Building a Foundation for Sustainable Infrastructure

Barriers to Infrastructure Development and Federal Policy Solutions

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Executive Summary

Most categories of American infrastructure—from transportation and water systems to public school buildings and electricity meters—are in dire need of modernization. A new approach to federal infrastructure policy can boost the economy while addressing threats from climate change and prioritizing social equity goals.

No single policy or funding commitment will be sufficient to meaningfully improve the state of U.S. infrastructure. New policies and programs are needed at each stage of the infrastructure project lifecycle, from project planning and analysis, through procurement, financing, construction, and maintenance. Both executive and legislative actions are needed to overcome barriers to infrastructure development.

Risks from climate change compound the urgency of U.S. infrastructure development. Many infrastructure systems are highly vulnerable to climate impacts, and new projects are needed to enable reductions in greenhouse gas (GHG) emissions and improve climate resilience. Given the enormous magnitude and diversity of infrastructure projects needed to put the United States on a net-zero-GHG pathway by mid-century (in line with the science-based climate targets in the United Nations' Paris Agreement), it is imperative that the federal government accelerate the development of "sustainable infrastructure"—projects that are planned, designed, constructed, operated, and decommissioned in a manner to ensure economic, social, environmental, and institutional sustainability over the entire infrastructure lifecycle.

A major federal push for new infrastructure development could have enormous economic benefits. Infrastructure investments generally have a substantial positive effect on GDP growth and employment, as well as a "welfare multiplier" effect, enhancing societal wellbeing. These investments could also boost strategic industries and improve U.S. economic competitiveness in growing sectors with export potential, such as low-GHG building materials. While the federal budgeting process essentially treats all line items, including infrastructure spending, as costs rather than investments, policymakers should account for the expected benefits (and avoided future costs) when making infrastructure funding decisions.

While past U.S. infrastructure policies have often exacerbated inequality, a well-designed infrastructure strategy can create economic opportunity for disadvantaged groups and improve social equity. Inclusive planning and targeted financial support can help ensure that infrastructure projects improve environmental justice and climate justice outcomes.

To accelerate the development of socially beneficial infrastructure projects, the federal government should pursue a suite of reforms targeting all stages of the project lifecycle.

Improving the processes for planning, evaluating, and permitting infrastructure projects - *Executive branch actions*

Infrastructure projects are generally developed in a piecemeal manner, and important climate concerns are sometimes ignored in environmental reviews. Robust processes for assessing infrastructure needs and evaluating project impacts are necessary to identify beneficial projects and get them built expeditiously. Federal policymakers should undertake numerous reforms to improve these systems.

The Executive Office of the President should articulate a federal vision for sustainable infrastructure focused on enabling economy-wide carbon neutrality by mid-century, and work to coordinate holistic infrastructure needs assessments and long-

term planning efforts among all federal agencies. The Council on Environmental Quality (CEQ) should issue guidance on best practices for inter-sectoral infrastructure planning for states, and encourage improvements through dialogue with state policymakers. Both federal agencies and states should prioritize inclusivity in these long-term infrastructure planning processes to account for the diverse needs of different communities.

Improved early-stage analysis of infrastructure plans and projects can help refine designs and avoid future delays related to community opposition or project permitting. Federal agencies should work to ensure that programmatic National Environmental Policy Act (NEPA) reviews follow the best practices of the strategic environmental assessment methodology, and CEQ should provide resources to help states use similar practices.

CEQ can also improve sustainable infrastructure development by standardizing the methodologies and tools used to evaluate projects' climate impacts in NEPA reviews, which currently differ greatly between agencies. New guidelines should establish best practices for the scoping process; requirements for analyzing projects' direct, upstream, and downstream GHG emissions; tools for estimating emissions as well as avoided emissions and carbon sequestration potential; frameworks to encourage the use of consistent assumptions, scenarios, and baselines; and recommendations for analyzing how expected climate impacts will affect a proposed project. In addition, by creating a new system to estimate the amount of "embodied carbon" in the construction materials of an infrastructure project, federal policymakers could take the necessary first step in reducing the substantial emissions from built infrastructure.

To accelerate the development of desirable infrastructure, the Federal Permitting Improvement Steering Council can leverage its existing authorities to compress permitting timelines for key categories of sustainable infrastructure. Federal agencies can aid this effort by allocating additional staff and resources focused on expedited permitting, where permissible.

Modernizing infrastructure-related procurement – *Executive branch actions*

Currently, environmental goals are not appropriately considered when federal entities invest in infrastructure assets or related goods and services. Existing procurement policies and tools are insufficient to encourage low-GHG choices in the near-term, and few long-term targets exist.

Government-wide procurement rules and systems should be updated so that that purchases and projects align with a goal of net-zero GHG emissions by 2050, inclusive of long-lived assets procured before 2050. Specific rules and targets should be developed for key categories, such as federal vehicle fleets and military infrastructure, to ensure that assets in these categories are compatible with the net-zero GHG goal by mid-century.

The federal government should also use a new procurement approach for federally owned energy assets, investing in emissions-free generation for the Tennessee Valley Authority and using the Department of Energy's (DOE) power marketing administrations to expand transmission infrastructure that can enable decarbonization of the electricity sector. Additionally, new federal policies and resources focused on pooled procurement can help states, municipalities, and project developers negotiate cooperatively with vendors when pursuing similar sustainable infrastructure investments.

Financing and grants for sustainable infrastructure – *Legislative actions*

Regardless of any improvements made in other stages of the infrastructure development lifecycle, projects cannot be built without appropriate financing options. Funding concerns were found to be the most common cause of infrastructure project delays in a recent Treasury Department study, and most federal infrastructure funding is subject to unpredictable

authorization and renewal cycles that are dependent on constantly changing political factors. Funding is also typically allocated for relatively narrow categories of projects, nearly all of which focus on transportation or water resources.

Congress can spur project development by expanding financing options for all categories of sustainable infrastructure, and this federal financial support can serve as a carrot to help shape the design of projects. Lawmakers should establish and capitalize a national infrastructure bank to provide a stable, long-running source of financing for desirable projects. Congress should also amend the Federal Credit Reform Act of 1990 so that an infrastructure bank is authorized to use loan repayments to continually issue new loans, untethered from the Congressional appropriations process. An infrastructure bank can also play critical coordination roles to help move projects forward.

Lawmakers should fund extensive loan guarantee programs to help a broad range of sustainable infrastructure projects secure financing. New legislation should expand and improve the existing DOE loan guarantee program, and establish a new loan guarantee program focused on additional categories of sustainable infrastructure.

Additionally, Congress should establish a well-funded grant program for sustainable infrastructure projects, with eligibility parameters that will support project development in all 50 states; prioritize projects that achieve significant GHG reductions; require evidence of inclusive planning and incorporation of climate risks; guarantee fair wages and benefits for workers; encourage outside funding to limit the "coupon effect"; and require maintenance planning.

Moving toward net-zero construction – *Legislative actions*

Action is needed now to make it possible for the next generation of infrastructure projects to be compatible with climate goals. Thirty to 70 percent of a structure's lifecycle carbon emissions can come from embodied carbon emissions, resulting from GHG-intensive construction materials such as cement, steel, iron, and glass. Decarbonizing the production processes for these materials (or developing suitable alternatives) will likely take decades, and it will require policy changes as well as sustained research and development (R&D) efforts.

Congress should establish embodied-carbon performance standards for the materials used on all federally supported infrastructure projects, targeting net-zero-GHG construction by roughly 2050. This legislation should also offer significant tax incentives for private-sector developers that choose to adhere to the standards.

To accelerate the development of low-carbon construction materials and manufacturing processes, Congress should dramatically expand R&D efforts in this area, with a significant focus on manufacturing, supply chain, and market development issues. A centralized coordinating body should be formed to set R&D priorities and manage collaboration and communication between different federal programs.

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The recommendations in this report attempt to realign all elements of the federal government's involvement in infrastructure development toward supporting sustainable infrastructure and moving toward carbon neutrality. Even if a net-zero emissions goal is not formally prioritized, these policy changes can help accelerate a broad range of desirable, resilient infrastructure projects, creating widely distributed economic benefits while meaningfully addressing climate change.

I. The Urgency of Modernizing American Infrastructure

Infrastructure systems undergird nearly every aspect of modern life and enable our society and economy to function. Definitions of infrastructure can be wide-ranging and broad,[1] though the term often refers to capital-intensive facilities and systems with long lifespans, including everything from public school buildings to electricity meters to federal vehicle fleets and drinking water systems. This report takes a broad view, focusing on all assets and systems that meet an expansive definition of infrastructure.

Most categories of American infrastructure are in dire need of modernization. The American Society of Civil Engineers gave U.S. infrastructure a grade of D+ in its most recent assessment,[2] and there is widespread agreement across the American political spectrum that major new infrastructure investment is necessary.[3]

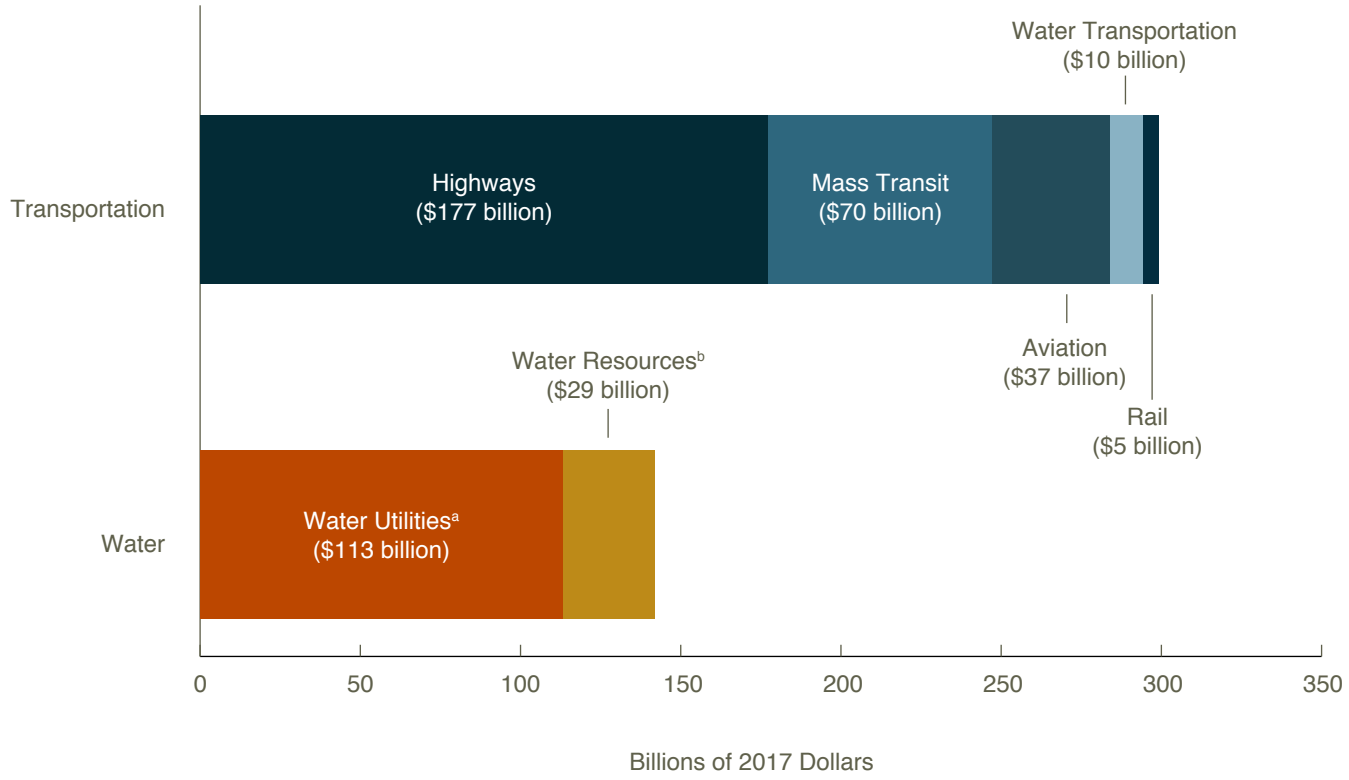
The federal government must take a new approach on infrastructure policy in order to meet current needs while addressing threats from climate change and prioritizing both economic and equity goals. No single policy or funding commitment will be sufficient to meaningfully improve the state of U.S. infrastructure. New policies and programs are necessary at each stage of the infrastructure lifecycle to ensure that decisionmakers plan, evaluate, build, and maintain projects that can best benefit Americans.

