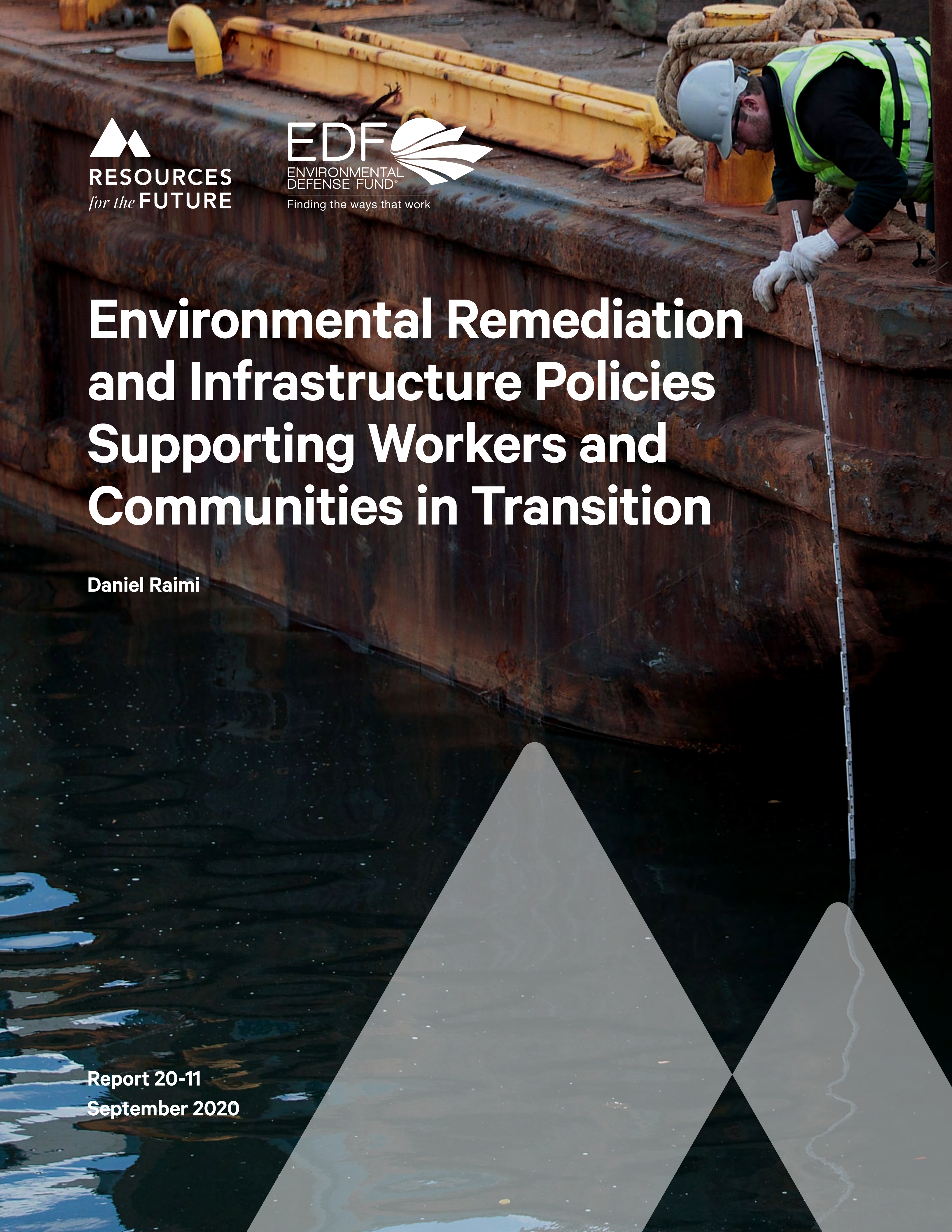

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Environmental Remediation and Infrastructure Policies Supporting Workers and Communities in Transition

Daniel Raimi

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About the Author

Daniel Raimi is a Senior Research Associate at Resources for the Future and a lecturer at the Gerald R. Ford School of Public Policy at the University of Michigan. He works on a range of energy policy issues with a focus on oil and gas regulation and taxation and climate change policy. He has published in academic journals including Science, Science Advances, Environmental Science and Technology, Energy Policy, and Journal of Economic Perspectives, popular outlets including The New Republic, Newsweek, Slate, and Fortune, and presented his research for policymakers, industry and other stakeholders around the United States and internationally. The Fracking Debate, his first book, combines stories from his travels to dozens of oil and gas producing regions with a detailed examination of key policy issues, and is published by Columbia University Press as part of the Columbia University Center on Global Energy Policy **book series**.

Current research examines the future of energy development in the United States, with a focus on how producing communities are managing near-term impacts while planning for the future. He also hosts Resources Radio, a weekly podcast from Resources for the Future, in which he interviews leading researchers on energy and environmental topics.

About RFF

Resources for the Future (RFF) is an independent, nonprofit research institution in Washington, DC. Its mission is to improve environmental, energy, and natural resource decisions through impartial economic research and policy engagement. RFF is committed to being the most widely trusted source of research insights and policy solutions leading to a healthy environment and a thriving economy.

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Environmental Defense Fund (EDF) is one of the world's leading environmental non-profit organizations. EDF's mission is to preserve the natural systems on which all life depends. Guided by science and economics, EDF finds practical and lasting solutions to the most serious environmental problems.

About the Project

This report is the second in a series prepared by Resources for the Future and Environmental Defense Fund that examines policies and programs to promote fairness for workers and communities in a transition to a low–greenhouse gas emissions economy, often referred to as a just transition. The series looks at existing public policies and programs, grouped thematically as "tools in the toolbox" for policymakers seeking effective strategies to address economic challenges associated with the transition. This series focuses on policies and programs that can support workers and communities in regions where coal, oil, and natural gas production or consumption has been a leading employer and economic driver. Other reports in the series present illustrative cases in the United States and discuss policy innovation abroad.

This report focuses on federal environmental remediation and infrastructure programs. Please visit **www.rff.org/fairness-for-workers** or **www.edf.org/ensuring-fairness-workers-clean-economy** for more information, other reports in the series, blog posts, and more.

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Abbreviations

AML	Abandoned Mine Land fund
ARRA	American Recovery and Reinvestment Act
BLM	Bureau of Land Management (DOI)
CDBG	Community Development Block Grant program (HUD)
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CWSRF	Clean Water State Revolving Fund
DOI	US Department of Interior
DOT	US Department of Transportation
DWSRF	Drinking Warer State Revolving Fund
EJ	environmental justice
EPA	US Environmental Protection Agency
FAHP	Federal-Aid Highway Program (DOT)
FPTP	Federal Public Transportation Program (DOT)
GAO	US Government Accountability Office
GHG	greenhouse gas
GWP	global warming potential
HTF	Highway Trust Fund
HUD	US Department of Housing and Urban Development
JT	Just Transition
NPL	National Priorities List (of Superfund sites)
OEM	Office of Environmental Management (DOE)
OLM	Office of Legacy Management (DOE)
OSMRE	Office of Surface Mining Reclamation and Enforcement (DOI)
RCRA	Resource Conservation and Recovery Act
UST	Underground Storage Tank program (EPA)

Contents

1. Executive Summary

Environmental remediation and infrastructure spending have a significant potential role in reducing pollution and supporting workers and communities affected by a transition to clean energy. This review examines major federal policies related to these two areas, highlighting the existing evidence on program effectiveness across multiple metrics.

Environmental remediation programs can provide near-term job opportunities and restore sites to economic use in regions with a history of pollution, including pollution from energy extraction and consumption. The evidence is strong that remediation increases nearby property values and provides job opportunities during cleanup. Depending on their design and implementation, increased efforts in this area could benefit energy communities and communities affected by the legacy of environmental injustice.

Recent research suggests that some of these programs, including remediating abandoned oil and gas wells, can provide direct jobs at relatively low cost, but evidence on the cost-effectiveness of job creation for the Superfund and Brownfields programs is mixed. Important questions regarding employment effects of remediation are whether they persist over time, and which workers and communities benefit most from these job opportunities.

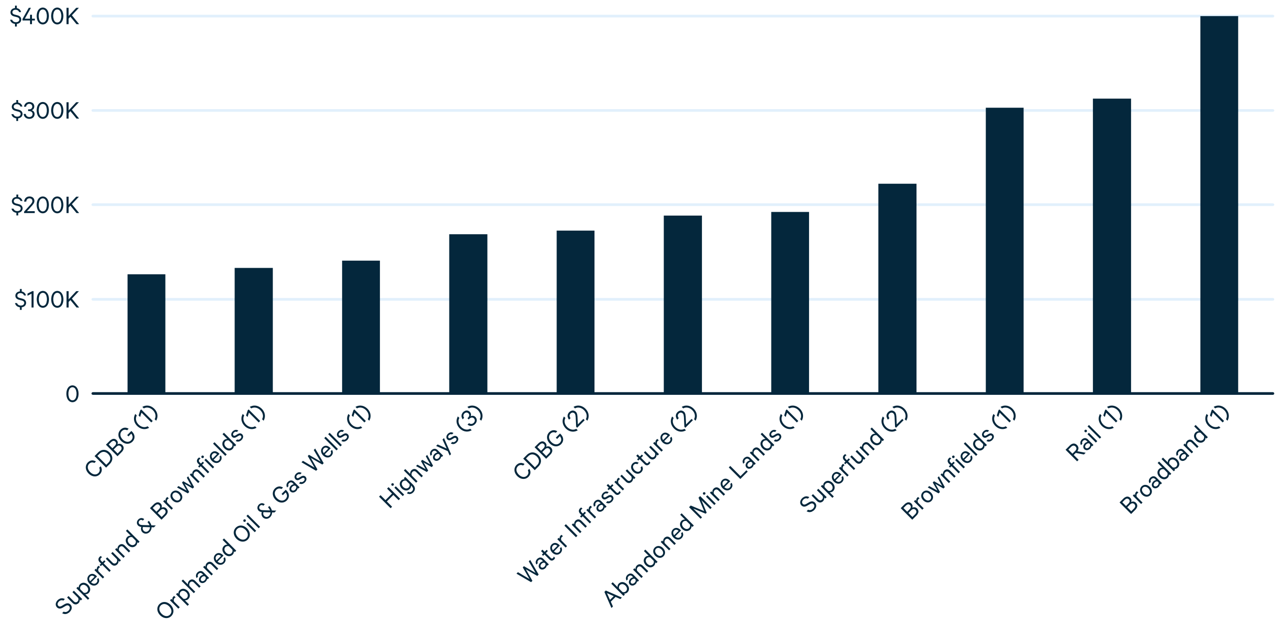
Infrastructure programs for highways, public transport, and clean water also have the potential to support employment and economic growth in communities heavily dependent on fossil energy. Although economists have debated whether transportation infrastructure investment increases overall economic activity or merely redistributes it, the latter outcome may be valuable in the context of an energy transition, particularly if new infrastructure serves communities negatively affected by a shift away from fossil energy.

Some infrastructure projects, particularly those providing clean water, can address the legacy of surface and groundwater pollution in some fossil energy producing and consuming communities. In addition, infrastructure investment—depending on its design and implementation—has the potential to reduce a legacy of environmental injustice.

1.1. Insights and Implications

- One common objective for government policy in the context of a "Just Transition" (JT) is supporting local employment in communities negatively affected by a shift toward clean energy. Although the **empirical evidence on the employment effects of many policies reviewed here is limited**, some recent analyses, mostly using input-output modeling, provide evidence on the cost-effectiveness of job

Figure ES1. Estimated Cost per Direct Job-Year for Select Program Types



Data Sources and Notes: (1) Pollin and Chakraborty (2020); (2) Larsen et al. (2020); (3) Garin (2019). CDBG = Community Development Block Grant.

creation across different spending programs. Some of the most cost-effective policies include federal block grant programs, environmental remediation programs, and highway construction. Rail construction and broadband expansion appear to provide fewer jobs per dollar of federal investment. Figure ES1 illustrates the cost per job-year associated with the programs examined in this report.

