How a new climate finance framework can shift the U.S. approach to investing in urban resilience

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Contents

I. Executive summary

As climate change continues to intensify—raising the urgency to address mounting risks and escalating costs—the public and private response remains slow and uneven. Steps toward more renewable energy are gradually taking hold, but a significant and immediate challenge continues to surround the country's urban built environment: an increasingly vulnerable network of transportation, water, and private real estate assets. From roads and sewers to homes and commercial buildings, the location and design of current physical systems keep adding more greenhouse gas emissions to the atmosphere, overconsuming natural resources, and exposing people to greater dangers.

If policymakers and practitioners are to accelerate climate action nationally, they can no longer overlook the needs of a broader set of built environment assets in urban areas.

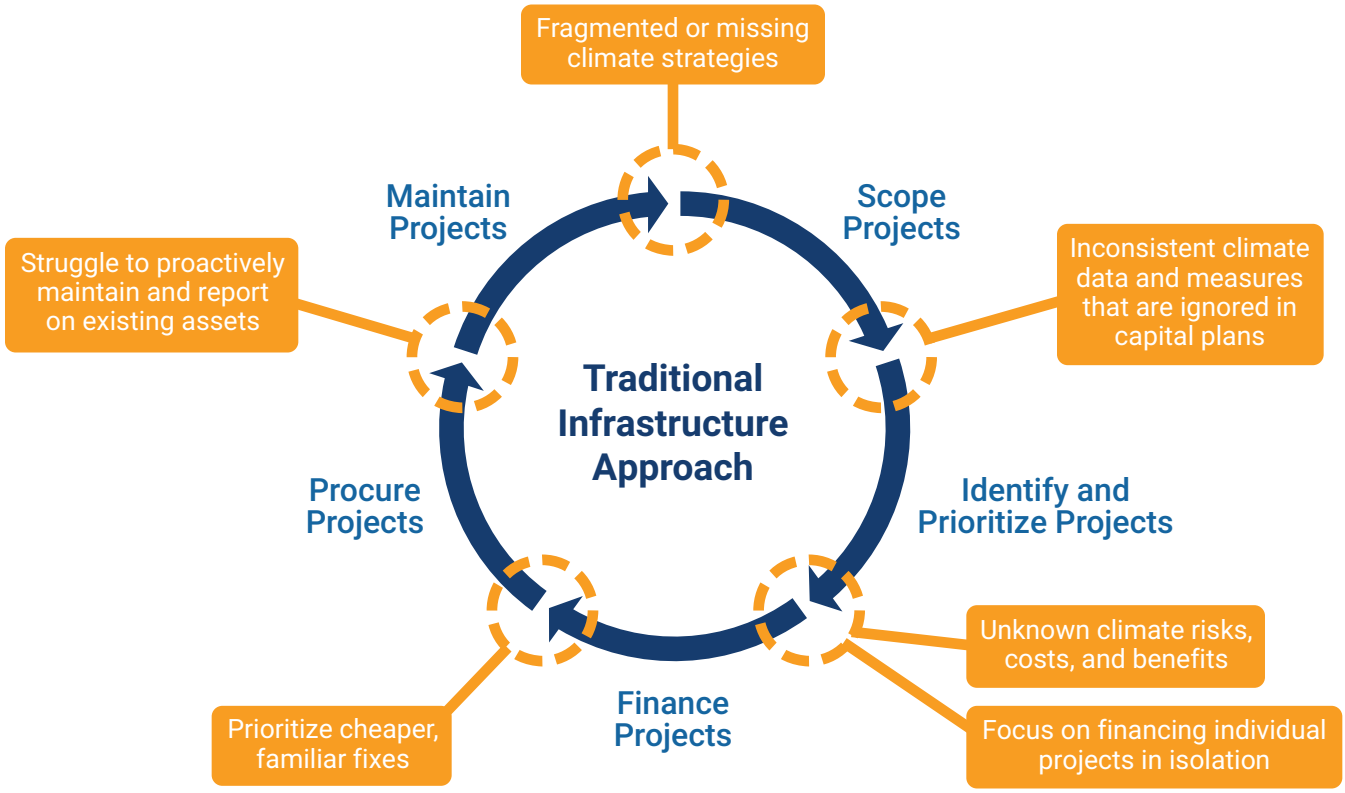
The lack of climate action within built environment sectors often comes down to a lack of climate investment—and that gap exists due to a **broken operational approach.** Public and private leaders, including local infrastructure owners and operators such as transportation departments and water utilities, tend to follow a rigid, sequential process that results in similar types of projects and reinforces many ongoing economic and environmental inequities. It is a broken chain of steps that overlooks climate needs and faces several major pain points:

- An **inconsistent data collection and measurement process** based on fragmented or missing climate strategies
- A **capital planning process** to identify current and future infrastructure projects that often overlooks climate needs
- A **project financing process** based on unknown climate risks, costs, and benefits that focuses on individual projects and often prioritizes the same financial instruments (e.g., municipal bonds)
- A **procurement process** that uses the same familiar designs, technologies, and materials susceptible to higher risks over time
- An **ongoing maintenance process** to manage existing infrastructure that often ignores lifecycle costs and reacts to climate needs in real time

Meanwhile, real estate developers, lenders, and owners do not yet have transparent, consistent data to assess climate risks associated with specific locations or properties. Additionally, the fragmentation of climate risk across multiple actors—property owners, lenders, investors, and insurers—reduces the incentive of any one participant to change investment decisions.

However, many policymakers and practitioners across the country are taking steps to boost their "urban resilience"—the capacity of the built environment to be more flexible and responsive to climate impacts. They are testing new designs and technologies—from seawalls to rain gardens to permeable streets—to reduce risks, save

FIGURE 1. Traditional project delivery for transportation and water infrastructure: A broken chain that overlooks climate needs



Source: Brookings literature review and interview findings

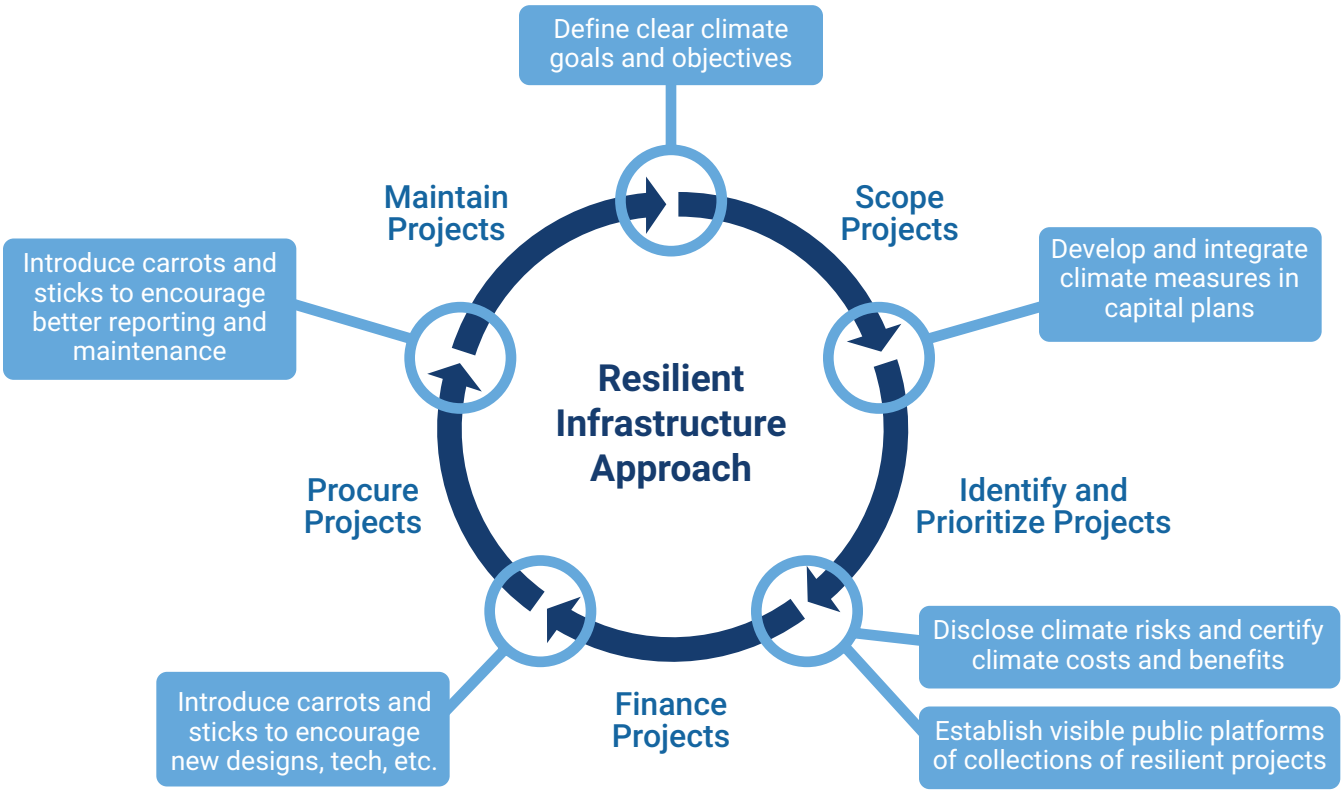
money, create jobs, and benefit households and businesses. At the same time, private investors have demonstrated increased interest (and impact) in launching more climate investments nationally. But with so many climate needs to address and so little coordination, leaders are still struggling to realize the full potential of these investments across the built environment; nearly $30.2 trillion in transportation, water, and real estate assets could be reconfigured for a more resilient future.

Public and private sector leaders must rethink *how* we invest, not simply *how much* to invest. To achieve the scale of investment the country needs, it's time to better tap the power of financial markets.

The U.S. needs a **new climate finance framework** to incentivize more climate investment, reduce risks in more places, and promote benefits for more people. Financial markets represent one of the most powerful ways to drive public and private action on climate resilience, but current public policies do not do a good job of steering capital to the most resilient uses. Regulations and public investment programs can better matchmake between private investors sitting on the financial resources and infrastructure owners and operators who have a demonstrated need. A refined framework should help identify, measure, and accelerate climate-conscious investments across the entire built environment by addressing several existing pain points:

- **Developing clear climate goals and objectives** and **improving climate measurement and data collection, especially to inform capital plans.** Infrastructure owners and operators managing transportation and water need to better align their climate strategies, not simply around a common definition of "resilience" per se, but around a recognition of shared climate risks, costs, and benefits.

FIGURE 2. Resilient project delivery approach for transportation and water infrastructure: A connected cycle that addresses climate needs



Source: Brookings literature review and interview findings.

- Leaders are not lacking financial instruments—they're lacking ways to tap their full power. **Disclosing climate risks and certifying climate costs and benefits** will provide greater clarity for infrastructure owners and operators as they look to finance projects and fill an information gap for ratings agencies and many current and prospective investors. The same applies to the insurance industry, ratings agencies, and institutional owners within the real estate industry.

- Minimizing climate risks and maximizing climate benefits need to reach more people in more places. Federal policymakers and regulators have a central role to play encouraging investment in the most resilient designs, technologies, and approaches. **Creating more visible public platforms of collections of resilient projects** could expand the reach and impact of these investments in more regions nationally. **A combination of carrots and sticks (new incentives and regulations)** can also spur investment in more resilient projects and more proactive maintenance of existing infrastructure assets in need of upgrades.

Using quantitative research and 30-plus interviews with industry and policy leaders, Brookings has examined hurdles and opportunities around this new climate finance framework, with a focus on how to develop a more resilient built environment. We emphasize new planning and investment approaches in public infrastructure assets—namely, transportation and water—as an initial step in charting future actions, while alluding to other considerations across a complex array of private real estate assets. While some regions fall somewhere between the "traditional" and "resilient" approaches described above, there is clear room to better identify and integrate climate improvements across the built environment.

This report lays out several market principles that public and private leaders should consider in executing future investments. It begins by describing the current climate investment challenges facing U.S. infrastructure (with an emphasis on assets beyond energy) and exploring the current broken chain of steps during infrastructure project delivery and real estate development. The report then discusses the potential for greater urban resilience, how financial markets can support it, and the various actors involved. Finally, the report examines how a new climate finance framework can promote a more connected cycle of steps that addresses existing pain points and accelerates more frequent, widespread resilient improvements nationally.

Challenges around climate investment—much like climate change—will not disappear overnight. Public and private leaders across the U.S. continually struggle to measure or price the negative impacts from a more destructive climate (or the positive impacts from more proactive climate action), which represents a sizable market failure. They also lack mature regulations and guidelines to protect and securitize assets across the entire built environment, which represents a sizable policy failure. But additional research and experimentation has the potential to accelerate climate investment. This report is one step in building greater capacity around these ongoing efforts.

Key Terms

This report covers a range of different climate and financial topics, primarily in a U.S. context and intended for readers who have some familiarity with these issues. However, many existing plans, policies, academic articles, and industry studies can vary widely in their use of certain key terms. These inconsistencies can lead to confusion among policymakers, researchers, and other leaders as they look to identify and address climate investment needs nationally.

To provide more consistent understanding of these evolving topics, below are definitions for several terms used throughout this report:

Built environment: Humanmade and natural systems that act as a foundation for the environment and economy. This report primarily focuses on publicly owned and operated infrastructure systems (including transportation and water) and other privately owned real estate (including residential and commercial buildings). It excludes publicly owned real estate such as schools and government buildings.

Urban resilience: The capacity of regions to adapt to climate change, specifically by reducing costs and maximizing benefits. This report primarily focuses on the performance of physical systems to be flexible and responsive to acute climate shocks (e.g., major storms and fires) or chronic climate stresses (e.g., rising rainfall and temperatures). "Regions" include a range of sub-national geographies such as cities, counties, and metropolitan areas.

Climate costs: Environmental and economic costs associated with acute and chronic climate impacts. While many studies focus on environmental costs in isolation (e.g., rising pollution or stormwater runoff), this report also concentrates on the economic costs associated with climate change (e.g., lost jobs, lost production, or property destruction). From an investor's point of view, quantifying these costs in dollar figures can make it easier to measure financial impacts. Increased risk exposure and uncertainty have multiplied costs across different regions, particularly in communities of color and among lower-income households.

