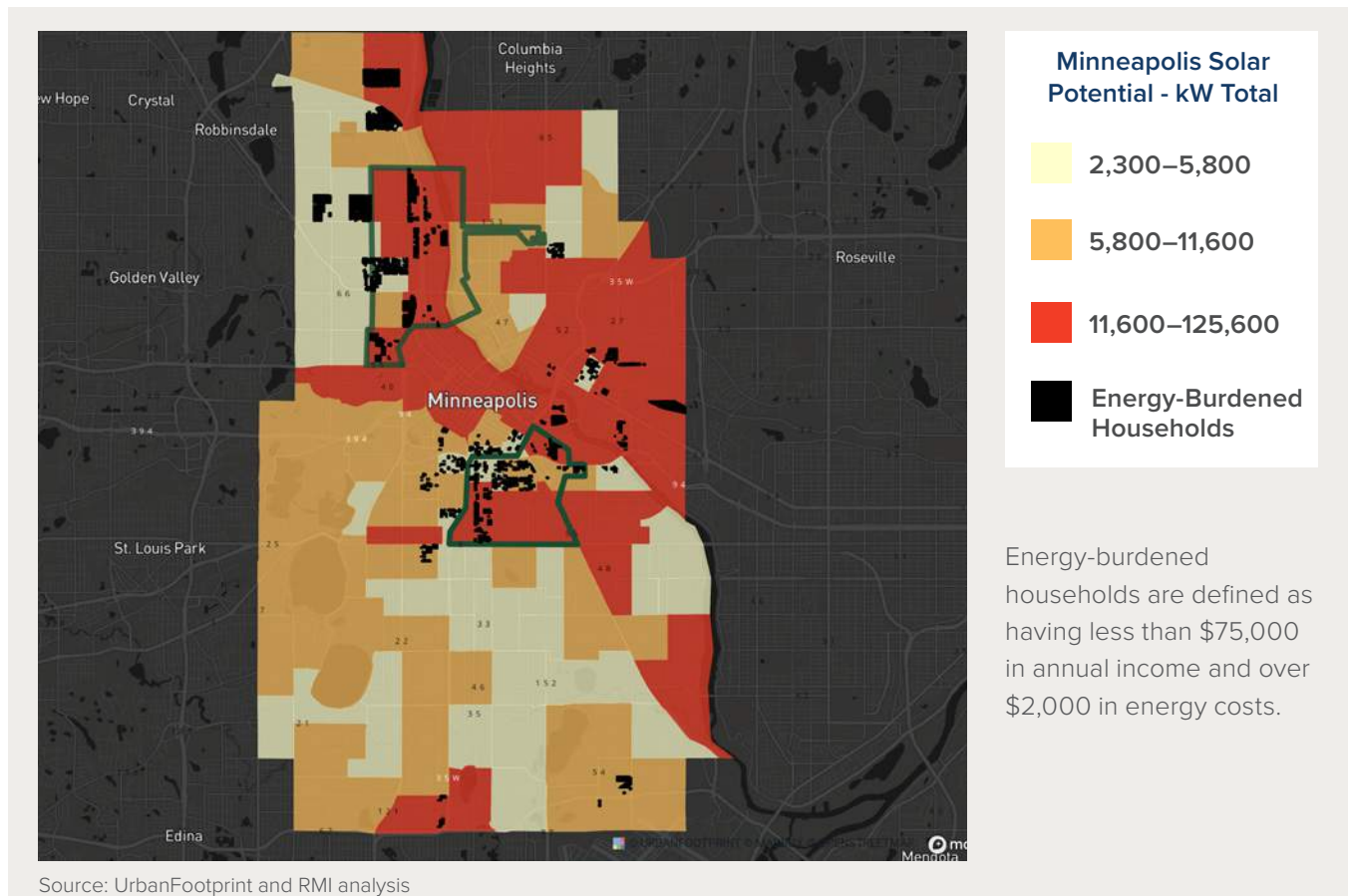
to provide access to affordable and low-credit-required financing, and structural barriers by pairing roof replacements with solar installs.

Connecticut’s Solar for All program serves as an example of developing an inclusive solarize-like program by partnering with the **Connecticut Green Bank** to provide low-income residents solar financing and with local community networks to effectively reach disadvantaged neighborhoods. In three years, this program increased solar penetration in Connecticut’s low-income communities by **188%** and helped over 900 low-income households go solar.

Similarly, Minneapolis’s solarize program shows the massive savings potential solarize programs can have. The **\$0.30/W price reduction** provided by the solar developer combined with federal, city, and utility incentives reduced project costs by almost 70%. While this program wasn’t specifically designed to support low-income neighborhoods, an UrbanFootprint analysis (Exhibit 3) shows households in **Minneapolis’s “green zones,”** areas with high concentrations of low-income communities, Indigenous communities, and communities of color, have 13% of the city’s residential solar potential, emphasizing the untapped potential if these programs aren’t designed to serve these communities.

EXHIBIT 3

Solar Potential in Energy-Burdened Communities in Minneapolis



Support community solar projects, including by targeting unconventional sites. Community solar projects are typically mid-sized projects (i.e., 1–10 megawatts) sited within the customer’s utility service territory and connected to the distribution grid. The solar output is divided among multiple subscribers, who receive utility bill credits for their share of the energy.

Community solar is a renewable solution that renters and those in multifamily housing can take advantage of because the array is not tied to a property. It can also include an explicit carveout for low-income and disadvantaged communities. Typically, the utility or a third-party developer builds and maintains the solar facility, while cities play the role of **project manager, facilitator, offtaker, or host**. As host, the city could offer discounted or free land to lower the subscription cost.

“Land” could also include brownfields or large parking canopies, which often create additional benefits such as reducing the use of open space and agricultural land, providing shaded parking, and bringing direct economic development benefits to host communities. For example, Nashville installed a 2 megawatt community solar project in a brownfield on top of what was a city landfill, converting a lot that had been **out of use for 40 years**. While municipalities have installed **403 MW** of renewables on brownfield sites as of October 2019, the EPA’s RE-Powering America’s Land program initially estimated more than **1 terawatt (TW) of renewable potential** in these locations.

Set an example by deploying rooftop solar on all viable municipal buildings (ideally combined with an overall municipal building retrofit effort). While on-site solar typically can’t offset all the electricity used by municipalities, it is a tangible way to show cities’ commitment to renewable energy while creating local jobs. And the federal government can play a role in financing these types of projects.

For example, **Albuquerque received \$25 million** from the **Clean Renewable Energy Bonds** program

to procure almost 8 MW of on-site solar, enough to offset 15% of municipal load. Albuquerque has also committed to spending **3% of its capital improvement funding** toward energy efficiency projects, so these on-site solar projects will offset an even larger portion of their municipal load over time.

Reduce the “soft costs” of small-scale solar through standardized, automated, on-line permitting. NREL’s SolarAPP (Solar Automated Permit Processing) online platform aims to **standardize and automate “instant permitting” across the United States** for small-scale solar systems. By offering a nationally standardized process to ensure systems are code-compliant, SolarAPP makes it possible to pull a permit and install a solar system **the same day**, rather than waiting days or weeks for permit approval. This approach—similar to those in leading solar countries like Germany and Australia—can lower non-hardware costs (e.g., customer acquisition, administration), support local installation businesses, free up valuable city staff time, and increase permitting revenue.

Meanwhile, California has taken a legislative approach to streamlining permitting. **AB 2188** (2014) required cities to streamline and expedite small residential rooftop solar energy systems and **AB 1236** (2015) created a streamlined and expedited process for permitting EV charging stations.

For cities with the ability to set their own energy codes, include a solar-ready requirement, so all new buildings either include rooftop solar or have the infrastructure in place to easily install it down the line. For example, **St. Louis, MO**, passed legislation in 2019 requiring all new commercial, residential, and multifamily buildings be built with roofs that can handle the added load, a reserved space on the electrical panel, and obstruction-free space on the roof for adequate solar capacity. Lancaster, CA, went a step further to mandate that new buildings have solar installed on their roofs to meet their load.

Federal Investments

Invest in grid modernization. Cities like **Minneapolis have been asking their utility to consider “non-wires alternatives”**—investments and operating practices that can enable greater renewables penetration on the grid while deferring or obviating the need for transmission and distribution system investments, at lower total resource cost. Federal funding support could help move the needle on these types of projects.

Congress should reauthorize the Smart Grid Investment Grant program. When this program was in effect from 2010 to 2015, the **\$3.4 billion invested** increased distribution system reliability by up to 50%, generated peak-load reductions of more than 30%, and reduced operational costs by up to 50% for the 99 projects funded. Additionally, it trained 75,000 workers nationwide, and supported 47,000 full-time-equivalent jobs.

Modernization projects should include equipment and controls to accommodate two-way flows of electricity, systems for aggregating and controlling DERs, software solutions for automating interconnection, advanced metering infrastructure, demand response and load shifting programs, data management systems, methods for improving visibility of DERs on the grid, and communications systems. The Electric Power Research Institute (EPRI) estimates that comprehensive grid modernization would cost **\$476 billion** while delivering up to \$2 trillion in benefits.