1.1.1. Environmental Remediation

- The federal government plays a large role in addressing polluted sites across the United States. ***These programs could be enhanced and targeted toward workers and communities negatively affected by an energy transition.***
- ***Millions of sites in the US need environmental remediation***, and emerging evidence points to poorly understood risks from sources such as dioxins, agricultural runoff, and coal ash. In many cases, remediation needs are in regions historically dependent on coal, oil, and natural gas production, offering the potential for new investment to support these workers and communities.
- Most evidence suggests that ***remediating polluted sites increases local property values.*** This could have particular benefit for fossil energy communities and environmental justice communities, which may experience a heavier burden of pollution than the broader population.

- There is strong evidence that ***remediation projects increase local employment temporarily***, but it is not clear whether those employment benefits continue after a site has been cleaned up. It is also unclear whether remediation projects support primarily workers in affected communities or workers from other locations. More research on the long-term employment effects of environmental remediation projects would be valuable.
- Some evidence suggests that ***environmental remediation projects may disproportionately occur in whiter communities*** and that remediation programs could lead to "environmental gentrification." This highlights the importance of considering equity and justice in the design and implementation of environmental remediation policies, and it raises the question of how to prioritize sites for remediation.

1.1.2. Broad Infrastructure Porgrams

- ***Transportation infrastructure projects create local construction and related jobs*** and can also induce longer-term economic development by making transportation easier and cheaper. Improving transportation networks in rural energy communities can enhance their physical access to markets, providing a stronger foundation for future economic growth.
- ***Economists have debated whether infrastructure investment—particularly for highways—increases overall economic activity or simply redistributes that activity.*** Although the former outcome is clearly preferable across society, the latter may also be valuable in the context of a JT if new infrastructure serves communities negatively affected by a shift away from fossil energy.
- ***Affordable access to clean water is essential for every community.*** If fossil energy communities experience declining tax revenue and/or population, it may become difficult for local governments to finance water system maintenance and upgrades. In addition, these communities may be at greater risk from the legacy of pollution that sometimes accompanies fossil energy extraction, processing, and combustion.
- Some federal programs, such as Community Development Block Grant, are primarily targeted toward urban areas, where relatively little fossil energy production occurs. In the context of a JT, additional ***resources could be directed to the small and midsize cities that often serve as commercial hubs for rural energy-producing communities.***
- Low-income areas and communities of color have experienced environmental injustices often related to the siting, maintenance, or administration of public infrastructure. The design, implementation, and enforcement of policies ***will shape whether, and to what extent, future infrastructure spending reduces or exacerbates historical inequities.***

2. Introduction

In recent decades, market forces have reduced the competitiveness of coal in the United States. In the decades ahead, continued innovations in the energy sector, coupled with the potential for ambitious climate change policy, pose major challenges for coal communities, as well as regions that rely heavily on the production and transformation of oil and natural gas. As policymakers evaluate options for deep emissions reductions, it is appropriate to consider how those efforts—coupled with ongoing changes in energy markets—can be paired with efforts to support communities negatively affected by a transition to a low-greenhouse gas emissions future.

The concept of *fairness for workers and communities*—language we borrow from the BlueGreen Alliance—suggests that deep reductions in greenhouse gas (GHG) emissions should not disproportionately burden segments of society that are heavily dependent on the production, transformation, and certain uses of fossil fuels (BlueGreen Alliance 2020). This is commonly referred to as a Just Transition (JT). The term has a range of meanings in various forums, but one of the more widely cited definitions comes from the International Labour Organization's (2015) "Guidelines for a Just Transition Towards Environmentally Sustainable Economies and Societies for All." To maintain consistency with academic literature and major domestic and international policies, such as the Paris Agreement, we use the JT term throughout this series, and in so doing we reference the concept of *fairness for workers and communities* provided by the BlueGreen Alliance.

In recent months, the economic effects of the COVID-19 pandemic have highlighted the risks for workers and communities that rely heavily on the fossil energy sector. Employment in the oil and gas sector in May 2020 reached its lowest level since 2006, well before the dramatic rise in domestic natural gas and oil production. In the US coal sector, a decades-long decline has been exacerbated by the steep drop in electricity demand, and coal mining employment in early 2020 dropped below 50,000, down from more than 175,000 in the 1980s, and its lowest level since the 1800s (BLS 2020).

Many policies have the potential to play a role in supporting workers and communities affected by such changes. In this review, we focus on two major types of policies that have received considerable attention in the JT context: environmental remediation programs (Section 3) and major infrastructure programs (Section 4). We focus on existing federal policies within these groups, discussing their potential role as well as the existing evidence on their effectiveness in boosting local economies, employment, and income.

Because there are hundreds—if not thousands—of federal and state policies in the areas of environmental remediation and infrastructure, we limit our analysis to the most significant programs. Table 1 introduces these programs and their primary targets, policy mechanisms, and recent funding levels. Table 2 summarizes the evidence on program effectiveness based on our review of the literature.

Table 1. Summary of Economic Development Policies and Programs Examined in This Report

Administrator	Name	Primary Target(s)	Mechanism(s)	2020 Spending (M$)
		Environmental Remediation		
DOE	Offices of Environmental and Legacy Management	Nuclear sites	Contracting	$7,617
EPA	Superfund	General pollution	Contracting	$1,185
DOI	Abandoned Mines Land program	Mine sites	Grants	$138
EPA	Underground Storage Tank program	Petroleum storage sites	Grants	$92
EPA	Brownfields	General pollution	Grants, technical assistance	$93[1]
States	Oil and gas well restoration on private or state lands	Orphaned oil and gas wells	Contracting	$53
DOI	Oil and gas well restoration on federal lands	Orphaned oil and gas wells	Contracting	$0.3
		Infrastructure		
DOT	Federal-Aid Highway Program	Road transport	Grants	$47,314
IRS	Tax exemption for state and local infrastructure bonds	State and local infrastructure	Tax exemption	$27,600
DOT	Federal Public Transportation Program	Public transport	Grants	$12,592
HUD	Community Development Block Grant program	Infrastructure, public facilities, housing, other	Grants	$8,425[2]
EPA	Clean Water State Revolving Fund	Wastewater systems	Grants	$1,694
EPA	Drinking Water State Revolving Fund	Drinking water systems	Grants	$1,164

DOE = Department of Energy. DOI = Department of Interior. DOT = Department of Transportation. EPA = Environmental Protection Agency. HUD = Department of Housing and Urban Development. IRS = Internal Revenue Service.

Notes: (1) Includes congressional appropriations and estimated tax expenditures. (2) Includes supplemental funding under the 2020 CARES Act.

Table 2. Summary of Evidence on Program Outcomes

Program or Policy	Outcome Type	Outcome
	Environmental Remediation	
Superfund, Brownfields, Underground Storage Tank	Property values	Remediating Superfund sites increases property values close to project locations. Although some earlier work found little effect; recent studies with richer data show that cleanup can increase values by 5–15%.
Superfund, Brownfields, mines	Employment	There is little rigorous evidence on the employment effects of these programs. Cleanup efforts provide short-term jobs for workers and nearby businesses, but long-term effects are not well-studied.
Superfund, Brownfields	Environmental justice	Some evidence shows that cleanup projects disproportionately benefit white communities and bring risk of "environmental gentrification."
DOE nuclear sites	Employment, income, migration	A series of regional simulation studies suggest that investment in robust severance packages, education, and recreation is the most effective way to support regional economies experiencing declining government investment.
Oil and gas well site restoration	Employment, GHG abatement	One recent analysis estimates that plugging orphaned oil and gas wells can provide employment and reduce methane emissions at relatively low cost.
	Infrastructure	
Water and wastewater	Cost-effectiveness	Provision of safe water is essential for the economic viability of every community. However, research shows mixed results of federal investment. One study found that federal investment led to increased local spending for wastewater systems, but for drinking water systems, federal dollars largely displaced, rather than augmented, existing funding sources.
Highways and public transportation	Employment	Spending on roads tends to increase short-term employment at considerably lower cost than spending on rail-based transportation. However, these estimates do not account for indirect and induced employment effects or effects on pollution levels.
Community Development Block Grant	Economic growth	Enhanced federal spending through Community Development Block Grant program improves local mortgage approval rates and increases the number of businesses in targeted communities. However, restrictions on how CDBG funds are spent may reduce program effectiveness.
Water and wastewater	Environmental justice	Low-income and minority communities disproportionately lack access to clean and affordable water systems.
Highways and public transportation	Environmental justice	Proximity of highways to low-income and minority communities has produced environmental injustices, particularly related to air pollution. New public transportation infrastructure can reduce congestion, lower air pollution, and reduce GHG emissions while providing local economic benefits for areas served by new infrastructure.

2.1. Scope of This Review

This review focuses on policies that support remediation of polluted sites (Section 3) and a limited selection of federal infrastructure programs (Section 4). Because our expertise lies primarily in environmental policy, we provide a more thorough treatment of those programs, and a more limited review of federal infrastructure efforts.

We focus primarily on federal policies, for several reasons. First, federal programs tend to have much larger expenditures than state policies. Second, federal policies on these topics have—broadly speaking—been operating for longer periods than state programs, providing more opportunity to evaluate their effectiveness. Third, deep reductions in GHG emissions will affect communities across the nation, suggesting that federal policy would be appropriate to address impacts across state lines.

Finally, we recognize that environmental remediation and infrastructure programs are not the sole tools available to policymakers to enable a JT. In companion reports, we address additional programs, including those designed to provide other public benefits, support regional economic development, and enhance workforce capacity.

2.2. Types of Environmental and Infrastructure Policies

Environmental remediation and infrastructure programs may play a substantial role in a JT. For environmental programs, the concept of JT includes environmental remediation to provide a foundation for future economic growth in communities historically dependent on fossil energy. Depending on the scope of action, a JT may also include addressing the legacy of pollution in environmental justice (EJ) communities. Infrastructure programs may play an important role because they can support local and regional economic growth in underserved fossil energy communities (again, this definition may also extend to EJ communities). In this section, we introduce both tools, provide context for their deployment, and discuss their relevance in a JT context.

2.2.1. Environmental Remediation and Restoration Tools

Environmental remediation and restoration programs are intended to remove pollution (remediation) or restore sites to their predevelopment state (restoration). Remediation reduces environmental and public health risks while also making a site useful for future development, whereas restoration allows the site to return to providing ecosystem services and other environmental benefits. Here, we focus on federally funded programs that support remediation of contaminated lands, abandoned mines, oil and gas infrastructure, and sites affected by nuclear weapons programs. In practice, most of these programs focus on remediation rather than full restoration.

Although most of these programs are primarily intended to protect public health and the environment, they have clear economic effects in both the short and the long term. Remediation efforts can cost tens to hundreds of millions of dollars and require heavy machinery and dozens of workers over months to years. Over the longer term, remediation can increase local property values, reduce public health hazards, enhance ecosystem services, and offer the opportunity for new development on previously blighted land. Some programs, such as the Brownfields program of the Environmental Protection Agency (EPA), have an explicit goal of enabling new economic activity on contaminated lands.

In a JT context, remediation programs hold particular promise because of their ability to address the legacy of pollution that can accompany the extraction, processing, and combustion of coal, oil, and natural gas. Many coal communities, for example, have faced water quality degradation associated with coal mines and coal combustion residuals ("coal ash"). For these communities, and others like them, addressing such environmental hazards can lay the groundwork for improved public health and future economic growth.

However, remediation and restoration programs may also raise new concerns. For example, the designation of sites for cleanup has the potential to stigmatize certain locations, some community members may be reluctant to welcome new industrial activity (e.g., earth-moving and other heavy machinery) into their neighborhoods, and cleanup activities could lead to environmental gentrification. We discuss each of these issues in detail in Section 3.3.