Climate benefits: Environmental and economic returns from resilient infrastructure improvements. Similar to climate costs, this report concentrates on benefits that can be quantified in dollar figures. For example, increased protection and certainty amid climate change can boost resource efficiency, property values, recreation, and workforce and industrial development. Likewise, reducing greenhouse gas emissions can reduce the cost of operations and bring about multiple co-benefits to human health from improved air quality.

Climate investment: Public and private funding and financing for resilient infrastructure improvements, whether they be physical assets or built environment operations.

Climate finance framework: An institutional framework for the public sector and private financial markets that incentivizes and scales consistent investments in more resilient infrastructure. This can include a combination of policies, programs, and regulations at a federal, state, or local level.

Predevelopment: Planning phase for infrastructure projects when they are scoped, identified, and prioritized, primarily for transportation and water needs. This includes articulating community values and priorities, collecting data, conducting technical studies, and defining a pipeline of needed projects. This phase precedes the actual engineering, design, construction, and operation of infrastructure.

Public platforms: Centralized inventories—or landing pages—of collections of infrastructure projects to be financed at a regional level. They can serve as a more visible way for local infrastructure owners and operators to connect with potential investors. For example, the Great Lakes Impact Investment Platform represents one of the first centralized landing pages that lists resilient projects, specific climate goals, and performance metrics across the St. Lawrence region.[1]

II. The climate challenge and hurdles to climate investment

Fueled by greenhouse gas (GHG) emissions and a warming atmosphere, the climate is unleashing more widespread destruction with each passing year.[2] Rising sea levels, flooding, and polluted water and air continue to put many people and places in harm's way, part of multidecade trend toward more climate risk globally.[3] At the center of all these risks and costs is a built environment that fails to mitigate or adapt to climate change. Steps toward more renewable energy are gradually taking hold, but the U.S. continues to invest in inefficient, vulnerable designs across an assortment of transportation, water, and private real estate assets.

Together, public and private leaders have the potential to jump-start additional climate investment across a broader suite of built environment assets, but the current U.S. system—with responsibilities fractured across many different actors, geographies, and infrastructure sectors—poses several hurdles to action. Current policies and programs frequently lack coordination, struggle to measure needs, and do not clearly spell out how new climate investment approaches can take hold. In other words, current market signals push public and private leaders to do the wrong things. The following subsections describe these hurdles in greater depth.

Framing the climate challenge

A more extreme and uncertain climate is impacting more people and places nationally. Massive hurricanes and storms are flooding regions from the Gulf to the Northeast. Severe droughts and wildfires are ravaging the West. Historic freezes and heatwaves are stretching from coast to coast. Looking out to the 2030s, 24% of U.S. counties will have high exposure to floods and 35% will have high exposure to heat stress.[4] More intense and prolonged rainfall is inundating homes and businesses, while hotter daily temperatures are scorching more neighborhoods.[5]

The impacts of a changing climate are also highly uneven. From Los Angeles to Flint, Mich., communities of color and lower-income households have historically endured a variety of environmental justice concerns; whether it's living close to coal-fired power plants or using lead-tainted water, many people have systematically failed to realize clean, safe outcomes.[6] Now, climate change has heightened the vulnerabilities of these communities.[7] Black households have had heat-related mortality rates at twice the level of other households in some regions, partially due to a lack of air conditioning and transportation access during heat waves.[8] Lower-income households disproportionately live in flood zones and in less expensive, poorly maintained structures, where they have represented more than half of applicants for federal insurance claims following Hurricanes Harvey, Irma, and Florence.[9]

Climate change is hitting more people in their backyards, and many current policies and industry practices are adding fuel to the fire. Despite calls to tackle this challenge head-on, public and private leaders across the U.S. frequently rely on approaches that systematically heighten climate risks and costs, creating moral hazards in the process.

Federal, state, and local leaders point to the urgency of taking climate action—rethinking highway expansions, adjusting prevailing patterns of urban development, and conserving water—but existing plans and policies often do the opposite. Public subsidies and zoning laws continue to support more roads and low-density land uses that gobble up natural resources, pave over green spaces, radiate heat, and cause flooding surges. Federal funding and regulations continue to prioritize the same vulnerable designs and technologies, including the maintenance of outdated facilities and buildings that generate pollution and fail to shield residents from harm.

Private leaders—including financial firms, investors, developers, and insurers—are also increasingly voicing their interest in (and shifting more money toward) climate action, but their existing business models frequently prioritize destructive practices. Individual and institutional investors continue to support fossil fuel industries in their portfolios every day. Real estate developers continue to meet the demand of households and businesses to locate in some of the riskiest regions nationally, from parched areas in the Southwest to inundated areas along the Gulf Coast. Banks and lenders continue to approve mortgages for properties in isolated, exposed geographies, including sensitive coastal areas and floodplains.

Combined, the climate response from public and private leaders has been insufficient. Their inability to address an outdated and inefficient energy system, still largely fed by fossil fuels, is a primary driver for climate change. And while the need to do more is obvious in the energy sector, there is also a need to not overlook other parts of the built environment; the United Nations itself has noted how leaders must "achieve a balance between adaptation and mitigation" in future climate actions.[10] Many

other physical systems are failing to address the worst climate impacts—a systematic shortcoming in how the country plans and invests. This report focuses on three sectors of the built environment that face several mounting and interrelated climate needs:[11]

- **Transportation infrastructure** includes roads and bridges; public transit; bicycle/pedestrian infrastructure; passenger and freight rail; airports; inland waterways; and other related facilities that are not only vulnerable to major storms and other acute climate shocks, but are also increasingly in need of repairs and upgrades that reduce pollution, improve access, and enhance more sustainable outcomes. Surface transportation is especially problematic, as the roadway infrastructure to support automobile-oriented development leads to longer travel distances, higher GHG emissions, greater stormwater runoff, and larger maintenance costs.[12]

- **Water infrastructure** includes drinking water, wastewater, and stormwater facilities as well as rivers, lakes, and other natural systems that face a number of scarcity and pollution concerns. Deferred maintenance combined with struggles to plan and pay for needed capital improvements have led to widespread water system failures and inefficiencies.[13] Overwhelmed sewers, leaking pipes, and outdated treatment facilities are resulting in runoff concerns, squandered natural resources, and higher bills.[14]

- **Privately owned real estate** primarily includes residential and commercial buildings that are fueling higher levels of emissions and runoff while leaving many occupants exposed to climate dangers. While industrial buildings and energy generation facilities are leading GHG emitters, the location and design of housing units, commercial buildings, and sprawling land uses can have higher relative pollution impacts.[15] For example, outdated zoning laws and building codes contribute to significant carbon footprints.[16] At the same time, continued construction (and reconstruction) in floodplains and other sensitive areas is leading to higher costs for many households and businesses.[17]

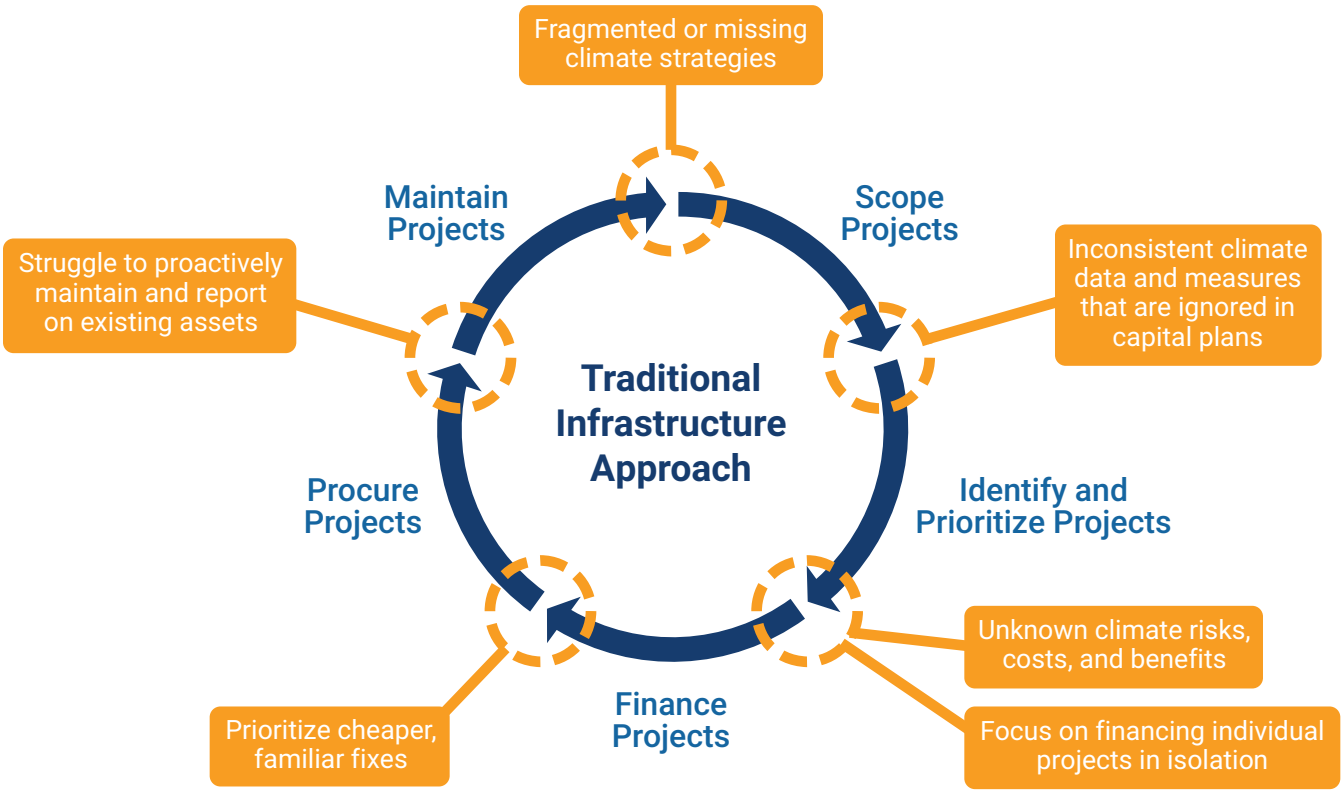
The need to reduce climate risks and costs has never been higher, and solutions continue to lack scale across the entire built environment. A wide range of public and private leaders—federal policymakers and regulators; local planners and practitioners; investors and financial firms; and many more—must better identify, measure, and address these built-environment-related climate challenges in the years to come.

Traditional project delivery: A broken chain that overlooks climate needs

As discussed in multiple interviews and verified by a general lack of literature on climate investment innovations across the built environment, public and private leaders in the U.S. do not follow a single, clear process to execute resilient projects. Public leaders involved in transportation and water tend to rely on the same types of measurement, planning, and financing approaches for any infrastructure project, which can be slow, disjointed, and reactive despite the urgency of climate change. At the same time, developers and investors involved in residential and commercial real estate often face a complex set of challenges around planning, financing, and implementing projects—often distinct by location and the specific type of development.

Typically, for both **transportation and water infrastructure,** state and local leaders go through a similar set of steps for each project: (1) an inconsistent data collection and measurement process based on fragmented or missing climate strategies; (2) a capital planning process to identify current and future infrastructure projects that often overlooks climate needs; (3) a project financing process based on unknown climate risks, costs, and benefits that focuses on individual projects and often prioritizes the same financial instruments (e.g., municipal bonds); (4) a procurement process that uses the same designs, technologies, and materials susceptible to higher risks over time; and (5) an ongoing maintenance process to manage existing infrastructure that often ignores lifecycle costs and reacts to climate needs in real time.

FIGURE 1 (REPEAT). Traditional project delivery for transportation and water infrastructure: A broken chain that overlooks climate needs



Source: Brookings literature review and interview findings

This rigid, sequential process results in similar types of projects and reinforces many ongoing economic and environmental inequities.[18] It is a broken chain of steps that overlooks climate needs and faces several major pain points in finishing any resilient project. At each step, this process can overemphasize engineering needs versus community values and lock in traditional designs and technologies that continue to expose people and places to climate impacts.[19] Although some regions may be doing a better job than others to address their climate needs—there is a continuum in how and where climate considerations occur during project scoping, prioritization, and financing—leaders still frequently:

1. RELY ON INCONSISTENT DATA AND MEASURES.

The predevelopment process for any infrastructure project should clearly identify and evaluate needs and priorities, yet policymakers, planners, and other practitioners often lack consistent definitions and data for climate resilience—or even climate risk.[20] Green infrastructure projects, for instance, may present unfamiliar designs to some leaders, who may only focus on environmental costs and exclude broader economic benefits.[21] The inability to accurately price the local costs and benefits of different projects at a regional or neighborhood scale is especially problematic given the uneven impacts of climate change, including various environmental justice issues.

State and local leaders may not have the technical or financial capacity to precisely model climate costs and benefits, and they may find it hard to quantify such diffuse impacts over time; much of this data is proprietary and handled behind closed doors by private data firms or the insurance industry.[22] And because the data is proprietary and expensive, it's either unavailable to certain places or only flowing to the gazelles. A lack of

asset management and asset mapping among governments further limit their ability to precisely identify, predict, or fix existing infrastructure, despite new digital technologies and sensors becoming more widely available.[23]

Researchers, data providers, ratings agencies, and investors face similar challenges when attempting to measure climate impacts themselves or collaborate with state and local governments. Although new models and measurement schemes are emerging to capture climate risks across the built environment, these efforts do not cover all types of infrastructure, do not reach all regions, and struggle to keep up with the pace of needed investment.[24] This is especially true around adaptation-focused projects (e.g., water and transportation) that can be too broad and ambiguous, or a "nightmare accounting exercise."[25] Since the impacts of mitigation-focused projects are easier to define and measure (via carbon prices, etc.), they are prioritized; yet "carbon pricing is the BMI of the climate world. It doesn't tell us anything about the overall health of the system."[26] There is no clear return on investment (ROI) for all climate projects in all places. Meanwhile, the incomplete or inaccurate disclosure of climate risks among issuers remains a challenge for ESG investors in particular, who may rely on conflicting taxonomies and ratings as a result.[27]

2. OVERLOOK CLIMATE NEEDS IN THE CAPITAL PLANNING PROCESS.

When deciding what infrastructure projects to prioritize, it is far too easy for state and local leaders to ignore climate considerations. There are few local or state requirements for long-range plans—including regional comprehensive plans or climate action plans—to translate these priorities into tangible changes on the ground.[28] Leaders in transportation departments, water utilities, and other units cover different service areas, develop budgets with different time horizons, and generally fixate on a pipeline of different projects with varying climate impacts. And even if infrastructure owners and operators incorporate climate needs into their budgets and plans, governors, mayors, chief financial officers, and other leaders who control the purse strings may not—and may not consider as many projects with intended lifecycles beyond the next 50 years due to a lack of reliable data.

