McKinsey Sustainability

Delivering transformative impact from US green bank financing

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Preface

This report offers an analysis of potential climate, health, and economic benefits from US green bank financing under the new Greenhouse Gas Reduction Fund (GHGRF), an Inflation Reduction Act of 2022 (IRA) initiative. In particular, the analysis focuses on funds disbursed through the GHGRF and their projected capacity to enable favorable effects, including private investment. Because the GHGRF includes a mandate to promote beneficial outcomes in disadvantaged communities and advance environmental justice in the United States, this report views potential impacts through that lens.

A set of 11 climate technologies that could be supported by the GHGRF are assessed as part of the analysis. Their potential impacts are measured in terms of expected greenhouse-gas (GHG) emissions reductions, job creation, cost savings, and health benefits for disadvantaged communities and across the United States as a whole. For each technology, McKinsey modeled estimated public- and private-capital deployment, the associated technology adoption rates, and the potential impact on the above-mentioned metrics. Established, recognized methodologies were applied to estimate emissions reductions and job creation from deploying these climate technologies, drawing on publicly available data. All emissions impact analyses align with overarching standards for estimating avoided and reduced emissions resulting from renewable-power generation, fuel-switching savings, and energy efficiency savings.

The potential impact on job creation was developed using an employment multiplier approach consistent with International Labour Organization guidance on estimating job-creating impacts from green and sustainability investments; specific factors were drawn from ranges based on US Bureau of Labor Statistics data. Cost savings include benefits from IRA financial incentives and were calculated from specific user costs for incumbent versus alternative low-carbon technologies. The Environmental Protection Agency's CO-Benefits Risk Assessment (COBRA) health impacts screening and mapping tool was used to calculate health impacts. Additional detail on approaches is included in this report, and a methodological annex is available on request.

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Executive summary

For well over a decade, green bank financing has channeled public dollars into private investments in green energy and climate transition in nations around the world and at the state and local levels in the United States. It is also the model chosen to disburse $20 billion of the $27 billion authorized in the Greenhouse Gas Reduction Fund (GHGRF), an Inflation Reduction Act of 2022 (IRA) initiative.[1] As the analysis in this report illustrates, well-coordinated and strategically targeted green bank financing could advance environmental justice through investment in disadvantaged communities. The analysis also shows this financing can help mobilize hundreds of billions in investment dollars toward achieving net-zero greenhouse-gas (GHG) emissions by 2050.

To reach net zero by 2050, the United States could need an estimated $27 trillion in climate investment.[2] Green bank financing could play a significant role in catalyzing this investment over the next decade. This report focuses specifically on the estimated need for and impact of investment in 11 key technologies across three themes—household and community decarbonization, business decarbonization, and energy system transformation. Aiding these particular investments could advance the GHGRF's dual goals of reducing emissions and benefiting disadvantaged communities while also fulfilling its mission to provide "additionality" through investments that would not have occurred without its funding.

As set out in this report, these 11 technologies will need substantial volumes of financing to realize their potential along the country's net-zero pathway. Over a decade, they would need an estimated $200 billion invested in disadvantaged communities and more than $1 trillion in total investment:

— $215 billion to decarbonize and deploy solar in households and communities

— $100 billion for businesses to deploy solar, decarbonize heating, and develop electric-vehicle charging infrastructure

— $700 billion to boost offshore wind power, deploy long-duration energy storage and transmission, and support the conversion of coal plants to new uses

Building to $1 trillion will take time. This analysis estimates that green bank financing could mobilize more than 12 times the GHGRF's public investment over ten years through appropriate, balanced leverage and private co-investment. This means that $20 billion in GHGRF funding, leveraged into $250 billion in combined public financing and private co-investment, could kick-start critical systemwide change. This $250 billion could empower innovation and creativity in channeling investment to communities that struggle to access finance, deliver transformational impact in disadvantaged communities, and contribute up to one-sixth of the emissions reductions needed over the next ten years on the pathway to 2050 US emissions goals.

According to this analysis, in a ten-year period, targeting this volume of leveraged green bank financing toward the 11 identified technologies could create 380,000 direct jobs, realize $30 billion in cost savings (over the expected lifetime of new investments), and avoid thousands of early deaths by reducing air pollution in disadvantaged communities. These benefits accompany broader benefits across the United States as a whole—including 850 metric megatons of GHG emissions reductions (CO_2), one million direct jobs, and $100 billion in cost savings—helping the United States

[1] The GHGRF includes a further $7 billion for states, municipalities, and tribal governments to finance zero-emission technologies in low-income and disadvantaged communities. For more, see "About the Greenhouse Gas Reduction Fund," US Environment Protection Agency, updated February 14, 2023.
[2] "Navigating America's net-zero frontier: A guide for business leaders," McKinsey, May 5, 2022.

make strong progress toward its climate ambitions. Realizing this scale of impact will also require careful governance and management to avoid mismanagement of funds, reduce frictions or waste, and avoid the crowding out of private investment—all of which could divert funding from its intended goals and reduce the impact potential of GHGRF support.

Five principles are critical to ensure and expedite the potential for GHGRF-funded investments to help realize national climate and environmental justice ambitions:

1. *Target investment based on measurable impact potential.* Defining comparable impact metrics and deliberately targeting financing to communities and technologies that deliver the greatest emissions reductions and equitable gains can amplify the effectiveness per dollar invested.

2. *Gain optimal leverage of private capital from GHGRF funding.* Employing deep financing expertise to raise capital and achieve substantial private cofinancing from the initial GHGRF funding, while remaining conscious of specific challenges in disadvantaged communities, can drive greater scale for direct green bank financing.

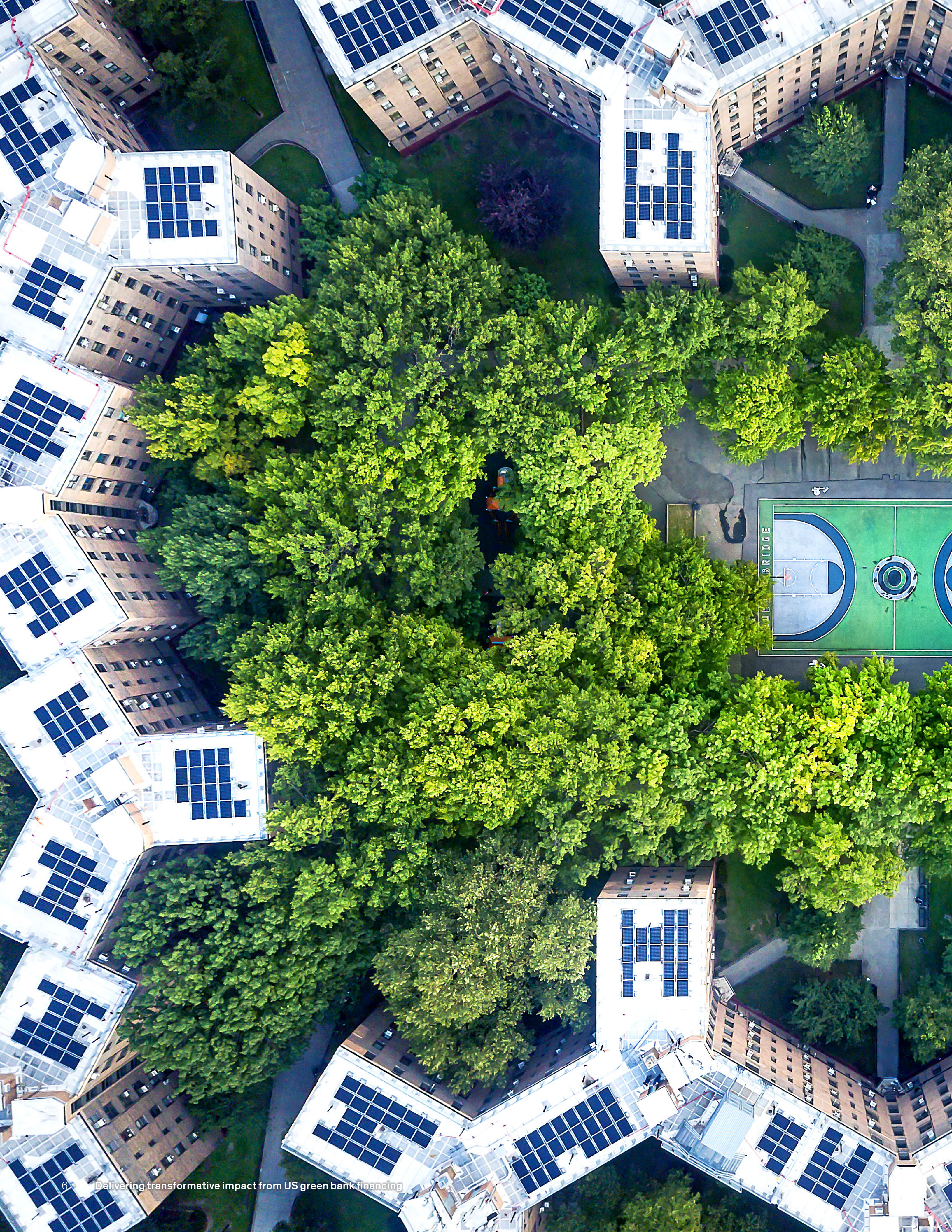
3. *Catalyze markets at scale by flexibly deploying a mix of financing approaches.* Disciplined approaches that incorporate continual market feedback and strategic review and that adjust to changing conditions and market needs can foster the catalyzation of sustainable, full-scale private financing in the future. Sharing learnings from successful financing approaches and investment performance can also boost knowledge and aid replication across regions.