2.2.2. Major Infrastructure Programs

One of government's primary and most widely supported activities (Pew Research Center 2019) is building and maintaining public infrastructure, particularly for transportation, water, and wastewater systems. Transportation systems enhance economic well-being by making it easier to move products and people to where they are most needed. Water and wastewater infrastructure protects public health and enables consumers and businesses to carry out essential activities.

Policies that support the construction and maintenance of public infrastructure are likely to play a substantial role in the a JT. Fossil energy extraction, transformation, and in some cases consumption often constitute a large portion of local tax bases, funding local infrastructure such as roads and water and wastewater systems (Newell and Raimi 2018; Morris et al. 2019). Policies and market forces that reduce the value of those resources (such as those involved in a shift to a clean energy economy) will therefore exert downward pressure on state and local revenues that fund such infrastructure, suggesting a possible role for the federal government. In addition, infrastructure programs have the potential to support broader economic development in affected regions by supporting local employment (in some cases, the skills of workers in transition may be a good match for new infrastructure jobs) and by enhancing market access for rural communities.

Because the federal, state, and local programs that provide infrastructure number in the thousands, we provide a high-level overview of only the largest federal infrastructure programs—those for highways, public transportation, and water infrastructure—and the federal policy that exempts state and local infrastructure bonds from federal taxes.

3. Environmental Remediation

The objective of policies to address pollution is typically to restore local environments so that they can either function as they did prior to human development (restoration) or be suitable for future development without endangering public health (remediation).[1] However, remediating polluted sites also has clear economic benefits. In the short term, workers and equipment are needed to execute projects. In the longer term, a remediated site has the potential to host new economic activities, and a healthier local environment may also attract new residents and spur economic growth.

Table 3. Summary of US Environmental Remedication Programs

Program	Relevance to Just Transition
Offices of Environmental and Legacy Management	Nuclear weapons programs have a created large legacy of contamination at many US sites. DOE's cleanup of these sites is the largest environmental management project in the nation. These sites will be a major issue for decades, and perhaps centuries, to come.
Superfund (CERCLA)	Superfund sites exist in nearly every state, include more than 1,000 of some of the nation's most polluted sites, and are disproportionately located in minority communities. Remediation reduces local pollution and blight, likely raises local property values, and can provide short-term employment.
Abandoned Mine Land Program	Thousands of abandoned mines and coal ash sites near power plants pose risks to water resources. Remediation can reduce local pollution and provide near-term employment in affected communities.
Underground Storage Tank Program	Underground storage tanks containing petroleum products are found across nation. Hundreds of thousands have released petroleum to the subsurface, and remediation can reduce risks of water and soil contamination.
Brownfields	The federal government provides grants and tax credits to local governments, businesses, and others for cleaning up and redeveloping polluted sites. Like Superfund, Brownfields projects appear to increase local property values and private short-term employment.
Orphaned and Abandoned Oil and Gas Wells	Hundreds of thousands, perhaps millions, of oil and gas wells have been improperly abandoned over time. Plugging these wells and restoring their surface locations can provide employment for oil and gas workers and reduce pollution.

1 Because most federal programs focus on remediation rather than restoration, we primarily use the term "remediation" going forward.

Remediation efforts may be particularly beneficial in communities that heavily depend on fossil energy production, transformation, or consumption. Many of these communities have a legacy of pollution, which can harm public health and deter investment in new economic sectors. Addressing this legacy has the potential to provide near-term employment opportunities for displaced workers and lay the groundwork for future economic growth.

3.1. Key Insights

- The federal government plays a large role in addressing polluted sites across the United States. ***These programs could be enhanced and targeted toward workers and communities negatively affected by an energy transition.***
- ***Millions of sites in the US need environmental remediation***, and emerging evidence points to poorly understood risks from sources such as dioxins, agricultural runoff, and coal ash. In many cases, remediation needs are in regions historically dependent on coal, oil, and natural gas production, offering the potential for new investment to support these workers and communities.
- Most evidence suggests that ***remediating polluted sites increases local property values***. This could have particular benefit for fossil energy communities and environmental justice communities, which may experience a heavier burden of pollution than the broader population.
- There is strong evidence that ***remediation projects increase local employment temporarily***, but it is not clear whether those employment benefits continue after a site has been cleaned up. It is also unclear whether remediation projects support primarily workers in affected communities or workers from other locations. More research on the long-term employment effects of environmental remediation projects would be valuable.
- Some evidence suggests that ***environmental remediation projects may disproportionately occur in whiter communities*** and that remediation programs could lead to "environmental gentrification." This highlights the importance of considering equity and justice in the design and implementation of environmental remediation policies, and it raises the question of how to prioritize sites for remediation.

3.2. Metrics for Evaluating Policy Effectiveness

A range of potential metrics can be used for evaluating the effectiveness of environmental remediation and restoration programs. Here, we focus on a relatively narrow band of metrics.

Our primary questions are whether, and to what extent, environmental remediation programs affect local economies, and what lessons can be applied to a JT context.

Most research in this area has focused on how remediation programs affect local property values. Because property values can reflect an individual's preferences, they are a useful proxy for understanding the benefits that a community experiences when a given remediation program occurs.

However, property values are an imperfect measure, for several reasons. First, they do not address all our outcomes of interest, such as local employment or wages. In addition, they do not fully account for public health effects and associated EJ concerns, since individuals do not have perfect information about the environmental hazards they may face when they purchase a property (Hausman and Stolper 2020).

Where evidence is available, we incorporate additional metrics of how programs may affect local and regional employment, income, and businesses. Unfortunately, studies on these effects are limited, consisting mostly of case studies and economic simulations using input-output models. These estimates are informative but generally less reliable than retrospective empirical analyses (e.g., Oosterhaven 1988).

3.3. Programs and Evidence

This section examines major federal programs to clean up polluted sites, focusing on land and water contamination, and the evidence of their effectiveness. Some programs target a broad range of polluted sites (Section 3.3.1); others address nuclear weapons or energy sites (Section 3.3.2), oil and gas sites (Section 3.3.3), and coal sites (Section 3.3.4).

3.3.1. General Pollution Remediation

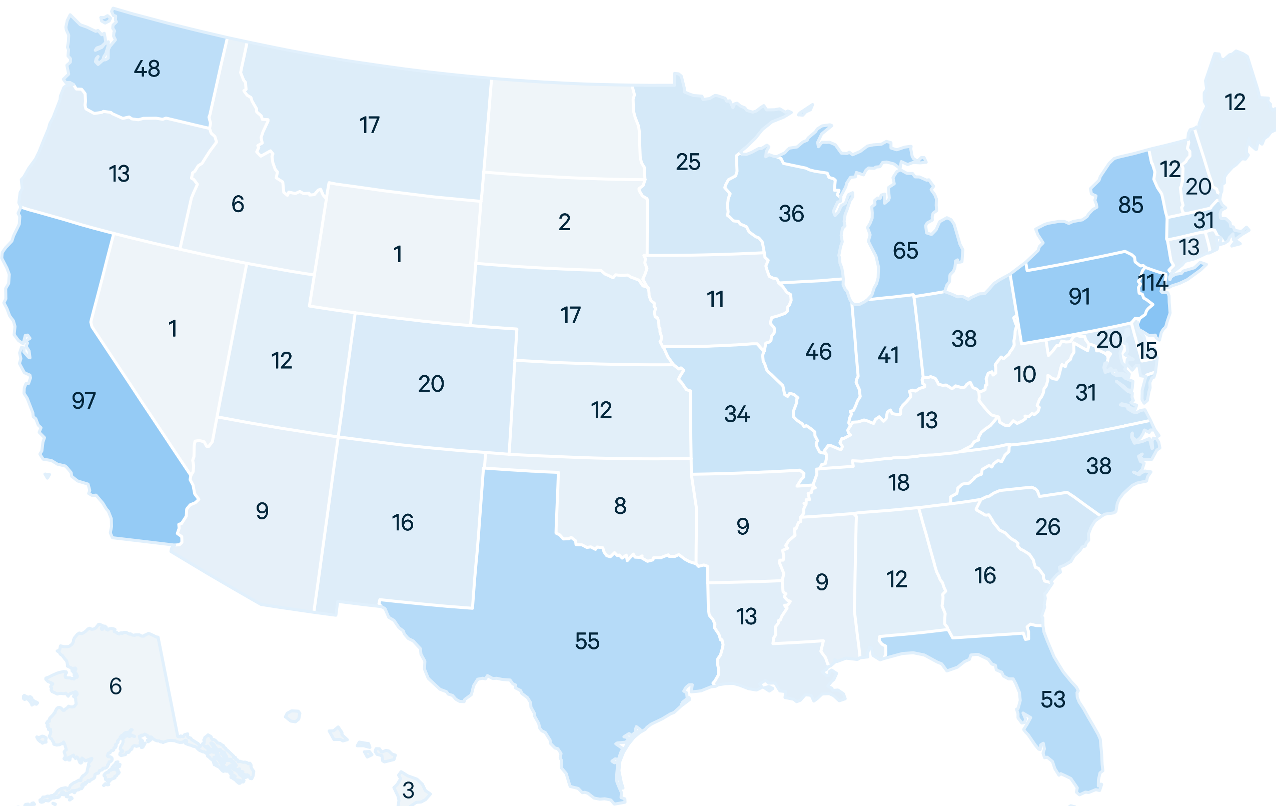
More than a century of industrial activity, often unregulated or underregulated, has created thousands of contaminated sites across the United States. The federal government's largest programs to address these sites are the Superfund and Brownfields programs, both administered by EPA.

3.3.1.1. Superfund

Superfund was established in the 1980 Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA). CERCLA regulates abandoned hazardous waste sites, establishes liability rules for contaminated sites, and imposed taxes on the sale of petroleum and chemical products to pay to clean up sites. These taxes were expanded in the 1980s but expired in 1995 (Probst 2009). In 2020, appropriations for the program were roughly $1.2 billion (EPA 2020k).

Potential Superfund sites are nominated by local or state authorities, then evaluated by EPA for inclusion on the National Priorities List (NPL), the official register of sites to be remediated. Superfund sites are, by definition, abandoned and have no owner, but EPA has the authority to identify parties that are responsible for contaminating a site in the past and requiring them to pay for cleanup. The 1,335 sites on the current NPL are scattered across the country, with an additional 51 proposed sites and 424 "deleted" sites where cleanup has been completed (EPA 2020j). Of the current NPL sites, the largest numbers are found in New Jersey (114), California (97), Pennsylvania (91), and New York (85) (Figure 1).

Figure 1. Current Superfund Sites, by State



Data Source: EPA (2020i). Data not shown for PR (19), RI (12), GU (2), and VI (1).

A large body of work has demonstrated that Superfund sites endanger local public health (e.g., Currie et al. 2011; Persico et al. 2016; Klemick et al. 2020). In the context of a JT, it is particularly important to consider the potential for remediation in communities where fossil energy production, transformation, or use has contributed to this legacy of pollution. Depending on one's definition of JT, it is also important to consider that Superfund sites are disproportionately located in communities of color (e.g., Stretesky and Hogan 1998; Ringquist 2005)).

Some early work suggested that Superfund cleanup may have little to no effect on local communities as reflected in housing prices (Greenstone and Gallagher 2008). Other early work found mixed results, with some sites experiencing substantial increases in property values, and others seeing no effect (Kiel and Williams 2007). One hypothesis was that site designation, if followed by long delays in remediation, would lead to the stigmatization of a neighborhood, even after cleanup occurred (Messer et al. 2006).

However, subsequent analyses using more granular data have found substantial benefits from cleanup. For example, Gamper-Rabindran and Timmins (2013) find that cleanup increases nearby home values by 15 percent on average, with the largest benefits accruing to homes located closest to the sites, which are typically cheaper (prior to cleanup) than homes farther away. Comparing the benefits with Superfund costs, Gamper-Rabindran and Timmins (2011) estimate that they are similar in size. As noted above, property values likely do not reflect the full range of benefits experienced by nearby residents, since lack of complete information means that buyers and sellers alike typically underestimate health damages from pollution (Hausman and Stolper 2020).