This report highlights barriers to successful infrastructure development at various stages of the project lifecycle and suggests federal policy interventions that could accelerate desirable projects and help meet the nation's enormous infrastructure needs. The policy recommendations, for both the executive branch and Congress, attempt to realign all parts of the federal government's involvement in infrastructure development toward the goals of supporting sustainable infrastructure and future carbon neutrality. Some of these recommendations overlap, and certain redundancies could emerge if policymakers adopt sweeping changes such as broad climate legislation. But the report offers a roadmap for federal policymakers seeking to advance low-carbon infrastructure in the near term while directing resources toward long-term climate, economic, and equity goals.

The Federal Government's Role

The federal government's infrastructure investments fall primarily into two categories: transportation and water. This federal spending includes both direct investments and grants to nonfederal entities, and covers capital projects as well as operations and maintenance. In 2017, federal transportation spending totaled $84 billion, split between highway projects ($46 billion), aviation ($17 billion), public transit and rail ($17 billion), and water transportation ($4 billion).[4] Federal spending on water resources such as dams, levees, and reservoirs totaled $10 billion in 2017, while spending on water utilities (including water supply and wastewater treatment facilities) was $4 billion.[5] State and local governments spend significantly more than the federal government on each of these transportation and water infrastructure categories.[6]

Federal Infrastructure Spending, 2017



Source: Congressional Budget Office, "Public Spending on Transportation and Water Infrastructure, 1956 to 2017" (October 2018)
a. Includes water supply and wastewater treatment facilities
b. Includes water containment systems (dams, levees, reservoirs, and watersheds) and sources of freshwater (lakes and rivers)

The federal government provides little or no direct funding for most other categories of infrastructure, though it does offer fiscal incentives such as tax credits and subsidies for some other types of infrastructure investments.

While federal funding is scant for many categories of infrastructure, numerous categories are critical to public wellbeing and the economy. The Department of Homeland Security has designated 16 critical infrastructure sectors whose assets and systems are considered vital to national economic security or health and safety.[7] These sectors include chemicals, communications, energy, food and agriculture, and healthcare, among others. Roughly 90 percent of all U.S. infrastructure, including most infrastructure in these critical sectors, is privately owned.[8] However, governments must work with both private and public owners to keep infrastructure systems resilient and functional.[9]

Regardless of federal funding or ownership status, the federal government plays key roles throughout the lifecycle of infrastructure projects. Federal policy decisions can greatly influence the types of projects that are planned and built, and the details of the project development process. For instance, policies that reduce financing problems and permitting delays can speed the development of necessary infrastructure. And federal rules can help dictate the types of infrastructure projects that developers or local authorities pursue. For example, new federal rules could require transportation infrastructure spending to prioritize low-carbon options, or establish standards related to climate-safe building codes or low-carbon building materials. Through such actions, the federal government can help encourage or require more desirable infrastructure projects that benefit the public, regardless of whether direct federal funding is provided.

According to the National Climate Assessment, climate change is expected to cause substantial losses to infrastructure and property over this century.

Infrastructure and Climate Change

The United States faces a pressing need to maintain and modernize a vast number of infrastructure systems, and this need is greatly compounded by the threat of climate change. Policymakers must help protect infrastructure systems from climate impacts, develop new infrastructure that can help accelerate greenhouse gas (GHG) emission reductions, and reduce emissions that result from built infrastructure.

According to the most recent National Climate Assessment, without significant GHG mitigation efforts, "climate change is expected to cause substantial losses to infrastructure and property and impede the rate of economic growth over this century."[10] Some sectors potentially face hundreds of billions of dollars in annual climate-related losses by the end of the century, and many types of infrastructure are especially vulnerable because they are typically designed for historical climate conditions, face outsize risk from extreme weather events, and will become more expensive to maintain and repair due to climate change.[11] In order to protect public wellbeing and the national economy as the climate changes, the United States will need to replace or modernize huge swaths of infrastructure.

New infrastructure is also critically needed as a tool to mitigate climate change. In order to meaningfully address the climate crisis, the United States and other countries will need to transition to a net-zero GHG pathway by roughly mid-century, reducing emissions wherever possible and offsetting all remaining GHG emissions with equivalent levels of natural or industrial GHG sequestration.[12] An infrastructure overhaul will be needed to enable significant emissions reductions in most sectors. This is an unprecedented challenge that will require building a vast number of diverse projects both large and small, from net-zero school buildings to mass transit to the many components of a carbon-free grid. The aggregate cost of projects needed to fully decarbonize the U.S. power grid has been estimated at $4.5 trillion, given the

state of current technology.[13] Achieving deep decarbonization in some other sectors could be even more difficult and costly, and some of the infrastructure needs for a net-zero economy are not yet well understood.

Furthermore, built infrastructure accounts for roughly 70 percent of global GHG emissions.[14] Policymakers must create new systems to help reduce emissions from both the construction and operation of projects, and accelerate innovation and market adoption in these areas.

Given the long lifespans of most infrastructure assets, the status quo in project development will likely perpetuate many emissions-intensive systems and practices, significantly worsening climate outcomes. New approaches, including a focus on upstream, holistic planning, are urgently needed so that new, long-lived assets can help address climate risks instead of locking in high levels of emissions.

Economic Benefits and Job Creation

Infrastructure investments have a substantial positive effect on GDP growth, and research suggests that these GDP benefits generally outweigh the costs of infrastructure services.[15] Studies also show that public infrastructure investment has a positive "welfare multiplier," as it enhances domestic welfare in addition to boosting economic output.[16] Despite these benefits, federal spending has declined by some key measures. Net public non-defense investment at all levels of government has fallen precipitously, from 3 percent of GDP in 1962 to 1.5 percent in 1980 and only 0.7 percent in 2019.[17]

Can the United States "Afford" Infrastructure Investments?

Evidence suggests that infrastructure investment can be enormously beneficial from an economic perspective, calling into question arguments that these investments are unaffordable or fiscally irresponsible. Economists often discuss the "multiplier effect" for infrastructure, as a dollar spent on an infrastructure project typically yields more than a dollar of economic benefit, both through direct productivity improvements and by enabling other portions of the economy to function better and grow. One study recently projected that a moderate increase in infrastructure investment could boost U.S. GDP by about 1.3 percent—far more than the average boost most countries would experience from similar investments, due to the nation's current infrastructure gap.[18] A Moody's analysis was even more bullish, estimating that a dollar of U.S. infrastructure spending generates $1.57 in GDP growth, providing better "bang for the buck" than nearly any other spending or tax cut option.[19] Other studies have estimated GDP gains as high as three dollars for every dollar of infrastructure spending.[20]

Such analyses undermine arguments that the country cannot afford infrastructure investments. In order to stimulate the economy and boost employment, infrastructure investment should be prioritized in federal budgeting. The federal budgeting process essentially treats all line items, including infrastructure spending, as costs rather than investments. It does not specifically account for whether low levels of spending will increase future costs, or whether the economic benefits from infrastructure investment offset the tax revenue that is allocated. Policymakers should be aware of these limitations in the budgeting process and make funding decisions that account for both the evolving economic consensus on appropriate debt levels[21] and the expected benefits (and avoided costs) of infrastructure investments.

A single large public construction project typically creates hundreds of jobs, and operational and maintenance needs for new infrastructure typically boost long-term employment.

Infrastructure investment typically leads to job growth, making it a powerful policy tool as the United States seeks to address record unemployment in the wake of the Covid-19 pandemic. A single large public construction project typically creates hundreds of jobs, and operational and maintenance needs for new infrastructure typically boost long-term employment.[22] Many of the jobs that would be created as a result of infrastructure expansion also pay middle-to-high wages and have limited barriers to entry (such as college-degree requirements).[23] By one estimate, increasing infrastructure investment by one percentage point of GDP would generate 1.5 million U.S. jobs.[24] The federal government can help ensure that the benefits of this job growth are distributed across the country by crafting policies and grant programs that stimulate new infrastructure projects in all states, as discussed in Section IV of this report.

Certain types of infrastructure investment could boost strategic industries and improve U.S. economic competitiveness in growing sectors with export potential. As the renewable energy sector has boomed in recent years, the U.S. renewables industry has retained the highest amount of manufacturing value added (including both direct GDP contributions and indirect boosts for other domestic industries) of any country, despite much larger manufacturing footprints in countries like China.[25] Demand is expected to skyrocket for many categories of sustainable infrastructure, with roughly $90 trillion in global spending projected over the next 15 years.[26] If the United States can expand industries with both domestic markets and export potential, such as renewable energy, clean transportation, and low-carbon building materials, the economic benefits could be enormous. As other countries work to develop their own industries in these areas, the United States will need to move quickly to secure an advantage.

Given the dire state of the U.S. economy and job market in the wake of the Covid-19 pandemic and the vast infrastructure needs of most states and regions, a concerted federal push to expand infrastructure could produce a wide range of major economic benefits.

Infrastructure and Equity

The United States has a checkered history with respect to infrastructure and social inequality. Project planners have repeatedly used infrastructure to promote segregation or provide resources exclusively to privileged groups while siting pollution-intensive infrastructure in communities of color.[27] Examples abound. The Federal Housing Authority's "redlining" of housing maps helped determine the types of infrastructure, lending, and housing available in different neighborhoods of every major American city, concentrating wealth and services in predominantly white, suburban neighborhoods while causing development to stagnate in many minority communities.[28] Highway projects have frequently been routed through Black neighborhoods, leading to the bulldozing of homes and businesses and the bifurcation of neighborhoods, often while intentionally limiting access to the benefits of this infrastructure (such as by omitting highway entrances and exits in these neighborhoods).[29] Policies governing telecommunications infrastructure have disadvantaged communities of color, limiting their access to critical services and economic opportunities.[30] Meanwhile, the vast majority of the nation's power plants, refineries, and other pollution-intensive infrastructure is located in or around communities of color, exposing these populations to serious health threats.[31]

Despite this problematic history, infrastructure investments can play a major role in combatting inequality. Empirical analysis has shown that increased infrastructure spending is historically correlated with reduced income inequality in U.S. states. Specifically, increased spending on transportation and higher education early in a decade correlates negatively with inequality metrics late in that decade, suggesting that this investment reduces inequality by boosting access to job and education opportunities, particularly for those in the bottom 40 percent of the income distribution.[32] Future infrastructure investment can help level the playing field for disadvantaged communities by providing valuable infrastructure services and creating jobs.

Infrastructure expansion is also central to environmental justice and climate justice goals since the impacts of pollution and climate change disproportionately affect disadvantaged groups, including communities of color.[33] Numerous new infrastructure projects will be needed to help the United States adapt to a changing climate and protect Americans—especially socioeconomically vulnerable groups—from expected impacts. Major infrastructure investment will also be needed to transition the country onto a low-GHG-emissions pathway in order to protect these groups (and all others) from longer-term climate impacts. For all these reasons, infrastructure investment has been identified as a critical tool in most equity-focused climate policy frameworks, including the congressional Green New Deal resolution.[34] Regardless of whether a broader effort like the Green New Deal gains political momentum, infrastructure investment can play a key role in advancing both equity and climate goals. To ensure such an outcome, equity concerns should be prioritized in infrastructure policy design, inclusive planning processes, and the provision of resources for projects, including direct federal grants.

Numerous new infrastructure projects will be needed to help the United States adapt to a changing climate and protect Americans—especially socioeconomically vulnerable groups—from expected impacts.