Plan for and invest in transmission upgrades. As cities and corporations redouble their large-scale renewable energy procurement, upgrades to our half-century-old transmission system will be key to unlocking the full potential for this market. This will help us move electrons from where they can be produced most cheaply to where they have the highest value. 88% and 56% of the country’s wind and solar potential, respectively, is concentrated in the mid-American region (i.e., the 15 states between the

Rockies and the Mississippi River), but this region will only account for 30% of projected 2050 electricity demand. Xcel Energy recently identified **transmission constraints** as the primary reason for why new utility-scale solar couldn’t come on line for 5 years and new wind projects couldn’t come on line for 10 years.

FERC requires transmission upgrade planning to **account for state renewable portfolio standards and utilities’ integrated resource plans (IRPs)**, but currently doesn’t factor in renewable targets set by cities or corporations, which often represent a significant increase over state mandates. Groups like the Minnesota Sustainable Growth Coalition, a nearly 30-member group of businesses and institutions, are urging regional grid operators to consider this demand for renewable energy in their transmission planning.



Market Reforms

While this report is primarily focused on infrastructure projects cities can lead, there are important market reforms needed at the state and federal level if we want to achieve the renewable penetration needed to be 1.5°C aligned.

Accelerate coal power plant retirements through ratepayer-backed securitization. Many uneconomic coal plants remain operating thanks to “cost of service” regulation (i.e., they earn a guaranteed rate of return even if it is cheaper to shut them down and build new renewables to replace them). There are, however, **several innovative financial approaches** that can be used to efficiently fund retirements, reinvest in clean energy, provide transition assistance for workers, and save customers money on day one. The most promising may be ratepayer-backed securitization—where utilities issue a bond with yields that are tied to the guaranteed returns—and use the proceeds from the bond issuance to invest in new, cheaper, and cleaner sources of energy. Securitization is currently enabled by legislation in five states.ⁱⁱ

Extend the “start of construction” and “placed-in-service” deadlines for wind and solar tax credits. COVID-19 is delaying solar and wind projects, and **developers have called for** the Internal Revenue Service (IRS) to classify the pandemic as an “excusable disruption.” This would enable projects to still receive the Production Tax Credit (PTC) for wind and Investment Tax Credit (ITC) for solar if supply

chain disruptions and construction delays prevent them from meeting deadlines.

Require that utilities in monopoly markets pursue “all-source procurement,” a unified resource acquisition process that allows a full range of potential resources to compete on equal footing. This will accelerate adoption of **clean energy portfolios** (CEPs)—combinations of renewables, energy storage, energy efficiency programs, and demand flexibility. CEPs are typically a more cost-effective replacement for retired coal capacity than new gas, as we have already seen in **Arizona, Indiana, Michigan, Minnesota, Oregon, and Utah.**

Scrap wholesale market rules designed to disadvantage clean energy resources like FERC’s Minimum Offer Price Rule (MOPR), which calls for the PJM regional transmission organization to require state-subsidized renewable generators to bid into the capacity market at **artificially high prices.** Rules set by PJM also make it **unnecessarily difficult for battery energy storage** to compete against traditional forms of generation. The PJM Cities Coalition, a group of 18 cities in PJM territory, **has actively been engaging** with the grid operator, and could play an important role in market reform.

Provide more regulatory certainty for transmission investments. States currently have the authority to approve and determine the rate of return on

ⁱⁱ A note on a just transition: While rapid coal plant retirement is needed to support a 1.5°C climate scenario and will result in healthier and safer communities, it can also result in job and economic loss in communities supported by the coal industry. As the Just Transition Fund highlights in its recently released comprehensive **National Economic Transition Platform**, providing a bridge for impacted workers to quality jobs is a key element in planning for a just transition. This can be supported by investing in paid training programs for jobs in the new, clean economy. For example, the **Coalfield Development Corporation in Wayne, West Virginia**, trains and employs former mine workers across five trades: construction, minefield remediation, arts and culture projects, sustainable agriculture, and solar energy initiatives. This program includes 33 hours of paid work, 6 hours of classroom time toward an associate’s degree, and 3 hours of life skills. They have trained 50 West Virginians in new careers, launched five new businesses, and redeveloped over 150,000 square feet of dilapidated property. These just transition plans are not one-size-fits-all, so cities are best positioned to work with their community-based leaders to design a plan to meet their unique, local needs.

transmission infrastructure investments. Unfortunately, they often take a narrow view of the benefits that accrue to themselves, not taking into full account the regional or national benefits of expanded transmission.

Congress could amend the *Federal Power Act* and give FERC the same authority to approve interstate transmission lines as it has to approve interstate natural gas pipelines. Providing long-term **regulatory certainty** to investors is critical to getting financing for these investments—which often have lifespans of 50 years or more.

Support a federal standard or guideline to streamline permitting for a broad range of DERs. Expanding on the model offered by NREL's SolarAPP, streamlined permitting for a range of DERs could cut red tape in thousands of local jurisdictions across the country and make it easier, faster, and cheaper to install EV charging stations, high-efficiency heat pumps, demand-responsive electric water heaters, behind-the-meter batteries, and other behind-the-meter assets in addition to rooftop solar. This would offer a powerful complement to FERC's recent **Order 2222** (and previous **Order 841**), which aims to encourage participation of DERs in the nation's wholesale electricity markets.



POWER CASE STUDY: CINCINNATI, OH

In 2017, Mayor John Cranley pledged that the City of Cincinnati would remain committed to the goals of the Paris Climate accord. This entailed powering all of Cincinnati’s municipal operations and the entire community with renewable energy by 2035. Cincinnati decided to pursue an off-site power purchase agreement because on-site solar alone would not be sufficient for either goal. To support its city-wide goal, Cincinnati has a community choice aggregation (CCA) program for local residents and businesses.

This program already offered 100% green energy, as well as **\$3.1 million in cost savings** in 2019 compared to the default offering from Duke Energy, the local utility. However, this claim rested on the purchase of “unbundled” renewable energy credits (RECs)—RECs associated with renewable energy facilities unassociated with the City’s physical electricity supply. Cincinnati wanted that renewable energy to come directly from a local project.

The City decided to combine two smaller subprojects—a 35 MW project to serve municipal operations and a 65 MW project backed by the CCA—into one 100 MW power purchase. By bundling these two subprojects, the 100 MW array was able to deliver a 9% price reduction.

While the project was not located in city limits, Cincinnati stated a preference for projects that were within 100 miles of city hall, and eventually selected a project just **40 miles east of downtown** Cincinnati. This was considered close enough to deliver local economic development impact. In partnership with Cincinnati State University and the **local chapter of the International Brotherhood of Electrical Workers**, the City will implement a **workforce skill and hiring program** that will put Cincinnati residents to work on the project.

The facility is scheduled to go into service in December of 2021. The full case study, prepared by Cincinnati’s assistant city manager, can be viewed at cityrenewables.org.





BROADBAND

THE BIG IDEA

Expand affordable, widespread broadband access—ideally at gigabit speeds with fiber and/or 5G wireless—via competition and municipal or public-private partnership (P3) programs.

WHY BUSINESS AS USUAL IS NOT ENOUGH

Over the past 20 years (1999–2018) cumulative private-sector investment in broadband infrastructure has totaled **an estimated \$290 billion**. However, there remains a large “digital divide” (also called a “broadband gap”) spanning both urban-rural lines and also from one neighborhood to the next within a city, often on socioeconomic lines. For example, **60% of low-income households** in New Orleans lack in-home internet access. In Seattle, **17% of all households** lack in-home internet access. Rural households are **12% less likely** to have home broadband than their urban and suburban counterparts.

In educational settings, this is also known as the “homework gap,” and it is substantial. Some **18% of US students**—nearly one in five school-aged children, or 3 million students—lack broadband internet at home. This homework gap becomes **even more pronounced along racial and income lines**: majority White neighborhoods have average broadband adoption rates close to 84% while majority Black neighborhoods average just over 67%; similarly, low-income households average 62% adoption versus 85% for higher-income households. Such a homework gap later translates into and compounds as an **income achievement gap**.

Although the total number of connections and average connection speeds have improved, truly widespread and affordable broadband access across America remains elusive. According to the most recent **Internet Access Services report from the Federal Communications Commission** (released in September 2020), 24% of Americans have no

access to speeds of at least 25 Mbps. This is the bare minimum for broadband qualification and dreadfully slow in today’s era of gigabit-per-second (or greater) fiber speeds in leading cities. Within developed census blocks (i.e., those that contain housing units), 28% had no access to speeds of at least 100 Mbps; another 44% had access to just a single provider offering such speeds. **Less than 10%** of 126 million US homes have true high-speed fiber, well below the **OECD average of 30%**.

Broadband competition **drives lower prices, faster speeds, and greater coverage** for residential customers, **yet the majority of customers live in non-competitive markets** with local monopolies and duopolies. Even further, while municipal broadband programs have consistently achieved greater access in their cities for lower prices, **22 states still prohibit or place significant roadblocks** in front of municipal broadband.

In today’s era of the COVID-19 pandemic, these challenges have become more acute and magnified than ever. **Network traffic has increased substantially** and widespread broadband has emerged as a crucial lever for the economy and society to function with the overnight explosion in remote work and remote schooling.