4. *Galvanize a distributed financing network aligned with a national vision.* Tapping into existing institutions' local knowledge and expertise to reach customers and stimulate demand and uptake can enable broader and faster distribution of investment, especially to nationally prioritized disadvantaged communities.

5. *Mobilize GHGRF funding quickly through a range of established mechanisms.* Rapidly deploying GHGRF funding—for example, by using existing project pipelines and managing liquidity across multiple facilities—can accelerate the virtuous circle of direct investment, private-capital leverage, capital recycling, and the "learning by doing" that drives market transformation at the scale and pace needed to achieve US climate targets.

These principles are reinforced by the quantitative assessment and analysis of GHGRF funding's potential and are critical components of its capacity to help achieve White House climate objectives to reduce emissions, create jobs, reduce costs, build green infrastructure, improve health, and advance environmental justice.

By including environmental-justice objectives in the GHGRF and setting the net-zero deadline for 2050, the United States has set the stage for investors to expand the potential of green bank financing with bold yet balanced and deliberate tactics. Climate transition, as well as equity in the distribution of its benefits, is an essential mission that calls for specialized knowledge, proven approaches, and scrupulous assessment and reflection. The analysis in this report illustrates the strong potential for green bank financing to accomplish climate and environmental-justice goals and to spark wider-ranging private investment and public–private collaborations in the United States.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1. Green legislation sparks new green-investment opportunity

The United States has reached a pivotal moment in climate transition and environmental justice, brought about by recent momentum in green legislation and investment. Since 2021, the US government has passed three pieces of legislation aimed at shifting capital flows into green technologies. The American Rescue Plan Act of 2021 provides funding to mass transit systems and to state and local governments for infrastructure improvements to water and sewage services.[3] The Infrastructure Investment and Jobs Act of 2021 allocates funding for infrastructure projects such as electric-vehicle (EV) charging infrastructure, transmission and distribution upgrades, and electrification and efficiency in buildings. Most recently, the Inflation Reduction Act of 2022 (IRA) directs new federal spending toward climate objectives.[4]

The IRA could provide nearly $400 billion or more in investments and incentives for technologies and initiatives that address climate change and environmental justice, based on data released by the Congressional Budget Office (CBO) and the Joint Committee on Taxation (JCT).[5] Some of the programs direct federal funding to a loan authority—the Department of Energy's Loan Programs Office—providing almost $400 billion in potential additional investment.[6] The IRA seeks to direct and catalyze investments into addressing climate, along with its objectives for healthcare and the federal deficit. The US Congressional Research Service (CRS) estimates the IRA, in combination with other policies, could help reduce 2030 carbon emissions to 40 percent below 2005 levels with a combination of tax breaks, subsidies, and funding for large-scale climate investments (see sidebar "US emissions goals").[7] The IRA could also drive more investment than estimated by the CBO in the event of larger-scale uptake of incentives and tax credits, faster market transformation, and greater cost reductions than suggested in the initial CRS analysis.

The IRA includes $27 billion earmarked for climate financing as part of the Greenhouse Gas Reduction Fund (GHGRF), of which $20 billion is intended to promote green bank financing and amplify and create incentives for investment in disadvantaged communities. This funding seeks to provide financial and technical assistance for projects that reduce or prevent GHG emissions and other forms of air pollution. At least 40 percent of this $20 billion is targeted to low-income and disadvantaged communities.[8] The GHGRF also includes $7 billion for states, municipalities, and tribal governments to finance zero-emission technologies in low-income and disadvantaged communities.

Green banks have operated at state and local levels across the United States and at the national level in several countries, including Australia, India, Japan, South Africa, and the United Kingdom. Green bank financing uses public funding to mitigate barriers to climate investment, crowd in private financing, and enable and accelerate the deployment of climate technologies, services, and new business models. By using financial solutions to address specific, deal-level barriers; reducing risk and building confidence in novel

3 American Rescue Plan Act of 2021, Pub. L. No. 117-2, 135 Stat. 4, 2021.
4 "Fact sheet: President Biden's leadership to tackle the climate at home and abroad galvanizes unprecedented momentum at start of U.N. Climate Conference (COP27)," White House, November 7, 2022.
5 "The Inflation Reduction Act drives significant emissions reductions and positions America to reach our climate goals," US Department of Energy, August 2022.
6 "The Inflation Reduction Act: Here's what's in it," McKinsey, October 24, 2022.
7 Ryan Jones et al., *Preliminary report: The climate and energy impacts of the Inflation Reduction Act of 2022*, Princeton University ZERO Lab, August 2022.
8 Inflation Reduction Act of 2022, Pub. L. No. 117-169, 136 Stat. 1818, 2022.

US emissions goals

The United States will need to invest up to $900 billion annually—four times its current average annual clean-energy investment—over the coming decades to meet its climate and environmental-justice objectives.[1] The United States has committed to reaching net-zero greenhouse-gas (GHG) emissions by 2050 and reducing its GHG emissions to 50 percent of 2005 levels by 2030.[2] Meeting this 2030 target calls for an annual emissions reduction of 6.0 percent, more than six times the 0.8 percent average annual reduction during the last decade,[3] and an average annual investment of $900 billion, or 4.0 percent of 2021 US GDP.

1 "Navigating America's net-zero frontier: A guide for business leaders," McKinsey, May 5, 2022; World Energy Investment 2022, International Energy Agency, June 2022.
2 *The long-term strategy of the United States: Pathways to net-zero greenhouse gas emissions by 2050*, US Department of State and the US Executive Office of the President, November 2021.
3 "Navigating America's net-zero frontier," May 5, 2022.

green investments; lowering financing costs; and bolstering broader financial market development, green bank financing can mobilize investment.[9] This includes helping enable private investment and flexibly drawing down and redirecting financing to new areas once private investors are ready and able to invest without public assistance.

Nonprofit organizations that meet GHGRF eligibility requirements may apply for up to $20 billion in funds to deploy green bank financing that mobilizes private investment.[10] Recipients may invest directly at the national or subnational level and indirectly through intermediaries at the regional, state, and community level; they may also provide other forms of financial and technical assistance.

Advancing environmental justice

Environmental justice refers to the fair treatment and involvement of all groups in the development, implementation, and enforcement of environmental policy, law, and regulation.[11] Disadvantaged communities commonly include people of color, low-income people, and members of other groups that face social and economic disadvantages more broadly. The communities themselves are historically underserved by public and private services and overburdened by environmental hazards (see sidebar "Identifying disadvantaged communities").[12]

Environmental justice is a key component of recent federal climate action, as embodied in Executive Order 14008, signed in January 2021.[13] The order instructed all US cabinet secretaries and the US attorney general to make achieving environmental justice part of their departments' missions. The GHGRF's mandate to allocate at least 40 percent of the $20 billion for green bank financing to benefit disadvantaged communities is an outgrowth of this directive.

Advancing environmental justice goals alongside emission reduction objectives requires investing in disadvantaged communities that have historically faced difficulty accessing financing. Lack of access to financial services is both a symptom and a source of disadvantage because economic mobility is predicated on the ability to use savings, investments, loans, and insurance. Supporting disadvantaged communities requires improving financial inclusion and delivering investments

9 *Green investment banks: Scaling up private investment in low-carbon, climate-resilient infrastructure*, OECD, May 31, 2016.
10 Inflation Reduction Act of 2022.
11 "Environmental justice," US Environmental Protection Agency, updated January 10, 2023.
12 Brenda Mallory, Gina McCarthy, and Shalanda D. Young, "Memorandum for the heads of departments and agencies," Executive Office of the President, July 20, 2021.
13 Joseph R. Biden, "Executive Order on tackling the climate crisis at home and abroad," White House, January 27, 2021.

Identifying disadvantaged communities

This analysis identifies disadvantaged communities (DACs) using the working definition developed by the Department of Energy (DOE) to support implementation of the White House's Justice40 Initiative. This approach draws on a review of established indexes of disadvantage and external and interagency engagement, defining DACs at the census tract level based on their cumulative burden across 36 burden indicators in four categories: fossil-fuel dependence, energy burden, environmental and climate hazards, and socioeconomic vulnerabilities.

Cumulative burden is calculated as the sum of percentile values across each of the 36 burden indicators at the census tract level. Each tract is ranked by cumulative-burden score. Census tracts in the top 20 percent and in which at least 30 percent of households are classified as low-income are identified as DACs. This methodology identifies 18.6 percent of US census tracts as DACs.[1]

[1] For more information on DOE-defined DACs, see "Justice40 Initiative," Office of Economic Impact and Diversity, accessed October 17, 2022.

at a local level. GHGRF funding creates new opportunities to innovate approaches to channeling investment toward disadvantaged communities that have struggled to access capital and finance.