The result is a lack of clearly defined climate objectives and priorities in the capital planning process; a lack of community engagement; a lack of standardized comparisons, pricing, and scoring of different climate projects; and a lack of "climate-smart" criteria to evaluate the performance of projects over time.[29] Limited predevelopment funding, staffing capacity, and technical awareness remain challenges for state and local leaders to integrate climate needs into their capital plans, even as researchers at Stanford University, the University of Washington, and elsewhere are trying to better address this gap.[30]

3. FAIL TO PURSUE A RANGE OF FINANCING AND FUNDING APPROACHES.

State and local leaders usually depend on tried-and-tested financing and funding strategies (e.g., municipal bonds and user fees) rather than experimenting with new approaches (outlined in the final section of this report). This is partly due to struggles developing clearer measures to price climate costs and benefits, in addition to challenges developing a consistent pipeline of resilient projects. One expert interviewed for this report noted that "predevelopment is the training phase of a marathon, and private capital comes in at mile 20 of a marathon."[31] Without a clear sense of where their jurisdictions should be targeting climate investment, leaders may not know the most efficient or equitable ways to generate additional local revenue, understand how to competitively apply for federal funding, or grasp how they should appeal to potential private investors.

There are no common national frameworks to compare different financing and funding strategies, and climate investment needs in each region are so diffuse that many leaders may not know where to start.[32] Green bonds are just one financing option available, but a range of other local revenue sources—including stormwater fees and "resilience fees" (specific to different land uses)—could generate support from homeowners, businesses, and property developers too.[33] However, there can be state-level restrictions on new local-revenue-raising authority

and a lack of state-enabling legislation around new public-private infrastructure financing approaches.[34] The fact is "money can be lumpy," and better tracking, testing, and certifying of new strategies is needed to spell out the benefits for regions and help investors better understand potential yields.[35]

4. PRIORITIZE CHEAPER, FAMILIAR FIXES.

The inclination for many state and local leaders is to strive for lower upfront costs and rely on traditional project designs, even though this approach can stunt innovation and lead to higher climate risks over time. As one expert noted, "The public system is not wired to listen to the investor signals; it is wired to complete easy projects through consulting firms."[36] The procurement process—which encompasses all the steps that governments or public authorities take to obtain goods and deliver projects—is geared toward using the same types of materials, designs, and technologies, and working with the same types of firms.[37] This is true even if other cost-effective upgrades and system transformations are possible.

Rising project costs, meanwhile, are becoming a reality nationally and further straining the ability of state and local leaders to take chances with new approaches. For instance, the Producer Price Index shows a 25% increase in national construction costs over the past 10 years, exceeding the overall Consumer Price Index.[38] Experts have pointed to the increased cost of materials, labor considerations, and a variety of permitting issues (including environmental compliance) as relevant factors. However, such costs may also prompt leaders to explore more efficient, cost-saving upgrades that boost climate resilience. Bundling different, novel projects together in one proposal and inviting a broader range of firms and respondents to work on these projects can lead to more frequent, flexible experimentation.[39]

5. STRUGGLE TO PROACTIVELY MAINTAIN AND REPORT ON EXISTING ASSETS.

Whether pursuing new projects or maintaining existing facilities, leaders usually react to climate impacts in real time. The U.S. focuses on recovery, not resilience. Jurisdictional fragmentation, fiscal capacity concerns, and regional political demands make it challenging to focus on older systems with serious climate needs—pipes and underground wires, for instance—rather than building newer, more visible projects. At the same time, the lack of geographic scale to improvements across existing facilities can further compound risks; isolated, one-off projects fail to support the connected and integrated systems needed to boost climate resilience.

Incomplete asset management strategies (and inventories) contribute to these maintenance backlogs, which can cause major problems for infrastructure operations and budgets. Reporting on asset conditions can be slow, haphazard, or missing entirely. For instance, water utilities may not always recognize what pipes are in poor condition or reaching the end of their useful life, and they may fail to identify or prioritize these assets in capital plans. This is not only an issue for federal agencies and regulators looking to improve climate outcomes, but also private investors who could support more of these projects; they lack timely, geographically granular information on these less visible projects that can fly under the radar.[40]

Challenges in the real estate sector

Approaches to boost climate investment in the **private real estate sector** suffer from fragmented risk and incomplete information. Developers and homebuilders who sell completed properties to other entities after construction have little incentive to consider the climate risk or impact of new projects. Property owners, including homeowners and institutional landlords, often lack information on location-specific property risk. Because most real estate is purchased with a mix of debt and equity, no single entity bears the full financial exposure to climate risk. Banks, financial intermediaries, and federal regulators do not transparently measure, assess, or incorporate climate risks in underwriting decisions.[41] And insurers may be sitting on climate risk data specific to different properties, but not share the information publicly or scramble to keep up with damages unfolding in real time.

That is all to say: The climate investment issues facing privately owned real estate are massive and complex, with little direction at a national level on how to define,

measure, or systematically address these needs. The differences between owner-occupied residential and commercial real estate are also vast, including different ownership, financing, and regulatory approaches. While this report only scratches the surface of these complexities, research and expert interviews raised a set of common pain points:

- DIFFICULTIES DEFINING CLIMATE NEEDS.

  Climate impacts are hitting residential and commercial properties that differ in their location, design, history, and future trajectory. The enormous scale of real estate assets that contribute to GHG emissions and/or are vulnerable to chronic and acute climate impacts leads to a confounding number of questions facing national, state, and local leaders. What properties face the greatest climate risks? Where and how will these risks impact property values and market demand? How will new and existing properties address these risks? Who will need to lead—and guide—these climate investments?

For instance, new building construction not only generates emissions, but also consumes natural resources and can open communities up to additional flood, fire, and other risks. This is especially true as suburban development continues to expand in many regions.[42] When it comes to residential construction, local zoning laws prioritize detached single-family homes and exclude other uses; some estimates show that this is the case for 75% of residential land.[43] Many centrally located communities near job centers and public transportation—the places where development would have the least harmful climate impact—have regulations that prohibit additional infill development, which pushes growth toward more harmful locations. Suburban (and exurban) greenfield construction further stretches the distances that residents need to travel, typically via a private automobile, which expands carbon footprints. The continued construction of offices, retail stores, and other commercial buildings in outlying areas furthers these same challenges.

FIGURE 3. Common pain points to address climate needs in residential and commercial real estate

DIFFICULTIES **DEFINING** CLIMATE NEEDS	CHALLENGES **MEASURING** CLIMATE NEEDS	VARIOUS **IMPLEMENTATION** ISSUES
▪ Wide range of impacts caused by new construction in suburban and exurban areas ▪ Huge variety of existing buildings that use energy inefficiently and cause other impacts ▪ Only react or rethink existing approaches when disaster strikes	▪ Reliance on "blunt and outdated" measurement tools ▪ Lack of geographically granular and timely data distorts property pricing and perceptions ▪ Failure to measure and account for uneven impacts hitting lower-income households and communities of color	▪ Federal government continues to back climate-risky mortgages and rely on unsustainable disaster recovery programs ▪ Local zoning laws and building codes perpetuate destructive development ▪ Owner and investor demands continue to drive a destructive market

Source: Brookings literature review and interview findings.

Meanwhile, existing residential and commercial buildings directly account for 13% of the country's GHG emissions through heating and other activities, and indirectly account for up to 30% when including electricity and energy use.[44] Private real estate owners and investors need to pursue more resilient building retrofits—think solar panels, energy-efficient appliances, and better insulation—and invest in denser construction in urban areas with fewer environmental impacts. Larger single-family homes consume more energy for heating and cooling, use more water, and drive up risks and costs for individual owners and communities. Likewise, some commercial buildings can span tens of thousands of square feet while having inefficient insulation, lighting, and HVAC equipment.[45]

The enormous range of private real estate assets—both new and existing—that drive climate risks makes it nearly impossible to get a handle on where the most pressing needs (and potential investments) exist. Instead, the country keeps constructing the same types of buildings in the same vulnerable locations, keeps relying on the same inefficient designs in existing locations, and only understands the extent of these problems when property damage occurs during a major storm or other acute climate shock.

CHALLENGES MEASURING CLIMATE NEEDS.

Measurement matters, yet consistently mapping climate risks across different properties and geographies represents a gargantuan task which lacks any clear agency or entity responsible for taking it on across the country.[46] While some federal agencies, such as the Federal Emergency Management Agency (FEMA), have attempted to develop better national measures, these efforts have often resulted in flawed and ignored findings.[47] Monitoring these risks over time is also an ongoing challenge. But academic and market research signals the urgency to do so; for instance, more than 300,000 coastal homes today (valued at $117.5 billion) are "at risk of chronic inundation in 2045—a timeframe that falls within the lifespan of a 30-year mortgage issued today."[48] Another 14,000 coastal commercial properties (valued at $18.5 billion) are at risk in similar locations.[49]

Existing climate data and measurement tools are often "blunt and outdated," struggling to measure risks and quantify benefits from taking climate action.[50] While real estate owners, investors, and insurers may understand some level of risk associated with individual properties, there is no standardized, precise way to track and price risks across all types of properties nationally. Data on risk exposure has continued to evolve, but data quantifying the benefits of resilience investment is still limited, with emerging research showing how much work remains to be done.[51] No data is available to "outline the interaction between climate hazard exposure, market sentiment and asset value and pricing."[52] These actors may instead rely on inaccurate flood insurance rate maps that were only just recently updated by FEMA, or they lack access to more accurate, proprietary data in the hands of academic researchers and insurers.[53]

The lack of clear data, measures, or understanding of climate risks across different property types can lead to distorted pricing and perceptions in the real estate market. Homeowners may overlook the true costs associated with sea level rise, flooding, and other chronic risks; for example, a study of 460,000 single-family property sales over the past decade shows that coastal properties sell for up to 10% less compared to other properties and could entice buyers looking for a good deal.[54] Valuations of commercial real estate are usually based on lagging or incomplete indicators—including potential business disruptions, insurance costs, and repair and replacement costs—which can obscure how lenders, borrowers, and investors assess risks over time.[55] And even when disaster strikes, prices usually rebound after only a few years.[56]

Failures to measure and internalize these real estate risks ultimately result in costs that keep hitting some individuals and communities harder than others. Lower-income households and communities of color not only have fewer resources to weather such costs, but they tend to locate in areas with more climate risk overall—whether in flood-prone neighborhoods or areas with more pavement and intense heat.[57] These costs impact owners and especially renters, who may lack the knowledge, understanding, or incentive to price long-term risks into short-term decisions.

IMPLEMENTATION ISSUES AROUND ANY CLIMATE IMPROVEMENTS.

The sheer scale of new and existing buildings in need of improvements is daunting, the upfront costs can be a barrier for individual households and businesses, and there is a practical challenge in steering construction (and investment) in more resilient ways across thousands of different jurisdictions. Existing mortgage and insurance markets are complex and divide financial risks among many actors—not just owners and renters, but also federal, state, and local governments and other intermediaries. That makes it hard to curb climate risks for new and existing real estate assets and fundamentally reshape and incentivize more resilient improvements.

The federal government is perpetuating this real estate challenge in many ways: by failing to incorporate climate risk in underwriting or securitizing residential mortgages; by continuing to serve as an insurer of first resort; and by failing to support more resilient upgrades. First, the government-sponsored enterprises—Fannie Mae and Freddie Mac, along with the Federal Housing Administration, Department of Agriculture, and Department of Veterans Affairs—have not traditionally considered climate risks when underwriting and securitizing mortgages. Second, the federal government continues to pump an unsustainable amount of money into disaster recovery programs that fail to identify or reduce long-term risks, including the National Flood Insurance Program (NFIP) and the Community Development Block Grant Disaster Recovery Program (CDBG-DR).[58] And third, the government has long underfunded resilient upgrades; as just one example, the Department of Energy offers weatherization assistance to lower-income households, but there is a lack of capacity—only about 2% of 38.6 million eligible low-income homes are weatherized each year.[59]

At a more local level, zoning laws and building codes continue to favor low-density development in suburban and exurban areas while failing to upgrade designs and equipment in existing buildings. Zoning in most communities requires both residential and commercial properties to include parking minimums and restricts the development of mixed residential-commercial development, multifamily housing, and other forms of dense, climate-friendly development. Individual municipalities, such as Seattle and Atlanta, have developed new plans and building codes to strengthen green building standards, but they are more the exception than the norm.[60]

Property owners and investors also continue to support many of these climate-destructive land uses, whether they realize it or not. The country's continued suburbanization—including both residential properties and commercial developments like office parks and big-box stores—have resulted in a built environment that perpetuates climate harms and fills many portfolios. For instance, nearly 35% of real estate investment trust (REIT) properties are now exposed to climate risks, whether due to inland flooding, coastal flooding, sea level rise, or severe storms.[61] While owners and investors are increasingly demanding more climate-conscious properties—and can do so more reliably with new green building standards—the reality is that traditional demands still drive much of the current market.[62]

III. Exploring the potential to invest in greater urban resilience

The U.S. faces many climate challenges and lacks clear institutional frameworks to address them. However, many policymakers and practitioners across the country are taking steps to boost their "urban resilience"—the capacity of the built environment to be more flexible and responsive to these climate impacts. They are testing new designs and technologies—from seawalls to rain gardens to permeable streets—to reduce risks, save money, create jobs, and benefit households and businesses. At the same time, private investors have demonstrated increased interest (and impact) in launching more climate investments nationally.

The following subsections describe the potential for more widespread investment in urban resilience, including: the types of projects and benefits that could be realized; why public funding and capital markets matter; the public and private actors who need to be involved; and the regulatory and technical guidance that could enable these investments to occur.

Defining urban resilience

Reducing climate risks and costs goes hand in hand with increasing climate resilience. While there is no single accepted definition for "resilience" among researchers and practitioners, this report considers a resilient built environment as one that is flexible and responsive to a variety of existing and future climate impacts.