Along with changes in housing values, population tends to increase in the area surrounding a remediated site, although this in-migration tends to consist of more affluent and better-educated individuals (Gamper-Rabindran and Timmins 2011), raising the issue of environmental gentrification (Sieg et al. 2004). From an EJ perspective, Gamper-Rabindran and Timmins (2011) do not find evidence that people of color are being displaced from these communities, but they do hypothesize that higher-income minorities are replacing lower-income minorities following remediation.

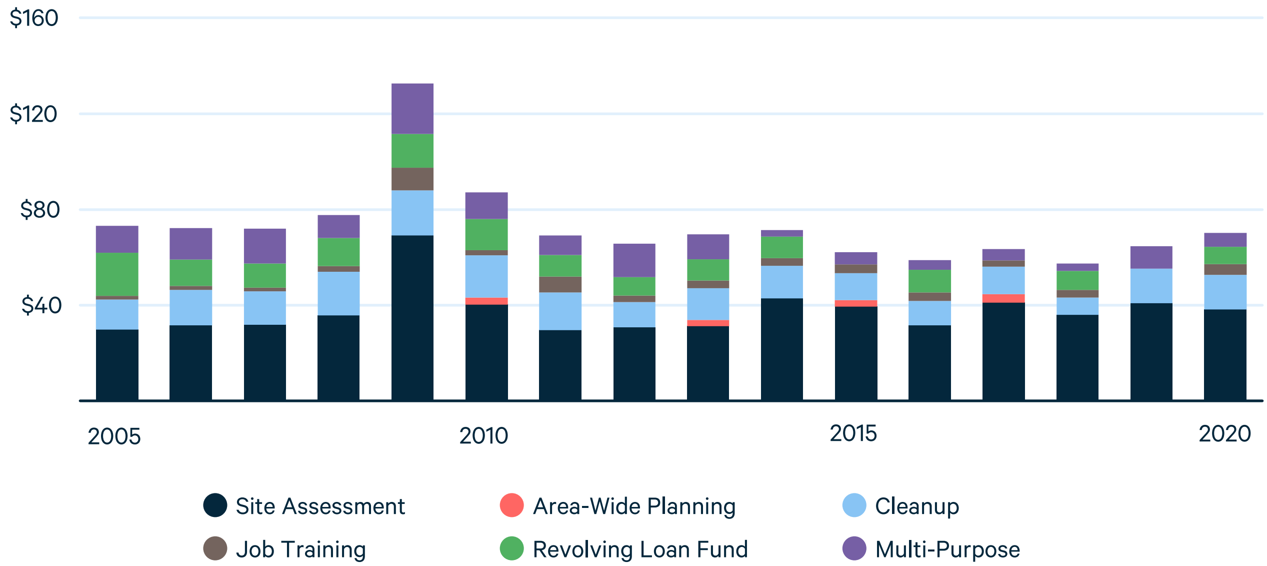
We were not able to identify any empirical research evaluating the employment effects of Superfund. One recent analysis (Larsen et al. 2020) uses an input-output model to estimate that a one-time investment of $20 billion in Superfund cleanup efforts would create 18,000 direct jobs annually over five years, equal to roughly 4.5 direct job-years per $1 million. Another input-output study (Pollin and Chakraborty 2020) estimates that Superfund and Brownfields spending creates 7.5 direct job-years per $1 million.

One important consideration regarding employment is that some situations—particularly disaster sites, such as the World Trade Center—pose an occupational safety risk (Maxwell et al. 2018). These risks highlight the importance of safety protocols and adequate protections for workers who are employed to clean up sites.

3.3.1.2. Brownfields

EPA's Brownfields and Land Revitalization Program assists states and communities in the cleanup and redevelopment of polluted sites by offering tax credits for developers. The program began with small grants to local governments in 1995 and was formalized in 2002, with 2020 appropriations of roughly $73 million (EPA 2020k) and tax credits on the order of $20 million per year (Joint Committee on Taxation 2019). The program funds a variety of activities, including site assessment, cleanup operations, job training (targeted to nearby residents), and revolving loan funds established by local entities to support future efforts. Over the past 15 years, 50 percent of grants went to site assessment, 17 percent to revolving loan funds, 16 percent for site cleanup, and the remainder to other activities.

Figure 2. Brownfields Grants, by Type (Million $)



Data Source: EPA (2020b).

As with the Superfund literature, most studies examining Brownfields have focused on property values as an outcome of interest. In an analysis of the program from 2002 to 2008 across 38 states, Haninger et al. (2017) find that cleanup increases nearby home values by 5 to 12 percent. They also estimate the broader welfare benefits of cleanup, finding that local welfare increases by 15 percent. Sullivan (2017) applies the estimates generated by Haninger et al. to homes surrounding 48 Brownfields sites across 17 states and estimates that cleanup would increase local property tax revenues by $29 million to $97 million annually. If these estimates are accurate, they indicate that the benefits for local public finances alone may exceed the costs to the federal government of cleanup over time.

More limited research from De Sousa et al. (2009), Woo and Lee (2016), and Schwarz et al. (2017) also indicates that cleanup increases local property values, though Schwarz et al. find that those living closest to cleanup sites (within 0.3 mile) see decreased property values, perhaps because of the physical appearance of sites following cleanup.

The employment effects of brownfields redevelopment have received less attention from researchers. Although grants clearly support workers who carry out assessments and clean up contaminated sites, it is not clear whether those activities increase or simply redistribute jobs economy-wide. In a review of case studies, Howland (2007) notes that the evidence on this question is mixed but estimates that when a site is remediated, that site hosts roughly 10 local jobs per acre. They also highlight a consistent finding that site remediation alone is not sufficient to revitalize struggling communities, and that broader strategies integrating Brownfields cleanups with other efforts appear necessary, particularly in the most distressed communities.

The only analysis that we have identified that uses empirical methods (rather than case studies or input-output modeling) on the effects of Brownfields projects on local employment comes from Swenson (2019). This work finds strong evidence that Brownfields projects increase employment for construction and service companies close to a site by 1.25 percent during remediation activities. It is unclear whether these effects persist after a site has been cleaned up. Larsen et al. (2020) use an input-output model and estimate that a one-time investment of $2 billion in the Brownfields cleanup efforts would create roughly 1,000 direct jobs annually over five years, equal to roughly 3.3 direct job-years per $1 million; Pollin and Chakraborty (2020) estimate 7.5 direct job-years per $1 million for both Brownfields and Superfund sites.

One potential concern related to the Brownfields program is that projects may be selected to target the most marketable communities and neighborhoods. This approach may offer the most economically efficient path for redevelopment, but it raises concerns over fairness. For example, McCarthy (2009) finds that projects in Milwaukee were disproportionately located in areas with higher percentages of nonminorities. Lee and Mohai (2012) raise additional EJ concerns with the program, highlighting the importance of equity and justice considerations in program implementation. In the context of a JT, it may be appropriate to prioritize sites in communities negatively affected by a shift away from fossil energy.

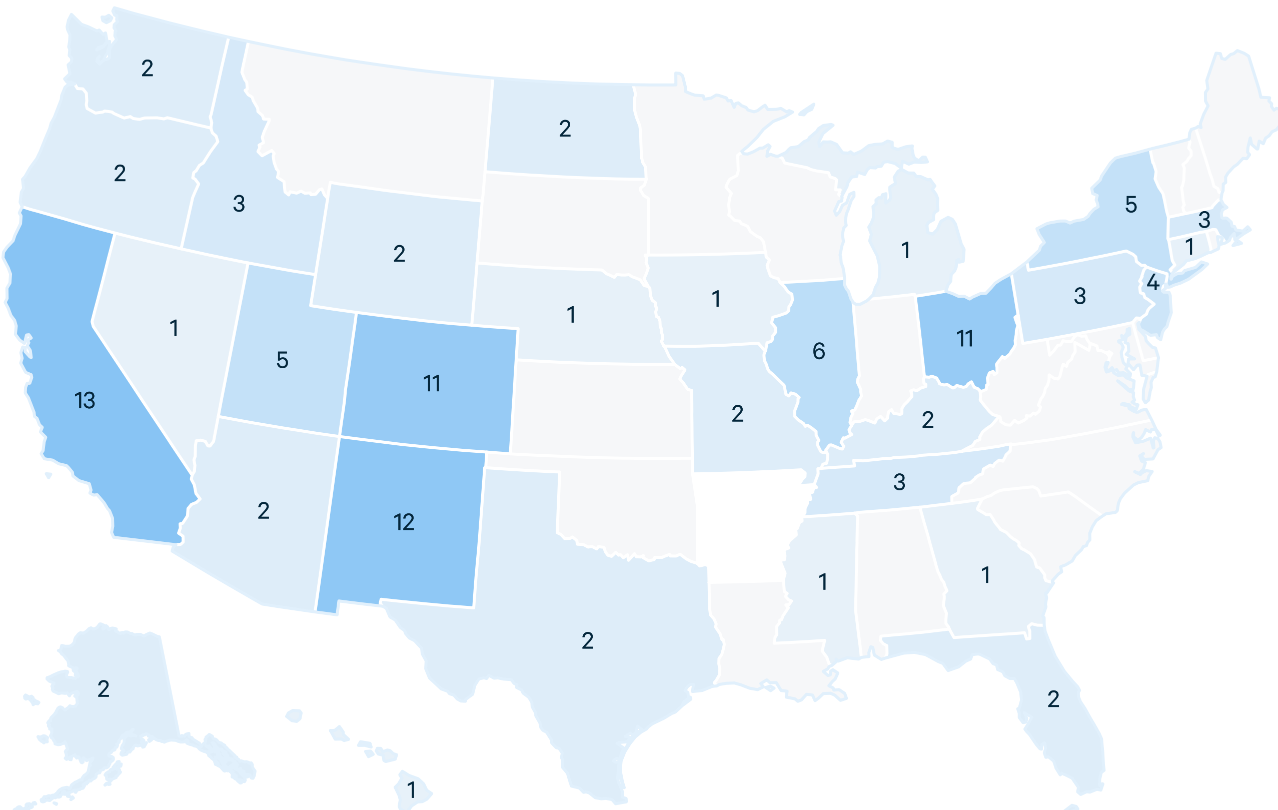
3.3.2. Nuclear Sites

Since the late 1930s, the US nuclear weapons program has generated “huge quantities of contaminated soil and water” associated with the production of liquid and solid radioactive wastes, spent fuel, and other material (DOE 2014, page 2). In terms of expenditure, efforts by the Department of Energy (DOE) to address this legacy of contamination represent the largest environmental management effort in the nation and perhaps the world.

This work is led by two major entities: the Office of Environmental Management (OEM) and the Office of Legacy Management (OLM). OEM, which received appropriations of $7.5 billion in 2020 (Holt and Clark 2020), oversees waste management and cleanup of facilities contaminated primarily by nuclear weapons programs. Once these sites are considered remediated, they are transferred to OLM, which was funded at $162 million in 2020 (DOE 2020b), for postclosure monitoring, land-use planning, and community services.

Since its inception, OEM has been responsible for cleaning up 107 sites, the largest number of which are in California (13), New Mexico (12), Ohio (11), and Colorado (11). Today, the 16 remaining active sites employ thousands of workers, led by Savannah River, Georgia (11,000); Hanford and Richland, Washington (9,400); Portsmouth, Ohio (2,400); and Oak Ridge, Tennessee (2,300) (DOE 2020a).

Figure 3. Office of Environmental Management and Legacy Management Sites



Data Source: DOE (2020a). Data not shown for PR (1). States in gray have no sites.