Within the context of the GHGRF's dual mission to advance climate impact and environmental justice, this report examines green bank financing across three key themes and 11 technologies and assesses the potential resulting environmental, economic, and social impacts. More broadly, it explores and illustrates the potential impact of GHGRF-enabled green bank financing to drive change in disadvantaged communities and across the United States.

2. Identifying technologies to make the most of green bank financing

Concentrating GHGRF-enabled financing on technologies and groups that would otherwise lack access to financing, especially in low-income and disadvantaged communities, can help deliver on its aims. Specifically, using this financing to mobilize low-carbon technology investments that would not have happened without this financing can help avoid crowding out the private sector and enhance the impact of GHGRF funding. And GHGRF-enabled financing can boost its overall efficacy by addressing barriers to investment such as insufficient household income, limited access to finance, high up-front technology costs, long payback periods, coordination challenges, first-mover costs, and a lack of recompense for "public good" investments.

GHGRF-enabled financing can foster additionality using two general approaches:

— *Support communities and groups that face challenges in accessing financing and investing in climate technologies.* Extending access to financing for climate-related investment to groups that could not otherwise obtain funding can enhance the additionality of funding and investments. This could involve extending financing access to households and businesses in disadvantaged communities for new decarbonization technologies such as heat pumps or rooftop solar. Additionality gains could also be realized by reducing up-front costs for households that would otherwise be unable to afford to purchase and install new technologies.

— *Support projects, technologies, and new business models that cannot currently access financing but could become scalable and investable in the future.* By investing in projects and technologies that cannot access private finance or by co-investing to enable private investment, GHGRF-enabled financing can help develop and deploy new technologies and markets. In addition to enabling climate impacts, broad deployment of technologies can help drive down costs, establish new markets, and facilitate even wider deployment over time.

This market development can also provide indirect benefits to disadvantaged communities, along with direct climate and socioeconomic benefits from investments in these communities. Examples of this include supporting high-cost emerging technologies such as offshore wind power generation or alleviating coordination and infrastructure investment challenges that stop small businesses from investing in EVs.

Framed by these two approaches to additionality, this report's analysis considers the potential impact from GHGRF-enabled financing associated with investments across a set of themes and technologies. Given the GHGRF's emphasis on using funding to advance environmental justice, the analysis also considers deployment approaches that prioritize disadvantaged communities and address both business and household or community decarbonization. In addition, the analysis considers the impact potential associated with targeted assistance for broader investments in energy system transformation, where GHGRF-enabled financing could complement existing initiatives. This complementary aid could involve using specific financing approaches or focusing on enabling investment and impact in disadvantaged communities.

To inform this analysis, 11 climate mitigation technologies across three themes were identified with input from a coalition of lenders and investors focused on green investment and disadvantaged communities. These themes and technologies represent areas in which GHGRF financing could drive additional investment, advance the GHGRF's mission to create additional impact, and help overcome considerable adoption challenges.[14]

In some cases, assistance for a given technology may be best suited to a particular time in its development; similarly, financing might be best suited for deployment to benefit specific groups. GHGRF-enabled financing could extend its reach for some technologies by piggybacking on government incentives for consumers and businesses. However, in cases where technologies are substantively supported by existing state or federal government initiatives, care should be taken not to duplicate efforts. In these situations, the added value of complementary assistance alongside government programs or via investment in disadvantaged communities should be carefully

Exhibit 1

Funding from the Greenhouse Gas Reduction Fund could support additional impact and benefit disadvantaged communities.

Theme	Technology	Rationale for GHGRF[1] support
Household and community decarbonization	• Residential rooftop solar and battery • Residential heat pumps • Heat pump water heaters • Community solar	High additionality potential for supporting disadvantaged communities by defraying high up-front costs that make this technology otherwise unaffordable and helping to ease coordination issues for community-wide investments
Business decarbonization	• Commercial heat pumps • Commercial rooftop solar and battery • Fleet depot electric-vehicle chargers	High additionality potential in disadvantaged communities and businesses more broadly, including defraying high up-front costs, helping scale the speed of deployment, and overcoming coordination challenges across small businesses
Energy system transformation	• Transmission	High additionality potential if targeted toward critical interconnections and areas of historical underinvestment to overcome issues of financial viability and coordination
	• Offshore wind	Additionality potential for investments focused on early-stage market making to improve economic viability in the face of current high costs and demonstrate feasibility on permitting and planning
	• Long-duration energy storage	High additionality potential for investments targeted at areas faced with historical underinvestment and with high synergy with other sectors; battery storage could be used to eliminate inefficient peaker power plants located disproportionately in disadvantaged communities
	• Coal conversion	High additionality potential for investments focused on disadvantaged communities and deployed to complement additional efforts to support coal conversion; for example, investments could help lower customers' costs from converting coal installations while complementing existing conversion initiatives

[1]Greenhouse Gas Reduction Fund.

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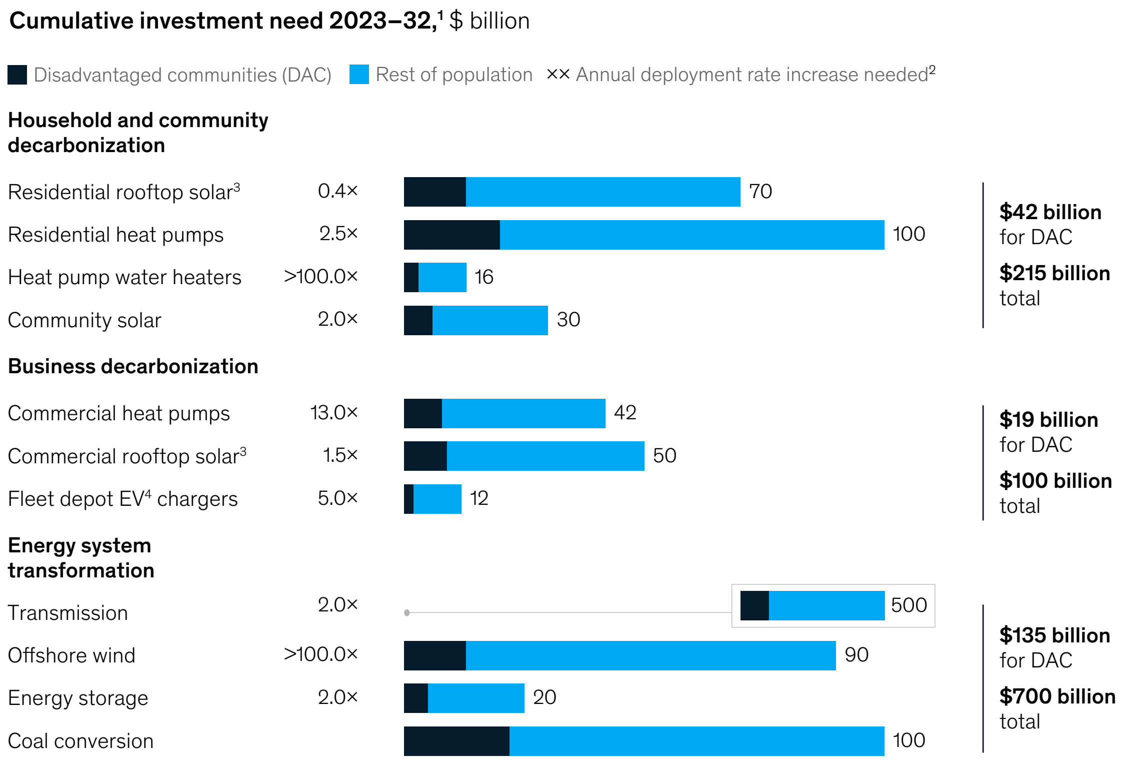
[14] The selection of climate mitigation technologies reflects the GHGRF's focus on reducing GHG emissions. There are also substantial investment needs for climate adaptation and for nature and biodiversity preservation across the United States and in disadvantaged communities, which are not considered in this analysis.

considered; financing should be scoped and designed to augment those programs and the collective impact. Examples of such government programs include the IRA Energy Infrastructure Reinvestment Program, which helps fund coal plant conversion for new uses; the Department of Energy Grid Deployment Office's various programs to aid investment in transmission; and the funding for energy storage demonstration projects included in the Infrastructure Investment and Jobs Act of 2021.

GHGRF-enabled financing could be used to aid investment and contribute to growth across a wider set of investments and technologies than those included in this report. And in practice, the focus of GHGRF-enabled financing across themes and the specific technologies that receive investment

Exhibit 2

Reaching net zero could require an estimated investment of $1 trillion across 11 technologies over ten years, including $200 billion in disadvantaged communities.



Note: Figures may not sum to total, because of rounding. Investment and cost estimates focus only on technology deployments that are eligible for Inflation Reduction Act incentives.
[1]Estimated; for Inflation Reduction Act incentive–eligible deployment only.
[2]Increase in annual rate of deployment needed to align with net-zero pathway or align with national targets.
[3]Includes battery storage.
[4]Electric-vehicle.