Whether responding to acute shocks (e.g., major storms and fires) or chronic stresses (rising rainfall and temperatures), resilient infrastructure can come in many different forms and serve many different functions, often involving new designs and technological innovations. For instance, resilient infrastructure can be humanmade and engineered, including sea walls and other large, centralized systems designed to protect regions. It can be natural, including wetlands and forests that are preserved to absorb pollution, runoff, and other hazards.[63] Upgrades can also be smaller and more decentralized, including electric vehicle charging stations, new building cooling and heating systems, improvements to pipes, and the installation of green infrastructure (such as rain gardens) to reduce flooding, damage, and costs.[64] Despite its varying form and function, resilient infrastructure ultimately aims to better respond to a changing climate, enabling the environment and economy to survive and thrive.

Resilient infrastructure improvements can occur at many geographic levels, with the aim to reduce or avoid costs. For example, green roofs and building weatherization upgrades—including better insulation and more efficient appliances—take place on individual properties.[65] Permeable streets—made of porous materials that can absorb water and reduce runoff—tend to stretch across neighborhoods.[66] Watershed improvements, restored tree canopies, and greenways—connected corridors and shared-use paths that preserve open space and vegetation—can span multiple local jurisdictions and multiply cost savings over time.[67] This report focuses on the entire suite of projects that boost "urban resilience," or the capacity of regions—cities, counties, and metropolitan areas—to mitigate and adapt to climate change.[68]

FIGURE 4. Geographic scale of climate-related infrastructure investments

Geographic level	Project examples	Reduced costs and increased benefits
REGIONAL 	▪ Greenways ▪ Urban tree canopy restoration ▪ Watershed improvement plans and projects	▪ Reduced greenhouse gas emissions ▪ Reduced flood risk ▪ Reduced wildfire risk ▪ Reduced urban heat island effect ▪ Increased resource efficiency ▪ Increased property values ▪ Increased recreation ▪ Increased workforce and business development
NEIGHBORHOOD 	▪ Permeable street and sidewalk upgrades ▪ Local park improvement ▪ Vegetated buffers to protect local streams	
PROPERTY 	▪ Green roof ▪ Rain garden ▪ Building weatherization	

Source: Brookings literature review and interview findings

Boosting urban resilience, though, is not just about reducing risks and costs. Resilient infrastructure improvements can unlock many benefits for regions. As one expert emphasized during our interviews, "Finance is a synthesis of value and risk, yet we often do not think about infrastructure in terms of value, we only think of it as risk; ideally, a new data gathering culture has to include forward-facing risk, not just historic risk."[69] Environmentally and economically, these improvements enhance the reliability and performance of existing infrastructure systems and can motivate the political will of leaders—including mayors, governors, and others—to make more proactive infrastructure investments. Major benefits include:

- **Increased resource efficiency.** Reuse technologies and designs used by energy and water utilities—including closed-loop cooling systems and bioretention facilities—can conserve resources and boost efficiency.[70] Trees, green roofs, and other natural infrastructure can lead to cooler conditions (which improve energy use) and better absorb and manage stormwater. Neighborhoods that incentivize shorter-distance trips are more likely to see people bike and walk, dramatically reducing energy consumption.[71]

- **Increased property values.** Being less exposed to acute and chronic climate events provides greater certainty to developers and property owners, leading to higher housing and neighborhood values. Improved aesthetics and greenery—including native landscaping, rain gardens, and other green infrastructure upgrades—can also improve the value of nearby buildings.[72] For example, a collection of 12 green infrastructure projects helped revitalize Milwaukee's Menomonee Valley and contributed to a 5.8% increase in nearby industrial property values, adding an assessed $1.56 million to the city's tax base.[73]

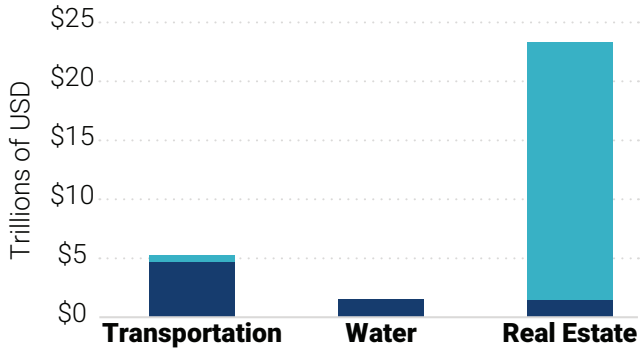
- **Increased recreation.** Proximity to parks, rivers, and other green infrastructure facilities offers a public amenity to residents, businesses, and visitors. This supports physical activity, public health, community engagement, and other recreational opportunities. Cities such as Chicago, which has 26 miles of public lakefront and 28 miles of riverfront, are prioritizing green infrastructure assets as part of larger recreation and economic development strategies.[74]

- **Increased workforce and industry development.** Constructing and maintaining infrastructure—including green infrastructure—not only has the potential to create more local, direct jobs in the short term, but also can support ongoing opportunities to educate, train, and engage prospective workers.[75] From 2001 to 2010, for instance, Oregon invested $411 million across 6,740 watershed restoration projects, generating between $752 million and $978 million in economic output and 4,600 to 6,500 jobs.[76] At the same time, additional research and development activities and business opportunities around new climate-friendly products and processes can power industrial growth and lead to more jobs.[77]

Meeting the need: Why public funding and capital markets matter

Achieving the country's long-run climate goals will require significant investments in our communities. According to Bureau of Economic Analysis estimates, physical assets within the transportation, water, and real estate sectors are worth nearly $30.2 trillion, and 74% of these assets are privately owned.[78] Together, the assets across the three sectors account for 58% of all public and private value in physical structures. There's no way around it: Rebuilding the country's cities, suburbs, and small towns will require significant financial capital.

FIGURE 5. Total value of US public and private built environment assets, 2019



Source: Brookings analysis of Bureau of Economic Analysis fixed assets data

Note: Built environment fixed assets include structural transportation (highways and streets, transportation structures, other transportation), water (sewer systems, water systems), and residential and commercial real estate.

The burden of raising and deploying such significant financial resources falls on both the public and private sectors. Unfortunately, America's current investment record is not yet good enough.

Although researchers and practitioners do not have a single, consistent measure to estimate the aggregate climate investment gap, Treasury Secretary Janet Yellen and other federal leaders have identified $2.5 trillion needed over the next decade to transition to a net-zero economy.[79] This estimate is consistent with other global research efforts that have pointed to lagging levels of U.S. climate investment; for example, U.S. public *and* private investment on resilient infrastructure improvements has averaged $74 billion annually in recent years—representing 13% of total global climate investment ($574 billion), despite the U.S. accounting for 29% of global wealth.[80] Meanwhile, most of this climate investment—$59.5 billion, or 81%—goes toward renewable energy projects, largely excluding other parts of the built environment.[81]

For the public sector, spending shortfalls are already endemic across the transportation and water sectors. The lack of durable and predictable public infrastructure funding has limited proactive climate investment, particularly among state and local governments, which account for 77% of public spending.[82] Facing rising project costs and other fiscal capacity constraints, many states and localities struggle to keep up with repairs for existing facilities, let alone pursue more resilient upgrades. On average, the U.S. spends $440.5 billion on transportation and water systems each year, falling by $9.9 billion in inflation-adjusted terms over the last decade.[83] Aging, inefficient facilities—from century-old pipes to dilapidated bridges—are not only susceptible to more failures, but also draining more money. As a result, the U.S. infrastructure investment gap now stands at more than $3.5 trillion.[84]

The urgency of climate investment and a lack of local fiscal capacity

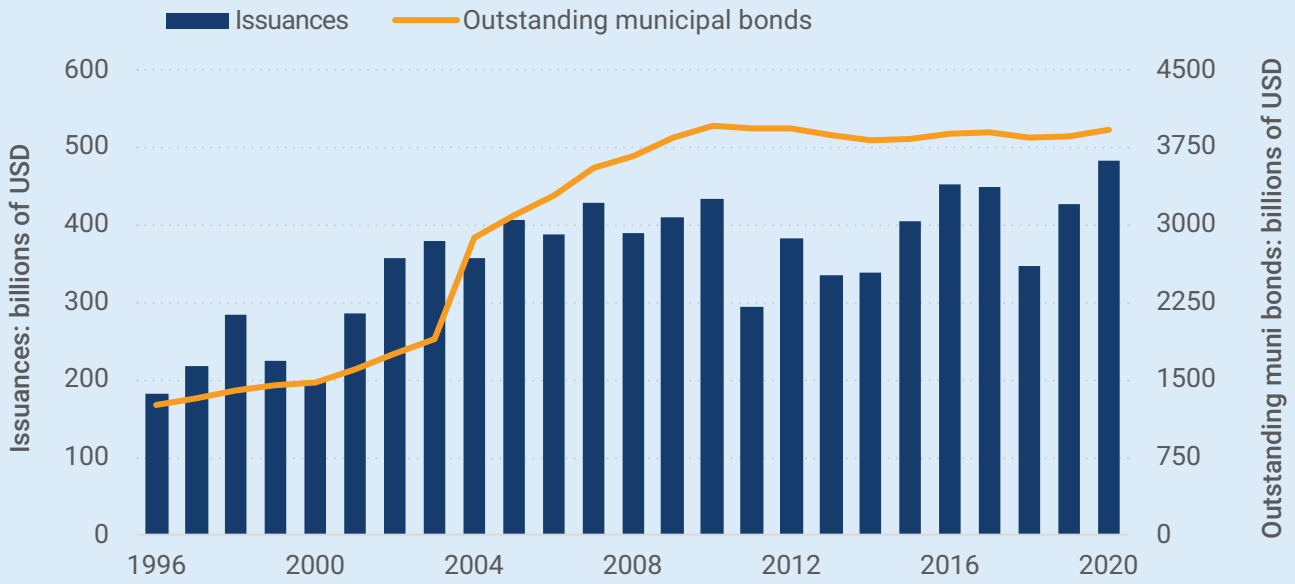
Climate change is impacting people and places differently across the country. The risks and costs are especially severe for state and local governments with less fiscal capacity to improve infrastructure that can mitigate and adapt to these impacts.[85]

Slower-growing metropolitan areas—including those with less population, job, and wage growth—are projected to experience more climate costs over the next few decades that could account for up to 17.5% of their GDP.[86] Destruction, displacement, and climate migration are further stressing these areas, including 1.2 million Americans who left their homes due to climate concerns in 2018 alone.[87] Local governments in some coastal regions could lose up to 50% of their property tax base due to sea level rise, making it difficult to generate enough revenue to pay for new upgrades or simply keep ahead of their existing needs.[88] In response, some local governments are already shifting the cost burden to current residents; for instance, Miami Beach, Fla. tripled its utility rates to pay for $650 million in drainage and roadway improvements to fend off rising seas.[89]

The need to rethink how (and how much) climate investment occurs in the transportation sector is of paramount importance, given that it now represents the country's top source of GHG emissions (29%) and is susceptible to widespread climate impacts.[90] Although federal leaders are aiming to launch historic investments in electric vehicles and transit, rail, and pedestrian improvements that support more resilient transportation infrastructure, the current approach to climate investment in this sector is mostly ad hoc, project-specific, and contingent on the plans of individual states and localities. Cities, counties, states, and other regional leaders are responsible for nearly three-quarters of the country's total public spending on transportation each year ($214.7 billion out of $298.8 billion) and still mostly emphasize congestion reduction, roadway expansions, and other 20th-century projects harmful to a 21st-century climate; they do so through a mix of taxes, user fees, and grants.[91]

The water sector is in a similar position—a diffuse set of climate investment needs are falling into the (often overwhelmed) hands of states and localities. Whether striving for more efficient water use or better managing stormwater runoff, there are more than 50,000 utilities scattered across the country responsible for about 90% of the country's total public spending on water infrastructure each year ($127.4 billion out of $141.7 billion).[92] A

FIGURE 6. The size of the US municipal bond market and new issuances, 1996-2020



Source: Securities Industry and Financial Markets Association

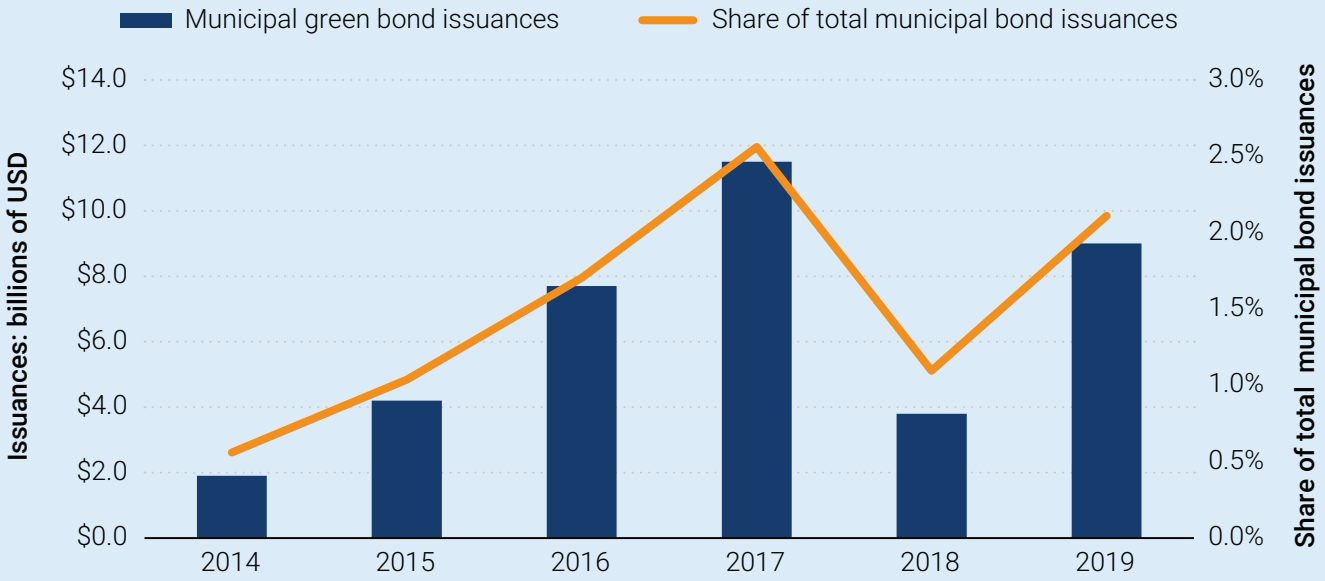
variety of capital and operational pressures—including combined sewer overflows, lead pipe replacements, and other aging infrastructure—are compelling utilities to raise rates and fees charged to households and other users that represent their primary revenue source.[93] However, these rates are leading to affordability concerns and are increasingly insufficient to address the country's mounting water capital needs, which are estimated at $740 billion over the next two decades.[94] While federal grants and loans—including those available through the State Revolving Fund (SRF) programs, the Water Infrastructure Finance and Innovation Act (WIFIA) program, and new COVID-stimulus measures—offer some support, they are also insufficient.[95]