With respect to the climate crisis, widespread broadband is critical on two fronts. First, it is an enabler of low-carbon, remote-first telework, telehealth, and other e-services. Second, it serves as an internet-of-things (IoT) backbone for smart grid,

smart transportation, and smart city technologies that support a clean energy economy. These include grid integration of fleets of DERs such as smart thermostats and HVAC equipment, residential solar-plus-storage systems, demand-responsive water heaters, and EVs.

HOW TO DO BETTER

Expanding affordable, widespread broadband access—ideally at gigabit speeds with fiber and/or 5G wireless—via competition and municipal or P3 programs unlocks multiple equity, economic, and emissions-reduction benefits.ⁱⁱⁱ These include closing the digital divide to foster more equitable communities and education systems, fostering economic development and attracting remote workers (often tech), supporting **e-government and telehealth**, and enabling **smart grid, smart city, smart buildings, and smart transportation infrastructure**.

INVESTMENTS

Consider launching a municipal broadband offering, especially in cities with a long-standing municipal electric utility that already has a customer base, history of service, rights of way for conduit, and existing human customer service infrastructure for offering broadband service. In 2010, Chattanooga **became the first US city** to offer its citizens broadband fiber-optic internet service at 1 Gbps or faster through its utility, Electric Power Board (EPB), which had already been serving the city for 75 years. By 2016, EPB served 82,000 people—more than half the city’s internet market at the time. Since then a **\$220 million infrastructure investment** has translated into more than \$865 million in economic benefits for the city, while offering discounts to low-income customers that have helped to close the digital divide.

Leverage P3s to deploy fiber infrastructure

and expand access while deferring the up-front infrastructure and program costs to a private-sector partner. Austin city officials have worked with Google Fiber to **beneficially boost local broadband competition, expand fiber networks into under-connected parts of the city**, and secure free fiber connectivity for 100 sites through 2023 via its **Community Connections program**. Many locations were chosen to support disadvantaged, underserved, and low-income communities, such as school district campuses and public library locations—in addition to providing free fiber broadband to 700 public housing units.

Tap into the cost efficiencies of “dark fiber.” Dark fiber refers to unused fiber-optic cable with available data capacity. Installing municipal fiber infrastructure—including laying fiber-optic cable—is most cost-effective when timed in conjunction with other public works projects such as street maintenance and work on electricity or water distribution infrastructure. Laying excess fiber capacity that will initially remain “dark” is a way to future-proof cities’ broadband infrastructure, while also reducing the total cost by avoiding future disruptive projects to lay new fiber.

Dark fiber can also become a revenue stream for city governments when available capacity is leased to private providers that want to offer or expand broadband service in the community. Reciprocally, municipalities leasing dark fiber capacity from private providers can be a less capital-intensive alternative to installing city-owned fiber networks.

ⁱⁱⁱ There is **some concern** around potential health risks associated with 5G broadband spectrum, with some scientists saying **there’s little evidence of danger** and others arguing **there could be health risks**. Although the 5G bandwidth spectrum introduces some new frequencies, it significantly overlaps with both **the bandwidths already in use for today’s prevalent 4G networks** and with **the 2.4 and 5 GHz wireless frequencies that have been prominent in home wireless routers for more than a decade**. This briefing document prepared for the European Parliament in March 2020 takes a measured perspective. We would encourage civic leaders to evaluate the scientific literature and weigh any legitimate concerns against the significant benefits of wireless broadband.

Upgrade and otherwise make city infrastructure (e.g., utility poles, street light poles) “5G ready” for hosting small-cell antennas. With download speeds of up to 1 Gbps and low latency, 5G has emerged as **an attractive alternative** that complements in-the-ground fiber (or even substitutes fiber in some cases) as a form of “wireless broadband.” Most major private-sector telecom companies—including Verizon, AT&T, and T-Mobile—are **launching “5G home broadband” services** that skip an into-the-home wired connection.

Because of the properties of 5G wavelengths, urban telecom infrastructure is shifting to a greater number of more-densely located small-cell antennas. Making city infrastructure “5G ready” offers a twofold opportunity to both expand broadband access for residents while also unlocking a new revenue stream for city governments, by leasing city infrastructure to private telecom providers to deploy their small-cell antennas.

Ensure that federal legislation includes targeted investments in telecommunication networks—including fiber-optic and wireless broadband—as part of a **green recovery package from the pandemic and/or Green New Deal-style climate action plans.** It is also important that this digital technology infrastructure, such as data centers, is designed with the lowest environmental footprint possible. These investments should include a commitment to digital equity and inclusion, so that all residents benefit from broadband deployment and expansion.

POLICIES

Foster broadband competition by supporting state and federal legislation that dismantles **private-sector telecom and internet service provider (ISP) strangleholds** on local markets through monopolies. This could include supporting a **nationally focused push for universal broadband access**, not unlike the Rural Electrification Act of 1936, as well as continued rollout and evolution of the **FCC’s 2010 National Broadband Plan**.

Open the doors to municipal broadband by undoing state legislation that **prohibits or significantly inhibits the ability of cities to launch municipal broadband networks.** Similarly, support the **FCC’s ability to preempt state efforts** that block municipal and other broadband expansion. Team up with organizations focused on strengthening local leadership capacity to roll out affordable broadband, such as **Next Century Cities**, whose members include more than 200 cities across the country; the **Coalition for Local Internet Choice**; and the **MuniNetworks initiative of the Institute for Local Self-Reliance**.

Support “right to remote work” legislation and other policies that foster a digital-first, equitable, low-carbon economy where practical (**as Germany debated earlier this year**). Remote work and other forms of virtual services (e.g., e-government, telehealth) enable people to “skip the trip,” avoiding commutes that inherently increase their energy, emissions, and climate footprint. (Also see the ideas around transportation demand management in the *Access and Mobility* section above.)

BROADBAND CASE STUDY: **SAN JOSE, CA**

As the hub of Silicon Valley and the largest city in Northern California by both area and population, San Jose grapples with large income and internet access disparities but also a tech-forward stance on infrastructure investment. With a **median annual household income of \$123,000** yet a cost of living 80% higher than the national average, nearly 100,000 residents lack access to in-home internet. The city set out to change that with its 2017 **Digital Inclusion and Broadband Strategy**.

The two-fold vision was simple: “Ensure all residents, businesses, and organizations can participate in and benefit from the prosperity and culture of innovation in Silicon Valley” and “broaden access to basic digital infrastructure to all residents, especially our youth...”

San Jose **worked with the private sector** to facilitate infrastructure deployment. In 2018, the city **announced agreements with AT&T, Verizon, and Mobilitie** that would bring better cell and internet service, hundreds of miles of fiber, and more than \$500 million of private-sector investment in San

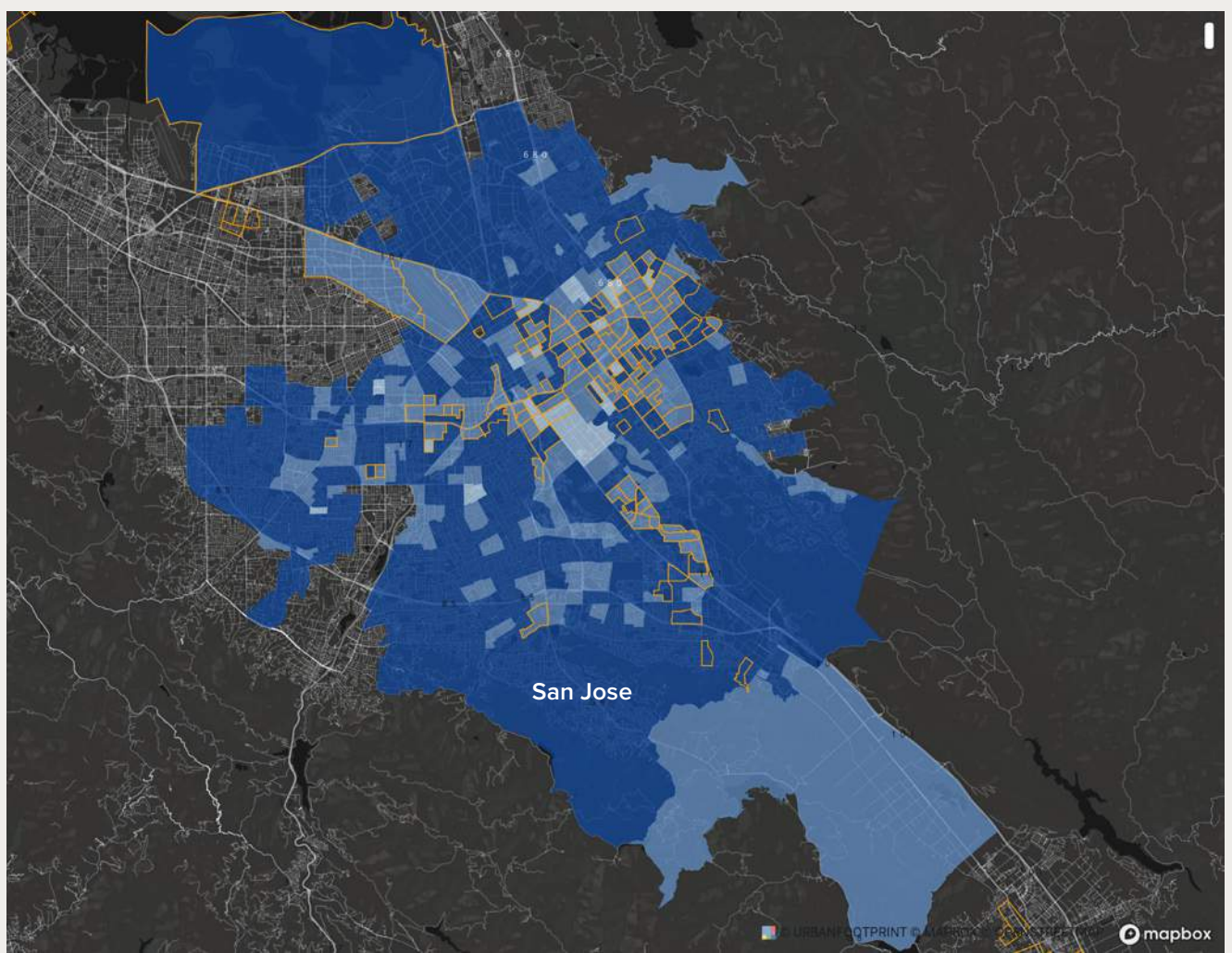
Jose’s broadband infrastructure. Related city revenue from providers—such as leasing city infrastructure as sites for small-cell antenna deployment—went into a Digital Inclusion Fund. At \$24 million (and counting), it has become the **largest such fund in the country**.