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will vary as needs for and barriers to investment evolve. Financing will also be dependent on any further guidance from the Environmental Protection Agency (EPA) on priorities for technologies, sectors, or groups. Nonetheless, examining these technologies and the rationale for using green bank financing to facilitate their deployment can provide lessons on how GHGRF-enabled financing can bolster broader impact.

Detailed below are the 11 technologies included in this analysis, organized within three themes—household and community decarbonization, business decarbonization, and energy system transformation.

Household and community decarbonization

— *Residential rooftop solar and battery:* solar photovoltaic panels that generate electricity in combination with a residential battery

— *Residential heat pumps:* electric heat pumps that heat and cool residential buildings using refrigerant and electricity to transfer heat from outdoor air or the ground to the inside of a building, replacing fossil-fuel systems

— *Heat pump water heaters:* water heating systems that use refrigerant and electricity to transfer heat from outdoor air or the ground to water in a storage tank; they can be combined with space-heating heat pumps, replacing fossil-fuel systems

— *Community solar:* solar photovoltaic panels that supply electricity to multiple individual or business customers; community solar can be located on-site (such as in multihousehold buildings with a shared rooftop) or off-site, or scaled to provide broader utility-level service

Business decarbonization

— *Commercial heat pumps:* electric heat pumps that heat and cool commercial buildings using refrigerant and electricity to transfer heat from outdoor air or the ground to the inside of a building, replacing fossil-fuel systems

— *Commercial rooftop solar and battery:* solar photovoltaic panels that generate electricity stored in a small battery for a single commercial unit

— *Fleet depot EV chargers:* chargers for commercial EVs, placed in fleet depots to support small-business fleet decarbonization

Energy system transformation

— *Transmission:* high-voltage transmission lines that carry electricity over long distances from electricity generation plants to substations, and distribution lines that prepare electricity delivery to end users

— *Offshore wind:* wind turbines installed offshore that generate electricity; these offshore turbines are larger than land wind turbines and can capture strong ocean winds

— *Long-duration energy storage:* battery electricity storage that provides flexibility and reliability to energy systems

— *Coal conversion:* early retirement of coal generation assets through financing

Exhibit 1 indicates where and how GHGRF funding could support additionality and impact for each theme or technology. Outcomes could be related to addressing financial or cost constraints or helping overcome nonfinancial barriers such as coordination challenges. Green bank tools such as technical assistance can be as important as financial tools in unlocking and enabling investment—for example, by providing information for homeowners, building capacity in installers, or helping investors develop new financing models.

Assessing investment needs

According to this analysis, realizing national climate goals and further US progress along the path to net zero will require an estimated $1 trillion or more in investment over the next decade across the 11 technologies identified, including around $200 billion in disadvantaged communities (Exhibit 2).

Over the next ten years, this analysis indicates that the four technologies identified to target household and community decarbonization would need $215 billion to align with a net-zero pathway; business decarbonization technologies are projected to require more than $100 billion. Among household and community decarbonization technologies, heat pumps and residential solar represent the areas of greatest estimated investment need, while heat pump water heaters represent the largest projected increase in the annual rate of deployment needed to meet the investment. Cumulative estimated community solar investment need is $30 billion, $6 billion of which is in disadvantaged communities. Projected increases needed in the annual deployment rate for business decarbonization technologies are considerable: 13 times for commercial heat pumps and five times for fleet depot chargers.

Energy system technologies such as transmission, offshore wind, and long-duration energy storage will need $600 billion or more in investment by 2032, and converting coal generation capacity by the end of the decade will require an additional $100 billion. The scale of this investment need relative to household and business decarbonization reflects the greater scope and larger project sizes for new national power-generation and energy-transmission systems. Because of their size and scope, these investments can also help enable wide-scale transformation of the energy system and the deployment of other technologies, such as renewable-power generation. (For more on this analysis's approach to estimating investment need, see sidebar "Sizing the investment need: Sources and methodology.")

Understanding impact potential

This analysis projects that investments in the 11 identified technologies can deliver substantial benefits to disadvantaged communities and across the United States. Low-carbon technologies and green bank financing approaches can strengthen communities across many dimensions, including climate mitigation, economic benefits, access to technologies, improved health outcomes, increased investment volumes, and greater access to finance. While many metrics are available to assess and compare impact across technologies and themes, this assessment focuses on four impact categories across major climate and social goals:

Emissions. Investments can help reduce emissions directly by replacing GHG-emitting technologies or fossil fuel–based electricity generation, or indirectly by enabling emission reductions across the energy system, as in the case of EV charging infrastructure or transmission infrastructure.

Job creation. The deployment of these new technologies can help create new jobs directly within targeted communities, in areas such as installation, construction, operation, and maintenance, and throughout the technology value chain. Deploying these technologies can also help create jobs indirectly across the United States.[15]

Cost savings. Deploying these technologies can help reduce energy costs for households and businesses when considering the cost of capital, fuel, and operation relative to the higher-emitting technologies they replace.[16]

Health. Investments in these technologies can help improve health outcomes via reductions in air pollution and the resulting declines in deaths and illnesses, such as asthma and heart disease, that are linked to pollution.

Across the 11 identified technologies, this analysis shows significant differences in the patterns of impact per dollar of investment. Assessing the impact potential across technologies for a

[15] This analysis focuses on direct and indirect jobs for installation, manufacturing, and maintenance. However, new jobs may also create new opportunities for training, retraining, and workforce development and may imply reductions in jobs in legacy fossil-fuel sectors. A broader assessment of economic impact could also explore the job quality, wages, and types of employment and entrepreneurship opportunities linked to different technologies and investments.

[16] Investments may also protect households and businesses against future cost increases due to increases in the cost of fossil fuel. This analysis therefore only focuses on a subset of total potential cost savings.

given volume of equal investment helps build understanding of the relative concentrations of impacts across different technologies. This understanding can help achieve a balanced prioritization of investment opportunities to address the GHGRF's multiple objectives. It can also inform capital allocation decisions across the technologies that lead to different impacts

Sizing the investment need: Sources and methodology

The investment need for the identified 11 key technologies is sized based on projected technology deployment over the next ten years and costed using established public technology-level estimates. Total deployment is based primarily on projected needs under a specific net-zero pathway, the Princeton Net Zero America (PNZA)[1] "high electrification" pathway, which assumes full electrification of transport and buildings by 2050 with no constraint on increased deployment of renewable energy or other energy supply changes.

For some technologies, deployment projections drew on additional sources or targets. These include the following:

— *Community solar.* Projections used National Renewable Energy Laboratory (NREL) data, calibrated to PNZA solar growth projections.[2]

— *Fleet depot electric-vehicle (EV) chargers.* EV charging analysis was conducted by McKinsey.

— *Offshore wind.* Projections used the 2030 offshore-wind development targets set by the White House.[3]

— *Long-duration energy storage (LDES).* Projections used the Bloomberg New Energy Finance market assessment and LDES Council market development estimates.[4]

— *Coal conversion:* Bespoke analysis was conducted using Environmental Protection Agency power plant data to identify low-performing plants.[5]

Technology costs were drawn from a unified source where possible to support consistency across the analysis. The analysis drew primarily on cost estimates from the NREL 2022 Electricity Annual Technology Baseline, using a "moderate" (versus "conservative" or "advanced") future-cost-reduction pathway. All cost data is adjusted to 2021 US dollars and accounts for labor cost differentials across states for installation cost components. For some technologies, the analysis drew on additional cost estimates:

— *Fleet depot EV chargers.* McKinsey conducted the EV charging analysis.

— *Transmission.* Cost estimates were obtained from PNZA.[6]

— *Long-duration energy storage.* Cost estimates were obtained from NREL and the LDES Council.[7]

— *Coal conversion.* Bespoke analysis was based on independent analysis that identified the value of coal assets considered "on the books" of regulated utilities that could be retired,[8] combined with unit costs of decommissioning based on costs from analogous reverse-auction conversion approaches in Europe.[9]

1 "Net-Zero America: Potential pathways, infrastructure, and impacts," Princeton University, 2021.
2 Paige Jadun et al., "Electrification futures study technology data," National Renewable Energy Laboratory (NREL), updated September 16, 2022; "Net-Zero America," 2021.
3 "Fact sheet: Biden-Harris Administration announces new actions to expand U.S. offshore wind energy," White House, September 15, 2022.
4 "Global energy storage market to grow 15-fold by 2030," BloombergNEF, October 12, 2022; "Net-zero power: Long duration energy storage for a renewable grid," Long Duration Energy Storage Council and McKinsey, November 22, 2021.
5 Emissions & Generation Resource Integrated Database (eGRID), Environmental Protection Agency, updated January 31, 2023.
6 "Net-Zero America," 2021.
7 "Utility-scale battery storage," NREL, updated July 21, 2022; "Net-zero heat: Long-duration energy storage to accelerate energy system decarbonization," LDES Council and McKinsey, November 9, 2022.
8 Christian Fong, "Securitization in action," Rocky Mountain Institute, May 24, 2022; Emissions & Generation Resource Integrated Database (eGRID), updated January 31, 2023.
9 Hanns Koenig et al., "Coal phase-out in Germany: The role of coal exit auctions," Aurora Energy Research, June 2022.