Lacking durable and predictable revenues while confronting a growing list of investment needs, state and local transportation and water leaders traditionally look toward the municipal bond market to finance projects. Municipal bonds provide tax-exempt debt in many cases that can offer a low-cost, familiar way for state and local governments to get projects done. And these bonds are popular; the U.S. municipal bond market now stands at more than $4 trillion in outstanding bonds, with transportation typically representing around 15% to 20% of the market.[96] However, continually issuing more debt may not be a feasible option for all places in years to come, given ongoing fiscal capacity constraints, lagging economic growth, and rising project costs.[97]

As more state and local governments look toward resilient infrastructure improvements, including green infrastructure projects such as rain gardens and permeable streets, there has been growing appetite to consider new types of bonds—notably, green bonds.[98] Green bonds (alternatively called "climate bonds") represent a newer debt instrument available to issuers with similar financial terms as standard municipal bonds, but are geared toward projects with certified "green" impacts (e.g., cleaner transportation or water management).[99] As a result, they can improve the environmental reputation of an issuer, appeal to a broader investor base, and serve as a valuable financing and communication tool.[100] However, green bond standards are still evolving and unclear to some issuers, who may need to spend more time and money on reporting and compliance.[101]

Green bond issuances are also still few and far between. Municipal green bonds, for instance, have jumped from $1.9 billion in 2014 to $9 billion in 2019, but they only account for a small share of the total volume of all municipal bonds: 2.1% of the $426.4 billion in municipal bond issuances in 2019.[102]

FIGURE 7. Change in municipal green bond issuances, 2014-2019



Source: Brookings analysis of Climate Bond Initiative and Securities Industry and Financial Markets Association data.

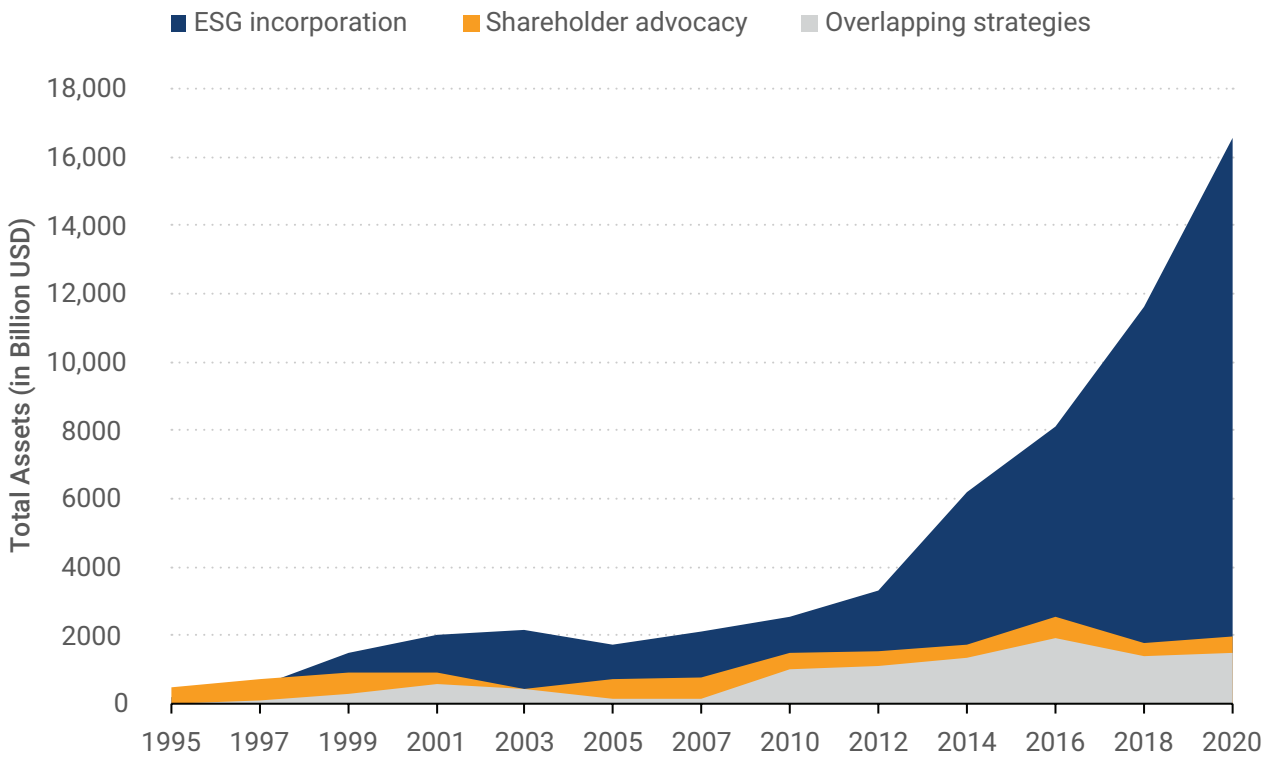
As important as the public spending is, the largest total investment in the built environment will come from the private sector. Already the primary owner of fixed assets, annual investments flowing from private capital markets easily outpace annual public spending across the transportation, water, and real estate sectors. Private capital markets help share, transfer, and hedge financial risks, and they have the potential to better identify, price, and incentivize additional climate investment opportunities.[103] Investors are not only seeking to minimize climate risk exposure in their portfolios, but also looking to expand support for climate-conscious asset classes that offer predictable long-term returns.

The rise of environmental, social, and governance (ESG) investing has sent strong market signals about private appetite for climate investment. Often associated with sustainable investing and impact investing, ESG investing refers to intentional investments aimed at generating a positive social or environmental impact, alongside a financial return.[104] ESG investments come in the form of funds and companies that reduce GHG emissions, better manage natural resources, and minimize a range of other climate impacts. However, the specific criteria and measurable outcomes of these investments vary. Inconsistent scoring methodologies, wide variations in financial disclosures among companies, and the emergence of different data providers to track all this information make it hard to compare ESG investments or evaluate if they advance ESG-related outcomes.[105]

Still, the rise in ESG investing is undeniable; an estimated $17 trillion of professionally managed assets in the U.S. involved some type of ESG criteria in 2020, which represents a third of all professionally managed assets ($51 trillion).[106] This total has soared 42% since 2018 alone.

The appetite for additional ESG investment—and improved climate outcomes in general—is growing in the private sector, but the question is how to direct

FIGURE 8. Sustainable investing in the US, 1995-2020



Source: US SIF Foundation

Note: Overlapping assets involved in some combination of ESG incorporation (including community investing) and shareholder advocacy are subtracted to avoid potential effects of double counting. Prior to 2010, assets subject to ESG incorporation were limited to socially and environmentally screened assets and did not include assets that considered only governance criteria.

this appetite in ways that support a more resilient built environment. Large private equity firms are rethinking investment strategies and publicly pledging trillions of dollars to address the climate challenge, including BlackRock, Goldman Sachs, J.P. Morgan, and Citi.[107] Sixty percent of the 3,000 largest U.S. publicly traded firms now mention climate risk in their financial reports, up from 35% only a decade ago.[108] In response, ratings firms are collecting, analyzing, and categorizing data on ESG investments domestically and globally. Federal agencies are also increasingly looking to better monitor climate investments and take more proactive action, including the launch of a new climate finance plan and the creation of a new Treasury "Climate Hub" by the Biden administration.[109]

However, heightened interest in climate investment is only the start to making a difference on the ground for more people and places. Public and private leaders need to systematically identify, measure, and accelerate resilient infrastructure investments by overcoming challenges around geographic fragmentation and fractured responsibilities.

Coordinating climate investment among a variety of public and private actors

Constructing, maintaining, and governing infrastructure—including the pursuit of more resilient infrastructure—involves shared responsibilities nationally. Yet these responsibilities are often overlooked, unfulfilled, or simply fail to register as priorities for many public and private leaders, who have an opportunity to break down existing siloes and accelerate climate investment.

FIGURE 9. Major public and private actors involved in overseeing or executing resilient investments across the built environment

	 State and local governments	 Federal agencies	 Private investors	 Ratings agencies
Activities Carried Out	▪ Own and operate public infrastructure assets ▪ Adopt and enforce zoning laws	▪ Set strategic priorities ▪ Enforce regulations, including disclosures ▪ Administer funding programs	▪ Invest in a range of built environment assets ▪ Buy, sell, and manage real estate ▪ Insure against risks	▪ Evaluate creditworthiness (or financial strength) of companies and government entities
Challenges Faced	▪ Fragmented governance ▪ Lack of fiscal capacity ▪ Struggles to measure and address climate needs	▪ Siloed oversight of different climate needs ▪ Insufficient and reactive climate funding	▪ Lack of regulatory certainty and transparency ▪ Challenges identifying projects and mobilizing capital	▪ Evolving needs around climate data and measurement ▪ Staff limitations around climate analytics
Examples	▪ Transportation departments ▪ Water utilities ▪ Planning agencies	▪ USDOT ▪ EPA ▪ DOE ▪ HUD ▪ FEMA ▪ SEC ▪ Treasury	▪ Individual and institutional investors ▪ Real estate investors ▪ Insurance companies	▪ Moody's ▪ Standard & Poor's ▪ Fitch Ratings

Source: Brookings literature review and interview findings.

As noted earlier, **state and local governments** are the primary owners and operators of the publicly owned transportation and water infrastructure assets in need of additional climate investment. They adopt and enforce zoning laws, building codes, and other regulations that establish the rules for what types of structures can be built in what locations and through what process. They are some of the most important regional leaders around climate change. But the enormous scale and variety of assets they oversee leads to a highly localized and fragmented approach to climate upgrades. Transportation departments, water utilities, and other regional authorities differ markedly in the service areas they oversee, types of facilities they manage, and capital projects they prioritize, from roads and transit to sewers and water treatment to parks and waste management. Frequently squeezed for time, financial flexibility, and technical capacity in the planning and procurement process, state and local leaders tend to rely on traditional designs and technologies that may contribute to more climate challenges over time: wider roads, bigger treatment plants, and so on.[110] Or they may underinvest and put off repairs entirely, reacting to climate challenges as they happen.[111]

The **federal government** relies on a collection of agencies (and sub-agencies) to set strategic priorities, implement regulations, and administer funding programs that not only struggle to keep ahead of existing infrastructure investment needs, but also do not comprehensively address mounting climate investment needs. The Environmental Protection Agency (EPA), Department of Transportation (DOT), Department of Housing and Urban Development (HUD), and Department of Energy (DOE) are among the most prominent agencies that oversee different parts of the country's built environment, including investments in more sustainable transit and pedestrian improvements, green infrastructure, renewable energy, energy-efficient housing, and more.[112] However, federal funding specifically for climate change has centered around research and development; in 2017, for instance, federal funding for climate change amounted to $13.2 billion, split across 19 different agencies and representing only a fraction of total program budgets.[113]

Many federal agencies also actively use financial principles or regulate capital markets to influence built environment activity. FEMA's National Flood Insurance Program is the primary insurer of private property against flood damage, but has teetered on the edge of insolvency due to mounting storms and damage.[114] The government-sponsored enterprises (Fannie Mae and Freddie Mac) and federal agencies that originate, insure, or regulate mortgages (the Federal Housing Administration, Department of Veterans Affairs, Department of Agriculture, and Federal Housing Finance Agency) do not currently take into account variations in climate risk for properties located in different parts of the country when underwriting, pricing, or securitizing mortgage loans.[115] Several other agencies, including the Treasury Department and the Securities and Exchange Commission (SEC), are only just beginning to identify needed climate strategies, regulations, and standards to guide economic development and investment activities.[116]

Beyond the public sector, multiple **private actors** are involved in climate investment. The insurance industry is perhaps most closely involved with the mounting risks and costs of climate change across the built environment—around property, liability, and casualty risks, to name only a few—but its preparedness to deal with these risks remains in question.[117]

This report primarily concentrates on the role of private investors: individuals, financial firms, and institutional asset owners, such as pension funds.[118] It also considers private real estate investors, including those individuals and firms who buy and sell properties as well as real estate investment trusts (REITs).[119] Globally, the United Nations Framework Convention on Climate Change (UNFCCC) has focused on the role of private investors to mobilize capital and fill the climate investment gap over the coming decades; the UN Sustainable Development Goals (SDGs), for instance, aim to tackle many of these climate investment needs and are estimated to require $3 trillion to $5 trillion annually to become a reality worldwide.[120] Following the Paris Agreement and other global climate pledges, private investors have expressed interest in additional climate investment, but in the U.S. (similar to many other countries), this interest has primarily centered around mitigation rather than adaptation—leaving out many risks facing the broader built environment.[121]

Investors in the U.S. lack consistent measures as well as regulatory certainty—and transparency—around the nature of different climate investment opportu-

nities. **Ratings agencies**, which evaluate the creditworthiness (or financial strength) of companies and government entities, are key actors in boosting this consistency for investors amid climate change. From Moody's to Standard & Poor's (S&P) to Fitch Ratings, these agencies are beginning to assess climate risks at a more geographically granular level and assign ratings to issuers across all asset classes, including ESG investments.[122] These data collection efforts and ratings assignments are still largely in development, but investors and issuers are taking notice and citing climate change with greater frequency, particularly in the municipal bond market, which is central to infrastructure investment.[123]

With so many climate risks to address and so little coordination, public and private leaders largely fail to seize a massive investment opportunity. They continue to rely on policies and programs that struggle to incentivize and scale more climate investments across the built environment nationally. But more consistent regulatory and technical guidance holds promise in identifying needed investments and activating more collaborative approaches.