Most recently in early 2020, the San Jose City Council **approved the first batch of community grants** as part of the city’s Digital Inclusion Fund intended to connect unserved residents to broadband. This has equity implications; Exhibit 4 shows that majority-Hispanic areas in San Jose are also the areas with the lowest broadband access, with only 36% of households having access. Meanwhile, Santa Clara County—of which San Jose is the county seat—is **considering new legislation** that would extend “right to telecommute” provisions in an eventual post-pandemic Silicon Valley economy.



EXHIBIT 4

Analysis of Broadband Access in Majority Hispanic Communities in San Jose



Percent of Households with Internet Access

- 53%–72%
- 72%–89%
- 89%–100%

Hispanic Majority Census Blocks

Source: UrbanFootprint and RMI analysis

5

WATER



WATER

THE BIG IDEA

Provide clean drinking water for all Americans while managing both drought and flood risk by upgrading our water distribution infrastructure (including lead service line replacement), sewage treatment improvements, a national water conservation program, and green stormwater infrastructure.

WHY BUSINESS AS USUAL IS NOT ENOUGH

Years of neglecting water infrastructure has led to rising concerns and major crises around health, safety, and water quality. These will only compound as hotter climates further strain water supplies, making water infrastructure critical for strengthening resilience against floods, drought, and wildfire.

Increased flooding is overwhelming sewer systems and pollutes rivers, lakes, and oceans. The **ASCE estimates** that aging pipes and inadequate capacity result in 900 billion gallons of untreated sewage discharging into US waterways each year. This results in an EPA-estimated 1.8–3.5 million people getting sick annually from recreational contact with contaminated water. On the other end of the spectrum, droughts can cause or contribute to **degraded water quality, food shortages, wildfires, buckled roadways, and increased stress on the grid**. Wildfires in turn can compromise **water quality and increase susceptibility of watersheds to flooding and erosion** by denuding landscapes of vegetation. (While wildfires heavily impact water, infrastructure ideas focused on mitigating wildfire risk can be found in the *Buildings* section and the *Cross-Cutting Case Study: Portland, OR*.)

Meanwhile, Flint, Michigan, put the issue of drinking water contamination, neglect, and mismanagement front-and-center as one of the most powerful environmental justice issues in America. Flint is not alone. Lead contamination has plagued cities including Baltimore, Newark, Chicago, Detroit, Milwaukee, Washington, D.C., and many others for

years. **USA Today** detected excessive lead in nearly 2,000 public water systems across all 50 states, and **access to clean drinking water** is most limited in low-income communities and communities of color.

Infrastructure funding for water systems **primarily comes from ratepayers**, which is not sufficient to keep up with the need. The EPA estimated over **\$470 billion** of infrastructure spending is needed over the next 20 years to ensure universal access to this basic human right in the United States. The pandemic has only heightened the importance of clean water, as handwashing is a critical tool in combating COVID-19. Cities and states have had to step in to **suspend water shutoffs** for residents unable to afford their water bills.

Finally, with more than **90,000 dams across the United States**, ensuring that dams, reservoirs, and levees are sound and resilient is critical for communities. Failures of these structures cause death, property damage, and environmental damages. **Growth in downstream communities** has dramatically increased the number of people at risk if dams fail. The American Society of Civil Engineers has given America's dam infrastructure a D grade and **17% of dams** were identified as "high-hazard potential." It will require an estimated investment of nearly **\$45 billion to repair** aging, yet critical, high-hazard-potential dams. A whopping 95% of our dams **are also not generating electricity**—representing a significant latent source of carbon-free electrons for those dams we do not decommission and deconstruct.

HOW TO DO BETTER

INVESTMENTS

Replace all lead service lines. Without full replacement, continued repair and maintenance will be needed to address pipe erosion, water contamination, and related health concerns. This is cost-prohibitive for most cities due to decades of deferred maintenance investments and increasing strains caused by climate change, and since this funding is often put solely on the backs of ratepayers. Federal investment through direct aid to cities is essential to enable local governments to do this now and to do it right. The City of Chicago is starting to embark on a replacement plan, but it is estimated to cost **more than \$8 billion**.

Cities can learn from Lansing's **\$42 million program** to proactively replace all 14,000 lead service lines in 12 years before a crisis occurred. They can also learn from Chicago's **recently announced Equity Service Line Replacement program**, funded initially through the City's Community Development Block Grant (CDBG) allocation, to prioritize low-income communities (\$15 million in 2021).

Best practices include replacing the lead pipes with copper pipes, the **"trenchless method"** of threading in pipe replacements, prioritizing the oldest pipes that are likely in the worst shape, and combining pipe replacements with sewer system upgrades and water main replacements to minimize cost, time, and disruption to everyday operations. Replacements also must be transparent, publicized, and communicated clearly to all residents. Lead line replacements **combined with additional drinking water programs, policies, and standards** will improve drinking water and public health.

Scale federal funding to meet all high-priority drinking water needs and address the sewage treatment backlog. Beyond lead, other challenges can compromise drinking water quality, including groundwater contamination, sewage overflows,

and surface runoff. Federal mechanisms like the EPA Clean Water State Revolving Fund and the Water Infrastructure Finance and Innovation Act (WIFIA) offer low-cost resources to cities to invest in a range of water quality projects, including sewage system and water treatment upgrades. Ensuring adequate funding levels for these programs will serve as a long-term commitment to ensure the safety of America's drinking water. These mechanisms have also proven to be strong vehicles for job creation; **the WIFIA alone has created more than 25,000 jobs since its inception in 2014.**

Develop a national "waterworks" program to save water and energy. Renewing and expanding the water workforce will help address major gaps in monitoring and metering, plumbing repairs and upgrades, lead service line replacements, design and deployment rainwater harvesting at scale, and dam maintenance. These programs should be funded federally and run locally, where communities can train, hire, and deploy teams locally. Cities such as **Camden, NJ**, and **Louisville, KY**, are already leading the charge. Beyond the immediate jobs and health benefits, water conservation efforts save both water and energy expended on pumping and water heating, reducing utility bills for homes and businesses. In addition to replacing lead service lines (described previously), this program would focus efforts on:

- **Leak detection, repair, and replacement.** The average water loss in systems is 16%. The EPA estimates that up to 75% of that loss is recoverable. Leaks can be detected through an in-person audit, water sensors that send the utility alerts on low water pressure, smart meters, and/or self-service water audit kits. New York City's leak notification program saved customers more than **\$26 million** in otherwise wasted water within two years of launching the program.

- **Install low-flow fixtures.** Low-flow fixtures that meet the EPA's WaterSense label requirement are at least 20% more efficient without sacrificing performance. Existing incentive programs or new ones can help accelerate these replacements, like a **low-income home assistance program** focused on water conservation. Tampa, FL, modified its plumbing code to require water-efficient plumbing fixtures and distributed water conservation kits to homeowners, reducing the city's per-capita water use by **26%**. This reduced its dependence on drought-sensitive open water sources, which provided 75% of the city's drinking water.
- **Rainwater harvesting.** Installing rainwater harvesting systems not only reduces impacts on stormwater systems but also repurposes the captured water as grey water for watering plants and for residential and commercial building use in toilets and HVAC systems. (Note: some states **have legislation** restricting rainwater harvesting.)
- **Repair, remove, or retrofit our aging dams.** The federal government should authorize a national dam rehabilitation and repair program, which would help fund the repair, removal, or rehabilitation of the nation's non-federal, high-hazard-potential dams. Rapidly scaling the deployment of teams trained to repair and upgrade deficient dams and levees will alleviate risk of overflows or structural failures, which pose an existential threat to downstream communities.