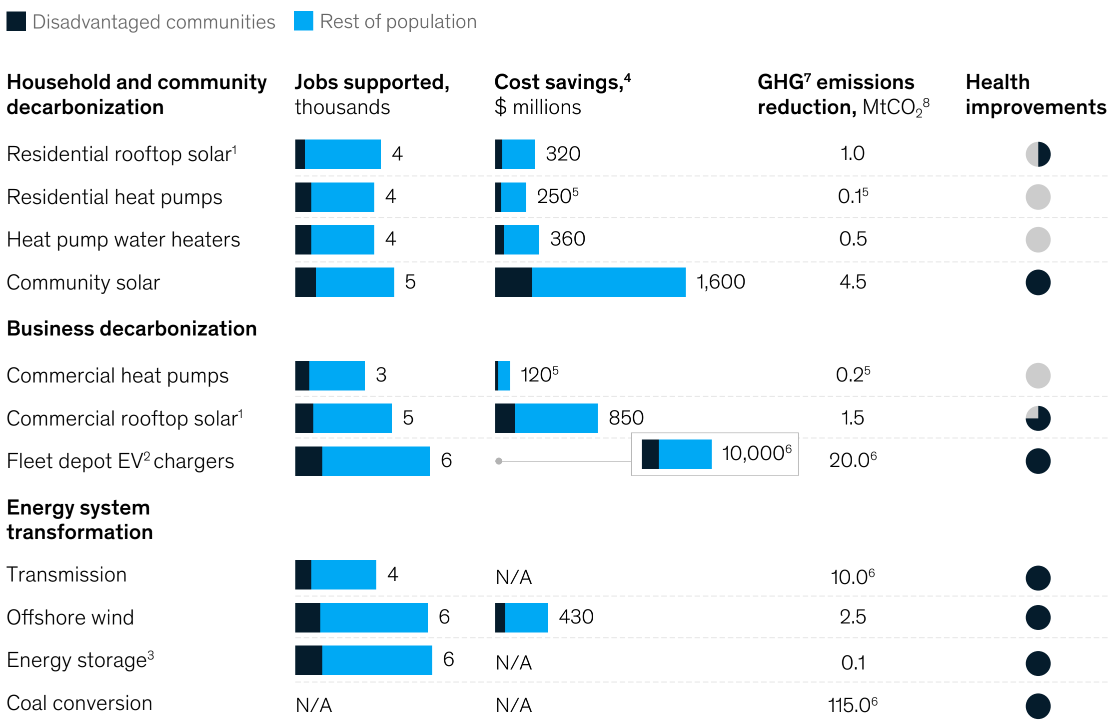
and that target different users and communities. Moreover, understanding relative impacts can bolster the case for technology deployment at a local level by demonstrating relevant local impact as well as broader benefits from reductions in GHG emissions. There is substantial variation in impact potential across and within the sets of prioritized technologies (Exhibit 3).

This analysis reveals nuanced profiles for impact across different themes and technologies (see sidebar “Calculating investment impacts: Sources

Exhibit 3

Decarbonization yields markedly greater predicted emissions reductions in energy system technologies while offering improved cost savings.

Community decarbonization outcomes assuming $1 billion investment per technology (2023–32)



Note: Figures are rounded. All numbers are cumulative.
[1]Includes battery storage.
[2]Electric-vehicle.
[3]The health impact of reducing fossil-fuel peaker plants is high in the surrounding area of the plants.
[4]Inflation Reduction Act incentives are included in calculations (except for fleet depot chargers).
[5]Cost and emissions reductions are from heating, not cooling.
[6]Enabled impact (all others are direct impact).
[7]Greenhouse-gas.
[8]Metric megatons of CO_2.
Source: McKinsey Sustainability Insights

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Calculating investment impacts: Sources and methodology

Greenhouse-gas emissions reductions
CO_2 impact is calculated based on the reduction in emissions from displacing high-emitting alternatives with new low-carbon investments. This general approach is customized for individual technologies based on their unique profiles:

Residential and commercial rooftop photovoltaics, community solar, and offshore wind. Each megawatt of deployed capacity replaces the same quantity of grid transmission generation. Reductions in greenhouse-gas (GHG) emissions are calculated by multiplying state grid emission-intensity factors by new renewable generation.[1]

Residential heat pumps, heat pump water heaters, and commercial heat pumps. Each technology deployed replaces a natural-gas counterpart. Total emissions are calculated by multiplying natural-gas emissions factors by the replaced natural-gas stock and subtracting added electricity emissions, assuming the national grid evolves to 70 percent renewable generation.

Fleet depot electric-vehicle chargers. Abatement is the product of enabled internal-combustion-engine (ICE) vehicle retirements and per-vehicle emissions intensities. Abatement is calculated from aggregate fleet levels, Environmental Protection Agency (EPA) ICE vehicle emissions, and EPA vehicle stocks. Added grid emissions from EV electricity usage are accounted for using state emissions-intensity data and a projection that the national grid will evolve to 70 percent renewable generation by 2030.

Transmission. The analysis uses the forecasts from the Princeton Net Zero America (PNZA) report to estimate the quantity of solar and wind enabled by this new transmission infrastructure.[2] The calculation of enabled emission reductions mirrors the emission-reduction calculations from solar and wind technologies.

Battery storage. Battery storage deployment replaces inefficient fuel oil peaker plants for the supply of short-term power with GHG abatement identified based on plant-level EPA annual emissions data, assuming storage capacity is powered by renewables.[3]

Coal conversion. Total annual emissions of specific retired coal plants are identified using EPA data.[4] Any direct replacements in generation capacity are assumed to be nonemitting.

Job creation
Technology-specific jobs in direct manufacturing, installation, and construction are modeled using capital expenditures and associated sectoral job multipliers based on US Department of Labor data.[5]

Cost savings
In most cases, savings are calculated based on the differences in the levelized costs of technologies, which consider capital, operations and maintenance, and energy costs. However, offshore wind calculations are based on the cost of equivalent fossil fuels used in electricity generation, and solar-technology calculations use the cost of electricity from the grid, their closest substitutes. Additional savings based on Inflation Reduction Act of 2022 incentives are accounted for when applicable.[6]

Health improvements
Following a similar approach to GHG-emission reductions, health improvements are quantified by multiplying air-pollutant emissions factors by pollutant reductions for each technology. Particulate emission reductions are converted to changes in the incidence of mortality, heart attacks, asthma, and lost workdays, using the EPA's CO-Benefits Risk Assessment (COBRA) health impacts screening and mapping tool.[7]

[1] Emissions & Generation Resource Integrated Database (eGRID), Environmental Protection Agency, updated January 31, 2023.
[2] "Net-Zero America: Potential pathways, infrastructure, and impacts," Princeton University, 2021.
[3] Emissions & Generation Resource Integrated Database, updated January 31, 2023.
[4] Ibid.
[5] Josh Bivens, "Updated employment multipliers for the U.S. economy," Economic Policy Institute, January 23, 2019.
[6] Levelized cost of heating (LCOH) for consumers, for selected space and water heating technologies and countries, International Energy Agency, updated October 26, 2022.
[7] "CO-Benefits Risk Assessment health impacts screening and mapping tool (COBRA)," EPA, updated January 25, 2023.

and methodology”). Household and community technologies such as rooftop solar and heat pumps may not offer the potentially high emissions reductions that some other technologies do. However, investments in these technologies, particularly in disadvantaged communities, can provide material cost savings to households and bolster job creation in targeted communities. They can also help households and communities own and manage their electricity access and usage and are an essential component of long-term emissions reductions from systemwide electrification.

Investments in technologies such as fleet depot EV chargers, transmission, energy storage, and coal conversion have the potential to create jobs, enable other decarbonization technology deployments, and provide indirect benefits. These technologies are central to enabling the deployment of critical technologies such as EVs and intermittent renewable-power generation from solar and wind. They are also essential to establishing the energy system required for large-scale climate transition.

Energy storage impacts—assessed in this report based on the ability to support conversion of fossil-fuel power generation in disadvantaged communities—could also be significantly greater if the role of energy storage in broader system decarbonization is considered.

Larger-scale power sector technology investments can offer high-potential emissions reductions, in addition to significant job creation and health improvements. Offshore wind and large-scale community solar can provide potential emissions reductions that are substantially greater than many other technologies and can also provide considerable cost savings for consumers. By reducing air pollutants from power generation, these technologies can also enable health improvements within communities.

3. Amplifying impact through strategy and design

This analysis shows that through careful design and deployment, initial green bank financing can enable substantially greater volumes of overall investment. There are a variety of ways in which green bank financing can support impact beyond initial capitalization, and a range of investment tools and approaches that can be employed (see sidebar "Green banking approaches to mobilize private investment"). Borrowing against equity or balance sheets can help increase the overall amount of deployable financing, for example, and repayments and other revenues can be reinvested into new lending. Several financing approaches that can help crowd in private investment well above public financing volumes are also available.