Pursuing "Sustainable Infrastructure"

Given the enormous magnitude and diversity of infrastructure projects needed to put the United States on a net-zero or low-GHG pathway, it is imperative that the federal government embrace new policies and programs to accelerate sustainable infrastructure. The United Nations and other major international organizations typically define sustainable infrastructure systems as those that are planned, designed, constructed, operated, and decommissioned in a manner to ensure economic, social, environmental, and institutional sustainability over the entire infrastructure lifecycle.[35] Developing sustainable infrastructure can help mitigate a wide range of environmental risks. Perhaps most importantly, given the country's lack of progress in addressing climate change, sustainable infrastructure projects can enhance climate resilience and reduce GHG emissions while also improving economic and social wellbeing. Despite these wide-ranging benefits, U.S. sustainable infrastructure development is likely to continue lagging without federal policy changes.

As a governing principle for infrastructure policy (and other aspects of federal policy), the President should commit to transitioning the U.S. economy toward net-zero GHG emissions by mid-century, in line with the science-based climate targets in the United Nations' Paris Agreement. Sustainable infrastructure development can be a major tool to help achieve this goal. But regardless of whether a net-zero emissions goal is prioritized, sustainable infrastructure development can lead to improved environmental and economic outcomes and help mitigate the climate vulnerability of existing infrastructure systems.

At nearly every stage of the infrastructure project lifecycle, prevailing practices create barriers to the efficient development of sustainable infrastructure. For example:

- Neither the federal government nor most states or regions have adequate systems for assessing long-term infrastructure needs and inclusively planning projects.
- Current methods for estimating the climate impacts of proposed projects make it difficult to compare them on an apples-to-apples basis, hindering efforts to prioritize or fund projects based on climate criteria.
- While the federal permitting process can help ensure robust, transparent environmental review, it also sometimes results in high costs and project delays that could be mitigated with new reforms.
- Federal procurement policies do little to encourage the consideration of sustainability metrics for infrastructure-related purchases. Resources to assist states with procurement could also do far more to make the provision of sustainable infrastructure easier and more efficient.
- Financing barriers and a lack of federal funding for many categories of infrastructure limit project development.
- Most infrastructure projects use highly carbon-intensive construction materials, leading to enormous environmental footprints that will be the norm for decades unless alternative materials or approaches are developed quickly.

To overcome these barriers and advance sustainable infrastructure projects at the necessary scale, policymakers across the federal government will need to adopt reforms. This report discusses current barriers to sustainable infrastructure development in the United States and potential policy solutions that both the executive branch and Congress could enact.

The federal government should broaden its approach to infrastructure policy and promote the development of all categories of sustainable infrastructure. Current investments, which focus almost exclusively on transportation and water infrastructure, are neither sufficient to meet national needs nor targeted to prioritize socially beneficial projects.

It is critical to establish new systems to plan projects inclusively, evaluate emissions impacts, permit projects efficiently, and provide financing and grants. The federal government should also work to advance the development of nascent materials and methods for net-zero-GHG construction.

These efforts can help stimulate a broad range of desirable infrastructure projects, creating widely distributed economic benefits while meaningfully addressing climate change. The result of these changes would be a cohesive infrastructure policy that can accelerate the economic recovery, protect communities from the threat of climate change, and improve wellbeing for Americans for decades to come.

II. Planning, Evaluating, and Permitting Projects

To develop beneficial infrastructure projects expeditiously, policymakers will need to establish clear goals for infrastructure development, as well as robust processes for assessing infrastructure needs and evaluating project impacts.

The federal government should articulate a clear vision for future infrastructure, focused on projects that can help the country transition toward a carbon-neutral economy, and it should work to encourage infrastructure planners to assess needs holistically and create long-term strategies. Most U.S. infrastructure is not built to withstand anticipated physical climate impacts, so new, resilient infrastructure is needed even if the federal government does not formally prioritize a mid-century net-zero emissions goal. Federal agencies and states should make long-term infrastructure planning processes inclusive to account for the diverse needs of different communities.

Improved early-stage analysis of infrastructure plans and projects can help avoid future delays related to community opposition or project permitting. The federal government should work to ensure that early-stage National Environmental Policy Act (NEPA) reviews follow the best practices of the strategic environmental assessment methodology, and it should provide resources to help states use similar practices.

Federal policymakers can also improve sustainable infrastructure development by standardizing the methodologies and tools used to evaluate projects' climate impacts in NEPA reviews, which currently differ greatly between agencies. New guidelines should establish best practices for the scoping process; requirements for analyzing direct, upstream, and downstream GHG emissions; tools for estimating emissions as well as avoided emissions and carbon sequestration potential; frameworks to encourage the use of consistent assumptions, scenarios, and baselines; and recommendations for analyzing how expected climate impacts will affect a proposed project. Additionally, by creating a new system to estimate the amount of "embodied carbon" in the materials of an infrastructure project, the federal government could take the necessary first step in reducing the substantial emissions from built infrastructure.

To accelerate the development of desirable infrastructure, the Executive Office of the President can leverage existing authorities to compress the permitting timeline for certain categories of sustainable infrastructure projects. Federal agencies can aid this effort by increasing dedicated staffing and resources focused on expedited permitting, where permissible.

Holistic and Inclusive Planning

To ensure that infrastructure planning and management do not occur in a silo-based manner that overlooks cross-sectoral needs and efficiencies, policymakers should adopt systems for holistic planning. For example, as part of its effort to develop improved strategies for long-term, multi-sectoral infrastructure planning, Michigan's 21st Century Infrastructure Commission conducted a study of best practices across multiple countries and U.S. states. The Commission identified several common elements of successful strategies, including:

- an articulated vision for future infrastructure,
- the establishment of a coordinating body for multi-sectoral infrastructure decisionmaking, and
- planning processes that focus on a long-term time horizon, with regular updates.[36]

The federal government should employ these strategies in its own infrastructure planning, and create rules and resources to help developers, states and municipalities do the same. **The Executive Office of the President should articulate a federal vision for infrastructure, emphasizing the need for projects to be compatible with an economy-wide net-zero emissions pathway by mid-century. It should also work to coordinate infrastructure needs assessments and long-term planning efforts among all federal agencies.** In particular, agencies with critical infrastructure permitting responsibility should develop proactive long-term plans rather than continuing to rely on reactive case-by-case action. This holistic approach to infrastructure planning across the federal government should help create a framework for cohesive project development.

Holistic planning is also desirable at the state level, as states plan a large portion of major infrastructure projects. Federal policymakers should encourage states to use a coordinating body to manage infrastructure strategy and planning if they do not do so already. Some states have created these bodies, such as the New York Works Task Force, which develops coordinated capital infrastructure plans among state agencies and authorities and makes recommendations on prioritization of projects, expedited permitting, financing options, and methods of procurement and contracting.[37] The California Infrastructure Planning Act centralizes many infrastructure planning responsibilities within the Governor's Office, which must submit a proposed five-year infrastructure plan annually to the Legislature, along with its proposed state budget.[38]

While these approaches do not guarantee effective planning, they make it vastly easier to evaluate and balance diverse infrastructure needs across different sectors, and craft suitable long-term plans. **The Council on Environmental Quality should compile guidance on best practices for inter-sectoral infrastructure planning for states, and encourage robust planning efforts through dialogue with state policymakers.**

Holistic planning efforts should account for infrastructure-repurposing opportunities and related challenges. For instance, as coal- and gas-fired power plants become less competitive due to both market forces and clean energy policies, plant closures are likely to accelerate.[39] Some plant closures will create opportunities to repurpose existing infrastructure (or infrastructure corridors), including electric transmission lines and rail lines linked to plants. The likely closure of North Dakota's largest coal plant is expected to make one of the nation's few high-voltage direct current transmission lines available for other uses, but local coal advocates have used zoning restrictions to keep new wind farms from connecting to the line.[40] Infrastructure planners should prioritize efforts to repurpose existing assets in efficient and socially beneficial ways, working closely with state or federal lawmakers to overcome local zoning issues or other challenges.

Larchmont Buzz

Los Angeles residents take part in a 2019 meeting with city planners to discuss neighborhood transit options.

Inclusivity in infrastructure planning is crucial to ensure that the needs of all communities are met and that projects generate community support rather than opposition. Infrastructure planning in the transportation sector has traditionally excluded communities of color, among other groups, leading to problematic distributions of transit infrastructure costs and benefits.[41] Despite a range of efforts to encourage minority and low-income community participation in state-level transportation planning processes around the country, progress has been limited.[42] The situation is likely worse in many other infrastructure sectors that have less formalized planning processes. As a condition for federal support of projects, policymakers should require states or developers to demonstrate substantive examples of inclusive outreach, such as the establishment of programs to solicit input from grassroots community groups in underserved areas.

Strategic Environmental Assessments

As policymakers formulate broad infrastructure plans, they should analyze the corresponding environmental impacts and address them at the planning stage. Analytical and participatory approaches that aim to integrate environmental considerations into policies and plans early in the decisionmaking process and evaluate them alongside economic and social considerations are often referred to as strategic environmental assessments (SEAs).[43] Such assessments offer a range of benefits and have a high potential to improve decisionmaking.[44] SEAs are becoming increasingly common practice in countries around the world,[45] in part because they help enable cost-effective planning adjustments before significant financial or political capital has been spent on a particular project outcome. **Federal policymakers should work to ensure that all early-stage environmental reviews conducted under the National Environmental Policy Act align with the best practices of the strategic environmental assessment methodology. Similar assessments should be encouraged for plans and projects that do not require NEPA review, including at the state level.**

The federal government already employs a form of SEA when it conducts programmatic NEPA reviews. These programmatic reviews can be useful in clarifying the broad environmental impacts of a policy or plan, and informing decisionmaking on subsequent rulemakings or projects. However, the process is still in need of improvement. As noted in 2014 guidance from CEQ, "[p]rogrammatic NEPA reviews have not been fully used for their intended purpose and when used, have often not fulfilled agency or stakeholder expectations."[46] CEQ should continue to hone guidance on programmatic NEPA reviews with the aim of making these reviews increasingly information-rich and transparent, with a detailed consideration of climate and other environmental effects. This should include in-depth analysis of how a given infrastructure plan or policy would aid or hinder a transition to net-zero GHG emissions in all affected sectors.

Federal agencies should also conduct SEAs for significant infrastructure policy changes even in cases where a programmatic NEPA review is not required. The output of these assessments can inform and clarify agencies' strategies and also help project planners understand areas of need. At the project level, a comprehensive NEPA scoping process, under which agencies solicit input from a broad range of relevant stakeholders to define the scope of environmental review, can help provide similar early-stage benefits and inform project design. (Additional recommendations on NEPA scoping are provided below.)

The federal government should also encourage states to use SEAs when developing infrastructure plans and programs, such as energy master plans, five-year infrastructure plans, and other long-term, capital-intensive efforts. Many states and local jurisdictions have their own environmental review processes equivalent to NEPA, and CEQ has an ongoing process of working with these states and jurisdictions to prepare memoranda that compare and contrast state/local environmental review requirements with NEPA requirements.[47] In these memoranda and related communication with local officials, CEQ should emphasize the importance of early-stage analyses that follow SEA best practices.[48] CEQ or agencies should also make federal resources and personnel available to assist with state SEAs when applicable. Existing and forthcoming CEQ guidance on NEPA reviews can provide a starting point for resources aimed at states.

The SEA process can increase infrastructure planners' awareness of potential environmental concerns that might be detrimental to communities or ecosystems, allowing them to adjust plans and projects accordingly. By addressing these concerns at an early stage, they will increase the chance that later-stage NEPA review and permitting processes go smoothly and do not result in public opposition, lawsuits, or lengthy delays.

Evaluating Projects' Climate Impacts

New infrastructure is needed in nearly every sector of the economy to enable decarbonization. For instance, a massive expansion of electric-vehicle charging infrastructure will be needed to make zero- or net-zero-GHG transportation possible, while high-voltage transmission lines will be needed to bring electricity from regions with abundant solar and wind potential to areas with high electricity demand in order to eliminate electric-grid emissions. Policymakers and private entities will need to determine which specific infrastructure projects should be prioritized and allocate limited resources to help them get built. The federal government can make this process far easier by establishing guidelines and tools that allow for a systematic comparison of the environmental impacts (including the GHG reduction potential) of different types of infrastructure projects.