OLM, with its substantially smaller budget, monitors roughly 100 sites previously managed by OEM and in some cases transitions them to beneficial uses, such as recreation and education (DOE 2020c). Figure 3 shows the locations of OEM and OLM sites. OLM also oversees the provision of benefits and pensions to remediation workers.

Frisch et al. (1998) use regional input-output simulations to estimate the economic effects of shifting from weapons manufacturing to remediation at five DOE sites. This shift entailed a decrease in overall regional DOE spending, which in turn leads to worse economic performance, particularly in more rural regions. In subsequent analysis, Greenberg et al. (2008) examine how remaining DOE spending might be used to support these economies and find that investing in robust severance packages, education, and recreation would most effectively limit income, job losses, and outmigration. Greenberg et al. (2010) also consider the consistency of DOE spending in these regions and find that highly volatile spending would result in “boom-bust” effects for local economies, felt most acutely in rural regions.

It is unlikely that the DOE remediation programs will play a major role in a JT. Although the work remains important, nuclear sites are not necessarily located in or around communities with a history of fossil energy dependence, and it is unclear whether the skills of the current fossil energy workforce are compatible with nuclear waste management.

3.3.3. Oil and Gas Remediation

The production, transformation, and distribution of oil and natural gas has the potential to create environmental damage at various stages. Here, we focus on two areas of substantial environmental risk: underground storage tanks and abandoned oil and gas wells.

3.3.3.1. Underground Storage Tanks

Whether above or below ground, the tanks used to store crude oil and refined petroleum products (e.g., gasoline, kerosene, diesel) can leak and damage nearby soil and water resources. EPA's Underground Storage Tank (UST) program, which began in 1984, requires tank owners and operators to install and operate equipment to certain standards, including the installation of leak detection equipment. The program also requires owners and operators to demonstrate that they are financially equipped to clean up potential spills, and in many cases the states have assisted owners in meeting those requirements.

Along with financial assurance requirements, EPA provides grants to states and tribes annually to prevent and clean up releases. These grants are made by the Leaking UST Trust Fund, which is funded by a tax of $0.01 per gallon on all motor fuel sales; it held a balance of roughly $850 million in May 2020 (US Department of the Treasury 2020). In 2020, Congress appropriated $92 million for the program (Pascrell 2019). In the context of a transition to clean energy, it is unclear how the program might be funded in the future if sales of petroleum-based motor fuels decline considerably.

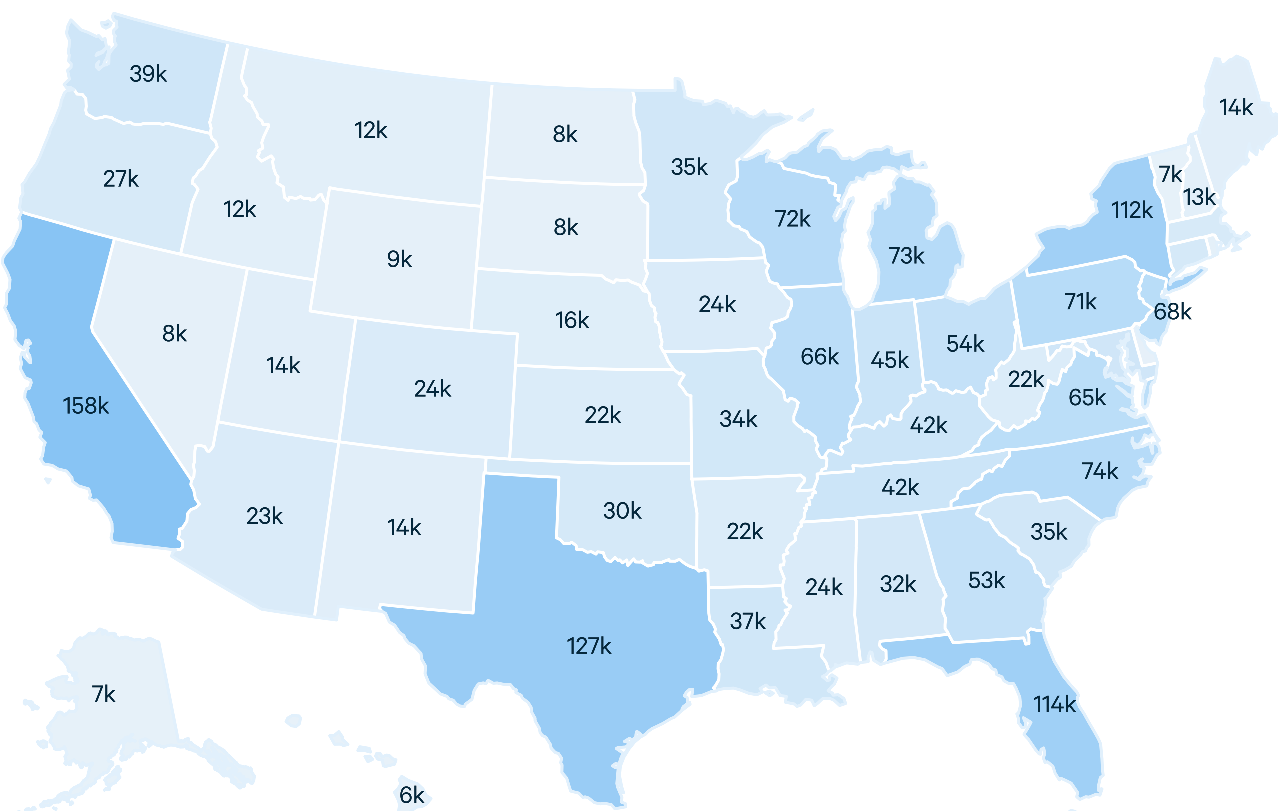
EPA estimates that more than 540,000 underground storage tanks exist nationwide at 193,000 locations, and that more than 2 million have been closed since the federal program began. Since its inception, the program has identified 558,000 releases from these tanks, with 64,000 yet to be cleaned up. Through the first half of 2020, EPA newly identified 2,400 releases (EPA 2020h).

Figure 4 illustrates the location of the hundreds of thousands of closed USTs across the US.

As with Superfund sites and Brownfields, most economic work has focused on the effects of remediation on nearby property values. Zabel and Guignet (2012) use household-level data from 1996 to 2007 and find that when leaks are highly publicized and severe, surrounding homes depreciated by 10 percent. Similarly, Guignet (2013) finds that when households are made aware (through water quality tests) that leaking tanks are contaminating their water supplies, home values decline by 11 percent. These results highlight the crucial role of information and suggest that prevention or cleanup of releases would increase property values by 10 to 11 percent.

We are not aware of any empirical studies on the employment effects of cleaning up leaking tanks. In the context of a JT, it is also unclear whether these tanks pose a particular risk in communities with a history of fossil energy production. Instead, it is likely that underground tanks are concentrated in and around urban centers, where demand for petroleum products is greatest.

Figure 4. Closed Underground Storage Tanks, by State (Thousands)



Data Source: EPA (2020h). Data not shown for MD (37,684), CT (29,645), MA (28,143), RI (9,324), DE (7,745), PR (6,006), DC (3,644), GU (506), VI (293), and tribal lands (6,274).

3.3.3.2. Oil and Gas Well Sites

One approach to reducing local and global pollution that has received recent attention is plugging and restoring abandoned and “orphaned” oil and gas wells (orphaned wells are those which have no owner and thus no responsible party to pay for plugging and reclamation). The EPA (2020) estimates that there are 2.1 million unplugged abandoned oil and gas wells across the United States, and that these wells emit methane that is equivalent to almost 10 million metric tons of carbon dioxide annually.[2] The Interstate Oil and Gas Compact Commission (IOGCC 2019) reports that states have identified 56,600 orphaned wells, and that hundreds of thousands of additional orphaned wells exist but have not been documented.

Plugging these wells and restoring the land surface not only reduces risks to local water resources and essentially eliminates methane and other emissions, it also reduces the hazard of falling into an unmarked abandoned well. What’s more, the skills and equipment needed to plug wells and restore sites are largely compatible with those used for oil and gas extraction, offering a clean opportunity for oil- and gas-producing communities.

Raimi et al. (2020) estimate that plugging and restoring the 56,600 orphaned wells that states, tribes, and the federal government have documented could provide roughly 13,500 job-years at a cost of $1.4 million to $2.8 billion. They note that scaling the program up to 500,000 wells could provide more than 100,000 job-years, but that level could create administrative challenges.

Although most wells sit on state and private lands, where states are the primary regulator, orphaned and abandoned oil and gas wells are also an issue on federal lands. The 2005 Energy Policy Act required the Bureau of Land Management (BLM) to develop a program to reclaim abandoned oil and gas well sites on federal lands, but that program was never funded at high levels. In multiple recent reports, the Government Accountability Office (GAO) has found that BLM faced challenges identifying these wells and may not have the financial capacity to fully restore abandoned sites (GAO 2018, 2019). GAO estimated that BLM spent roughly $300,000 per year from 2010 to 2017 on oil and gas site restoration, but that future reclamation costs could total $46 million for wells that BLM officials identified as “at risk” of becoming orphaned (GAO 2018).

3.3.4. Coal Site Remediation

Coal production and processing have created a variety of environmental hazards, from acid drainage, subsidence, and collapse to long-burning underground fires. These issues are well known to have caused considerable pollution to nearby water resources

2 This estimate assumes a 100-year methane global warming potential (GWP) of 34. Using a 20-year GWP of 86 would produce an estimate of roughly 24 million metric tons per year of CO2-equivalent. For more, see Raimi et al. (2020).

(e.g., Johnson and Hallberg 2005; Wright et al. 2015; EPA 2020a) and—in extreme cases—even the abandonment of cities or towns (e.g., Nolter and Vice 2004).

Coal consumption also creates by-products that have the potential to cause pollution. In particular, coal combustion residuals, often referred to as "coal ash," are stored in impoundments that can contaminate subsurface aquifers (e.g., Harkness et al. 2016; Vengosh et al. 2019) and, in rare cases, spill enormous volumes of waste into the environment and communities (e.g., EPA 2020f, 2020c).

Cleaning up these sites could reduce the risks of future pollution and support local employment during cleanup, particularly in communities with a history of coal production and consumption. Here, we focus on the federal Abandoned Mine Land program, which is the most prominent federal tool to address production and processing sites; additional options are discussed in Hansen and Hereford (2010). Other policies have been proposed to address the issues associated with coal ash, particularly the Obama administration's 2015 EPA rule on monitoring and remediation (EPA 2020e).