Scaling investment

According to this modeling, green bank investments can also spur broader market shifts by demonstrating the viability of investment opportunities and helping to bring down real or perceived investment costs and risks for other investors. The catalytic effect for private investment includes direct mobilization through co-investment in projects that are derisked or enabled by green bank financing tools or technical assistance.

But the impact potential goes beyond these specific projects. Green bank investments can identify and validate commercial opportunities for other investors and enable early-stage technologies that later develop into viable investments, bringing down risks and costs over time through aid for technologies as they mature. Furthermore, green bank investments demonstrate how new financing approaches can work in practice for green technologies and for target customers, including those in low-income and disadvantaged communities. While limited quantified evidence exists of the scale of these broader indirect mobilization effects, estimates that consider the role of public investment in spurring market development in developing and emerging economies suggest that the scale can be substantial. Every dollar of public investment may be able to catalyze $4 in broader private investment in the same sector in the year it is invested and up to twice that over three years following the investment.[17]

This analysis indicates that through ambitious, but achievable, approaches to leverage capital and mobilize investment, $20 billion in initial GHGRF funding could help generate $250 billion in total investment—and up to $310 billion if GHGRF recipients can achieve high levels of private mobilization (Exhibit 4). A simplified framework for considering the total mobilization potential of GHGRF green bank financing was considered for the analysis and is based on the following:

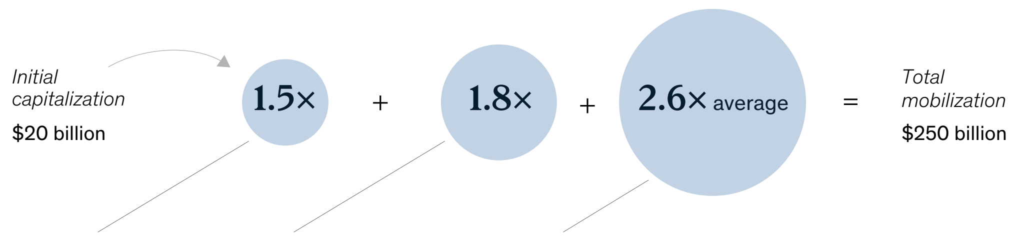
Balance sheet leverage. Raising additional capital on the back of a balance sheet or capital reserves may be able to leverage an additional 50 percent in investment resources over the first ten years of GHGRF-enabled financing. Over time, this could approach leverage levels of large international public lenders—around $3 of leverage per dollar in assets.

Capital recycling. Recycling initial lending through loan redeployment and securitization of loans (selling loans on to other investors) to enable further lending may be able to turn every dollar deployed into nearly $2 in investment over ten years. This would result from a combination of redeploying loan

[17] Chiara Broccolini et al., "Mobilization effects of multilateral development banks," *World Bank Economic Review*, May 2021, Volume 35, Number 2.

Exhibit 4

Greenhouse Gas Reduction Fund capitalization of $20 billion could support $250 billion or more in total investment.



Balance sheet leverage
Possible to leverage an additional 50% in investment resources over the first ten years of GHGRF[1]-supported financing
- Multilateral development banks leverage 3× their equity capital, building on decades of investment track record
- Connecticut Green Bank raised 1.5× its balance sheet

Capital recycling
Feasible to redeploy 5-year tenor loans (on average) and securitize 20% of the loan portfolio
- Green banks in Connecticut, New York, and Washington, DC, have an average loan maturity of 7 years
- Scenario assumes interest and service fees cover loan losses and expenses

Private-finance mobilization
Potential to mobilize 2×–3× investment, varying across technologies and the communities targeted
- American Green Bank Consortium and the Green Finance Institute cite average mobilization ratios of 2.3×–3.0× across banks and programs, or ~$180 billion
- Under high-performance matching leaders, leverage ratio of up to 1:5 may be possible for some markets, boosting overall mobilization to ~$240 billion
- Substantial indirect mobilization possible via market catalyzation, up to 1:4 additional leverage (~$280 billion)

Total leverage and mobilization
Total investment potential could reach $600 billion including indirect mobilization
- Total direct investment and direct mobilization range from $250 billion to $310 billion
- Including indirect mobilization across private investment could double catalyzed investment

[1]Greenhouse Gas Reduction Fund.
Source: American Green Bank Consortium; *Boosting MDBs' investing capacity: An independent review of multilateral development banks' capital adequacy frameworks*, G20 International Financial Architecture Working Group, 2022; Chiara Broccolini et al., "Mobilization effects of multilateral development banks," *World Bank Economic Review*, May 2021, Volume 35, Number 2; IMF; McKinsey analysis

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repayments to new loans and securitizing a portion of loans to expedite additional available lending capital.

Private finance mobilization. This is the use of investment tools and risk mitigation instruments to mobilize private-sector investment at the individual-transaction level. There is a wide range in leverage observed from green bank financing. If GHGRF-enabled financing can match the overall level seen by US green banks,[18] it may be able to unlock nearly three additional private dollars for every public dollar invested. If the funding is designed to build on previous experiences, even greater leverage may be possible, especially in market segments and for technologies that are relatively more profitable. Some green banks and loan funds have seen leverage ratios of $5 and $6 per public dollar. At the same time, GHGRF-enabled financing should be cautious in targeting very high leverage, as

[18] This overall mobilization ratio reflects total public expenditure—including a mix of grant finance, loans, and other green bank financing and support approaches—and total private co-investment associated with green bank activities.

Green banking approaches to mobilize private investment

Green bank financing can mobilize investment through a range of investment tools. Common approaches and real-world examples of each are outlined below.

Grants. Grant funding is provided without a requirement for repayment through subsidies or rebates and can be particularly effective for assisting the deployment of higher-cost, early-stage technologies or for aiding customers with lower ability to pay. For example, the Rhode Island Infrastructure Bank's Municipal Resilience Program supports municipalities in developing climate resilience strategies and provides grants for implementing climate resilience projects.[1]

Direct loans and credit enhancement. Loan financing—whether direct lending or partnering with other financial institutions through on-lending or credit enhancement—is the most common type of financing in green financial institutions and has been widely used to support a range of green investments. For example, the UK Green Investment Bank (GIB) municipal street-lighting program provided municipalities with loans to upgrade street lighting with more energy-efficient lights. The UK GIB designed the loans' fixed rates and terms to match the payback period of the project, providing financing that was better suited to the specifics of green investments.[2]

Guarantees and derisking tools. Guarantees are a type of risk-hedging method through credit enhancement. They can be provided by many entities to assist private lenders and create incentives for them to invest when they are not confident about a project's financial viability. Various types of guarantees target different forms of risk, including credit, technology, and political risks.[3] Loan loss provisions or offtake agreements can also reduce credit risks linked to defaults or broader market conditions. For example, with almost $12 billion in new funding through the Inflation Reduction Act of 2022 and building on funding provided since its establishment in 2005, the Loan Programs Office, part of the US Department of Energy, provides federal loan guarantees to cover up to 80 percent of a qualified project's cost within target themes, including innovative clean energy; advanced-technology-vehicle manufacturing; energy infrastructure on tribal lands; greenhouse-gas capture, storage, and use or sequestration; and reinvestment in energy infrastructure that is no longer operational.[4]

Aggregation and securitization. With aggregation, individual small and medium-size projects are bundled together through techniques such as loan warehousing (originating small assets under a common contract structure). Securitization takes these aggregated assets and turns them into standardized tradeable assets. Aggregation and securitization can reduce transaction costs and open new financing pools for investments in green sectors.[5] However, developing and deploying these approaches with suitable oversight and governance to support appropriate transparency and risk management is crucial. For example, the Connecticut Green Bank has aggregated 32 energy efficiency and solar-photovoltaic projects and bundled their collective revenue streams for sale. Using the securitization process, Clean Fund—a capital provider—purchased a single class of senior bonds to fund 80 percent of the portfolio purchase price, while the Connecticut Green Bank retained ownership of two tranches of subordinated bonds. After this first transaction, the Connecticut Green Bank attracted further investment through a partnership with Hannon Armstrong to increase the number of projects, which were funded using a special-purpose-vehicle structure.[6]

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[1] "Municipal Resilience Program," Rhode Island Infrastructure Bank, accessed November 2022.
[2] "Low energy streetlighting: Making the switch," Green Investment Bank, February 2014.
[3] "Loan Guarantee Program 101," Taxpayers for Common Sense, October 16, 2012.
[4] "Inflation Reduction Act of 2022," US Department of Energy, accessed November 2022.
[5] *Unlocking renewable energy investment: The role of risk mitigation and structured finance*, International Renewable Energy Agency, June 2016.
[6] "Aggregation and securitization," Coalition for Green Capital and Green Bank Network, March 2019.

catalytic and additional investment in early-stage technologies or in low-income or disadvantaged communities can be associated with lower private co-investment.