Further systematizing the environmental review process under NEPA could establish a best-practice template for transparently estimating projects' climate impacts, which could be used in federal permitting as well as earlier-stage analyses and evaluations outside of federal jurisdiction. Many large infrastructure projects are required to complete an environmental impact statement (EIS) or environmental assessment under NEPA, so improving the NEPA review methodology and making it function as a uniform "gold standard" that could be used in other contexts could generate efficiencies as well as spillover benefits for states and municipalities conducting review processes.

In 2016, CEQ issued a guidance document on assessing GHG emissions and climate change effects for infrastructure projects subject to review under NEPA, offering the most comprehensive federal recommendations to-date for evaluating climate impacts.[49] The Trump administration later withdrew this guidance and issued new rules that drastically limited the scope of climate impact assessment required in NEPA reviews.[50] The 2016 guidance offered useful recommendations to encourage a fuller accounting of climate effects, but left some key decisions to the discretion of federal agencies.[51] CEQ also planned to conduct a review of agencies' proposed changes to NEPA procedures in light of the 2016 climate guidance,[52] but the Trump administration's withdrawal of the guidance ended that effort.[53] CEQ should undertake a new effort to systematize climate analysis in NEPA review, expanding on the 2016 blueprint.

CEQ should significantly improve NEPA review, particularly with respect to climate impact evaluation and cohesiveness across entities. The scope and depth of climate analysis varies considerably in NEPA environmental impact statements for infrastructure projects, both within and across different categories of infrastructure.[54] Federal agencies use a variety of different methodologies and tools for project scoping, determining a frame of reference, and monetizing costs and benefits of GHG emissions.[55] This lack of uniformity makes it extremely difficult to compare different projects' climate impacts on an apples-to-apples basis, limiting the ability of policymakers to prioritize or fund projects based on climate characteristics.

CEQ should issue new NEPA guidance related to analyzing climate impacts, with specific details on:

- **Scoping** – CEQ guidelines should encourage consistent practices across federal agencies for the EIS scoping process, under which agencies solicit input from relevant stakeholders to define the scope of impacts that will be discussed in an EIS. Agencies should prioritize inclusivity and participatory approaches, initiating dialogue with a broad range of stakeholders in the scoping process. Agencies should also be required to produce comprehensive scoping documents that are available for public comment. Climate impacts should be included in the scope of disclosures for all projects that have an effect on GHG emissions, avoided emissions, or sequestration, even if the impact is deemed relatively small. CEQ should then work with individual agencies to hone and harmonize these practices so that the process is as uniform as possible across agencies.

- **Guidelines for appropriate analysis and monetization of direct, upstream, and downstream GHG emissions impacts**[56] – Many past environmental reviews under NEPA have omitted analysis and/or monetization of GHG emissions, or used inconsistent methods.[57] This analysis is critical in ongoing decarbonization efforts, as policymakers must be able to evaluate projects' impacts and establish their compatibility with climate targets (such as net-zero emissions by mid-century, inclusive of all long-lived assets built after 2020). CEQ's 2016 guidance removed language from earlier drafts that required agencies to account for both upstream emissions (when a project leads to emissions earlier in the supply chain) and downstream emissions (that occur later in the supply chain).[58] Instead, the 2016 guidance required that agencies take into account only "reasonably foreseeable indirect effects."[59] And the Trump administration's new NEPA regulations in July 2020 dramatically narrowed the scope of climate analysis in NEPA reviews, including analysis of indirect emissions.[60] New CEQ guidance

should reverse these changes and require relevant upstream and downstream analysis. Additionally, agencies should be required to monetize emissions impacts using the Social Cost of Carbon/Social Cost of Methane metrics, enabling decisionmakers to better understand the significance of the impacts.[61]

- **Tools for GHG emissions estimation** – To the extent possible, NEPA review should employ existing GHG estimation models and tools that can streamline the review process and make estimates consistent.[62] The 2016 CEQ guidance indicates that agencies can make use of GHG estimation tools discussed in CEQ's 2012 Guidance for Accounting and Reporting GHG Emissions, though some of these options are outdated or poorly suited for assessing emissions from individual projects or actions.[63] CEQ should offer updated, specific recommendations for estimation tools and encourage agencies to use a consistent set of options.[64] Both the U.S. government[65] and other entities around the world have developed numerous relevant tools, many of which are specifically designed for infrastructure evaluation[66] and could be useful parts of CEQ's recommended toolkit. CEQ could also borrow elements of California's approach, which requires all projects to complete a uniform list of questions about impacts and use the same model to quantify emissions[67] (including full-lifecycle impacts and offsite/indirect impacts,[68] with separate estimates for "uncontrolled" emissions and emissions after any mitigation measures are taken[69]).

- **Calculating avoided GHG emissions and carbon sequestration potential** – Many new infrastructure projects are desirable specifically because of their ability to help reduce GHG emissions or sequester carbon. Estimating avoided or sequestered emissions is a relatively new practice, so CEQ should evaluate existing methodologies and compile specific recommendations for how this analysis should be conducted and which tools or models should be used. This effort should be a high priority, given the current lack of guidance and the importance of using these calculations to evaluate new projects.

- **Using consistent assumptions and scenarios** – Estimates of future emissions or avoided/sequestered emissions may rely in part on assumptions about the future state of the economy, technology development, sectoral changes, and other factors. CEQ should establish scenarios for this analysis (relying in part on existing scenarios from the IPCC and other bodies), as well as guidelines for how agencies should form and transparently disclose additional assumptions. CEQ should regularly monitor how agencies make and use assumptions related to GHG estimates, and work to promote ongoing consistency across agencies.

- **Establishing appropriate baselines** – To meaningfully assess climate impacts, agencies will often need to establish relevant baselines from which to compare the effects of projects or policies (these baselines are often discussed as part of the "no action" alternative in an EIS). Since many infrastructure projects have long lifespans, creating baselines or "no action" scenarios can involve some amount of future projection, and climate impacts can affect baseline environmental conditions and related agency analysis.[70] CEQ should issue specific guidance on methodologies to set baselines and require that baselines incorporate the best available scientific projections of climate-related impacts. CEQ should then work with agencies to ensure consistent implementation. Some tools for estimating project-related GHG emissions can also be used to help set baselines,[71] and CEQ should make use of such tools where appropriate.

- **Incorporating expected climate impacts into project design and analysis** – Many environmental reviews do not adequately consider how expected impacts from climate change, such as increased flood and wildfire risk, will affect proposed projects.[72] Even those that acknowledge these risks often fail to incorporate the impacts into project design and related decisionmaking.[73] Project developers and federal agencies would benefit greatly from improved, publicly available data on expected climate hazards, and the federal government should expand

its efforts to produce such data. In the meantime, CEQ guidance should specify that all NEPA reviews should include robust discussion of how estimated climate impacts might affect proposed projects, using the best currently available data sources. Reviews should also discuss related assumptions and efforts to incorporate these risks into project design.

These additional requirements and recommendations could in some cases expand the scope of work required for NEPA review, but should also increase project transparency and in many cases reduce stakeholder opposition and legal risk. And once federal agencies and project developers have become accustomed to new methodologies and tools that are employed consistently, the overall review process could be more streamlined.

Measuring Embodied Carbon in Infrastructure Projects

A clearer understanding of the *full-lifecycle* environmental footprint of infrastructure projects is a necessary first step in any effort to reduce that footprint. Beyond a project's operational GHG emissions, "embodied" carbon emissions—from the extraction, manufacture, transportation, assembly, maintenance, and deconstruction of the materials that make up structures—can account for 30 to 70 percent of a structure's lifecycle carbon emissions.[74] Quantifying embodied carbon emissions in infrastructure projects can help identify target areas for materials-related R&D funding and inform the design of policies to reduce embodied carbon emissions (these issues are discussed in Section V).

CEQ should convene an interagency working group to develop a standardized system for estimating the embodied carbon in infrastructure projects, and require this disclosure in NEPA reviews once it is sufficiently developed. While lifecycle assessment and embodied carbon measurement are emerging fields, significant advances have been made in recent years. A number of existing studies and tools from researchers, foreign governments, and U.S. states can be used as a starting point for the development of a uniform federal system for measuring embodied carbon. For instance, the Embodied Carbon in Construction Calculator is a promising, open-access tool that could be used or adapted for NEPA reviews.[75] And the Buy Clean California Act requires contractors bidding on state infrastructure projects to disclose emissions for four construction materials: structural steel, carbon steel rebar, flat glass, and mineral wool board insulation (though concrete, a significant source of infrastructure emissions, is omitted).[76] A similar process could potentially be developed for NEPA reviews.

The federal government should establish guidelines for measuring and reporting embodied carbon rather than leaving this effort to states or other entities. If a patchwork of different approaches proliferates among various states and industry associations, project developers could find it more difficult to gauge and report embodied carbon while working on projects in multiple jurisdictions. Additionally, future policies that seek to reduce embodied carbon in infrastructure will be hindered if projects cannot be easily compared. While the federal government cannot prevent states or industry bodies from pursuing their own approaches, most groups would likely coalesce around a well-designed federal system.

When federal agencies evaluate projects, embodied-carbon estimates must be considered in the context of other GHG impacts, including avoided-emissions potential and the impact of taking no action. For instance, a public transit project that entails significant embodied-carbon emissions but can greatly reduce other sources of emissions by decreasing car and air travel will likely be beneficial from a climate perspective, and preferable to taking no action. Quantifying embodied emissions in NEPA reviews will disclose useful information to inform thorough project evaluation, and the performance standards and R&D efforts discussed in Section V can help reduce embodied carbon emissions over time.

Accelerating the Permitting Process

The NEPA environmental review process is a precursor to federal agencies' issuance of permits for infrastructure projects. Federal environmental review and permitting processes help ensure robust project analysis and public transparency, though they are often criticized as choke points that delay infrastructure development.[77] Some have advocated for constraining these processes, and the Trump administration has issued regulations limiting the project disclosures required under NEPA.[78] These limits and other efforts to weaken environmental review could inhibit understanding of important project impacts, leading to potentially damaging outcomes, while also increasing legal uncertainty that can delay projects.

While environmental review should not be weakened, the federal government can take steps to accelerate the timeline of the permitting process for highly desirable projects, such as those with the potential to greatly reduce GHG emissions. Some of this could be accomplished by better leveraging the Federal Permitting Improvement Steering Council (FPISC). The FPISC was created as part of the Fixing America's Surface Transportation (FAST) Act in 2015 in order to "improve the timeliness, predictability, and transparency of the Federal environmental review and authorization process" for certain infrastructure projects.[79]

The Executive Office of the President should direct the Federal Permitting Improvement Steering Council and relevant federal agencies to accelerate the timeline of the permitting process for sustainable infrastructure projects. The FPISC should prioritize low-GHG projects across multiple infrastructure categories, developing aggressive but realistic timelines for key categories of covered projects.

The FPISC has taken steps to shorten permitting timelines for many projects. A 2014 Government Accountability Office report calculated that the average time to complete a full EIS is 4.6 years, though times can vary significantly across project types.[80] For infrastructure projects that meet certain criteria and apply for "covered" status, the FPISC is authorized to develop recommended Performance Schedules, including intermediate and final completion dates for environmental reviews and other authorizations.[81] Performance Schedule timeframes must reflect use of the most efficient applicable processes, and cannot exceed the average completion time for environmental review or authorization of projects within the same infrastructure category.[82]

Covered projects are still required to obtain all of the same NEPA approvals as typical, non-accelerated infrastructure projects, but FPISC efforts to set timelines and track progress on a public dashboard[83] may be correlated with reduced permitting times.[84] Of the FPISC's 23 covered projects in fiscal year 2019, 48 percent had project lengths equivalent to or less than the original length designated by the FPISC (meaning these projects had shorter-than-average completion times in their relevant categories), while another 23 percent were less than five months behind the designated completion schedule.[85] It is unclear from available data and the FPISC's reports to Congress what factors have driven shorter completion times for some projects, but, in addition to overseeing Performance Schedules, public tracking, and agency coordination, the FPISC establishes best practices for expedited permitting and works with agencies to implement them; these efforts could also shorten timelines.[86] It is also possible that FPISC-covered projects have been prioritized by reviewing agencies.