Improving regulatory and technical guidance

Climate change is exposing the built environment to greater risk, with significant financial ramifications to state and local governments and other private actors, including investors. Notably, these climate impacts are throwing the financial profile of whole regions into question, which could limit their ability to borrow capital and lead to other economic spillover effects.[124] Even though financial markets have the ability to better identify, price, and hedge these risks—and promote investment across a range of asset classes—the U.S. (similar to many other countries) lacks any consistent regulations or guidelines to measure climate investment needs and mobilize capital.

U.S. financial regulators, led by the SEC, have a mission of "protecting investors, maintaining fair, orderly, and efficient markets, and facilitating capital formation."[125] Yet the SEC, in addition to other federal agencies (e.g., the Treasury Department and the Federal Reserve) and other market actors (e.g., ratings agencies and

financial firms), are still trying to "decisively measure, understand, and address" the risks of climate change to the U.S. financial system, according to assessments from the U.S. Commodity Futures Trading Commission and other researchers.[126] Coalitions of business leaders have also voiced concerns about the inability of financial regulators to classify climate change as a systemic risk, with "significant, disruptive consequences on asset valuations, global financial markets and global economic stability."[127] Instead, a lack of clarity or outright misconceptions around the climate profile of different asset classes via "greenwashing" has taken hold, especially among ESG investors.[128]

There is a need for a new **climate finance framework**—an institutional framework for the public sector and private financial markets that incentivizes and scales consistent investments in more resilient infrastructure improvements nationally.

Such a framework should be informed by the creation and implementation of regulations governing the trading of securities, including stocks.[129] During the Great Depression, the 1933 Securities Act and 1934 Securities Exchange Act aimed to ensure investors received more complete, precise information on securities (i.e., disclosures) and established comprehensive guidance on how exchanges of these securities would occur. Rather than only relying on inconsistent, state-specific "blue sky laws," the federal government created the SEC. Now a similar need has arisen today given the financial risks posed by climate change and all the various assets in need of additional investment.

Perhaps the biggest need is around climate disclosures—the financial risks that companies and issuers (including local and state governments) face around climate change. Public companies in U.S. are required to disclose financial data, including material risks, as part of annual financial reports to investors, but there are ongoing debates around the inclusion of climate risks.[130] Such disclosures have the potential to greatly expand information on climate costs, benefits, and other impacts to the built environment nationally, but they would require more extensive enforcement and monitoring.[131] Questions also remain on whether disclosures would need to be mandated by regulators or demanded by large investors, and whether a "systemwide" view could be better served by regulators, investors, and ratings agencies working together.[132]

Still, many experts in our interviews agreed: There is a dearth of clear information on climate risks in financial markets. And the lack of consistent regulations and guidance does not just matter for measuring, pricing, and reducing climate risk. A lack of consistent regulations and guidance fails to maximize the role of markets as a "catalyst" for resilient infrastructure improvements.[133]

In other words, how can markets better "securitize" resilient infrastructure projects? There is a need to better define the roles and responsibilities of different actors, from those mobilizing financial capital (investors and lenders) to those setting market standards (the SEC and ratings agencies) to public infrastructure owners and operators (at a state and local level) to private developers and real estate owners. Federal leaders need to consider both carrots and sticks to promote investment, including regulations and incentives.

Indeed, fostering more accountable, proactive climate investments across the built environment demands action from federal agencies and other market actors, including ratings agencies. Developing consistent, easily translatable standards for what constitutes a "resilient project" or resilient investment can be a challenge. For instance, classifying "clean" versus "dirty" finance flows has attracted attention among researchers and investors, with no consistent framework or objectives in place to compare different infrastructure investments.[134] There is also a need for federal leaders to use policy to promote geographic and demographic equity in terms of financial market activity—otherwise, the county's uneven climate impacts will continue to fester.[135] Demand among investors is only increasing for public and open access climate data that allows them to "compare publicly available disclosure information and sustainability-benchmarked financial products" that can address these broader economic and environmental needs.[136]

Bridging gaps in knowledge and practice can create greater certainty for regional leaders and private investors as they look to improve the built environment and unleash capital at a scale that can ultimately save the planet. Moving from a sequential "project-by-project approach towards a holistic financing strategy" has the potential to consistently get more resilient projects done.[137] But given the widespread uncertainties and limitations in the current finance system around climate, developing any new strategies and testing any new ideas will take some time.

IV. Defining a new approach and steps to get there

The urgency of climate change is pushing many public and private leaders to test new resilient infrastructure projects in different regions. But more frequent experimentation, more consistent measurement, and more rigorous evaluation of outcomes across the entire built environment are still lacking nationally. The U.S. should use the power of financial markets to deliver resilient infrastructure at a national scale, establishing a new institutional framework—a new climate finance framework—that incentivizes more climate investment, reduces risks in more places, and promotes benefits for more people.

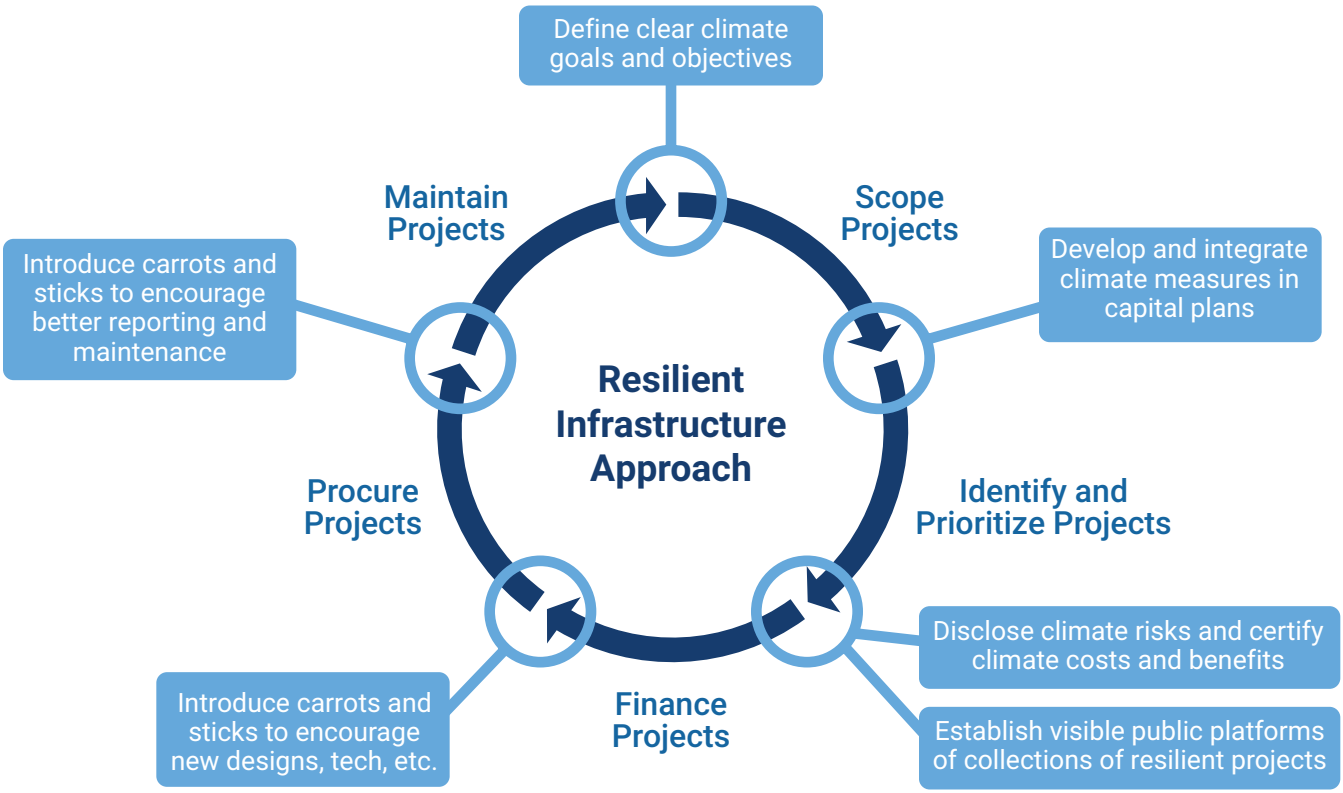
Improving urban resilience at the scale the country needs depends on better matchmaking between private investors and infrastructure owners and operators. A purposely developed climate finance framework has the potential to do just that by addressing some of the missing foundational pieces in our current policies, programs, and markets.

At a fundamental level, the U.S. needs a clearer process that is not a broken chain struggling to get individual projects done in individual places, but instead is a connected cycle accelerating the completion of collections of projects in collections of places. Multiple experts interviewed for this report emphasized how state and local leaders in transportation and water need to embed resilience in their plans and project delivery approaches, allowing for the more visible aggregation of resilient projects to be financed.[138] Real estate developers, owners, investors, and regulators also need to recognize the climate needs in existing and future projects. That means they need to account for and address the impacts of bad projects—whether at the planning stages, or worse, once built—and adjust the market and policy rules that incentivize them in the first place.

Developing this approach will require an enormous, coordinated effort to build all the regulations and other policies that will shift climate planning and investment activity. State and local governments, federal agencies and regulators, private investors, insurers, ratings agencies, and multiple other actors have roles to play. But first, the framework needs a set of guiding principles. These are the foundational elements to better identify who needs to do what, when they need to do it, and where they need to do it: the "pain points" to take action.

This report frames how such an approach could overcome the climate investment hurdles previously described and discusses outstanding steps that must be addressed for this approach to become a reality. It emphasizes transportation and water infrastruc-

FIGURE 2 (REPEAT). Resilient project delivery approach for transportation and water infrastructure: A connected cycle that addresses climate needs



Source: Brookings literature review and interview findings.

ture assets as starting points for policymakers to consider, with additional comments geared toward the particularly complex relationship between public regulators and private real estate investors. While private real estate is not reflected in the figure above, this sector does share some commonalities in the types of steps that need to be taken, including better climate measurement.

The following subsections explore three main categories of "pain points" that appear during the scoping, financing, and execution of different projects:

- **Measuring climate needs:** Much of this process starts with **developing clear climate goals and objectives** and **improving climate measurement and data collection, especially to inform capital plans**. Owners and operators managing transportation, water, and real estate need to better align their climate strategies—not simply around a common definition of "resilience" per se, but at least around a recognition of shared climate risks, costs, and benefits.[139] That means both mitigating and adapting to climate change in ways that respond to uneven impacts across different jurisdictions and populations. Doing so can serve as a basis to measure and collect climate data more consistently, which can help owners and operators determine where resilient investments are most needed as part of their capital plans.

- **Financing resilient projects:** Leaders are not lacking financial instruments—they're lacking ways to tap their full power.[140] **Disclosing climate risks and certifying climate costs and benefits** will provide greater clarity for owners and operators as they look to finance projects and fill an information gap for ratings agencies and many current and prospective investors. Armed with more consistent climate measures and scores, leaders may also feel more emboldened to test out new financing approaches and seek other pots of funding—federal or otherwise—that may have previously felt out of reach.

- **Scaling climate investment:** Minimizing climate risks and maximizing climate benefits need to reach more people in more places. Federal policymakers and regulators have a central role to play in encouraging investment in the most resilient designs, technologies, and approaches possible. Financing more projects should not occur in isolation; **creating more visible public platforms for collections of resilient projects** could expand the reach and impact of these investments in more regions nationally. **A combination of carrots and sticks—new incentives and regulations—can also spur investment in more resilient projects and drive better climate reporting**. For example, funding for additional predevelopment assistance was a top concern raised by many experts during our interviews.[141]

Public and private leaders need to recognize that such an approach will not happen overnight—they need to learn to crawl before they can walk. The big question is: What are some of the immediate steps they can take now to achieve short-term wins and build momentum around long-term goals? The magnitude of climate risks, costs, and missed benefits demands it.

Steps toward improved climate measurement

The predevelopment process needs to begin with **clear climate goals and objectives** at a regional level. Without an overarching sense of what climate priorities should be addressed across projects, leadership remains fractured, infrastructure siloes remain persistent, and geographic fragmentation remains a drag on any coordinated improvements. While different regions have different climate needs and there is no one-size-fits-all approach to climate planning, policymakers, planners, and other local practitioners should have a shared understanding of climate risks, costs, and benefits as part of current and future infrastructure investment conversations.[142] National resilience planning standards, informed across multiple regions and overseen by federal agencies such as DOT, EPA, and HUD, could offer more clarity. For instance, global coalitions of regions—including those as part of C40 Cities and the Resilient Cities Network—have already pioneered common planning frameworks around hazard mitigation, community engagement, and more.[143]

These regional planning efforts should not center on creating one static, uniform definition of "resilience," but on creating a visible and actionable set of principles to guide data collection, project development,

and ongoing evaluation of climate outcomes.[144] The emergence of new comprehensive climate plans at a regional level ("climate action plans") has provided similar roadmaps to help infrastructure owners and operators reduce GHG emissions, promote resource efficiency, and prioritize other improvements.[145] From Houston to San Diego, these plans are supporting more frequent and transparent climate measures and targets, frequently in line with the Paris Agreement.[146] However, many of these plans are still nascent and lack a clear history—or trajectory—to get more resilient projects done and hit certain goals. Similar to other national and global climate planning efforts, they can also overemphasize steps toward greater mitigation, which, while important, can overlook some of the broader built environment needs highlighted in this report and elsewhere.

In itself, "resilience" will not be a market driver as much as reducing climate risks and seizing climate benefits in accountable, transparent ways. Resilience is a squishy term that means different things to different people, but climate risks and benefits are more precise and quantifiable. Private investors do not want to invest in risky projects that simply sound good on paper and act as a "Band-Aid" to irresponsible transportation, water, and real estate projects that have taken place over many decades; investors want to invest in systems-of-systems that address engineering shortfalls and are tied to clear values-based frameworks.[147] Infrastructure owners and operators need to embed climate resilience in their plans and project designs—and not just in flashy, visible projects, but in less glamorous, routine projects such as pipe repairs.

When scoping projects, then, regional leaders need to move beyond cherry-picking resilience projects in isolation and relying on qualitative planning documents that may pay lip service to climate resilience but do not integrate clear climate measures or outcomes in project delivery frameworks. **Improved climate measurement and data collection** are essential to identify and prioritize resilient infrastructure projects within capital plans. That means (1) better identifying climate risk exposure across different types of new and existing infrastructure assets; (2) accounting for costs; (3) estimating benefits; and (4) evaluating outcomes across a project's full lifecycle—all ideally coordinated at a regional level.