Cities exposed to high-risk dams can push their state to focus on **oversight programs** to maintain dams for future generations and adapt dams to changing climates. In addition to repairing and removing dams, the DOE estimates there is also potential to add up to **12 GW of new clean energy capacity** across the United States, equivalent to increasing the size of the existing conventional hydropower fleet by 15%.

Manage flooding in buildings, communities, and sewer systems by deploying green stormwater infrastructure. This is a versatile and scalable solution that embraces vegetation, bioretention, green roofs, and water-capture strategies to redirect and absorb stormwater and floodwater to prevent it from contaminating natural waterways and overwhelming sewer systems.

Cities and states are increasingly embracing **complete and green streets** with permeable pavements and vegetated medians to retain and capture water while encouraging safe, multi-modal transportation. Instead of constantly maintaining local, state, and federal roads annually, the United States can adapt over **2.6 million miles of roads (94% of which are made of impermeable asphalt)** to manage water runoff. The **low maintenance costs of permeable pavement** make it a solid long-term investment. **Innovative parks** are also being intentionally designed within cities and adjacent to rivers and lakes to filter and limit pollution from stormwater runoff.

Atlanta's **Historic Fourth Ward Park** was a major urban area that was vulnerable to flooding and sewer overflows during storms. It has been transformed into a stunning 17-acre public park that is estimated to have saved over **\$15 million** compared with conventional drainage. (See the *Natural Systems* section for more on this topic.)

WATER CASE STUDY: NEWARK, NJ

In 2017, Newark, the largest city in New Jersey (population: 282,000), learned of elevated lead levels after the city changed the water's acidity. The City **failed multiple citywide tests** on lead levels between June 2017 and June 2019. In 2019, more than 15,000 households—disproportionately from non-white neighborhoods—were unable to drink clean water from the tap.

The City **developed a plan—launched in February 2019**—to replace all 18,720 lead service lines in its drinking water system with copper pipes. The City also installed a new corrosion control treatment system in May 2019 to reduce the lead levels as the replacement work proceeded. Originally a 10-year plan, the City secured a **\$120 million** county-backed

loan with the debt service financed by a renewed \$155 million lease agreement between the City and the Port Authorities of New York and New Jersey to reduce its tenure to between 24 and 30 months. Contrary to the **original plan**, the updated replacements will be at no cost to residents.

As of May 2020, the City has replaced 10,000 lines and is on pace to replace all lines ahead of schedule, despite the pandemic. Along the way, communication has been key to maintaining community trust: clarifying who and which neighborhoods of the City were impacted and what measures are being taken as the replacements are made. Newark maintains an active **database** tracking updates.



6

NATURAL SYSTEMS



NATURAL SYSTEMS

THE BIG IDEA

Protect and enhance natural systems (“green infrastructure”), both buffering and serving as an alternative to human-made systems (“grey infrastructure”) while ensuring that every American has access to green space.

WHY BUSINESS AS USUAL IS NOT ENOUGH

Many American cities are in an ongoing cycle of managing complex, highly interconnected, and increasingly brittle natural systems. Our cities are complex “systems of systems,” but too often we manage each of these as discrete challenges to be addressed through blunt force. The business-as-usual approach typically involves large, capital-intensive infrastructure projects.

At present only **3%** of public and private funding goes toward protecting, restoring, or enhancing natural systems (i.e., “green” infrastructure like wetlands), while the rest goes to “grey” infrastructure (e.g., concrete walls). We need to embrace a “soft infrastructure path” that leverages the interconnected relationship between human-made and natural ecological systems. Until then, cities will contend with the problematic and expensive trade-offs between green space, water, energy use, quality of life, and equity.

The business-as-usual approach to urban natural systems has also resulted in highly unequal access to green space, exposure to heat stress, and mental health impacts. A park is one of the few public spaces that many people have for recreation, exercise, fresh air, and public demonstration. However, a history of racist land-use practices (including redlining) left communities of color with **disproportionately lower** access to parks and green space, higher concentrations of paved surfaces, and higher, heat-island-induced temperatures.

A **recent study** of 100 cities across the country found that neighborhoods formerly subject to redlining suffer from 5°F hotter temperatures in the summer, with many reporting as much as a 12°F difference. Access to green space also brings **substantial mental health benefits**, such as lower levels of depression and anxiety and greater social engagement.

Deficiencies in urban natural systems result in higher energy consumption—and emissions—related to mechanical cooling. Elevated summertime temperatures in urban heat islands increase cooling-energy use and contribute to urban smog. Outside cities’ cores, summer heat islands result mainly from lack of vegetation and the low albedo (the portion of light reflected) by urban surfaces. Mitigation of urban heat islands can potentially reduce national energy use in air conditioning by **20% and save over \$10 billion per year in energy** use and improvement in urban air quality.

Finally, grey stormwater infrastructure has become the default while cities have lost out on the benefits of green stormwater infrastructure via natural systems. **Over half of America’s wetlands** have been lost since 1780. Our cities do not need to sacrifice population growth to preserve urban forests, parks, and wetlands, but they must stop growing poorly.

Our auto-centric development patterns have given rise to vast networks of highways, parking lots, and impervious surfaces. Many of our cities **devote over half** of their land to roads and parking—exacerbating runoff, flooding, storm-management problems, and water pollution. When rainfall hits an impervious surface, it meets whatever pollutants sit on that surface. In cities this includes road salt; sediment; trash; oil, heavy metals, or toxic chemicals from cars and trucks; pesticides or fertilizers from lawns and gardens; and even viruses or bacteria from animal waste. These contaminants turn pristine rainfall into dirty runoff. But rather than tackle the problem at its roots, our cities are overly reliant on “grey” stormwater infrastructure practices, such as costly piping systems, treatment plants, and retention ponds.

HOW TO DO BETTER

INVESTMENTS

Implement a federally funded, **city-run urban reforestation program**. Street trees improve retail revenues and property values; they also have the effect of increasing walkability and slowing traffic. Businesses on treescape streets show **12% higher income**. Every \$1 invested in tree planting and maintenance produces **two- to five-times** the investment in benefits such as cleaner air, improved water quality, increased property values, and lower energy costs due to shading and reduced heat-island effects. Reforestation and natural systems restoration are also highly labor-intensive, creating an estimated **40 jobs** for every \$1 million in investment.

Nationwide, trees provide an estimated **\$6.8 billion** per year in health benefits. A 10% increase in urban tree canopy reduces ozone by **3%–7%** and one tree absorbs as much carbon in a year as a car produces **driving 26,000 miles**. It is, of course, important to choose the **right kind of trees** for these programs, taking into consideration native species best-suited to the climate and ecosystem, proximity to other features (e.g., highways, parks, and roads), and other factors to maximize tree survival and minimize maintenance.

In addition to sequestering carbon while they grow, trees can deliver important benefits after they die. At end-of-life, plant biomass could potentially be turned into **biochar** (produced by burning organic waste in oxygen-free chambers) and buried, which further sequesters carbon, improves soil health, and increases water retention.

Make high-quality parks accessible for all. Because parks play such a vital role for public health, social discourse, and the environment, cities should adopt the **Trust for Public Land’s** aspiration of making a park accessible to everyone within a 10-minute walk. But accessibility alone is not enough. Many cities have ample coverage of parks, but disadvantaged communities still contend with underinvested and low-quality parks. Cities should prioritize improvements to these spaces first, then invest in an expansive distribution of new parks, large and small.

Many communities have also shown success with “pocket parks,” which are smaller, low-cost alternatives to the capital- and resource-intensive parks with which we’re all familiar. One possible location for pocket parks is abandoned or vacant lots that are often focal points for city disinvestment. If an abandoned property is not fit to be restored, it could be demolished and turned into a park, increasing surrounding property values and adding valuable community assets.

For example, **Detroit’s Civic Commons project** turned vacant lots into parks and neighborhood hubs for community gardens and smaller recreation spaces. The city also partnered with workforce development programs to train and employ 20 residents on green-collar construction and maintenance jobs, which allowed residents to participate in the revitalization of their communities. Schoolyards represent other possible sites. **New York City**, in partnership with the Department of Education and the Trust for Public Land, launched a “schoolyards to playgrounds” program to ensure that all New Yorkers live within a 10-minute walk of a park or playground. The City

invested \$95 million to open 266 schoolyards (outside of school hours) as playgrounds and community parks in disadvantaged neighborhoods.

Establish and implement a green stormwater infrastructure program. Green stormwater infrastructure projects have emerged as cost-effective alternatives to concrete- and capital-intensive infrastructure. These projects ensure that natural systems are built back into the urban landscape. Bioswales, permeable pavements, biofiltration planters, and tree canopy all contribute to absorbing and filtering stormwater—reducing the potential for flooding, improving the natural environment, and decreasing the need for capital-intensive water infrastructure.