3.3.4.1. Abandoned Mine Land Reclamation Program

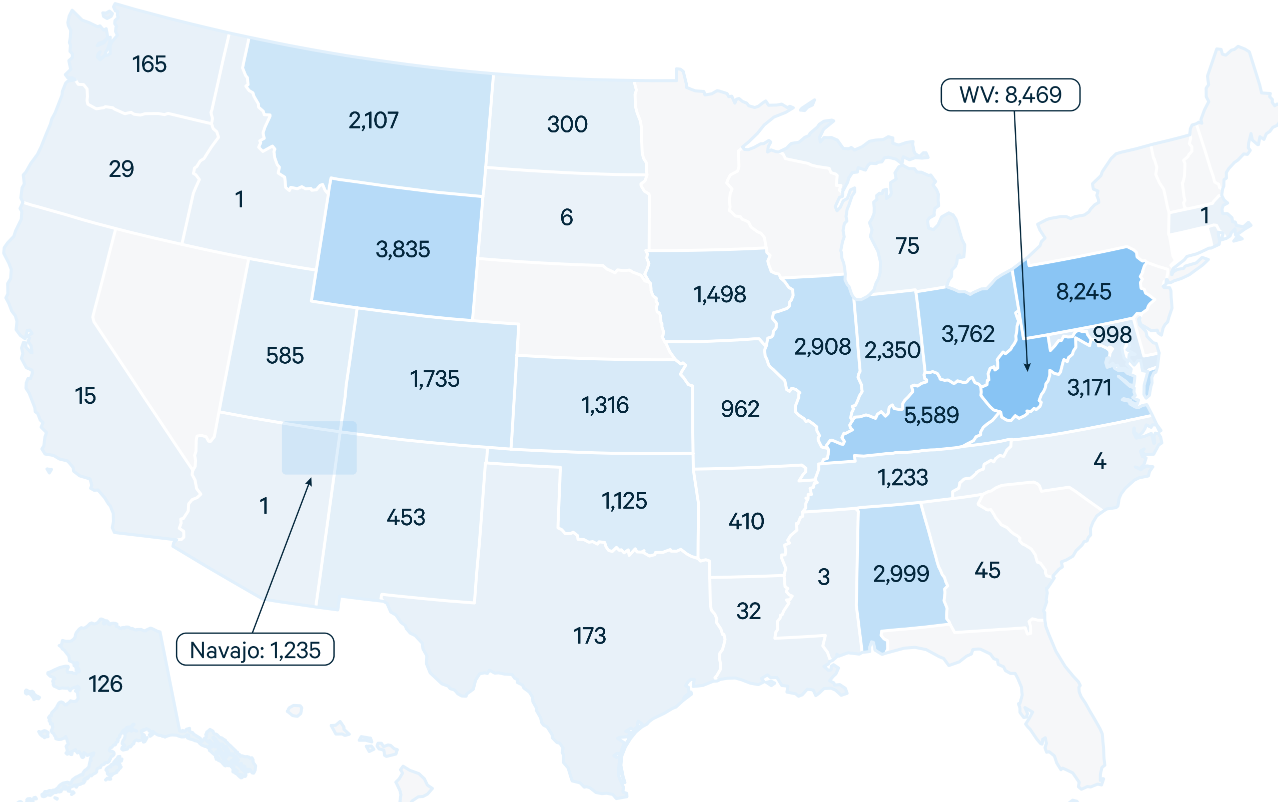
The 1977 Surface Mining Control and Reclamation Act established federal regulations for active coal mines and created the Abandoned Mine Land (AML) fund to clean up mines that had no owner to pay for cleanup and were abandoned prior to 1977. The fee, paid by all mine operators, is currently set at $0.28 per ton of surface-mined coal, $0.18 per ton of subsurface-mined coal, and $0.08 per ton for lignite (Office of Natural Resource Revenue 2020). In 2019, these taxes raised $142 million, and the fund balance stood at $2.3 billion (OSMRE 2020b).[3]

AML funds are distributed in the form of grants by the Office of Surface Mining, Reclamation, and Enforcement (OSMRE), part of the Department of Interior, to states and tribes to pay for local cleanup efforts. As of this writing, OSMRE's online data system lists 56,414 abandoned mines nationally (though it is not clear how many are coal mines), with by far the largest concentrations across Appalachia, led by Pennsylvania and West Virginia (Figure 5). Although the primary purpose is to reduce pollution, OSMRE has administered since 2016 a pilot program to target funds to Appalachian and tribal communities with the explicit goal of enhancing local economic development (OSMRE 2019).

In 2020, the largest recipients were Wyoming ($36 million), Pennsylvania ($32 million), West Virginia ($23 million), Illinois ($12 million), and Kentucky ($11 million) (OSMRE 2020b). Notably, more than $1.4 billion has been transferred from the AML fund to

3 Recent legislation (Cartwright 2019) has proposed extending the program and adjusting the criteria for revenue distribution to states.

Figure 5. Abandoned Mines, by State



Data Source: OSMRE (2020a). Data not shown for RI (2) and tribal lands (1,675) except for Navajo Nation, which has by far the largest number of sites (1,235). States in gray have zero mines documented in the OSMRE database.

support pensions for the United Mine Workers of America since 1996 (OSMRE 2018), raising the concern that the fund is not providing all of the environmental benefits that it could.

Cleanup of abandoned mine sites offers the potential for environmental and economic benefits, particularly for coal workers and communities. These projects can alleviate water quality problems caused by acid mine drainage or other sources. These improvements, in turn, could enhance local property values (similar to the effects of Superfund and Brownfields sites, discussed above) and natural amenities that could increase recreational tourism.

We are not aware of any literature assessing the effects of AML restoration projects on these outcomes, or any peer-reviewed literature that assesses the employment effects.

Several reports from consultants and advocates do estimate employment effects but must be read with caution, since they are precleanup estimates rather than retrospective analyses, and they do not account for any broader economic effects (positive or negative) from investing in mine cleanup (compared with investing in some other project). With that in mind, Hansen and Hereford (2010) estimate that each $1 million in AML expenditures in Appalachia produces 12 to 13 job-years, and a mine restoration project in Montana estimated 10 job-years per $1 million (Wagner and Shropshire 2009). Another report on cleanup and remediation at a coal plant in Montana estimated 5 to 6 job-years per $1 million of spending, with cleanup occurring from 2020 through 2069 (Northern Plains Resource Council 2019).

In addition, recent reporting has illustrated at least one creative approach for reusing AML sites in Kentucky: introducing elk as a means of attracting tourism (Whang 2020).

4. Broad Infrastructure Programs

In this section, we review six major federal infrastructure spending programs that could play a substantial role in the context of a JT. As noted in Section 2.1, our primary expertise lies in environmental policy. Our analysis of infrastructure programs is therefore descriptive, with a limited review of evidence on program effectiveness. We do, however, consider some important conceptual frameworks for evaluating the effectiveness of infrastructure spending in a JT context.

The federal government spends billions of dollars annually on infrastructure construction and maintenance through many programs—for highways and roads, public transportation, waterways, airports, water and wastewater systems, and more. In general, the federal government delivers dollars (and in some cases, technical assistance) to states and localities, which perform the relevant work or partner with contractors. Here, we examine six of the largest programs by spending, as shown in Table 4.

Table 4. Federal Infrastructure Programs

Program	Relevance to Just Transition
Federal-Aid Highways Program	The federal government spends tens of billions of dollars each year to support planning, construction, and maintenance of state and local roads. Because access to transportation plays a critical role in economic development, the direction and magnitude of spending shapes local economic outcomes. In a JT context, expanding highway access for communities in transition could enhance market access and local economic growth.
Tax Exemption for State and Local Infrastructure Bonds	State and local infrastructure is often funded through bonds, which the federal government subsidizes by exempting bondholders from certain taxes on bond interest. Continuation, expansion, or adaptation of this policy has the potential to incentivize public and private investment in regions affected by a JT.
Federal Public Transportation Program	The federal government supports local bus, rail, and other public transportation through grants to states and localities. Expanded public transportation can spur economic growth in areas served by these networks, along with reducing congestion, GHG emissions, and local pollution.
Community Development Block Grant	Federal funding for housing and other community infrastructure has primarily supported cities and urban areas. Although the communities most affected by a deep decrease in fossil energy production are primarily rural, grants to midsize cities in rural regions could potentially be expanded in a JT.
Clean Water and Drinking Water State Revolving Funds	The federal government provides grants to capitalize loan programs administered by state governments, which provide below-market loans and other financial support for wastewater and drinking water systems. These programs have the potential to support communities in transition, especially those with water quality challenges.

4.1. Key Insights

- ***Transportation infrastructure projects create local construction and related jobs*** and can also induce longer-term economic development by making transportation easier and cheaper. Improving transportation networks in rural energy communities can enhance their physical access to markets, providing a stronger foundation for future economic growth.
- ***Economists have debated whether infrastructure investment—particularly for highways—increases overall economic activity or simply redistributes that activity.*** Although the former outcome is clearly preferable across society, the latter may also be valuable in the context of a JT if new infrastructure serves communities negatively affected by a shift away from fossil energy.
- ***Affordable access to clean water is essential for every community.*** If fossil energy communities experience declining tax revenue and/or population, it may become difficult for local governments to finance water system maintenance and upgrades. In addition, these communities may be at greater risk from the legacy of pollution that sometimes accompanies fossil energy extraction, processing, and combustion.
- Some federal programs, such as Community Development Block Grant, are primarily targeted toward urban areas, where relatively little fossil energy production occurs. In the context of a JT, additional ***resources could be directed to the small and midsize cities that often serve as commercial hubs for rural energy-producing communities.***
- Low-income areas and communities of color have experienced environmental injustices often related to the siting, maintenance, or administration of public infrastructure. The design, implementation, and enforcement of ***policies will shape whether, and to what extent, future infrastructure spending reduces or exacerbates historical inequities.***

4.2. Metrics for Evaluating Policy Effectiveness

Unlike the environmental remediation programs described in the previous section, infrastructure spending does not typically seek to address environmental externalities. Indeed, some programs (e.g., highway spending) have the potential to exacerbate environmental and equity challenges, depending on their design and implementation.

Because of these differences, we begin with a conceptual discussion of the potential for infrastructure spending to (1) provide employment; (2) enhance social welfare; (3) provide short-term economic stimulus; (4) increase long-run economic productivity; and (5) affect EJ outcomes. We then turn to the specific programs listed in Table 4.

4.3. Theoretical Background and Evidence

4.3.1. Employment

Federal infrastructure spending has the potential to boost employment in construction, operations, and maintenance, along with supporting jobs indirectly by providing valuable public services (e.g., convenient transportation or clean water). In the context of a JT, infrastructure investment can support economic development and public health in communities negatively affected by a shift away from fossil energy. These jobs may be particularly valuable if the skills they are require are similar to those of workers displaced from jobs in fossil energy production, processing, and use.

However, different infrastructure programs lead to different levels and types of employment opportunities. One recent report (Pollin and Chakraborty 2020) provides estimates of labor requirements associated with various infrastructure spending options, including the share of that labor in the manufacturing sector. The authors use input-output modeling and estimate that spending on surface transportation, parks and recreation, and schools are the most labor intensive, leading to roughly 12 direct job-years per $1 million in spending; broadband, rail, electricity, and airport infrastructure are the least labor intensive, generating 3 to 4 direct job-years per $1 million.

4.3.2. Social Welfare

Economic theory dating back to John Stuart Mill (1848) argues that government investment in infrastructure can enhance social welfare because certain industries that rely on networks, like electricity, water, roads, rail, and canals, are natural monopolies (i.e., they have high start-up costs and strong economies of scale). Modern textbook economics theorizes that natural monopolies lead to outcomes that are socially inefficient (McEachern 2016), justifying government intervention through regulation, ownership, or other means.

In addition, some infrastructure provides goods that create positive externalities, and governments can improve social welfare by subsidizing or producing goods with these positive spillovers (Federal Reserve Bank of St. Louis 2012). For example, clean drinking water reduces mortality and morbidity while also increasing worker productivity (Hutton and Haller 2004).

In the context of a JT, infrastructure investment could be targeted to enhance welfare in communities negatively affected by the transition. Decreasing tax revenue is a particular concern where energy production, transformation, or consumption accounts for a substantial share of the tax base that funds roads or public transportation (Newell and Raimi 2018; Morris et al. 2019).

4.3.3. Short-run Economic Stimulus

Economists debate the role of infrastructure investment as a short-run, countercyclical tool for economic recovery. Under a traditional Keynesian economic model, any type of government spending (productive or wasteful) can provide short-run economic stimulus (Ramey 2020). Infrastructure investment could thus have the double benefit of improving long-term productivity (Section 4.3.4) and providing short-term economic stimulus.

However, many economists express doubt about the short-run value of public infrastructure investment. Because effective stimulus requires rapid injections of money into the economy, infrastructure projects that unfold over multiyear time scales may not fit the bill (Copeland et al. 2009). In fact, delays in construction of publicly funded infrastructure could have quite small or even negative short-run impacts on economic output and labor (Leeper et al. 2010; Ramey 2020). However, if economic conditions remain weak for years, infrastructure spending could be an appropriate tool for targeted stimulus (Copeland et al. 2009).