Chicago Transit Authority

Infrastructure subcategories potentially worthy of FPISC prioritization could include public transportation, offshore wind, high-voltage transmission, electric-vehicle charging infrastructure, and carbon-dioxide pipelines for direct air capture and carbon utilization projects.

The FPISC's efforts to accelerate permitting schedules could be leveraged further. Project categories currently subject to FPISC jurisdiction include renewable or conventional energy production, electricity transmission, surface transportation, aviation, ports and waterways, water resource projects, broadband, pipelines, manufacturing, and mining; other sectors can be approved by a majority vote of the Council.[87] Individual projects in these categories must apply for covered status. Within each category, the FPISC has identified a number of subcategories (e.g., the renewable energy production category contains subcategories for biomass energy production, federal hydropower, solar, etc.).[88] Prior to 2020, the FPISC published only a generic Performance Schedule for use across all categories, due to a lack of available data to determine average project completion times and develop tailored Performance Schedules for each category.[89] The Council has more recently begun issuing category-specific Performance Schedules, but more work could be done to establish schedules and best practices at the subcategory level.

To help accelerate sustainable infrastructure projects, the FPISC should work with CEQ and other agencies to identify subcategories with especially high GHG-reduction potential, and prioritize the development of aggressive but realistic Performance Schedules for them, frequently aiming for timelines considerably faster than the subcategory's average completion time. At the same time, the FPISC should deprioritize its efforts for GHG-intensive categories, such as conventional energy and mining. Subcategories potentially worthy of prioritization could include offshore wind, high-voltage transmission, electric-vehicle charging infrastructure, public transportation, and carbon-dioxide pipelines for direct air capture and carbon utilization projects. To assist in this process, the FPISC should work with relevant federal agencies to solidify review protocols and resources that facilitate speedy review.

Congress and the Executive Office of the President should increase dedicated staffing and resources for expedited review and permitting at relevant federal agencies. The facilitating agency or lead agency for a project is directed to follow the FPISC's Performance Schedule timetable for a covered project, but is allowed to deviate from the timeline based on several relevant factors, including the resources available to each agency.[90] Internal agency or interagency factors were the reason for 44 of 168 schedule modifications for covered projects during fiscal year 2019, and the causes cited include agency capacity/resource issues and delays in interagency coordination.[91] A 2014 interagency steering committee on federal infrastructure permitting highlighted the importance of improved staffing strategies for permitting, offering suggestions including the creation of a dedicated team to support improved permitting that could work with rotating detailees from various agencies.[92]

Going forward, federal agencies' staff and resources should be allocated in a manner that avoids permitting bottlenecks or delays for priority projects. These resource needs should be reflected in the President's annual budget request, and Congress should authorize appropriate funding. If Congress does not act, the Executive Office of the President should direct agencies to reallocate resources where possible to enable expedited review and permitting.

Project planners can also accelerate the environmental review and permitting process by conducting early-stage strategic environmental assessments, as discussed above. These assessments can provide data and stakeholder input that helps inform later environmental reviews. They can also identify potentially problematic issues that can then be mitigated at the planning stage, streamlining review and permitting efforts.[93]

By developing clear, accelerated timelines and specific review protocols for desirable subcategories of projects, the FPISC can speed the development of sustainable infrastructure. The Executive Office of the President can also help accomplish this goal by offering resources to assist federal agencies and helping encourage early-stage strategic environmental assessments.

III. Infrastructure-Related Procurement

New federal procurement approaches can help ensure that environmental goals are appropriately considered when federal entities invest in infrastructure assets or related goods and services. Government-wide procurement rules should be updated so that that purchases and projects are compatible with a goal of net-zero GHG emissions by 2050, inclusive of long-lived assets procured before 2050. Specific rules and targets should be developed for key categories, such as federal vehicle fleets and military procurement, to ensure that assets in these categories are compatible with the net-zero goal by mid-century.

The federal government should also use a new procurement approach for federally owned energy assets, investing in emissions-free generation for the Tennessee Valley Authority and using the DOE's power marketing administrations to expand transmission infrastructure that can enable decarbonization.

Additionally, new federal policies and resources focused on pooled procurement can help states, municipalities, and project developers negotiate cooperatively with vendors when pursuing similar sustainable infrastructure investments.

Modernizing Federal Procurement Policies

Federal agencies spent $584 billion on procurement in fiscal year 2019, according to the Government Accountability Office.[94] Much of this spending went toward infrastructure-related goods and services, including federal buildings' operations, military equipment, and information-technology expenses.[95] Environmental considerations factor into some federal procurement decisions, as a variety of laws, executive orders, and regulations have established a patchwork of category-specific requirements.[96] Examples include recovered-material or biobased-content minimums[97] and Energy Star requirements[98] for various product categories. But few procurement rules target extensive GHG reductions. Creating new policies that consider climate impacts in a comprehensive manner and push toward carbon neutrality could significantly reduce the federal government's GHG footprint.

Federal procurement strategy is largely overseen by the Office of Management and Budget's Office of Federal Procurement Policy (OFPP), which was established by Congress in 1974 and tasked with providing overall direction for government-wide procurement policies, regulations, and procedures.[99] The OFPP is headed by an Administrator who is appointed by the President and confirmed by the Senate.[100]

The OFPP is directed by statute to promote economy, efficiency, and effectiveness in federal acquisition processes.[101] At the direction of the President, the OFPP Administrator should interpret this mission to include efficient use of resources and the consideration of economic harms from climate change. With this in mind, the OFPP should modernize federal procurement policies. **The Office of Federal Procurement Policy should issue new rules requiring that purchases and projects are compatible with a goal of net-zero GHG emissions by 2050, inclusive of long-lived assets procured before 2050.** These procurement rules should account for both direct and indirect emissions. For instance, policies governing information-technology expenditures should account for emissions related to energy use at data centers, and rules governing procurement of building materials should differentiate between those made with GHG-intensive inputs or practices and alternative options with lower GHG footprints.

The General Services Administration (GSA) should also begin a holistic reevaluation of policies and tools, so that pre-negotiated procurement options for federal agencies align with a target of carbon neutrality by 2050. In the near-term, **the General Services Administration should update its Sustainable Facilities Tool, which helps identify procurement options with desirable environmental attributes,**[102] **to more specifically target carbon-neutral and low-GHG options.** The GSA should also work with federal agencies to develop agency-specific resources that facilitate a move toward the net-zero-emissions goal as soon as possible, before the 2050 target where possible.

In addition to this broad reevaluation of federal procurement policies, some other specific areas of procurement should be prioritized for reform in the near term, as discussed below.

Federal Vehicle Fleets

Federal vehicle fleets are a significant source of GHG emissions, and improved procurement policies could substantially lessen their environmental impact even before the 2050 targets discussed above. In various fleets, the federal government owns nearly 650,000 vehicles, which cumulatively travel nearly 5 billion miles per year.[103] Roughly 34 percent of these vehicles belong to the U.S. Postal Service, with another 39 percent belonging to other civilian agency fleets (the remainder are part of military fleets).[104]

Existing federal regulations on Motor Vehicle Management call for the procurement of vehicles that meet federal fuel economy standards for their vehicle categories (some military and law enforcement vehicles are exempt).[105] **New executive actions and GSA rules should target more stringent vehicle-emissions goals, with the aim of procuring only zero-emissions light-duty vehicles by 2030, and only zero-emissions vehicles for all classes by 2050**, with limited exceptions for technological or operational infeasibility. This procurement target would send an important market signal and help boost innovation by U.S. automakers, particularly in medium- and heavy-duty vehicle categories, as more than 60 percent of federally owned vehicles are trucks.[106]

In addition to the environmental benefits of this policy change, federal agencies (and taxpayers) would likely benefit from greatly reduced vehicle maintenance costs, since many electric vehicles are projected to have significantly less expensive lifecycle maintenance needs than internal-combustion-engine equivalents.[107]

Federal agencies (and taxpayers) would likely benefit from greatly reduced vehicle maintenance costs if the federal government moves toward zero-emissions vehicle fleets.

To assist federal agencies in making the transition to zero-emissions fleets as quickly as possible, the GSA's Office of Fleet Management and the DOE's Federal Energy Management Program should update their resources related to procurement and management of alternative-fuel fleets and associated infrastructure. These resources can help inform charging infrastructure plans, fleet management strategies, and other important considerations.[108]

Military Procurement and Accelerated Innovation

While military procurement decisions are generally coordinated separately from processes governing civilian agencies,[109] **the Department of Defense (DOD) should commit to military procurement policies that are compatible with a goal of net-zero GHG emissions by 2050, inclusive of long-lived assets procured before 2050.** The DOD should aim to make no exceptions to this policy for facilities-related energy use, and limit exceptions for operational energy use (such as fuel for jets and ships) to rare, strategically important cases.

Aggressive emissions-reduction plans align with overarching DOD strategies. The DOD has publicly identified climate change as a significant threat to its existing infrastructure, with climate impacts threatening dozens of military bases and other installations.[110] DOD officials have also highlighted climate change as a "threat multiplier" that will greatly worsen numerous national security challenges.[111] Despite these concerns, the DOD is the world's largest institutional user of petroleum and emitter of GHGs.[112] The military is responsible for the vast majority of federal energy consumption, including 57 percent of facilities-related energy use and nearly 90 percent of vehicle-related energy use.[113] In recent years, the DOD has increasingly embraced renewable energy projects and other efforts to reduce fossil-fuel use, largely because reducing the military's (and the country's) dependence on fossil fuels is strategically beneficial from a security perspective.[114] However, the DOD has not yet articulated a broad vision for sustainable infrastructure or low-GHG procurement.

Making all newly built and procured military infrastructure compatible with a net-zero-emissions goal will be a monumental challenge, but establishing such a goal can accelerate innovation in both the public and private sectors. To help overcome technical obstacles related to this goal, the DOD could leverage the Defense Advanced Research Projects

Diane Durden/U.S. Marine Corps

In recent years, the Department of Defense has increasingly embraced renewable energy projects and other efforts to reduce fossil-fuel use, largely because reducing the military's (and the country's) dependence on fossil fuels is strategically beneficial from a security perspective.

Few entities in the world are better positioned to pursue rapid breakthroughs in technologies like low-carbon aviation and advanced microgrid systems than the Department of Defense.

Agency (DARPA), which has been described as having "the longest-standing, most consistent track record of radical invention in history," with innovations that include the internet, global positioning satellites, and drone technology.[115] The DOD also has relationships with a vast network of innovative companies, having spent more than $380 billion on procurement of military infrastructure, goods, and services in fiscal year 2019, including state-of-the-art aviation equipment and other advanced technology.[116] Few entities in the world are better positioned to pursue rapid breakthroughs in technologies like low-carbon aviation and advanced microgrid systems than the DOD.

Pursing a net-zero emissions goal for military infrastructure projects and procurement would not only reduce the climate footprint of the world's largest institutional emitter, it would likely result in spillover benefits from technological development in hard-to-decarbonize categories, thereby boosting U.S. industries and exports.

Federal Energy Assets

The federal government owns numerous electricity generation and transmission assets through the Tennessee Valley Authority (TVA) and federal power marketing administrations (PMAs). The Executive Office of the President should use policy directives, appointments, and other necessary measures to ensure that newly procured federal energy assets are compatible with a goal of net-zero emissions by mid-century.