Cities can integrate these projects in just about any environment—from waterway-adjacent property to streets in the urban center. The City of Philadelphia found that the net present value of green infrastructure for stormwater control ranged from **\$1.94 to \$4.45 billion**, while grey infrastructure benefits ranged from only \$60 to \$140 million over a 40-year period. By using green infrastructure, Lancaster, Pennsylvania, estimates it will be able to reduce **stormwater flows into its system by 700 million gallons**, reaping over \$600,000 in annual savings. A similar study by Milwaukee, Wisconsin, estimates future annual savings of **\$1.3 million** due to reduced pumping and wastewater treatment. (For more on this topic, see the *Water* section.)

Restore and reclaim urban wetlands as a resilience strategy. Wetlands serve as natural sponges that capture carbon, mitigate flooding, and filter pollution. They are critical sources of biodiversity that store twice as much carbon as our forests and protect our communities from the impacts of storm surges and hurricanes.

In fact, coastal wetlands in the Northeast United States **prevented \$625 million** in property damage

during Hurricane Sandy. Cities such as New York have looked to restore and expand coastal wetlands in the wake of such storms. In Texas, conversion of an old public golf course into a re-established wetland and public park retained **100 million gallons of water** during Hurricane Harvey, despite being unfinished. After successfully mitigating the Harvey flooding, the target project completion date for this project was moved forward from 2030 to 2022.

POLICIES

Adopt a green and cool roofs building code.

Rooftops contribute directly and significantly to increased neighborhood temperatures. A conventional dark roof may exceed ambient air temperature by 90°F or more on hot days. Much of this heat is transferred directly into the building, leading to increased energy usage in addition to creating higher temperatures around the building.

Conversely, a green roof that includes rooftop gardens and other vegetation can reduce roof temperatures by as much as **30°F–40°F** and building energy use by nearly 1%. These roofs also provide the added benefit of reducing and filtering stormwater runoff and absorbing air pollutants. The life expectancy of a green roof is **twice that of a regular roof**. Even if a building owner is unable to—or chooses not to—create a green roof, they can save energy and lower temperatures with a reflective coating. Research suggests that if every roof in large cities were “cool roofs” the urban heat island effect could be decreased **by a third**. Cool roofs can also provide cost savings from reduced cooling loads in the summer.

Update land-use policies and implement up-zoning

to incent infill development while preserving urban open spaces. Sprawl is the biggest reason we lose or compromise natural systems, so by being thoughtful about development and increasing density where desired, we can better preserve our natural systems and their myriad benefits. (See the *Cross-cutting Case Study: Portland, OR* for detail on this.)

NATURAL SYSTEMS CASE STUDY: DENVER, CO

As one of the fastest-growing cities in the country, Denver employed a holistic approach to harnessing natural systems to reduce the heat island effect, mitigate carbon emissions, improve stormwater management, and increase equitable access to green space.

Increasing equitable access to trees and high-quality parks

As the gateway from high plains to the Rocky Mountains, the City and County of Denver reside in a semi-arid environment. Aside from the trees that naturally grow along rivers and creeks, Denver's tree canopy and urban natural environments are the result of a century of planting and ongoing maintenance.

Recently, Denver has accelerated its commitment to expanding green space, urban parks, and tree canopy. In November 2018, Denver voters overwhelmingly approved a quarter-percent increase to the city sales tax to generate revenue for increased investment into existing and future city parks. The following year, in 2019, Denver's City Council approved a 20-year plan, **Game Plan for a Healthy City**, to increase its tree canopy and expand its park network.

The plan calls for increasing the city's tree canopy to 20% of land cover by 2040. As one of the lowest-ranking cities for tree canopy coverage in the country, Denver has 13% tree canopy coverage, while only 4% of its downtown core is covered with trees. The policy comes at a critical time for the city, which is in danger of losing many of its trees to the emerald ash borer beetle, an invasive species that has recently arrived in the region. With up to 20% of its tree canopy consisting of ash trees, Denver **has removed more trees** than it has planted in the past six years. The city is bracing itself for more.

The plan also established a goal of making parks accessible within a 10-minute walk for 100% of its residents. Denver is well along the way to achieving its goal: **91% of residents live within a 10-minute walk of a park**, significantly above the national average of 55%. While this is certainly praiseworthy, only 8% of Denver's city land is used for parks and recreation, below the national median of 15%. Most importantly, not all parks are the same in terms of quality and upkeep. Park quality across neighborhoods tends to vary considerably along lines of income and race. Denver, like many cities, is recognizing that it must **reverse the lingering ills** of redlining and other racist land use policies.

To increase equitable access to parks and greenery, Denver and local stakeholder groups are employing a range of creative and tactical interventions. In partnership with Denver, Trust for Public Land (TPL) is working in several communities with limited access to parks and greenspace.

In the Westwood neighborhood of southwest Denver, the Urban Land Conservancy purchased the site of a now-demolished thrift store. There, a team that also includes TPL, Denver's Office of Economic Development, Wells Fargo, and Colorado Health Foundation created a small pocket park. Located next to a middle school and across the street from a Boys Club, the Westwood Pocket Park serves as a key connective public space, providing recreation and a place to congregate for young people in the community. It also connects to an emerging bike network that will provide children with safer routes to school.

Wetlands Restoration

With Denver's extensive growth and intensive real estate development, many of the city's natural waterways have been largely avoided until recently. Perhaps the most prominent, the South Platte River, was practically treated as a sewer over the past few decades. In 1965, the South Platte River experienced unrelenting, torrential rains, leading to one of the most catastrophic floods in the state's history. What followed was the construction of two dams to the west, as well as decades of flood mitigation efforts that left the river slower and shallower. These efforts made the river safer and less likely to flood, but also made it less appealing for recreation and a poorer natural habitat.

To safely restore the South Platte River to a dynamic environment that gives rise to improvements in fish stocks, ecosystem vitality, and urban recreation, the City of Denver and the US Army Corps of Engineers have begun an **\$11 million project** that will span a 2.4-mile stretch of the river. The project aims to increase the river's flows to natural levels, while restoring 22 acres of aquatic habitat and 11 acres of riparian habitat.

Green Stormwater Management

Denver is ambitiously pursuing measures to mitigate the potential for flooding in disadvantaged communities. The communities of Elyria Swansia, Cole, Clayton, Skyland, Whittier, Five Points, and Northeast Park Hill typically see the worst flooding during major storms. To aid these communities, Denver is establishing natural detention areas and creeks to absorb extra flood waters, as well as restoring wetlands. It is also undertaking a large multi-year project at the Globeville Landing Park that will serve as an outfall (an area where storm water enters and can be absorbed by greenery).

Watershed Management

Denver's water supply depends directly on healthy forests and watersheds as Denver Water's collection system receives water from rainfall and snowmelt on national, state, and private land. After two wildfires resulted in the utility spending nearly \$28 million on response efforts for water quality treatment and sediment and debris removal, Denver Water developed its **Forests to Faucets** program. This partnership between the utility, the Rocky Mountain Region of the US Forest Service, the Natural Resources Conservation Service, and Colorado State Forest Service enables Denver Water to treat forest on private, federal, and state land within the watershed. Over the next five years, these partners have committed to invest \$33 million in projects to restore more than **40,000 acres of forestland**.

Green and Cool Roofs

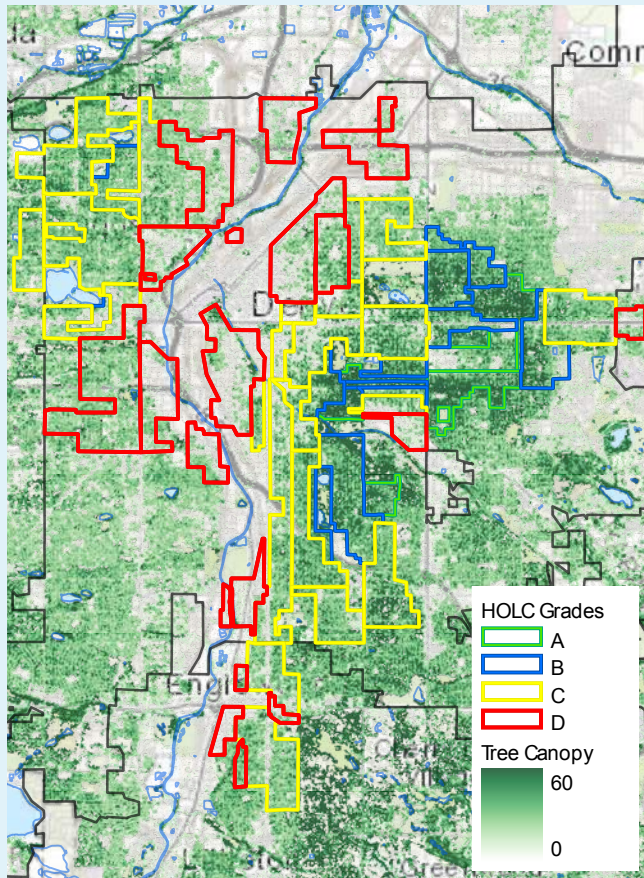
Denver's green building ordinance (formerly called the Cool Roof program, and before that, the Green Roof program) reduces building cooling energy requirements and urban heat island effects. The policy requires new buildings 25,000 square feet or larger to have a green or cool roof to absorb or reflect sunshine.