In the context of a JT, where energy communities may face long-term structural changes, long-term outcomes may well be the most relevant time frame to consider.

4.3.4. Increasing Long-run Productivity

Economists have debated the broad economic effects of public infrastructure investment. In particular, debate continues over whether public infrastructure investments (particularly in transportation) increase aggregate growth or simply shift growth toward the locations that the infrastructure is serving (e.g., Fogel 1970; Holtz-Eakin 1994; Holtz-Eakin and Schwartz 1995a, 1995b).

However, one survey of 75 studies concluded that infrastructure spending tends to increase aggregate economic growth (Romp and Haan 2007). In a more recent review, Redding and Turner (2015) find that highways and railroads boost economic growth in urban areas by increasing overall economic activity and shifting that activity toward the infrastructure. In more rural areas, where the negative effects of a JT may be more acute, they find that increased growth near new infrastructure tends to come at the expense of more remote areas. In the context of a JT, this is not necessarily a problem, since government may seek to redirect economic activity toward communities negatively affected by a sharp shift away from fossil energy.

Evidence on the economic benefits of public transportation is more limited (Duranton et al. 2020) and somewhat mixed. Two recent modeling studies examining Berlin and London estimate that rail expansion substantially increases city populations and property values (Ahlfeldt et al. 2015; Heblich et al. 2020). However, the researchers also note that although expansion of rail benefits workers by reducing travel costs and improving access to city amenities, the increased number of laborers entering the city would tend to reduce wages.

4.3.5. Infrastructure and Environmental Justice

A large literature explores and seeks to explain EJ problems, focused largely on the co-location of polluting facilities in and around low-income and minority communities (e.g., Mohai et al. 2009). This work extends to the siting of publicly funded infrastructure and demonstrates that minority communities are often disproportionately exposed to pollution.

In particular, numerous studies have documented that urban schools with a larger proportion of minority children are more likely to be exposed to pollution from freeways, which contributes to asthma and other health conditions (Gunier et al. 2003; Green et al. 2004; Kim et al. 2004; Bae et al. 2007). The siting and operations of water and wastewater systems can also have substantial EJ implications. For example, wastewater treatment plants have the potential to emit considerable amounts of volatile organic compounds, which can cause health damages for workers and nearby residents (Namkung and Rittmann 1987). In addition, poor maintenance and monitoring of drinking water systems have led to disproportionate exposure for minority and low-income communities to water pollutants such as nitrate (Schaider et al. 2019), arsenic (Balazs et al. 2012), and lead (Kennedy et al. 2016).

Enforcement of regulations is another EJ concern. In one analysis, Konisky and Schario (2010) find that enforcement of the Clean Water Act varied across race and class dynamics, with less enforcement observed in lower-income communities.

Looking forward, infrastructure investment has the potential to exacerbate or reduce EJ concerns in several areas. For example, public transportation investments that reduce traffic on freeways (or reduce pollution from vehicles on those freeways) can help address existing EJ issues. In addition, investments in water systems can reduce the disproportionate effects of water pollution on low-income and minority communities. On the other side of the coin, spending that does not account for these issues has the potential to exacerbate historical and existing inequities.

4.4. Major Programs

With the conceptual framework in place, we now turn to a primarily descriptive analysis of six major federal infrastructure programs.

4.4.1. Transportation Infrastructure

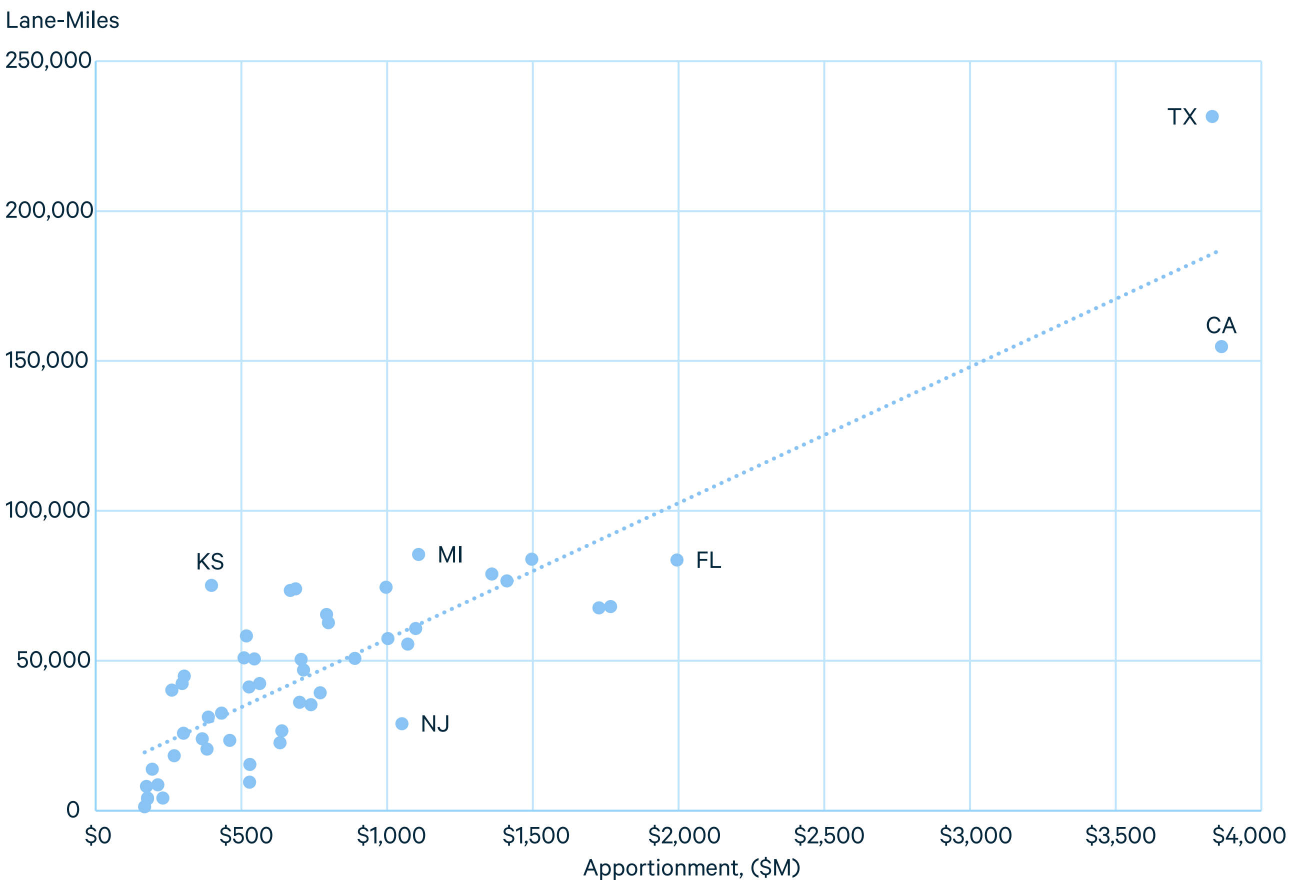
We begin by reviewing three major federal transportation programs. The first two—the Federal-Aid Highway Program (FAHP) and the Federal Public Transportation Program (FPTP)—are largely funded through the Highway Trust Fund (HTF), which is financed by an excise tax on the sale of petroleum products. Notably, HTF revenues have not kept pace with federal spending, requiring Congress to transfer funds from other sources (including the UST program; see Section 3.3.3.1) (CRS 2018a). The third policy, a tax exemption for state and local infrastructure bonds, is "funded" by forgone federal tax revenue.

4.4.1.1. Federal-Aid Highway Program

The federal government distributes FAHP funds through multiple programs that use formulae to calculate each state's share. These formulae include a state's share of lane-miles, vehicle miles traveled, diesel fuel consumption, and tax payments into the HTF (CRS 2019b). In 2020, Congress appropriated roughly $47 billion for FAHP programs (CRS 2020b).

Broadly speaking, apportionments reflect a state's number of lane-miles, with some variation. Figure 6 shows each state's lane-miles and their 2018 FAHP apportionment. Texas and California had the largest apportionments, at roughly $3.8 billion each, although Texas had 76,000 more eligible lane-miles. Several other states are indicated for reference.

Figure 6. State Lane-Miles and Federal-Aid Highway Apportionments in 2018



Data Source: DOT (2019).

Several recent studies have examined the economic effects of increased FAHP spending under the American Recovery and Reinvestment Act (ARRA) of 2009. Garin (2019) examines the effects of highway spending using county-level data and a difference-in-differences approach, finding that ARRA increased construction jobs at a cost of $169,000 per job-year and increased wages for construction workers. However, the study does not find that highway spending has any significant effect on the broader county-level economy. Another analysis (Leduc and Wilson 2013) finds that federal investment in highways generally has little long-term effect but can have positive near-term effects, particularly during recessions.

One important consideration for a JT is whether, and to what extent, highway investments occur in the largely rural areas that have relied on fossil energy production, and whether economic effects vary between urban and rural areas. As noted above, Redding and Turner (2015) find that rural regions near highways experience increased economic activity, but that this increase may simply reflect a redirection toward highways and away from rural regions not served by the infrastructure.

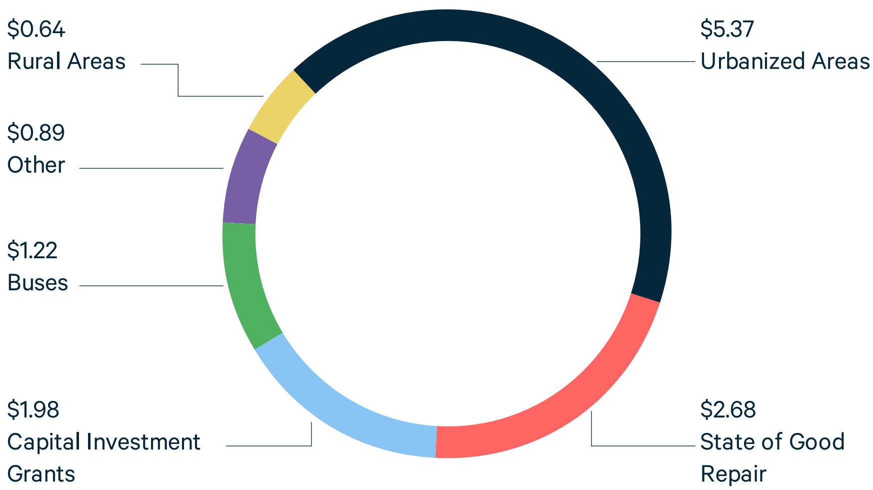
From an EJ perspective, Duranton and Turner (2011) find that increased highway construction does not reduce highway congestion, indicating that further buildout of these networks could exacerbate existing inequities in pollution exposure. Investment in public transportation (Section 4.4.1.2) may offer a more promising route to ultimately reduce congestion.

4.4.1.2. Federal Public Transportation Program

The federal government began investing in local and regional public transportation in earnest in the 1960s, when many privately operated transit businesses became unprofitable as private automobile use soared. FPTP, administered by the Department of Transportation (DOT) through its Federal Transit Administration, allocated $13 billion in 2020 across a variety of programs. These funds represent roughly 17 percent of total funding for public transportation, less than local governments (36 percent), fares (26 percent), and state governments (21 percent) (CRS 2020a).

The largest FPTP program is the Urbanized Area Formula Program, which allocates funds to states based on metropolitan population data, along with bus route miles, passenger miles, bus revenues, and other factors. Other major programs include the State of Good Repair, which primarily supports maintenance on existing rail systems; Capital Investment Grants, which funds development or expansion of new public transport systems; grants for purchasing buses and building bus facilities; and the Rural Area Formula Program, which supports public transit outside metropolitan regions (Figure 7).

Figure 7. Federal Public Transportation Program Appropriations, 2020 (Billion $)



Data Source: DOT (2020).