Doing so, of course, is easier said than done. Identifying climate risks is an evolving science based on sophisticated models that may evaluate only one type of project in one neighborhood at one point in time. Efforts focused on business risk exposure, for instance, have taken years of testing and application globally, led by bodies such as the World Bank and International Finance Corporation.[148] The pace of data collection does not always match the pace of project need and investment, either.[149] However, new climate risk screening tools are emerging to more consistently measure near-term risk drivers for banks and classify risks based on specific hazards (e.g. heat waves or floods).[150] Federal agencies, such as the National Oceanic and Atmospheric Administration (NOAA), are also leading new initiatives to measure climate risks.[151] And the insurance industry continues to sit on a variety of detailed climate risk data, which the Treasury Department has recently elevated as an economic priority.[152]

Federal agencies should also lead in improved measurement of real estate risks, working closely with researchers and insurers. One of the most glaring needs is FEMA's flood maps, including a clearer designation of the properties that need insurance, which multiple assessments from the Government Accountability Office (GAO) and others have recommended.[153] New accounting standards can help better model loan and credit losses here as well; for instance, the Current Expected Credit Loss (CECL) accounting standard adopted by the Financial Accounting Standards Board (FASB) would estimate losses over the life of loans rather than only focusing incurred losses.[154] Beyond revising existing programs and considering new standards, federal agencies should also continue to consider nimble ways (e.g., new models, maps, and data points) to better measure risks, as many individual regions and technology startups are testing.[155]

However, regional leaders cannot just fixate on climate risks— ultimately, they need to measure climate costs and benefits. These not only include environmental costs (e.g., rising emissions and stormwater runoff) and environmental benefits (e.g., improved air and water quality), but also include economic costs (e.g., property destruction and job losses) and economic benefits (e.g., increased property values and job gains). Environmental costs and benefits are generally easier to quantify than more diffuse economic impacts across regions, but experts during our interviews agreed: Even "thematic clumping of measurements" would help

investors and other stakeholders better understand and price potential climate impacts.[156]

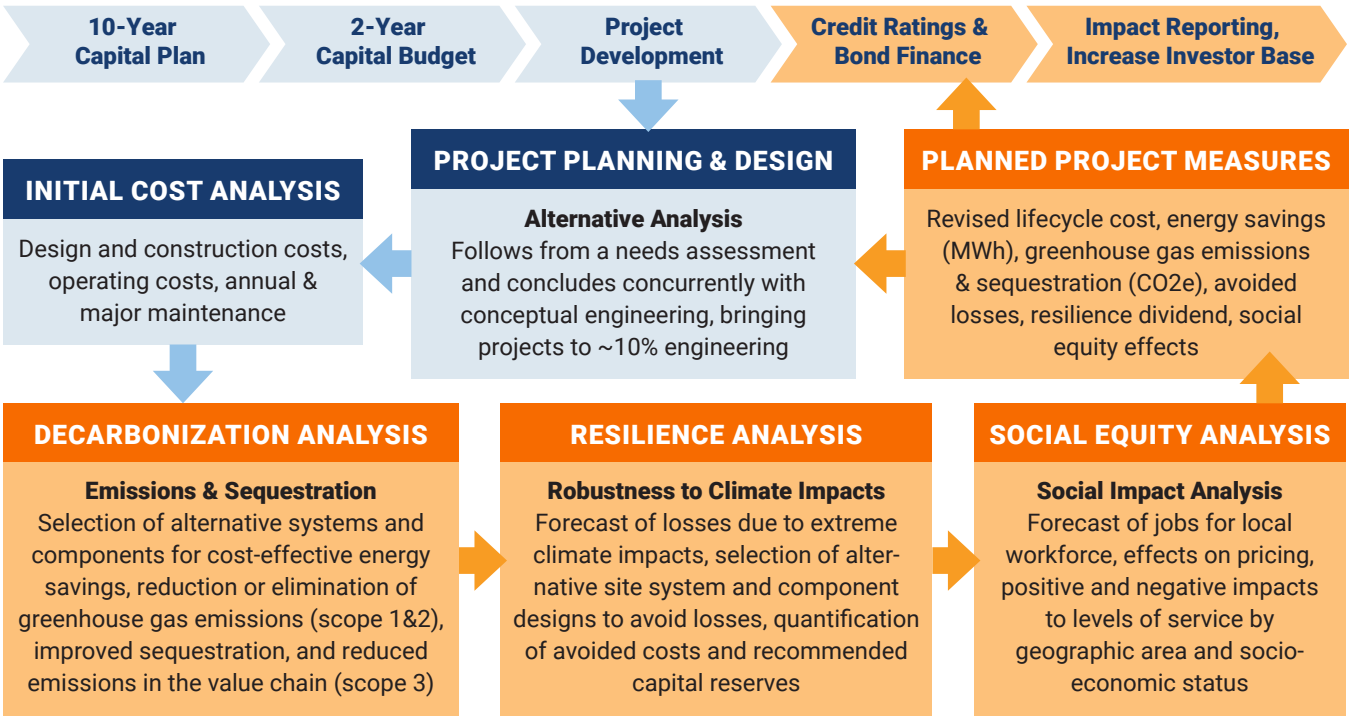
Fortunately, several regional collaborations and modeling efforts are emerging to do just that. The Center for Neighborhood Technology's Green Values Calculator, for instance, compares the performance of different green infrastructure projects across a range of property types: residential, commercial, and more.[157] Likewise, two global networks of regions—Local Governments for Sustainability (ICLEI) and C40 Cities—are leading the creation of consistent GHG emission inventories.[158]

The key is collecting and translating this climate risk, cost, and benefit data in ways that regional leaders can use, especially to better manage existing assets and guide future investments.

That starts with coordinating among other researchers, regions, and organizations to develop and test new climate measures. To integrate these climate measures more proactively, infrastructure owners and operators need to go through trial and error; local circumstances make it hard to create common measures due to jurisdictional fragmentation, varying climate needs, and different infrastructure assets, but there should be some easily translatable environmental and economic measures that all regions can begin testing and communicating.[159] For example, the Natural Capital Project—a partnership between Stanford University, the Chinese Academy of Sciences, the University of Minnesota, the Stockholm Resilience Centre, the Nature Conservancy, and the World Wildlife Fund—relies on an interdisciplinary team of researchers and practitioners to better measure the benefits of resilient improvements across different regions.[160] It recently launched an "Urban InVEST" tool as a new public data platform for local governments, developers, and other leaders; below is an example map generated by the tool.[161]

The ultimate integration of these climate measures into capital plans holds perhaps the most promise in shifting how regional leaders identify and prioritize resilient projects. As multiple experts described during interviews, "the budget cycle is the linchpin" for climate investment; regional leaders, particularly infrastructure owners and operators, need to be able to articulate their climate needs and the infrastructure projects that are ripe for investment.[162] Improved asset management, including asset inventories, can pinpoint trouble spots and opportunities for additional efficiency and reliability, while allowing for more detailed analyses of climate risks over a project's full lifecycle.[163]

FIGURE 10. Application of climate-smart methodology in SFPUC capital planning: Wastewater Enterprises



Source: Jan Whittington, personal communication, November 2021.

Note: Orange boxes represent new procedures or improved content anticipated from the application of a climate-smart approach.

"Climate-smart capital improvement planning" embodies many of these ideas: It establishes consistent climate criteria during the budget process; allows for the modification of projects early in design for climate mitigation and adaptation purposes; evaluates multiple projects based on standardized scores; and creates a preference for different projects.[164] In turn, it offers a replicable model across regions that prompts planners to prioritize climate issues and develop a pipeline of resilient projects; the San Francisco Public Utilities Commission (SFPUC) is among the first regional entities to follow such an approach.

Carrying out all this measurement and planning activity can demand considerable staff time, technical capacity, and flexible funding—resources that many regional leaders lack. But infrastructure owners and operators need better information to identify needs and prioritize projects, while markets and investors require metrics from the get-go to compare different investments.[165] That is why additional federal funding—or even philanthropic support—for predevelopment assistance is essential to give regional leaders the room they need to test new approaches.[166] Project incubation is required to show proof of concept to investors and political leadership, and once impact metrics are available, investors can build impact portfolios.[167] However, many regions may still lack the incentive to innovate and the ability to operationalize this approach.

This is where federal regulators, ratings agencies, insurers, and investors themselves come into play. According to assessments by the U.S. Commodity Futures Trading Commission, "financial regulators, with the private sector, should create 'consistent, comparable, and reliable climate risk data and analysis to advance the effective measurement and management of climate risk."[168] For instance, the Financial Stability Oversight Council (FSOC) could "incorporate climate-related financial risks into its oversight and reports to Congress."[169] Even other federal agencies, such as EPA and Treasury, could consider hiring more "climate accountants," or specialized staff, to work with regions on these measurement issues. At the same time, many ratings agencies, insurers, and ESG investors are already creating common taxonomies for climate risks and asset categories—information that could potentially be shared with the public sector, depending on the right incentives or regulations.[170]

Steps toward improved financing of resilient projects

Armed with better climate data and better climate plans, regional leaders—particularly infrastructure owners and operators—should be well equipped to tackle their climate challenges. They should not only have an ability to reduce costs and increase benefits, but they should also have a clearer value proposition to drive future climate investments. Mayors, chief financial officers, and other leaders who finalize budgets and control purse strings should know how specific resilient infrastructure projects can boost their regional environmental and economic performance. A clearer pipeline of projects, backed by more visible climate measures and more willing political leadership, should also appeal to investors and open the door to more money and financing possibilities.

In our interviews, one expert put it simply: "Financial instruments follow markets."[171] Investors and other financial institutions will not spend the time developing financial instruments if there is nowhere to use them. Most investors are interested in a spectrum of climate (adaptation and mitigation) investments to diversify their portfolios. Meanwhile, regional leaders may have a sense of where they want to go project-wise but lack the financial instruments to craft and deliver their visions. Both investors and regional leaders have "pet metrics, pet projects, and pet instruments," according to one expert, but they should have a more systematic approach to financing resilient improvements.[172] That is why disclosing climate risks and certifying climate costs and benefits for different projects is essential to accelerate action.

In other words, federal agencies and regulators—including the Treasury Department and SEC—should standardize the types of financial reporting and clarify the types of financial instruments around climate investment.

There is a wide gap between "investors' expectations and current reporting practice, both in the quality and granularity of information disclosed."[173] Currently, most investors follow inconsistent green bond standards, which lack quantitative benchmarks and require third-party verification.[174] Even though these standards are developed with technical and industry

working groups, they focus less on their usability and have less granular benefit articulation. Having common standards for climate risk reporting and financial instruments would help issuers, investors, and regulators better monitor climate needs and activate more climate investment.[175] Common taxonomies for climate investments have emerged most notably in the European Union, which many investors and other market actors are eyeing closely.[176]

More standardized reporting has the potential to inform and satiate investor appetite for green bonds in particular. While municipal green bond issuances still only represent a sliver of the total municipal bond market, many experts in our interviews believed there is pent-up demand to issue more green bonds and launch more climate investment generally. That's especially true for assets that promote adaptation, not just mitigation.[177] Green bonds offer issuers the chance to boost their reputation, reach more investors, increase their credit ratings, and ultimately reduce borrowing costs, but the U.S. hasn't hit the threshold for the "positive snowball effect" (i.e., more investors interested than offerings, which reduces borrowing costs).[178] For example, appealing to institutional and non-U.S. investors can expand the types of financial instruments and reduce the cost of capital for issuers. In addition, green bonds present an opportunity to partner more closely with the insurance industry; insurance companies already rank among the largest investors in municipal bonds, which represent more than 12% of their total bond exposure.[179] If allowed to have a "first go" at green bonds, insurers could promise better data access and higher-quality, lower-cost insurance to regions.[180]

But green bonds only represent one type of instrument available to issuers and investors. They are not the "holy grail" for all climate investments.[181] Just because green bonds exist does not mean that they are always more cost-effective or easier to use than other approaches. For instance, traditional municipal bonds can offer lower interest rates and more familiar terms to issuers, who are (usually) never turned down, have less arduous reporting, and have a fiduciary responsibility to go with instruments that give them a better price.[182] Even though they may not be labelled "green," traditional municipal bonds still support numerous transportation, water, and other resilient projects. The municipal market is sizable and (arguably) already on the frontlines of climate change from both risk and opportunity standpoints; the "first tremors of climate will be felt in the municipal bond market," according to one expert we interviewed.[183]

While real estate assets do not follow the same project delivery approach—and financing—as transportation and water infrastructure, improved climate disclosures could promote more accurate pricing and more responsible lending and borrowing. The Federal Housing Finance Agency (FHFA) has already requested more input from researchers and industry leaders on data availability gaps, climate risks, and financial disclosures, with the aim to improve its "analytical capabilities" and better "identify and assess" future real estate risks.[184] Ensuring any potential disclosures are "consistent, comparable, and decision-useful" is key, and FHFA's efforts are ongoing and will require additional feedback given the variety of real estate assets (and concerns) nationally.[185] However, existing ESG reporting could offer some precedent for the types of measures examined in the future; in 2018, for instance, 66 of the top 100 REITs reported publicly on their ESG efforts, including information on emissions, energy use, and waste management.[186]

Improved financial standards can also support a broad range of other emerging instruments and approaches. Clearer information on climate risks and returns, for instance, could inspire more confidence in environmental impact bonds (EIBs)—new "outcomes-based" financing tools that provide upfront private capital for environmental projects and then pay investors depending on how the projects perform.[187] Water utilities from Washington, D.C. to Atlanta to Buffalo, N.Y. have already pursued EIBs to support green infrastructure upgrades, and many other leaders have expressed interest.[188] Public-private partnerships (PPPs)—contractual arrangements between public and private entities, typically used to design, build, finance, and/or operate infrastructure—have continued to gain attention as well, including their role for climate projects. Community-based public-private partnerships (CBP3s) represent a type of PPP that emphasizes green infrastructure and local economic development; Prince George's County, Md. has led perhaps the most notable CBP3 to date.[189]

FIGURE 11. Examples of financing approaches and funding sources for resilient infrastructure

	Category	Description	Examples
Financial instruments	**Municipal bonds**	Debt securities issued by state and local governments (and other regional entities) to support a range of capital projects, including transportation and water upgrades. They are generally tax-exempt.	Miami "Forever Bond"; Houston METRONext bond for transit improvements
	Green bonds	Alternatively called "climate bonds," they represent a newer debt instrument available to issuers with similar financial terms as standard municipal bonds, but are geared toward projects with certified "green" impacts (e.g., cleaner transportation or water management).	Commonwealth of Massachusetts Green Bond, San Francisco Public Utilities Commission (SFPUC) Green Bond
	Environmental impact bonds (EIBs)	New "outcomes-based" financing tools that provide upfront private capital for environmental projects and then pay investors depending on how the projects perform.	DC Water EIB, Atlanta Department of Watershed Management EIB, Louisiana Coastal Protection and Restoration Authority (CPRA) EIB
Funding programs	**Formula grants**	Federal funding allocated to recipients, including state and local governments, based on pre-existing formulas, or criteria (e.g., population).	Federal-Aid Highway Formula Grants, Community Development Block Grants (CDBG)
	Competitive grants	More flexible federal funding awarded to eligible applicants, including state and local governments, based on competitive proposals and projects.	Building Resilient Infrastructure and Communities (BRIC) grants
	State Revolving Funds (SRFs)	State-administered programs (capitalized by federal funding) that provide low-cost loans and other financing to eligible local entities, such as water utilities.	Clean Water State Revolving Fund (CWSRF), Drinking Water State Revolving Fund (DWSRF)
Other approaches	**Green banks**	Financial institutions (primarily run at a state level in the U.S.) that help coordinate and scale resilient investments through loans and other financing options.	New York Green Bank, Rhode Island Infrastructure Bank
	Public-private partnerships (P3s)	Contractual arrangements between public and private entities, typically used to design, build, finance, and/or operate infrastructure.	Denver FasTracks Public Transit P3, City of Rialto Water P3
	Community-based public-private partnerships (CBP3s)	Specific type of P3 aimed at helping communities address stormwater management concerns and boost local economic growth.	Prince George's County, Md. Clean Water Partnership

Source: Brookings literature review and interview findings.