The federal government is well positioned to reform the TVA's procurement approach. Established by Congress in 1933, the TVA is the nation's largest public power provider, serving nearly 10 million people in parts of seven southeastern states.[117] The TVA currently operates as a not-for-profit government corporation, funding its operations through electricity sales and power system financings, with no federal appropriations.[118] Legislation in 2004 altered the TVA's governance structure so that it now resembles that of a large corporation, though the TVA board of directors is appointed by the President and confirmed by the Senate.[119] **The President should issue a new policy directive on procuring emissions-free federal energy assets, and appoint new Tennessee Valley Authority directors who are committed to transitioning the TVA toward 100 percent carbon-free electricity by mid-century.**

The TVA portfolio remains far from total decarbonization. While the TVA has reduced its GHG intensity in recent years,[120] in part as a result of coal plant retirements and operational changes that followed a lawsuit over Clean Air Act violations,[121] it still operates six coal-fired sites (with 7.9 gigawatts of capacity) and 17 natural gas- and/or oil-fired sites (with 12.5 gigawatts of capacity).[122] And its 20-year Integrated Resource Plan projects 2 to 17 gigawatts of natural gas additions.[123] Reformed procurement efforts that target emissions-free generation and related infrastructure (including transmission) could both reduce the TVA's GHG footprint and provide a model for private utilities looking to decarbonize.

These new policies must be designed to comply with the TVA Act, which sets the framework for the Authority's governance (though some legislative amendments to the Act might also be desirable). The TVA Act includes an "objective that power shall be sold at rates as low as are feasible."[124] Current TVA electricity rates are lower than those of over 70

The Department of Energy's federal power marketing administrations have authority to develop electric transmission projects without state veto.

percent of major U.S. utilities.[125] If necessary, slight rate increases to help cover the costs of new, low-GHG assets needed to meet federal clean-energy targets may well be compatible with the TVA Act. In such a case, policymakers should explore options to assist low-income customers who might be negatively affected. The Act also prevents the TVA from issuing more than $30 billion in power bonds and discount notes;[126] the Authority currently has $22.8 billion in total debt and financing obligations.[127] The TVA could use additional debt to finance procurement of low-GHG assets. Some advocates have also proposed amendments to the TVA Act that would allow for additional debt issuance, including green power bonds backed by the federal government[128] (current TVA debt is not federally guaranteed). Additionally, while the TVA is exploring participation in the Southeast Energy Exchange Market (SEEM),[129] it might secure greater benefits (including decarbonization benefits) from joining a regional transmission organization, though this might require amending the TVA Act. Even without new legislation, executive actions can vastly improve TVA procurement.

The federal government could also create something of an indirect procurement option for new high-voltage transmission lines, which are critical for decarbonization but often face major siting barriers. New transmission infrastructure that can bring renewable power from wind- and solar-abundant regions to population centers will almost certainly be necessary to efficiently decarbonize the U.S. electricity system.[130] However, transmission projects have repeatedly been halted by project opponents in state approval processes.[131]

The Department of Energy's four federal power marketing administrations (PMAs) should use their authority to develop transmission projects without state veto, providing a new avenue for getting desirable transmission projects built.[132] The PMAs operate electric systems in 34 states in order to sell the electricity generated by federally owned hydroelectric dams,[133] and they own roughly 14 percent of the country's transmission network.[134] The PMAs have authority to develop their own transmission projects outside of the state approval process, and the Energy Policy

Act of 2005 added a new provision that grants the DOE authority to partner with private developers on transmission projects.[135] Under these partnerships, state-level veto can be avoided if a PMA is the nominal owner of a project, while an outside entity is able to provide private financing and expertise.[136] The Western Area Power Administration has taken a similar approach (using additional authority) as part of its Transmission Infrastructure Program,[137] partnering with private companies to complete two transmission projects and begin developing several others.[138]

By further leveraging these authorities, the DOE could build or directly facilitate the construction of new transmission projects that can help decarbonize the electric system in multiple regions. These efforts should be prioritized based on DOE analyses of specific transmission needs to achieve net-zero GHG emissions by mid-century; one such analysis was recently completed.[139] The PMAs' authority covers large swaths of the country but not all regions, and other legal parameters must be considered. But this approach offers significant potential for aiding transmission expansion.[140] Other existing authority, such as federal permitting of interstate transmission within designated "national interest electric transmission corridors" should also be used to speed transmission development.[141] Through these efforts, the federal government can help a variety of entities essentially "procure" transmission infrastructure to aid decarbonization.

Pooled Procurement Resources for States and Municipalities

Independent of any federal efforts to pursue sustainable infrastructure, many states and localities that are seeking to decarbonize will have overlapping infrastructure needs. As a result, numerous state and local governments, as well as private entities, are likely to pursue similar projects and purchases at similar times, from electric school bus fleets to low-carbon building materials to advanced energy metering technology. As a result, some of these governments and project developers could be forced to bid against each other, potentially increasing project costs.

As municipalities increasingly explore purchases of electric school bus fleets, pooled procurement resources could help reduce costs.

The GSA should create new federal resources to assist with pooled procurement, so that state and local governments pursuing similar sustainable infrastructure investments can negotiate with vendors cooperatively rather than competitively. Federal entities already benefit from cooperative procurement. GSA Schedules (also referred to as Federal Supply Schedules or Multiple Award Schedules) serve as the government's primary tool for pooled procurement. These long-term, government-wide contracts with commercial firms offer government buyers access to more than 11 million products and services at volume discount pricing.[142] GSA Schedules allow for fast order placement with vetted vendors at pre-negotiated, "fair and reasonable" prices.[143] Purchasing through these Schedules also eases regulatory compliance.[144]

Through the GSA's Cooperative Purchasing Program, state, local, and tribal governments can make purchases through a limited number of GSA Schedules for information technology, security, and law enforcement products and services.[145] Other programs allow nonfederal government entities to make qualified purchases from *all* GSA Schedules in the context of disaster preparation or response,[146] or designated public health emergencies (the Covid-19 pandemic is one such emergency).[147]

The GSA should expand its offerings for state, local, and tribal governments, allowing these entities to make purchases through all GSA Schedules relevant to sustainable infrastructure (broadly defined) on a permanent basis. This policy change would allow state and local governments to procure necessary goods and services for their own projects, and to assist with procurement when working with private developers on high-priority public-private partnerships.

Several GSA Schedules are highly relevant for sustainable infrastructure. For instance, the Facilities Schedule allows procurement of complete buildings, building materials, and building energy management technology and services,[148] while the Industrial Products and Services Schedule allows procurement of such items as water treatment products, power distribution equipment, and heavy machinery.[149] Working with experts from other federal agencies such as the Environmental Protection Agency and the DOE, the GSA should assess the GHG impacts of procurement options and highlight low-GHG options in procurement portals. This can enable both federal and state/local buyers to use GSA Schedules for pooled procurement for sustainable infrastructure projects.

The GSA should also solicit input from states and municipalities on medium- to long-term project plans and procurement needs, so that it can add new products and services to Schedules. And to assist with pooled procurement for items that are not yet part of GSA Schedules, the agency should offer guidance and tools on sourcing, contract negotiations, and other matters for state and local governments.

IV. Financing and Grants

Regardless of any improvements made in other stages of the infrastructure development lifecycle, projects cannot be built without appropriate financing options. Funding concerns were found to be the most common cause of project delays in a Treasury Department report analyzing 40 recent infrastructure projects (regulatory requirements such as environmental review, which are often blamed for project delays, were found to play a far smaller role).[150] Thousands of diverse infrastructure projects will be needed in the coming decades in order to improve U.S. economic standing, reduce GHG emissions, build resilience to climate impacts, and improve social equity. Establishing steady sources of financing is essential to move these projects forward.

Most federal infrastructure funding is subject to unpredictable authorization and renewal cycles that are dependent on constantly changing political factors.[151] This funding is also typically allocated for relatively narrow categories of projects, nearly all of which focus on transportation or water resources.[152]

As discussed in Section I, federal investment in sustainable infrastructure can likely produce economic benefits that significantly outweigh associated costs, boosting GDP, employment, and important domestic industries. New federal financing and grant programs can be a vehicle for economic growth.

Legislative solutions will be necessary to expand financing options and spur sustainable infrastructure development. Programs offering federal financial support can serve as a carrot to help shape the design of infrastructure projects, so that developers prioritize projects that reduce emissions, offer inclusive benefits, and enhance resilience.

To accelerate the development of infrastructure projects that generate revenue but might not attract major investment from traditional sources, Congress should create a federal infrastructure bank and extensive loan guarantee programs. Additionally, Congress should establish a well-funded grant program for sustainable infrastructure projects, with eligibility parameters that will support nationwide project development, significant GHG reductions, fair wage and benefit guarantees for workers, and other desirable traits.

Creating a National Infrastructure Bank

A national infrastructure bank (or a green bank/climate bank with a heavy focus on infrastructure, broadly defined) can help provide a stable source of financing for desirable infrastructure projects, while also playing critical coordination roles to help move a wide range of projects forward. **Congress should establish and capitalize a national infrastructure bank to provide a stable, long-running source of financing for sustainable infrastructure projects. Lawmakers should also amend the Federal Credit Reform Act of 1990 so that the bank is authorized to use loan repayments to issue new loans.**

Green banks are public or nonprofit financial institutions that help environmentally beneficial projects secure capital, often using unique financial tools such as credit enhancements and long-term debt.[153] There are currently 15 state and local green banks operating in the United States, which have facilitated more than $5.3 billion in investment in climate-friendly projects since 2011.[154] To date, these green banks have mobilized $3.60 of total capital for every dollar of green bank investment.[155] A well-capitalized national infrastructure bank could similarly leverage private capital that otherwise

might not be directed to sustainable infrastructure projects in order to provide a stable source of financing. Several recent congressional bills have attempted to create a bank along these lines.[156]

State and local green banks have mobilized $3.60 of total capital for every dollar of green bank investment. A national infrastructure bank could similarly leverage private capital that otherwise might not be directed to sustainable infrastructure projects.

This model is best suited for projects that have revenue streams but might not easily attract mainstream investors. For instance, electric-vehicle charging stations on rural highways might be profitable over the long term but take some time to recoup upfront costs. And low-to-middle-income homeowners interested in distributed energy resource installations (such as rooftop solar panels) might struggle to secure financing due to credit score requirements, even though these installations will likely be profitable. A national infrastructure bank could help get such projects financed and built while generating returns over the long run.

Many state infrastructure banks/green banks use funds received from loan repayments to continue issuing new loans, but a federal infrastructure bank could not use this "revolving" model unless current restrictions are changed. The Federal Credit Reform Act of 1990 (FCRA), which established rules for calculating the budgetary costs of direct loans and loan guarantees issued by the federal government, prohibits loan repayments to be used for new loans.[157] As part of any legislation creating a national infrastructure bank, Congress should amend FCRA rules so that an infrastructure bank could provide loans on a continual basis without receiving new appropriations each year. This would help untether a federal infrastructure bank from politically charged appropriations debates, provided that sufficient capital is made available upon the bank's creation.

In addition to financing projects, a national infrastructure bank could also play important coordination roles. The national bank could provide resources and expertise to assist state and local green banks with project evaluation and operational best practices, allowing smaller banks to more efficiently direct their resources toward project finance. Jurisdictions with access to both a state/local and national bank would benefit from a larger pool of available financing options. A national infrastructure bank could help lead securitization efforts to accelerate the retirement of coal plants and other outdated infrastructure.[158] And the bank could help coordinate federal loan guarantees for desirable infrastructure projects (discussed below); help project developers navigate other federal resources, including procurement processes (discussed in part III); and play a lead role in administering a new federal grant program for eligible projects (discussed below).

Federal Loan Guarantees

Using public capital to reduce infrastructure investment risk can help lower the cost of finance and increase rates of return, helping to crowd-in capital from the private sector.[159] Federal loan guarantees can be used in such a manner, reducing risk for private investors by promising to cover all or part of project loans in the case of a default. **Congress should fund extensive loan guarantee programs to help a broad range of sustainable infrastructure projects secure financing.** Some of these loan guarantees could be administered by a newly created infrastructure bank.