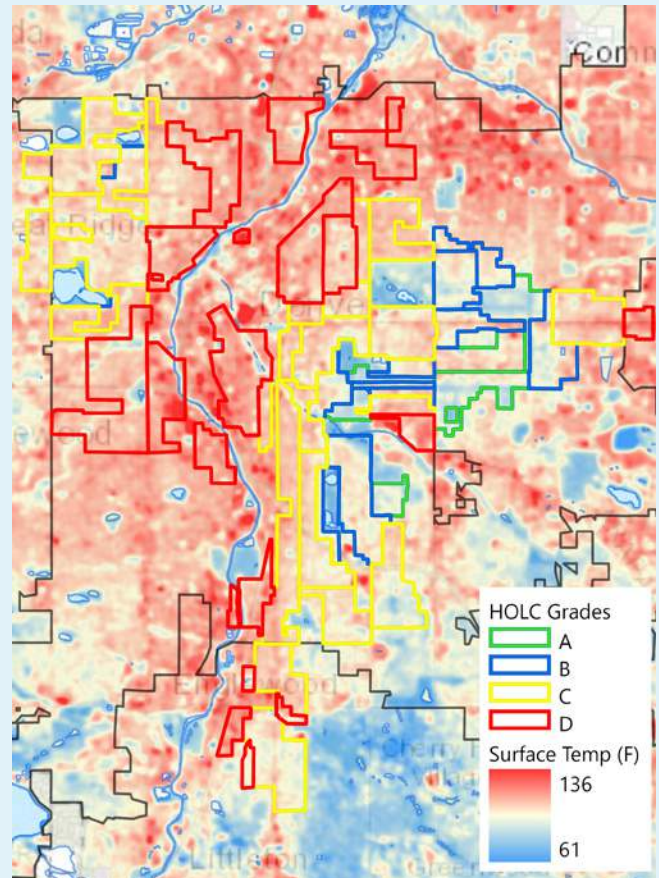
EXHIBIT 5:

How Redlined Communities in Denver Experience a) Tree Cover and b) Urban Heat Island Effect

Tree Cover



Urban Heat Island Effect



The maps show a relationship between the racially driven and discriminatory lending practices and exposure to heat-island effects. The maps overlay the 1933 Home Owner Loan Corporation’s (HOLC) residential security designations with land surface temperatures and tree canopy. HOLC “graded” neighborhoods into four categories based in large part on their racial makeup. Neighborhoods with a “C” or “D” grade were considered declining or hazardous, respectively. Otherwise known as “redlining,” these designations led to discriminatory housing policies that continue to affect cities today.

Source: Groundwork Denver

CROSS-CUTTING CASE STUDY: PORTLAND, OR



CROSS-CUTTING CASE STUDY: PORTLAND, OR

BRINGING IT ALL TOGETHER

Clean infrastructure that takes an integrated, system-level approach can create greater impact than designing infrastructure for each sector separately.

Cities as Systems of Systems

The physical relationship and interactions between different infrastructure systems have a powerful effect on how each individual system functions. Smart housing policy can reduce transportation emissions. Better transportation planning can reduce climate vulnerability. We can achieve major energy savings and embodied carbon from replacing “grey” infrastructure with green.

This systemic efficiency potential often gets overlooked as companies and institutions often operate in sectoral silos. Cities, however, as overseers of all these systems, are perfectly positioned to play an integrative role. Portland’s land-use strategy is a great example, holistically addressing challenges related to mobility, energy, housing, natural systems, and resilience.

A History of Environmentally Driven Land Use and Energy Policies

Portland’s environmental credentials are a legacy of decades of sensible city- and state-led policy. In 1973, the State of Oregon established a comprehensive land-use planning regulation requiring urban areas to define urban growth boundaries, beyond which development cannot expand. The policy regulated sprawl at a time when many other American cities were growing outward with expansive and disconnected suburbs. Each urban area in Portland effectively has a no-development buffer around it, requiring efficient use of land and infill housing. In addition to stemming sprawl, these urban growth boundaries provide multiple co-benefits; preserving carbon-sequestration resources, maintaining highly biodiverse ecosystems, and limiting exposure to wildfire risk.

However, as effective as this policy has been, popular cities like Portland—with high job growth and housing demand—have seen rises in rents and property values. And we have seen a similar situations outside of Oregon. Boulder, CO, for example, created a growth boundary of its own **in 1977** (following an earlier “**urban service boundary**” known as the Blue Line dating to 1959) and has since seen significant cost-of-living increases and a housing crunch.

Legalizing Multifamily Housing

In August 2020, the City of Portland passed the most ambitious zoning reform in the country. It came on the heels of the State of Oregon’s own sweeping decision to ban local governments from mandating single-family residential zoning and legalizing the development of duplexes, triplexes, and fourplexes. In Portland, developers are allowed to go even further; as high as six-unit apartments, as long as half of those units are made available to low-income renters. Prior to this policy, three-quarters of the city was **off-limits** to increases in housing.

To further incentivize multi-unit housing, Portland has **increased the allowable floor-to-area ratio (FAR) for multi-unit buildings** while reducing FAR for new single-family homes. FAR is the total building square footage divided by the lot size, so reducing FAR minimizes allowable building sizes. These reforms will promote the development of “missing-middle” housing—smaller, more-affordable units that are increasingly hard to come by in many cities across the country. As housing unit sizes decrease, people spend less on utility bills since **per-capita energy use spent on heating and cooling** decreases. Reduced lot sizes also mean reduced water use, with higher

densities yielding **a 5% reduction in water use** over time compared with suburban development.

Portland is also arguably the largest market for accessory dwelling units (ADUs) in the country. ADUs—including “granny flats,” garage apartments, and backyard cottages—have helped increase the availability of lower-cost housing and enabled homeowners to better afford home payments, serving as a key anti-displacement tool. Now with the recent land development reform, these units will likely proliferate even more—providing people of all walks of life with housing in one of the most walkable cities in the country.

Portland has also eliminated parking mandates in three-quarters of the city’s residential land. This will encourage major improvements in the use of space in residential areas. It will also directly benefit homeowners who are seeking to build and rent out ADUs in their backyards (parking restrictions had previously prevented homeowners from allocating sufficient space for these ADUs). But this policy will be most critical for apartment developers who would not otherwise be able to provide enough affordable units.

People-First Transportation Policy

Because of its comprehensive and holistic planning processes, Portland is one of the most transit-, bike-, and pedestrian-friendly cities in the country. For decades, Portland has prioritized shared and active modes of transportation. Lined with trees and wide sidewalks, many of its streets are calm, safe, and highly walkable. The city has designated bike lanes **since the 1960s** and more recently started protecting them.

Portland is also an epicenter for innovation in mobility. It was one of the first cities in America to adopt a light-rail line, and its transit agency, TriMet, has led the industry in open-source data. Most recently, the city has started a “Rose Lanes” project, designating corridors for bus-priority lanes that will be unencumbered by general traffic.

Portland’s land-use reform comes at a critical time for transportation climate policy. Despite being a **hub** for electric vehicle adoption, Portland’s transportation emissions continue to climb thanks to increasing VMT. Portland’s land-use reform will help address this problem by enabling people to live closer to key destinations, thereby reducing vehicle use.

However, Portland does also offer at least one significant cautionary tale. Like many cities, the positive environmental impact of many of Portland’s policies could be fully negated if the city continues to expand its highways. These efforts will only lead to more vehicle use—thanks to the phenomenon of “induced demand”—more emissions, and more pollution. Highways are fossil-fuel infrastructure. As Portland has showcased through its other progressive practices, the city has ample resources and alternatives that should obviate the need for expanding it.