However, given the variety of climate needs facing regions and the variety of financial instruments available, many experts in our interviews expressed caution about adopting new standards too quickly. They see value in common frameworks and federal guidance, but some expressed concerns over "EU taxonomy-esque standardization" in the U.S., which could be too political and hurt competition among regions and investors.[190] Other experts noted that federal regulators and the financial industry should not rush into setting new standards because that "could set the bar too low"—instead, they should gradually increase standards after getting a better sense of current market challenges and help normalize measures first.[191] Investors and ratings agencies are already starting to do some of this work in the development of ESG criteria and frameworks, as are other organizations that classify different types of green projects, measures, and outcomes.[192]

Additional considerations for expanded climate disclosures

Infrastructure owners, operators, and investors cannot be solely responsible for judging climate risk. There is a need for more consistent national standards around climate reporting to aid in risk assessment, capital formation, and more.[193] The U.S. Commodity Futures Trading Commission noted in its assessment of the current market that "financial regulators should work together with the private sector to develop U.S. specific standards/classifications for physical and transition risks, exposure, sensitivity, vulnerability, adaptation, and resilience, and assets classes and sectors."[194] Federal leaders should identify a clear body, such as the SEC or set of agencies, that will ensure regions, investors, and other market actors follow such metrics. If the SEC or some other civic-minded public entity assessed risk publicly, it could create more low-risk investment opportunities for private equity capital.[195]

Federal leaders won't be able to do this alone; they will need to work closely with investors and regional leaders to test any reporting standards. Investors are already testing many new climate criteria and exploring reporting needs, so they may be able to handle the regulatory administrative burden more effectively than fiscally constrained state and local governments.[196] But regional leaders have precedent for assuming additional reporting needs too; until 50 years ago, local governments did not disclose their pension deficits, and now, these are more visible.[197] Additional reporting requirements in existing federal grant programs could expedite this process as well. For instance, EPA could include climate evaluations as an eligible (or required) category in SRF and WIFIA funding, and FEMA could include similar evaluations as part of future BRIC grants.[198] FEMA could also require states to model expected losses over the same time periods and determine how those are changing based on the investments FEMA gives states through the BRIC and hazard mitigation programs.[199]

Ratings agencies should also aid in these reporting efforts, which federal leaders can further incentivize. Ratings agencies already play the role of "pseudo-regulatory agencies" that send signals to the market about things that matter, including climate.[200] From Fitch Ratings to Moody's to S&P, ratings agencies have been cautiously collecting and deploying risk data to affect ratings, but these are mostly in a pilot phase.[201] A big challenge, though, is that rating agency analysts do not always have the capacity to meaningfully consider climate risk. Analysts (1) don't have the time to learn about climate risk; (2) companies (and regions) don't disclose enough relevant information; and (3) there are insufficient climate analytics.[202] Additional federal support for these efforts could accelerate the process.

The insurance industry should help expand the scope and reliability of reporting. Insurers are not only risk managers, but also investors and data managers. And as mentioned previously, they are sitting on a lot of proprietary data that could help regions, investors, ratings agencies, and even scientists better evaluate risks and rewards for future resilient investments. While this data is central to the business models and competitiveness of insurers, federal leaders should incentivize more sharing and lead a "paradigm shift from risk awareness to risk transfer," according to one expert we interviewed.[203] The fact is that a "four-degree world is uninsurable and uninvestable," and federal leaders need to look toward insurers and other private actors to more consistently report and respond to these risks. Doing so would be good for taxpayers, businesses, and budgets.[204]

Many investors, particularly large institutional investors, are more focused on the projects financed and disclosures of those projects, rather than the labelling of individual financial instruments. If anything, experts noted that climate investment—and new financial instruments—have been better for the conference industry than the environment.[205] One experts also noted that sometimes, "creative funding and financing may not be the most effective funding and financing."[206] While each project is unique, more consistent climate measures and standardized financial reporting should allow regional leaders to prioritize and advertise what types of improvements are needed, when they're needed, and where they're needed.

Steps toward improved scaling of climate investment

Scaling climate investment in more regions is essential, and that requires financing more projects in more places. Even if climate-related disclosures and other reporting improve, investors will still need to see more of the potential resilient projects and communities where they can invest. The reverse is true for infrastructure and real estate owners: They could benefit from a common portal listing more of the potential investors. The **creation of more visible, public platforms** to matchmake between owners and investors. These platforms represent centralized inventories—or landing pages—of collections of infrastructure projects to be financed at a regional level. They can serve as a more visible way for local infrastructure owners and operators to connect with potential investors.

No matter where the money comes from or how it gets channeled, there are trillions of dollars waiting to be invested from private equity, pensions, and even insurance companies. Everyone is looking for "good" projects, but there is no agreed-upon definition or clear way to identify the location of these "good" projects.[207] Transportation and water projects can cross multiple jurisdictions and have long time horizons, while private real estate projects are property-specific and may not take as long to complete. However, aggregating collections of resilient projects at a regional scale in visible ways—with clear information on their risk profiles, community impacts, and return on investment—can appeal to investors, fill their portfolios, and create greater scale.

Doing so could lead to more "negotiated, competitive transactions," which are better for green bonds, because the issuer can tell their story, get feedback from investors, and choose investors.[208] The Great Lakes Impact Investment Platform, for instance, represents a novel "geographically-specific, impact-focused investment platform" that lists resilient projects, specific climate goals, and performance metrics across the St. Lawrence region.[209] Multiple Great Lakes states and Canadian provinces collaborated to make it possible.

These public platforms, though, cannot simply feed into a void. Investors need more sophisticated ESG criteria to better respond to regions' needs. A range of investors—particularly, large financial firms—have a gold-rush mentality to get more capital out there, but ensuring this capital is directed at particular places and projects of need is crucial. Just as regional leaders are testing new financial instruments and platforms, investors also need to refine their own criteria for future climate investments and develop more mature business models. Much of this activity necessarily happens behind closed doors and explains the competitive advantage of different investors, but that does not mean federal agencies do not have a role to play. For instance, the Biden administration has emphasized the need to steer federal climate funding toward disadvantaged communities, particularly through the new Justice40 Initiative, which can inform program priorities at EPA, HUD, and FEMA.[210]

Once resilient projects are identified and financed, that still leaves their actual execution: procurement and ongoing maintenance. Pursuing the most resilient designs and technologies in new projects and incorporating them in upgrades to existing facilities should be a priority for regional leaders, particularly infrastructure owners and operators. Ongoing community engagement also matters to ensure projects are executed in ways that maximize social equity and other resilience benefits.[211] But some leaders, including chief financial officers, may still prioritize traditional designs, technologies, and approaches because they are more familiar, cheaper upfront, and easier to get across the finish line. That's especially the case in regions with less economic growth and fiscal capacity.

However, federal policymakers and regulators should encourage (or require) more forward-looking approaches to drive greater efficiencies and avoid higher long-term costs across the built environment

in all regions. There needs to be greater geographic scale to any market activity. **A combination of carrots and sticks—new incentives and regulations—can spur investment in more resilient projects in more places**.

Federal leaders have an opportunity to drive better project delivery across different regions via clearer planning requirements and flexible funding opportunities. They should not just rely on outdated, unresponsive technical assistance or rigid grant programs that require a complicated, resource-intensive application process.[212]

Additional federal funding for predevelopment assistance can help in the procurement process. Improved project procurement and maintenance should not simply occur in regions that have the fiscal capacity to try out new approaches. And innovation should not be limited to flashy, new projects. Many regional leaders, including mayors, get excited about building an asset, but are less excited about maintaining that asset; yet it is the full lifecycle of an asset that determines its ultimate resilience.[213] Additional federal support for outcome-based procurement policies, for instance, can shift the focus from engineering specifications to broader environmental and economic outcomes. Engineering firms, such as Jacobs, are already attempting to measure and incorporate social impact values into procurement processes, with the potential for greater scaling and replication.[214]

More flexible funding and new planning requirements in existing federal programs can help, too. For example, SRF funds are usable for resilient projects, but they are underutilized because there is often no incentive for regional leaders to take risks.[215] Utility staff and other practitioners cannot get off the short-run supply curve, let alone think about long-term projects or demands; however, SRF funds could reward more resilient infrastructure experimentation as a clearer eligible dimension. Beyond flexible funding, federal agencies could also attach more strings related to climate measurement and investment in existing programs. DOT, for instance, requires metropolitan planning organizations (MPOs) to create traffic models for regions, but it could also require transportation resilience measures that are model-based, not just narrative-based.[216]

Additional carrots and sticks could also be directed more specifically toward private investors. Experts in our interviews emphasized that there are two drivers of investor demand for resilient projects: climate realities and government incentives.[217] These incentives could include: (1) grants to pay for green bond issuance support (e.g., reimbursement for third-party verification of benefits); (2) tax-exempt reciprocity for issuers and investors; (3) making it more expensive to issue unlabeled securities; (4) linking project performance to climate outcomes; and (5) making green bonds triple tax-exempt (in which interest payments are exempt from local, state, and federal taxes).[218] It can be hard for investors to depend on government subsidies because they can change over time and during different political cycles, but they are essential to invest in "underdeveloped" markets in particular; without a subsidy (or incentive), the financial returns and risks may not make sense for investors.[219]

Federal leaders need to consider incentives and reforms for private assets as well, especially in residential and commercial real estate. As this report noted earlier, FHA, FHFA, Fannie Mae, and Freddie Mac must take into account variations in climate risk for properties located in different parts of the country when underwriting or pricing mortgage loans. Given the enormous number and variety of buildings in need of greater resilience, experts in our interviews also noted how these structures will serve at the center of a "retrofit economy."[220] Many private property owners are looking for every opportunity to find money to retrofit their buildings, and creating more incentives (via DOE, HUD, or elsewhere) to retrofit their buildings could be transformational. Existing local incentives, such as density bonuses, could also inform more proactive federal leadership on these issues—informing potential new legislation or regulatory structures.[221]

At a more local level, better pricing of climate risk in residential real estate should also feed into how Fannie Mae and Freddie Mac securitize mortgages—which could influence the actions of originating lenders. This could include denying mortgages in high-risk areas or even offering higher interest rates (or having higher eligibility requirements) for these properties. Beyond these market mechanisms, local governments should also update zoning laws that require low-density uses, parking minimums, and certain lot sizes, and consider ways to restrict construction in areas with ongoing climate risks. Managed retreat remains a consideration in some regions as well, where floodplain ordinances and other (overlay) regulations can reduce development along vulnerable coasts and sensitive ecological areas.[222]

V. Conclusion

Climate change poses enormous structural challenges for how the built environment functions, including the transportation, water, and private real estate sectors. Addressing these threats demands a fundamental rethinking of how built environment investments currently take place and a reimagining of how they could support greater long-term resilience.

No single actor or investment approach can solve the country's climate challenges on its own. Federal, state, and local leaders share various responsibilities in identifying, measuring, encouraging, and regulating where and how resilient investments should take shape. Publicly owned infrastructure networks cannot reduce climate impacts without working in unison. Private investors, insurers, and ratings agencies all influence where investments take place and the quality of the real estate and other physical assets built. Minimizing climate costs and maximizing climate benefits at the necessary scale demand new approaches that will influence all these disparate actors in predictable ways.

The potential for financial markets to price and reduce climate risks, expand climate benefits, and accelerate resilient upgrades across different regions can deliver such scale. But simply identifying relevant projects and deploying new financial instruments and approaches will not cut it. Public and private leaders need to strengthen the policies, programs, and regulations that support any market activity. Steps toward a new climate finance framework offer a path to enhance climate data collection and measurement, improve financing, and scale investments that help more people and places.

Still, the complexity and variety of built environment needs are immense, and any steps forward will likely take time and involve trial and error. Ongoing research and experimentation are essential to test out new solutions. This report is a first step outlining some of the major pain points and considerations for public and private leaders as they address these climate investment priorities more extensively.

Endnotes

1 Great Lakes Impact Investment Platform, "About the Platform," available at: https://greatlakesimpactinvestmentplatform.org/about/.

2 National Oceanic and Atmospheric Administration, "Billion-Dollar Weather and Climate Disasters," available at: https://www.ncdc.noaa.gov/billions/.

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