The DOE's Loan Program Office (LPO) oversees loans and loan guarantees for energy infrastructure. These programs have successfully accelerated the deployment of dozens of projects while generating revenue for American taxpayers. To date, the LPO has issued $35.69 billion in loans and loan guarantees to more than 30 projects, resulting in more than

$50 billion in total project investment.[160] The LPO has received interest payments of $3.15 billion, while actual and estimated losses have totaled only $0.79 billion.[161] Despite the fact that many projects receiving loan guarantees face market barriers and risks due to their use of new technology, the loan guarantee program "has a loss ratio well below that of conventional lenders."[162] This program has been highly successful at helping innovative energy infrastructure projects secure financing to overcome the technological "valley of death"—when new technologies are at highest risk of failure due to financing difficulties at the commercial deployment stage.[163]

The LPO's loan guarantee program should be expanded with additional funding and adjusted to fully focus on projects compatible with a goal of net-zero emissions by mid-century. Title 17 of the 2005 Energy Policy Act, which established the loan guarantee program for innovative technologies, required that a project "avoid, reduce or sequester greenhouse gases" in order to be eligible for loan guarantees.[164] However, in June 2020, the LPO expanded the eligibility requirements to include fossil energy projects that avoid, reduce, or sequester GHGs emissions *or air pollutants*.[165] Fossil energy projects that claim to reduce air pollution through efficiency improvements or other measures can now be considered for loan guarantees, and the $8.5 billion in loan guarantee authority for fossil energy projects[166] dwarfs the $4.5 billion available for renewable and efficiency projects.[167] New legislation should greatly increase loan guarantee authority for renewable and efficiency projects, and stipulate that all projects receiving Title 17 support need to be consistent with mid-century carbon-neutrality goals.

Congress should also establish a new loan guarantee program broadly focused on other sustainable infrastructure projects. This program could be patterned after the LPO's Title 17 program, with a focus on projects that reduce GHG emissions and have a reasonable prospect of repayment. A federal infrastructure bank would be well suited to administer this program, using loan guarantee authority to attract additional private sector capital. The program should prioritize guarantees for projects that offer the greatest GHG reduction potential, using some of the suggested estimation methodologies discussed in Section II of this report.

Grants for Sustainable Infrastructure

Copious funding will be needed in order to build the diverse range of infrastructure projects necessary to strengthen the U.S. economy and properly address climate change. Public investment in these projects is both necessary and desirable. As discussed in Section I, every dollar spent on infrastructure typically results in more than a dollar of economic benefits as well as a "welfare multiplier" effect that boosts societal wellbeing.

With properly directed federal grants, Congress can create incentives for states and project developers to build infrastructure that addresses equity concerns, environmental threats, and economic needs. **Congress should create a robustly funded federal grant program for sustainable infrastructure projects, with the following design elements:**

- **Separate pools of funding for each state, to support locally valued GHG mitigation or climate adaptation projects** – Every state faces different infrastructure needs, climate risks, and areas of potential growth as the country shifts toward a low-GHG economy. Congress should design a program that allows all states to benefit directly from federal grants, and prioritize their own areas of need. States should have significant discretion in selecting projects that receive grants from their funding pool, provided that these projects meet the criteria of the grant program. In addition to projects that modernize infrastructure and reduce pollution from high-emitting sectors like transportation and energy, these grants could fund climate adaptation projects that improve resilience and protect vulnerable communities.

- **A federal funding pool for priority interstate/federal projects** – Some desirable infrastructure projects that offer diffuse benefits to multiple states many not be prioritized in state-specific funding decisions. A separate funding pool should be created for interstate or federal projects, which could include interstate electric transmission, high-speed rail, and a host of other important project categories. A portion of the federal funding pool could also be used to to supplement state pool funding for projects with especially large emissions-reduction or sequestration potential.

- **Requirements for long-lived infrastructure assets to be consistent with net-zero GHG pathways** – In order to be eligible for grants, all projects should be required to demonstrate compatibility with a goal of carbon-neutrality by mid-century. This analysis can be informed by projects' NEPA reviews, which should include detailed estimates of direct and indirect emissions impacts. For any proposed projects that would result in GHG emissions after 2050, states should outline defined plans for carbon sequestration efforts that would offset these emissions.

- **Grant amounts based in part on the level of GHG reductions a project can facilitate** – Some infrastructure projects can help enable widespread emissions reductions, and the value of such reductions should be recognized in grant allocation decisions. As one example, the Gateway Tunnel, which would significantly expand rail capacity along the Northeast Corridor, could increase rail ridership and correspondingly reduce emissions from automobile and air travel.[168] As is typical in NEPA reviews, the project's EIS focuses on direct emissions from construction and operation, and does not quantify that broader emissions-reduction potential.[169] To help evaluate projects and determine their grant amounts, the grant program should request that developers submit a systematic analysis of how a project can facilitate GHG reductions outside of its own operations (see the related recommendations in Section II of this report). These anticipated reductions should help dictate the level of grant funding for projects, and projects with major reduction potential should be eligible for funds from both the state and federal grant pools.

- **Requirements for projects to incorporate likely climate impacts into their design (based on best-available data)** – Virtually none of the model building codes and other design standards that jurisdictions typically apply to infrastructure projects currently consider risks from climate change impacts.[170] The Government Accountability Office has recommended that the federal government proactively provide climate projections to standards-developing organizations and help facilitate the inclusion of this information in new codes and standards.[171] The Commerce Department should take the lead on interagency efforts to implement this recommendation. But until such updates are complete, project developers and states seeking grants should incorporate the best available local climate impact projections into their project design and planning. In order to receive grants, developers should be required to show evidence of how projects are being designed to account for these expected climate impacts.

- **Requirements for projects to demonstrate evidence of inclusive planning, including input from relevant frontline communities** – As discussed in Section I, infrastructure development can be a powerful vehicle for increasing economic opportunity and promoting equity, but only if the needs of disadvantaged communities are accounted for in project design and selection. Project developers and states seeking federal grants should be required to show that they have solicited and incorporated considerable input from all relevant communities that would be served by (or excluded by) an infrastructure project. This outreach should include communication with frontline communities and cooperation with relevant community groups to solicit input. In theory, these inclusive planning efforts should already be prioritized in the scoping process for NEPA review and other early-stage outreach, but such activities should be required for all projects that receive federal grants.

- **Employment criteria, such as fair-wage guarantees and reasonable benefits, for all projects that receive grants** – The employment impacts of a major grant program for sustainable infrastructure could be considerable, and the program should be designed to ensure that newly created jobs pay fair wages and offer appropriate benefits. The Davis-Bacon Act and related prevailing-wage provisions mandate that construction jobs funded by many federal programs offer prevailing wages and fringe benefits.[172] But maintenance and operations jobs on many projects use public-private-partnership models that are not covered by any wage or job-quality standards.[173] And even when standards do apply, the prevailing wage and benefit rates in many areas fall below the living wage.[174] An infrastructure grant program should establish a wage/benefits floor for all jobs associated with grant-funded projects, so that projects offer economic security to workers, even in regions with low prevailing wages.

- **Policies to limit the "coupon effect" and encourage new sources of outside funding** – Analysts have highlighted how the possibility of federal funding sometimes slows efforts to raise other capital and develop projects, as developers and officials wait to see if federal funds will be granted.[175] To overcome this "coupon effect," a grant program should create incentives for external funding or financing. Projects should be required to raise a portion of necessary funds outside the federal grant process so that grants function in a manner akin to a matching program, amplifying investment for sustainable infrastructure projects that meet grant program criteria. In order to receive its full pool of grant funding, each state will need to develop a slate of inclusively planned, low-GHG projects that have some private or state funding. The Department of Transportation's Smart City Challenge successfully employed a competitive grant program that offers some lessons for this model,[176] though a new infrastructure grant program could feature larger pools of funding and more transparency about the likelihood of securing grants.

- **Requirements to incorporate maintenance planning** – Infrastructure maintenance often suffers from a lack of adequate focus and funding, hindering the ability of existing infrastructure to provide adequate social benefits.[177] Projects seeking grants should be required to provide detailed maintenance plans and funding sources to help ensure that this critical area is not overlooked after projects are built.

An infrastructure grant program with these design elements could play a pivotal role in accelerating desirable and economically beneficial projects around the country. As Congress explores options to rebuild the U.S. economy in the wake of the Covid-19 pandemic, this type of program should be prioritized.

V. Moving Toward Net-Zero Construction

Action is needed now to make it possible for the next generation of infrastructure projects to be compatible with climate goals. Construction materials such as cement, steel, iron, and glass are highly GHG-intensive. Decarbonizing the production processes for these materials (or developing suitable alternatives) will likely take decades, and it will require policy changes as well as sustained R&D efforts.

Assessments of GHG emissions from the built environment often focus on the operational phase of a structure's life, such as emissions associated with heating, cooling, or normal use of equipment. However, 30 to 70 percent of a structure's lifecycle carbon emissions can come from "embodied" carbon emissions—those that result from the extraction, manufacture, transportation, assembly, maintenance, and deconstruction of a structure's materials.[178] Embodied carbon emissions from the built environment make up a significant portion of global carbon emissions as a whole, with recent estimates ranging from 11 percent[179] to 23 percent.[180]

Reducing the emissions associated with a few major building materials could drastically reduce embodied carbon emissions for most categories of infrastructure. Cement production alone has been estimated to account for 4 percent[181] to 7 percent[182] of total global carbon dioxide emissions, while steel production accounts for roughly 5 percent.[183] While it is notoriously difficult to decarbonize the production of these (and other) construction materials, research has identified a number of promising options,[184] and near-term federal efforts can jumpstart the process.

Cement production alone has been estimated to account for 4 to 7 percent of total global carbon dioxide emissions.

Congress can drive transformational change in the construction sector by establishing long-term, aggressive lifecycle-emissions standards for all infrastructure projects that receive federal support. These standards can push project developers to use less GHG-intensive materials in the near term while pursuing systemic changes that can put the construction industry on a path toward net-zero emissions in the coming decades. To accelerate the development of carbon-neutral materials and manufacturing processes, Congress should also dramatically expand R&D efforts in this area, with a significant focus on manufacturing, supply chain, and market development issues.

These are sensible federal investments, especially in light of the fact that the federal government is a major developer of infrastructure and the largest owner of buildings in the country.[185] The United States is also the world's largest importer of embodied carbon.[186] With new, forward-looking policy changes, Congress can chart a path toward carbon-neutral infrastructure construction by mid-century, and build U.S. capacity in growing clean-construction markets.

Embodied-Carbon Performance Standards

Congress should establish embodied-carbon performance standards for the materials used on all federally supported infrastructure projects, targeting net-zero-GHG construction by roughly 2050. These standards, which could be supported by new analytical methods for measuring embodied carbon (discussed in Section II), should apply to all projects that receive any federal financing, grants, or other project support. **This legislation should also offer significant tax incentives for private-sector developers that choose to adhere to the standards.** These standards would guarantee a market for new, low-GHG materials that might initially cost more than traditional options, reinforcing the success of the R&D efforts discussed below.

Past U.S. technology-forcing policies have spurred breakthroughs that redefined key domestic industries.

Past U.S. technology-forcing policies have spurred breakthroughs that redefined key domestic industries. The 1970 Clean Air Act required dramatic emissions reductions for automobiles that would be manufactured only five years later, presenting technical and economic challenges that some viewed as insurmountable.[187] Yet the EPA automobile standards that resulted from the legislation successfully forced the development and adoption of landmark pollution-control technologies including the catalytic converter in 1975 and the three-way catalyst in 1981.[188] Embodied-carbon performance standards for construction materials could use a much longer timeline, and benefit from extensive federal R&D support.

The success of technology-forcing standards often depends on such factors as sufficient inter-firm competition to stimulate aggressive R&D, and credible enforcement.[189] Competition will likely be substantial if policies promoting clean construction materials take hold in the United States and potentially other countries. To aid with enforcement, Congressional legislation should establish stringent non-compliance penalties and robust oversight resources so that future federal agency discretion or political interference do not result in toothless enforcement.