By spreading GHGRF financing across the portfolio of 11 key technologies, this analysis shows how financing can help realize both substantial climate impact and meaningful investments in disadvantaged communities. Nonetheless, real-world allocation may consider a broad range of factors. In line with the funding allocation proposed by the GHGRF, more than 40 percent of the initial capital allocation is targeted toward disadvantaged communities, chiefly through funding investments in household and community decarbonization technologies. Investments in this market will likely have high additionality because of long-standing barriers to accessing capital and financial services. However, when deciding how to allocate financing across technologies, GHGRF funding recipients will likely consider a wide variety of constraints and objectives. They may establish targets for how investment is split across sectors or technologies or decide to design sector-agnostic financing instruments. Recipients may also face specific constraints on which sectors they can invest in, depending on further EPA guidance.

Driving impact

By leveraging initial capital and supporting investment across a portfolio of opportunities, green bank financing can help deliver considerable climate and social impact over ten years, as shown in this analysis (Exhibit 5). Distributing $250 billion in direct and mobilized green bank financing across 11 key technologies can provide and enable significant GHG emission reductions. Furthermore, deploying these technologies can offer cost savings, job opportunities, and health improvements. Examining these co-benefits offers a more holistic understanding of climate and environmental justice and facilitates prioritization and the targeting of investments.

This analysis applies $8.5 billion in initial capital to household and community decarbonization to mobilize and leverage $106 billion in total financing. The $4 billion in initial capital for business decarbonization leads to $76 billion in total investment, while the $5.5 billion in initial financing for energy system transformation leads to $68 billion in total financing. The analysis reserves $2 billion of the initial $20 billion in GHGRF funding for investment-related technical assistance, nonfinancial activities to build markets, job training for new vocations, and the establishment of new subnational green-financing institutions.

This $250 billion in investment could, according to this analysis, contribute up to one-sixth of the emissions reductions needed over the next ten years on a pathway to net zero by 2050. Community solar, offshore wind, transmission, and fleet depot EV chargers are the largest contributors to emissions reductions within this portfolio of 11 key technologies. Rooftop solar also plays an important role by enabling potential increased electrification in commercial and industrial use cases. By targeting emissions in the transportation and power generation sectors, which are the greatest contributors to pollution, these technologies can have a consequential impact on helping achieve US climate goals.

At this deployment scale, these technologies could help create an estimated 400,000 direct jobs in disadvantaged communities and more than 1.1 million direct jobs in total. These jobs are distributed across the installation and operation of the technologies, along with other functions. Alongside these direct jobs are more than 3.0 million additional indirect jobs created in supply chains and as a result of increased spending. Ensuring employees with the correct skills are in place when needed across value chains will require coordinating training and apprenticeships with a particular focus on extending opportunities to members of the disadvantaged communities that the investments target.

Because many of these technologies are more energy efficient than their GHG-emitting counterparts, households and businesses in disadvantaged communities could benefit from $30 billion in direct cost savings in the medium

Distributing $250 billion in direct and mobilized green bank financing across 11 key technologies can provide and enable significant GHG emission reductions. Furthermore, deploying these technologies can offer cost savings, job opportunities, and health improvements.

Exhibit 5

Strategically deploying capital can increase social and economic impact while maintaining high overall emissions reductions.

Assuming $250 billion in capital deployed

■ Disadvantaged communities ■ Rest of population

Total capital allocation, $ billion	Household and community decarbonization	*Deployment,[4] DAC vs total*			Cumulative GHG reduction, $MtCO_2$[5]	Jobs supported,[6] thousands	Cost savings,[7] $ millions	Health improvements[8]
23	Residential rooftop solar[1]	*HH:*	*800K*	*1.6M*	17	90	7,500	
52	Residential heat pumps	*HH:*	*6.5M*	*13.0M*	4[9]	190	13,000[9]	
12	Heat pump water heaters	*HH:*	*4.0M*	*8.0M*	4	45	4,000	
19	Community solar	*HH:*	*1.2M*	*16.4M*	85	86	30,000	
	Business decarbonization							
28	Commercial heat pumps	*TJ:*	*110*	*380*	4[9]	98	3,400[8]	
38	Commercial rooftop solar[1]	*GW:*	*9*	*29*	55	170	32,00	
10	Fleet depot EV[2] chargers[3]		*115K*	*600K*	185[3]	60	95,000[3]	
	Energy system transformation							
19	Transmission[3]	*GW/km:*	*10*	*10*	195[3]	70	N/A	
28	Offshore wind	*GW:*	*2.5*	*13*	65	180	12,000	
19	Energy storage[1]	*GWh:*	*27*	*140*	0.3	120	N/A	
2	Coal conversion	*GW:*	*12*	*12*	225[3]	N/A	N/A	

[1]Includes battery storage.
[2]Electric-vehicle.
[3]Enables emissions reductions and cost savings.
[4]DAC is disadvantaged communities. K is thousand, M is million, HH is households, TJ is terajoules, GW is gigawatts, GW/km is gigawatts per kilometer, and GWh is gigawatt hours.
[5]Metric megatons of CO_2.
[6]Direct jobs.
[7]IRA incentives are included in calculations (except for cost estimates of fleet depot electric-vehicle charger cost estimates).
[8]For energy storage, the health impact for reducing fossil-fuel peaker plants is high in the surrounding area of the plants.
[9]Cost and emissions reductions are from heating, not cooling.

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and long term. An additional $20 billion in indirect fuel cost savings could also be realized from EV investment enabled by the investment in fleet depot infrastructure. This estimation of lifetime cost savings between technologies considers capital costs, operation and maintenance costs, and fuel costs. It is therefore heavily dependent on forecasts of future energy prices. For example, comparing the cost of installing and running a heat pump with the cost of a natural-gas furnace over product lifetimes requires forecasting electricity and natural-gas prices. These prices can vary substantially depending on future supply, demand, and policies. Considering additional policy benefits, such as IRA tax credits, reveals potential cost savings that can accrue to consumers and businesses from the deployment of these technologies.

Green technologies generate lower (or even zero) emissions of NH_3, NOx, PM2.5, SO_2, and VOCs[19] than incumbent emitting technologies. These air pollutants are linked to a variety of cardiac and respiratory diseases. Based on this report's analysis, the large-scale replacement of polluting technologies with the air-pollution-reducing technologies in this portfolio could have consequential effects on health over a decade. Lives saved through reductions in adult and infant mortality, for example, could total approximately 24,000. Hospital admissions for respiratory and cardiovascular conditions could decrease by approximately 15,000, while incidences of asthma exacerbation could fall by approximately 400,000. These reductions are in addition to declines in incidences of other illnesses attributable to lower emissions of harmful air pollutants. By reducing the incidence of these diseases through pollution mitigation, the deployment of technologies that reduce emissions can help improve community health and, consequently, decrease the number of workdays missed by 1.9 million.

[19] Ammonia, nitrogen oxides, particulate matter, sulfur dioxide, and volatile organic compounds.

4. Principles for deploying green bank financing

To help realize impact potential on the scale indicated in this analysis, GHGRF-enabled green bank financing would need to be effectively programmed and deployed. If well deployed using a coherent national approach, GHGRF-enabled financing (in conjunction with the broader IRA, other national and subnational public financing programs, and private-market actors) could play a pivotal role in creating a more inclusive path to net zero. Realizing impact will also require careful governance and management to avoid the mismanagement of funds, to reduce frictions or waste, and to manage the risk of fraud—all of which could divert funding from its intended goal and reduce the impact potential of GHGRF support.

In our estimation, five key impact principles that draw upon green bank experiences should be considered to help fulfill this potential.[20] Reviewing these principles offers an opportunity to reflect on the mission of the GHGRF while considering some concrete examples of making the most of publicly funded investment.

1. Target investment based on measurable impact potential

This analysis illustrates that defining comparable impact metrics and smartly targeting financing to achieve emissions reductions and equitable environmental-justice goals can amplify the effectiveness of financial support. For GHGRF recipients, these impact metrics can serve as explicit performance indicators to inform capital allocation decisions across technologies and communities. There may be trade-offs between different goals within individual investment opportunities, but by targeting multiple goals in aggregate across the portfolio of investments identified, GHGRF funding can help achieve beneficial outcomes.

Targeting financing to technologies and communities with the greatest potential for emissions reductions could mean addressing region-specific challenges. Decarbonizing older buildings in the Northeast and decarbonizing coal-dependent power production in the Northeast and Midwest are just two examples of such projects. Other targets for financing could include technologies such as transportation electrification, which enables sectorwide transformation and is needed across the country. Coordinating and enabling cross-state projects that may particularly benefit from at-scale capital, such as deploying transmission lines needed to deploy renewables, is yet another potential target for financing.[21]

Disadvantaged communities bear outsize climate burdens, face specific investment challenges, and are particularly underserved by traditional financial

[20] An earlier version of this chapter appeared in *Sustainability Blog*, "Principles to catalyze impact from green bank financing," blog entry by Ana Barbedo, Jason Eis, Nick Kingsmill, and Cindy Levy, McKinsey, December 4, 2022.
[21] Michael Goggin, Rob Gramlich, and Michael Skelly, *Transmission projects ready to go: Plugging into America's untapped renewable resources*, Americans for a Clean Energy Grid, April 2019.

institutions.[22] In these communities, financing could be targeted toward funding for explicit allocation objectives, such as Cleveland's GO Green Energy Fund, which targets low-income communities.[23] Alternatively, financing could target the propagation of replicable investment models, such as the Solar for All programs in many US states that help low- and middle-income households install solar power.[24]

2. Gain optimal leverage of private capital from GHGRF funding

Deploying initial funding using financing expertise to generate appropriate and responsible leverage can help increase the overall capital deployed as well as its impact, this analysis shows. Private cofinancing, capital recycling, and a well-balanced portfolio can all help foster investment at greater scales. Striking the right balance of targeting private-sector leverage, additionality, and impact for beneficiaries will be important for achieving overall GHGRF goals. Optimal leverage can vary based on technology maturity, community needs, and the availability of complementary grant-based programs. In addition, lower leverage ratios may be likely when investing in less established technologies or disadvantaged communities. Financing approaches may also need to balance short-term private leverage against longer-term market catalyzation goals.