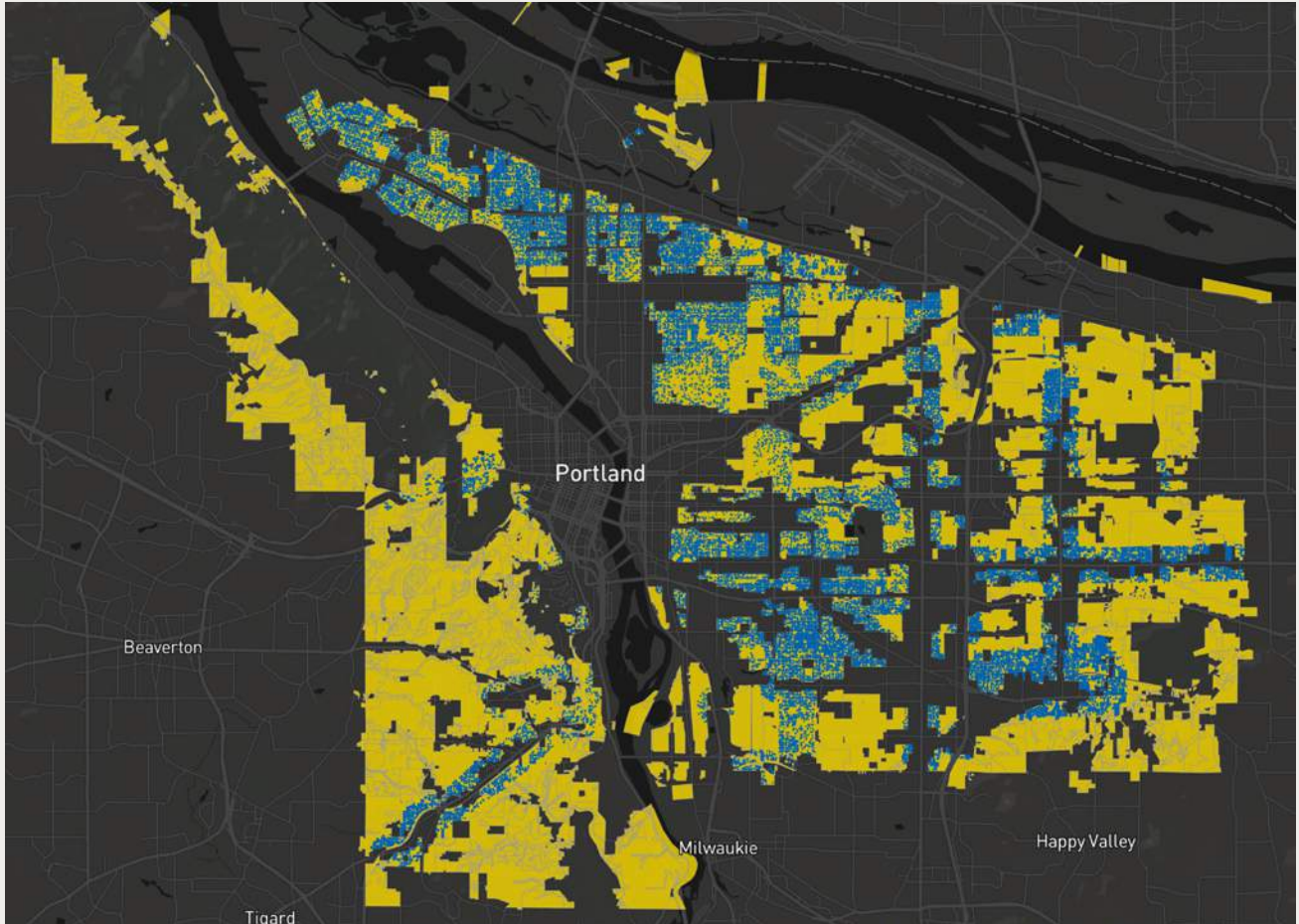
Wildfire Protection and Resilience

At the time of this writing, wildfires are raging across Oregon. Over 5 million acres and 2,350 homes have been lost, with **over 40,000** residents now displaced. This crisis brings into clear view the challenges and perils associated with the wildland-urban interface (WUI): the areas throughout our country where our development has expanded into forests and other wild areas.

Though the City of Portland’s—and the State of Oregon’s—land-use reform will not solve all of these problems, it may mitigate the damage going forward. The reform will enable the development of more affordable housing where it is needed—close to jobs, schools, hospitals, and other critical destinations—and not where it is vulnerable. Of course, some will still choose to live in the WUI, but this reform helps give people greater choice of where they choose to live, what kind of home they live in, and the quality of life they enjoy.

EXHIBIT 6:

Portland Residential Infill Project—Development Capacity



Portland Zoning

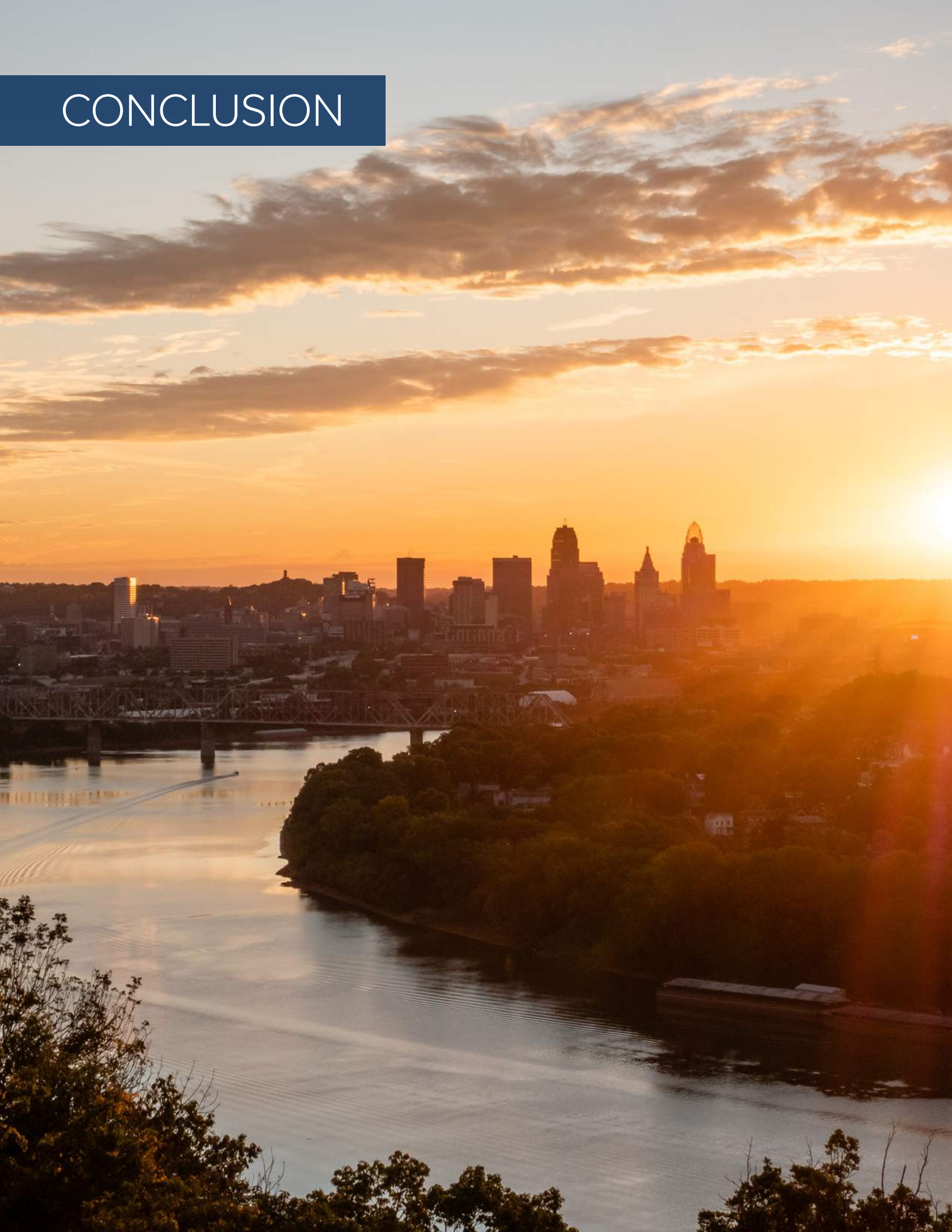
■ Infill Development Opportunities

■ Existing Single-Family Zoning

This map represents the capacity for development—not what is likely to take place in the near-term. Up until Portland’s recent zoning reform, 77% of its residential properties were zoned as single-family (highlighted in yellow). To identify parcels that could potentially be redeveloped as duplexes, fourplexes, or sixplexes (now legal in Portland), we identified parcels with a low improvement-to-land value ratio. To ensure that development would be supported by high-quality transit, we selected only parcels within a quarter mile of transit routes with buses that arrive every 15-minutes during peak periods. We found over 29,000 housing units with the potential to be redeveloped (highlighted in blue).

Source: UrbanFootprint and RMI analysis

CONCLUSION



CONCLUSION

The COVID-19 pandemic is a tragedy that will define this generation of Americans and mark this decade in American history. Its economic devastation is likely to prove larger than any downturn since the Great Depression. Our economy may well have underutilized resources—factories, workers, fields, capital, industrial capacity—for years to come. And there is of course the grim reality that more Americans have died from COVID-19 in 2020 than died in World War I; that number could surpass American deaths in World War II by the end of the year.

The United States may never look the same after the pandemic. But it can recover to become better, stronger, more equitable, and more resilient than ever before. In doing so, it can lift up the American people and economy while re-establishing America's reputation around the world as a source of leadership and innovation. Just as World War II and the 9/11 terrorist attacks unified and gave common purpose to the country, so too can pandemic recovery galvanize America's civic leaders and citizens.

We need to seize this moment to ensure that, at the very least, the United States effectively and intelligently puts its full economic muscle to work rebuilding a better America. This means accelerating the clean energy transition, preparing our landscapes and communities to withstand the climate instability we are already experiencing, and directly and effectively confronting the massive inequalities that are tearing America apart.

This requires investments both large enough for the present moment and visionary enough for tomorrow's needs, investments that are driven by the on-the-ground needs of Americans in their own communities. Our cities understand these needs best—because cities are where those needs are felt. A clean, equitable, resilient investment program, guided by our cities, like the one outlined in this report, could be our best down-payment on a brighter American future.





Bloomberg Philanthropies

22830 Two Rivers Road
Basalt, CO 81621 USA
www.rmi.org

25 East 78th Street
New York, NY 10075
www.bloomberg.org

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