Federal embodied-carbon standards could be modeled in part on California's Buy Clean program. The Buy Clean California Act, adopted in 2017, establishes a process wherein certain construction materials (structural steel, carbon steel rebar, flat glass, and mineral wool board insulation) will be assigned a maximum acceptable lifecycle global-warming potential, and state entities will only be allowed to purchase materials with embodied emissions below that level.[190] The

program is expected to reduce imports of GHG-intensive steel and other materials while boosting cleaner domestic alternatives.[191] The House Energy and Commerce Committee has laid out one potential version of a federal "Buy Clean" program in the discussion draft of the CLEAN Future Act.[192]

Federal embodied-carbon standards should target net-zero emissions by mid-century, with enforceable milestones in intervening years. Near-term milestones can motivate procurement choices that achieve some significant embodied-carbon reductions. For instance, the energy- and GHG-intensity of steel can vary significantly from one mill to another as well as from one country to another.[193] If the developers of the Oakland Bay Bridge project had accepted bids from steel mills in California and Oregon rather than from a more carbon-intensive Chinese mill, the project could have avoided an estimated 180,000 metric tons of carbon emissions.[194] Multi-stage federal standards could help ensure that project developers support manufacturers that are using cleaner and more efficient production processes now, while also establishing clear market expectations for the coming decades and spurring private R&D investment. The suggested procurement policies and tools described in Section III of this report can help systematize the sourcing of low-GHG building materials, with options being updated as the standards tighten over time.

If legislation along these lines proves to be politically infeasible, a future administration should pursue executive actions with similar aims. The EPA could work to regulate emissions from various industrial sectors pursuant to Section 111(d) of the Clean Air Act, addressing GHGs from the production of many types of construction materials. Because such actions could lead to carbon leakage through increased imports of GHG-intensive materials, an administration could concurrently work to implement border adjustments on such materials. A legislative approach focused on standards for projects should still be prioritized, as it would likely be more efficient and have less significant leakage concerns.

R&D for Clean Construction Materials

Many different federal entities are involved in a patchwork of R&D activities relevant to decarbonizing industrial materials. For instance, the Commerce Department's National Institute of Standards and Technology led an effort to measure the performance of low-carbon concrete.[195] The DOE's Advanced Research Projects Agency – Energy (ARPA-E) coordinates a program focused on manufacturing, processing, and recycling light metals that could compete with steel for some infrastructure projects.[196] The DOE's Advanced Building Construction Initiative works to ensure that new approaches in building fabrication, materials, and logistics align with energy efficiency goals.[197] And the National Academies of Science, Engineering, and Medicine (NASEM) is in the midst of a major project to analyze the technology, policy, and societal dimensions of accelerating decarbonization in the United States, including a focus on R&D needs.[198]

Congress should vastly expand federal R&D efforts related to low-carbon construction materials and industrial decarbonization, and create a program structure that integrates manufacturing, supply chain, and market development activities into R&D efforts. A centralized coordinating body should be tasked with setting R&D priorities and managing collaboration and communication between different federal programs. This coordinating body should collaborate closely with industry partners to assess needs and barriers to commercial viability. The NASEM is well suited to play a prominent role in R&D coordination, building on the findings of its decarbonization study.

Several key areas of inquiry should be prioritized for clean materials R&D. It will be critical to decarbonize sources of industrial heat for the production of steel, cement, glass, and other materials. Steel blast furnaces and cement kilns typically operate at more than 1000°C, and require constant or on-demand heat. Nearly half of the GHGs emitted from

these industrial processes are a result of fossil-fuel combustion to generate high temperatures.[199] Producers of these materials could potentially use hydrogen combustion as a substitute heat source. Blue hydrogen (from the reforming of natural gas, with carbon capture) would add roughly 10-50 percent to production costs, and could pave the way for use of cleaner green hydrogen (from electrolysis of water, powered by renewable energy) once costs drop.[200] A pilot carbon-free steel plant that uses green hydrogen began operating in Sweden in late 2020; this and other international examples could offer lessons for U.S. efforts.[201] U.S. clean materials R&D should explore new methods to cost-effectively deploy hydrogen as an industrial heat source.

R&D efforts should also focus on carbon capture, utilization, and storage (CCUS) applications that are relevant for construction materials. Experts have highlighted the potential to use captured carbon to create construction materials including concrete, aggregate, and plastics.[202] Several companies have made significant strides in using captured carbon dioxide to create low-GHG cement (a primary input for concrete),[203] and additional R&D support could likely speed the timeline for bringing such materials to market. Analysts currently see CCUS as the most cost-effective way to decarbonize production processes for steel, cement, glass, ceramics, petrochemicals, and other materials used in construction.[204] CCUS also offers a promising "carbon management" option that could allow materials manufacturers, infrastructure developers, and others to offset GHG emissions that cannot easily be reduced, through point-source carbon capture or direct air capture.[205]

An expanded R&D program should target all phases of the project lifecycle, seeking to stimulate early-stage innovations that create new products and processes as well as addressing barriers related to manufacturing, supply chain constraints, and market penetration. These later-stage concerns should be integrated into the design of early-stage R&D programs, with the entire network of federal clean-materials R&D efforts following a framework informed by best practices from past successful R&D initiatives.[206]

These efforts to boost development of cleaner construction materials could have enormous economic benefits for American industry. As more countries embrace ambitious emissions-reduction targets, the demand for low-carbon construction materials is likely to grow precipitously. Securing a first-mover advantage in this sector could help bolster U.S. competitiveness for decades. Federal R&D spending has a successful track record in furthering U.S. innovation and competitiveness, as nearly one-third of U.S. patents have stemmed from federally funded research.[207] Without ambitious clean-materials R&D, the construction of new infrastructure projects will likely continue to exacerbate the climate crisis for the foreseeable future.

Conclusion

American infrastructure is in urgent need of modernization, and new federal infrastructure policy efforts can be enormously beneficial. Federal policymakers should work to advance a wide range of sustainable infrastructure projects in order to address threats from climate change, rebuild the economy in the wake of the Covid-19 pandemic, and improve social equity.

Stimulating the development of desirable projects will require policy changes at every stage of the infrastructure project lifecycle, from project planning and analysis, through procurement, financing, construction, and maintenance. Both executive and legislative actions will be needed in this process.

Executive branch efforts can greatly improve early-stage development of infrastructure projects. New reforms can encourage holistic, inclusive infrastructure planning; improve processes and methodologies for analyzing projects' climate impacts; accelerate the permitting process for targeted projects; and establish new procurement policies and resources to help ensure that environmental goals are appropriately considered when federal entities invest in infrastructure assets or related goods and services.

Congress has a critical role to play in advancing sustainable infrastructure. Given the enormous magnitude and diversity of infrastructure projects needed to put the United States on a net-zero or low-GHG pathway, it is critical to establish stable, long-term financing mechanisms for a broad range of projects. Lawmakers can provide necessary sources of financing through such actions as the creation of a national infrastructure bank, the expansion of loan guarantee programs, and the establishment of a sustainable infrastructure grant program. Congressional action is also needed to put the construction industry on a path toward net-zero emissions. New embodied-carbon standards for federally supported infrastructure projects and a robust R&D program for clean building materials can help pave the way for carbon-neutral infrastructure projects.

These recommendations can help establish a cohesive infrastructure policy that helps stimulate a broad range of socially beneficial infrastructure projects, creating widely distributed economic benefits while meaningfully addressing climate change.

Summary of Policy Recommendations

The administration should prioritize the following executive-branch actions:

Planning, Evaluating, and Permitting Projects

(1) The Executive Office of the President should **articulate a federal vision for infrastructure, emphasizing the need for projects to be compatible with an economy-wide net-zero emissions pathway by mid-century.** It should also work to **coordinate infrastructure needs assessments and long-term planning efforts among all federal agencies.**

(2) The Council on Environmental Quality should compile **guidance on best practices for inter-sectoral infrastructure planning for states**, and encourage robust planning efforts through dialogue with state policymakers.

(3) Federal agencies should work to **ensure that all early-stage environmental reviews conducted under the National Environmental Policy Act (NEPA) align with best practices for strategic environmental assessments**, and the Council on Environmental Quality should **encourage similar assessments at the state level** by providing guidance and resources.

(4) The Council on Environmental Quality should further **systematize the environmental review process under NEPA by issuing new guidance on analyzing climate impacts**, with specific details on:

   a. The scoping process for environmental impact statements

   b. Guidelines for appropriate analysis and monetization of direct, upstream, and downstream GHG emissions impacts

   c. Tools for GHG emissions estimation

   d. Calculating avoided GHG emissions and carbon sequestration potential

   e. Using consistent assumptions and scenarios

   f. Establishing appropriate baselines

   g. Incorporating expected climate impacts into project design and analysis

(5) The Council on Environmental Quality should convene an interagency working group to develop a **standardized system for estimating the "embodied carbon" in the construction materials of infrastructure projects**, and require this disclosure in NEPA reviews once it is sufficiently developed.

(6) The Executive Office of the President should direct the Federal Permitting Improvement Steering Council (FPISC) and relevant federal agencies to **accelerate the permitting process for sustainable infrastructure projects while maintaining robust environmental review**. The FPISC should prioritize low-GHG projects, and agencies should make all possible efforts to **increase dedicated staffing/resources focused on expedited permitting**.

Infrastructure-Related Procurement

(7) The Office of Management and Budget's Office of Federal Procurement Policy should issue **new federal procurement rules** requiring that purchases and projects **target net-zero GHG emissions by 2050, inclusive of long-lived assets built before 2050**.

(8) The General Services Administration should **update the Sustainable Facilities procurement tool**, which helps identify procurement options with desirable environmental attributes, to more specifically target carbon-neutral and low-GHG options.

(9) New executive actions and General Services Administration rules should target **more stringent vehicle-emissions goals for federal fleets**, with the aim of procuring only zero-emissions light-duty vehicles by 2030, and only zero-emissions vehicles for all classes of by 2050.

(10) The Department of Defense should commit to **military procurement policies that are compatible with a goal of net-zero GHG emissions by 2050**, inclusive of long-lived assets procured before 2050.

(11) The President should issue new a **policy directive on procuring emissions-free federal energy assets, and appoint new Tennessee Valley Authority directors who are committed to transitioning the Authority toward 100 percent carbon-free electricity** by mid-century.

(12) The Department of Energy's federal power marketing administrations should **use existing authority to develop high-voltage transmission projects without state veto**, providing something of an indirect procurement option for desirable transmission projects.

(13) The General Services Administration should create **new federal resources to assist with pooled procurement**, so that state and local governments pursuing similar sustainable infrastructure investments can negotiate with vendors cooperatively rather than competitively.

Congress should pursue the following legislative priorities:

Financing and Grants

(1) Establish and capitalize a **national infrastructure bank** to provide a stable, long-running source of financing for sustainable infrastructure projects. Lawmakers should also amend the Federal Credit Reform Act of 1990 so that the bank is authorized to use loan repayments to continually issue new loans, untethered from the Congressional appropriations process.

(2) Fund **extensive loan guarantee programs** to help a broad range of sustainable infrastructure projects secure financing.

(3) Create a **robustly funded federal grant program for sustainable infrastructure projects** with the following design elements:

   a. Separate pools of funding for each state, to pursue locally valued mitigation or adaptation projects

   b. A federal funding pool for priority interstate/federal projects

   c. Requirements for long-lived infrastructure assets to be consistent with net-zero-GHG pathways

   d. Grant amounts based in part on the level of emissions reductions a project can facilitate

   e. Requirements for projects to incorporate likely climate impacts into their design (based on best-available data)

f. Requirements for projects to demonstrate evidence of inclusive planning, including input from relevant frontline communities

g. Employment criteria, such as fair-wage guarantees and reasonable benefits, for all projects that receive grants

h. Policies to limit the "coupon effect" and encourage new sources of outside funding

i. Requirements to incorporate maintenance planning

Moving Toward Net-Zero Construction

(4) Establish **embodied-carbon performance standards for the materials used on all federally supported infrastructure projects**, targeting net-zero-GHG construction by roughly 2050. Offer significant **tax incentives for private-sector developers that choose to adhere to the standards**.

(5) Vastly **expand federal research and development efforts related to low-carbon construction materials**, including cement and steel. Structure these programs to better integrate R&D with manufacturing, supply chain, and market development activities, and establish a centralized coordinating body to set R&D priorities and manage collaboration.

These recommendations can help accelerate a broad range of desirable infrastructure projects, creating widely distributed economic benefits while meaningfully addressing climate change.

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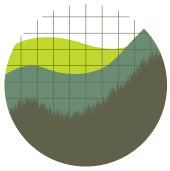

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