Strategic use of co-investment and risk-reducing instruments (such as guarantees) to help directly crowd in private investment could include a range of risk mitigation strategies. Concessional terms for unsecured lending and underwriting real or perceived risks in the absence of a market track record are two possible strategies. For example, in 2020, US green banks mobilized $1.7 billion in total clean-energy investments using $440 million of their own financing.[25]

Efficient capital management and securitization of loans (for sale to private partners) can help free up capital for new lending. Capital management, for example, can minimize undeployed capital and facilitate the aggregation and securitization of smaller loans. Such programs and tactics can also pave the way for future securitizations in that asset class after scale is reached. The Hawaii Green Infrastructure Authority's Green Energy Market Securitization Program, which reduces the cost of clean-energy loans to consumers through a rate reduction bond structure, is one real-world example of this approach.[26]

Balancing less risky investments against riskier ones within a portfolio can help promote financial stability while bolstering early-stage and emerging technologies and disadvantaged communities. A balanced approach can potentially enable debt issuance while affording room for lower returns or higher losses in some segments of the portfolio. One application of this approach is the lending portfolio of Australia's Clean Energy Finance Corporation, which includes commercial-rate senior loans whose proceeds are used expressly to cross-subsidize other concessional-rate lending programs.[27]

3. Catalyze markets at scale by flexibly deploying a mix of financing approaches

Disciplined investment approaches that incorporate continual market feedback and strategic review and learning from and adjusting to changing conditions and market needs can help realize high additionality from GHGRF support. By focusing on innovative and leading investment approaches, deploying

[22] *Climate change and social vulnerability in the United States: A focus on six impacts*, EPA, September 2021.
[23] Peter Krouse, "Cleveland-based green bank in line for federal dollars to fight climate change in disadvantaged communities," Cleveland.com, August 24, 2022.
[24] For more, see "Solar for All," New York State, accessed March 6, 2023; "Solar for All," Washington, DC, Department of Energy & Environment, accessed March 6, 2023; "Illinois Solar for All," Elevate, accessed March 6, 2023.
[25] *Green banks in the United States: 2021 U.S. green bank annual industry report*, American Green Bank Consortium and Coalition for Green Capital, May 2021.
[26] "GEMS (Green Energy Market Securitization) Program frequently asked questions," Hawaii State Energy Office, November 2014.
[27] *CEFC Investment Policies*, Clean Energy Finance Corporation, April 2021.

specialized knowledge, and removing specific barriers to private financing, this financing can also help create more favorable conditions for pure private financing in the medium and long term.

Using specific financing approaches can help alleviate technology-specific challenges, which can include technology performance risks, construction and operational cost risks, lack of liquidity, regulatory uncertainty, and market immaturity. The UK Green Investment Bank, for example, invested in a series of offshore wind projects across key stages in the deployment journey to tackle a broad set of evolving risks, accelerating competitive private financing of the sector.[28]

Certain approaches can help disadvantaged communities overcome a range of barriers to accessing finance. Barriers related to credit history, for example, can include lack of collateral, mismatches between ability to pay and investment costs, and small ticket size. Various state and local green banks assist the rollout of residential solar panels with on-bill payments rather than traditional loans, for example, and have used targeted funding to bring down the costs of technology or borrowing.[29]

Employing systematic learning and flexibility in how financing is allocated can aid reprioritization of investment toward approaches with the greatest demonstrated impact and need for additional public support. This involves ending financing where the private sector has stepped in. In 2015, for example, the Connecticut Green Bank withdrew direct-investment assistance for commercial property assessed clean energy (C-PACE) as the market matured and private investors filled the bank's role.[30] Sharing lessons around investment performance and where different financing approaches are successful could contribute to learning across the green-investment community, enable further market development, and foster greater overall levels of private investment.

4. Galvanize a distributed financing network aligned with a national vision

Drawing on local knowledge and expertise in existing institutions, coordinating best practices, and building publicly available resources to reach customers and accelerate demand can aid the effective deployment of key technologies, especially to disadvantaged communities.

Working directly or in partnership with local institutions and intermediaries that have established relationships with end customers and supply chains could involve local community development financial institutions (CDFIs) as well as commercial financial institutions and businesses. Building demand will require a range of interventions, such as grants or other funding for customer engagement and awareness building. For example, local green banks such as Michigan Saves have long-standing relationships with local contractor networks, landowners, and credit unions; they have also garnered community trust and have accumulated experience driving deal flow.[31]

Options to build skills and knowledge across local ecosystems to help increase their effectiveness could include standardized green-financing procedures and documents, replicable supplier agreements, and common metrics and technology infrastructure to monitor and evaluate impact. For example, the CDFI Fund provides financial awards for technical assistance of up to $125,000 to build the capacity of CDFIs through hiring, training, and other activities.[32]

[28] *The Green Investment Bank*, National Audit Office, December 12, 2017; *The role and impact of the EIB and GIB on UK infrastructure investment*, Vivid Economics, May 2018.
[29] "Clean energy finance: On-bill programs," EPA, September 2019.
[30] "Greenworks Lending—a financier of commercial property assessed clean energy (C- PACE) loans—announced that it has closed four C-PACE transactions totaling $1 million," PACENation, August 31, 2015.
[31] "Webinar series: 'Unlocking clean energy investment in the commercial and industrial sectors,'" Green Bank Network, June 2018.
[32] *Audit of the Community Development Financial Institutions Fund's financial statements for fiscal years 2021 and 2020*, US Department of the Treasury Office of Inspector General, December 15, 2021.

5. Mobilize GHGRF funding quickly through a range of established mechanisms

Rapidly deploying GHGRF funding can jump-start investment and accelerate the learning-by-doing needed to propel market transformation. Expeditiously defining robust criteria and guidance for targeting and disbursing those funds can help facilitate effective mobilization while ensuring communities that need more time to roll out investment at scale are not left behind.

One way to expedite mobilization is to focus funding initially on more advanced technologies and on helping existing intermediaries fund established pipelines of projects. In 2021, its first year of operation, the UK Infrastructure Bank focused investment on a mix of direct project lending and cornerstone investment in smaller funds that were ready to receive capital.[33] In the United States, alongside broader IRA incentive programs, green bank financing could potentially mobilize an array of intermediaries, such as retailers with existing customer campaigns.

Offering funding commitments, such as lines of credit or conditional grants, can enable partner intermediaries to advance financing opportunities promptly without tying up capital before projects are ready for financing. Various multilateral development banks have built finance facilities in the past two decades, demonstrating the capacity for such facilities to mobilize a sizable network relatively quickly. For example, the Green Economy Finance Facility (part of the European Bank for Reconstruction and Development) reaches more than 140 local financial institutions across 26 countries.[34]

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[33] *Strategic plan*, UK Infrastructure Bank, June 2022.
[34] "About GEFF," European Bank for Reconstruction and Development and Green Energy Financing Facility, accessed November 29, 2022.

By including environmental-justice objectives in the GHGRF and setting the net-zero deadline for 2050, the United States has set the stage for investors to expand the potential of green bank financing with bold yet balanced and deliberate tactics. Climate transition and equity in the distribution of its benefits is an essential mission that calls for heavy reliance on specialized knowledge, proven approaches, and scrupulous assessment and reflection.

This report provides estimates for possible impact from GHGRF green bank financing based on an analysis of a specific set of technologies and parameters. The analysis illustrates the strong potential for green bank financing to accomplish climate goals and spark wider-ranging private investment and public–private collaborations in the United States. It also acknowledges the need for flexibility and agility to maintain progress in the face of anticipated and unforeseen circumstances and events.

An approach that balances the potentially competing interests of increasing investment leverage, serving disadvantaged communities, and reducing GHG emissions is the ideal. However, the real-world outcomes of that approach will almost certainly involve compromises as new systems and markets evolve and priorities and needs adapt. Progress never occurs in a straight line. Nonetheless, given the potential shown in this analysis for green bank financing to help realize cost savings for businesses and energy consumers, decarbonize US power systems, create jobs, and engender lasting social, health, economic, and environmental benefits in disadvantaged communities, there is tremendous promise in the paradigm.

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