One particularly relevant program, and the only geographically targeted program we identified, is the Appalachian Development Public Transportation Assistance Program, funded at $20 million in 2020. The largest recipients of these funds in 2020 were Pennsylvania ($4.8 million), West Virginia ($1.9 million), and Kentucky ($1.8 million) (DOT 2020).

Because of the broad scope of this report, we do not review the literature on the economic, employment, or other effects of public transportation investment. However, as with FAHP, the geographic distribution of government investment in transportation will have significant bearings on communities negatively affected by a deep decrease in fossil energy production.

4.4.2. Other Infrastructure

4.4.2.1. Tax Exemption for State and Local Bonds

Since the federal income tax was introduced in 1913, it has exempted interest earned on most local and state bonds. This policy helps reduce the interest rate paid by state and local governments, shifting costs to federal taxpayers. This exemption has resulted in tax expenditures of roughly $20 billion to $30 billion annually from 1994 through 2017 (CRS 2018b) and was projected to result in tax expenditures of roughly $28 billion in 2020 (Joint Committee on Taxation 2019). As of late 2017, total US state and local tax-exempt bond debt totaled roughly $3 trillion (CRS 2018b).

The exemption saves hundreds of billions of dollars for states and localities (but reduces revenue for the federal government). Marlowe (2015) estimates that between 2000 and 2014, the policy reduced interest payments by $715 billion, and that repealing the exemption would increase debt payments by $70 to $115 per $1,000 in borrowing.

Because these savings largely lower the cost to states and localities of providing public infrastructure, they have the potential to offer several benefits in the context of a JT. As noted above, new infrastructure projects can enhance market access for rural regions while also providing employment in the construction sector, where skills may be similar to those of workers displaced from certain fossil energy jobs.

One relevant example is the Qualified Opportunity Zones, established in the 2017 Tax Cuts and Jobs Act, which incentivizes investment in economically distressed regions (IRS 2020). However, such tax incentives may primarily benefit high-income investors rather than the low-income communities where investments are targeted (Drucker and Lipton 2019).

4.4.2.2. Community Development Block Grant Program

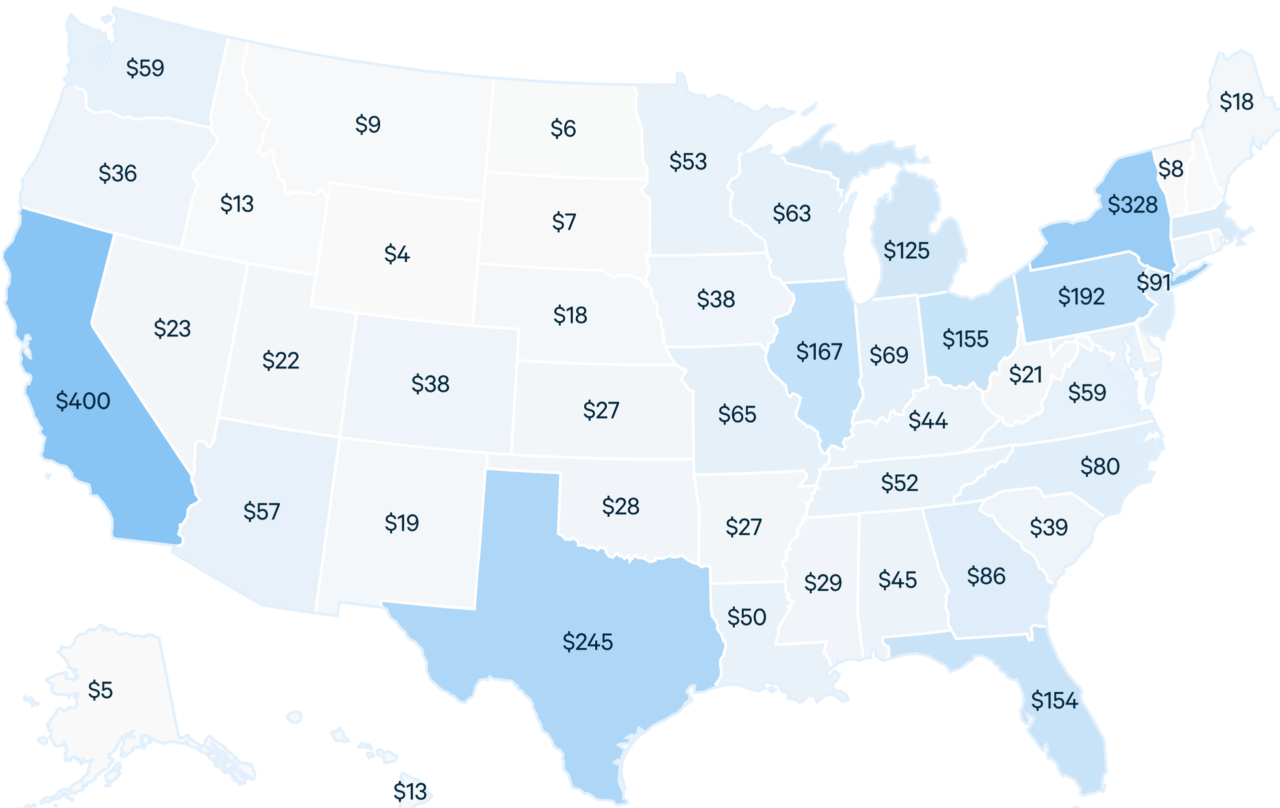
The Community Development Block Grant (CDBG) program provides formula-based grants to states and localities primarily to support housing for moderate- and low-income households; it is administered by the Department of Housing and Urban Development (HUD). In 2020, the program was appropriated $3.4 billion (CRS 2020c), with additional funding of $5 billion under the CARES Act (CRS 2020d).

The standard CDBG program allocates 70 percent of funds to cities and urbanized counties, and 30 percent flows to states, which have considerable discretion in how they allocate funds to other local governments. In 2020, the states receiving the highest levels of funding were California ($400 million), New York ($330 million), and Texas ($245 million) (Figure 8).

Along with supporting affordable housing in urban communities, CDBG may also boost local employment and economic development. One empirical analysis (Galster et al. 2004) estimates that increased CDBG spending in the mid-1990s led to higher mortgage approval rates, larger mortgage amounts, and more businesses in targeted areas, even in the most distressed neighborhoods. Larsen et al. (2020) use input-output modeling to estimate that a one-time expenditure of $30.4 billion in CDBG would lead to 35,000 jobs annually over five years, or roughly 5.8 jobs per $1 million.

One critique of CDBG is that the program's requirements on how funds may be used inhibit communities from investing in their preferred projects, including projects in and around polluted sites (e.g., Howells 1996), which could be relevant for both JT and EJ purposes. Other issues related to program design and implementation are discussed in Rohe and Galster (2014).

Figure 8. 2020 Community Development Block Grant Allocations (Million $)



Data Source:: HUD (2020). Amounts not shown for MA ($103), PR ($57), MD ($53), CT ($41), RI ($17), DC ($16), NH ($13), DE ($7), GU ($3), VI ($2), AS ($1), and MP ($1).

From a JT perspective, the bulk of CDBG funds are allocated to cities that are not economically reliant on fossil energy production as a key economic driver. However, some funds do currently flow to midsize cities closely tied to energy, such as Bakersfield, California ($4 million); Washington County, Pennsylvania ($4 million); and Midland, Texas ($1 million) (HUD 2020). It is conceivable that CDBG funds could be reallocated to support energy communities in transition, although it is not clear how effective such an intervention would be, particularly if population were to decline in these communities.

4.4.2.3. Clean Water and Drinking Water State Revolving Fund

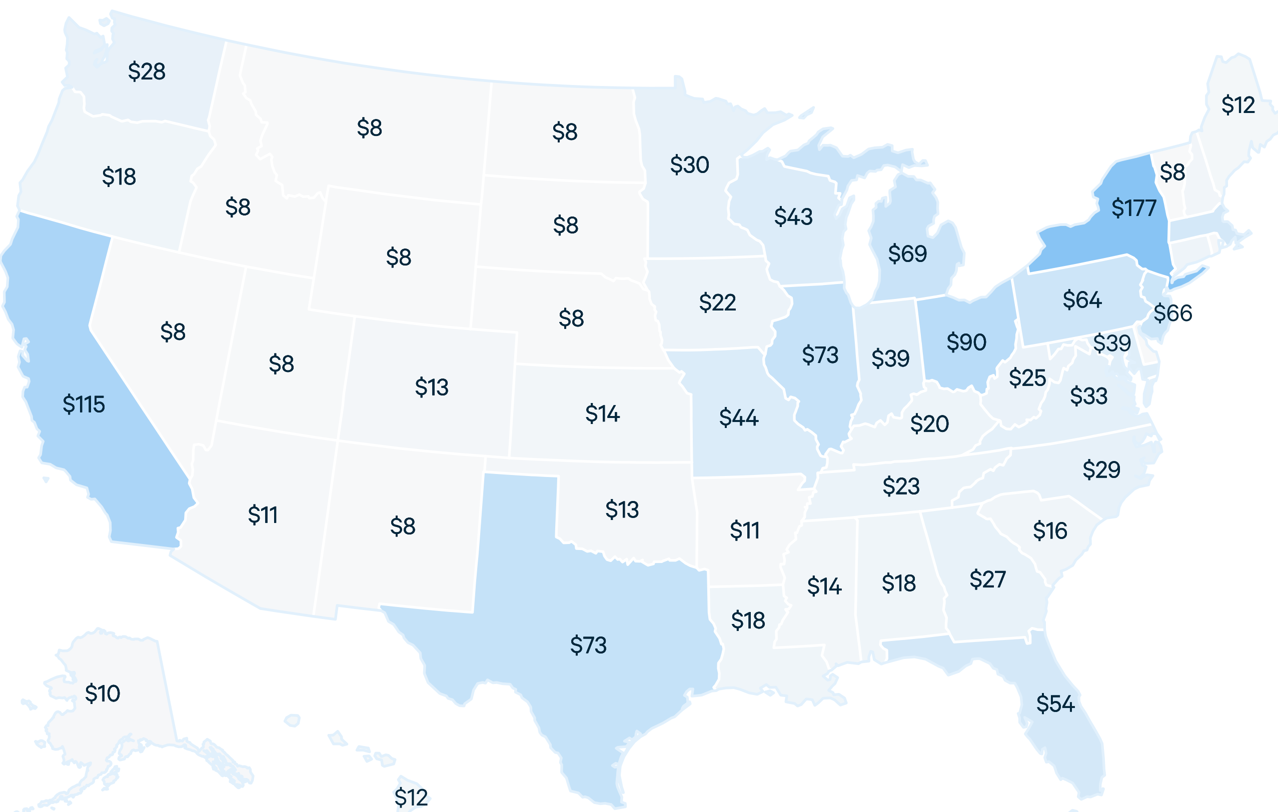
The federal government provides grants to fund state-administered loan programs that finance local wastewater and drinking water projects. States provide 20 percent matching funds to complement federal grant awards, and a small portion of federal funds also supports technical assistance, particularly for communities operating small systems. The Clean Water State Revolving Fund (CWSRF) has provided nearly $100 billion for wastewater projects since 1972, and the Drinking Water State Revolving Fund

(DWSRF), established in 1996, has provided $23 billion. Appropriations for the CWSRF and DWSRF were $1.7 billion and $1.2 billion, respectively, in 2019 (CRS 2019a).

CWSRF projects can take various forms, including the construction and maintenance of local wastewater-processing facilities (known as publicly owned treatment works), the development of plans to manage discharges from nonpoint sources, and projects to manage stormwater flows. Funds are allocated to states based on a static formula that has not changed over time; according to EPA, the formula does not distribute funds appropriately to states most in need (EPA 2016). For example, in 2020, New York State received more than three times the allotment of Florida, even though Florida has a larger population. Of the $1.7 billion in funds distributed in 2020, the largest recipients were New York ($177 million), California ($115 million), and Texas ($73 million), as shown in Figure 9.

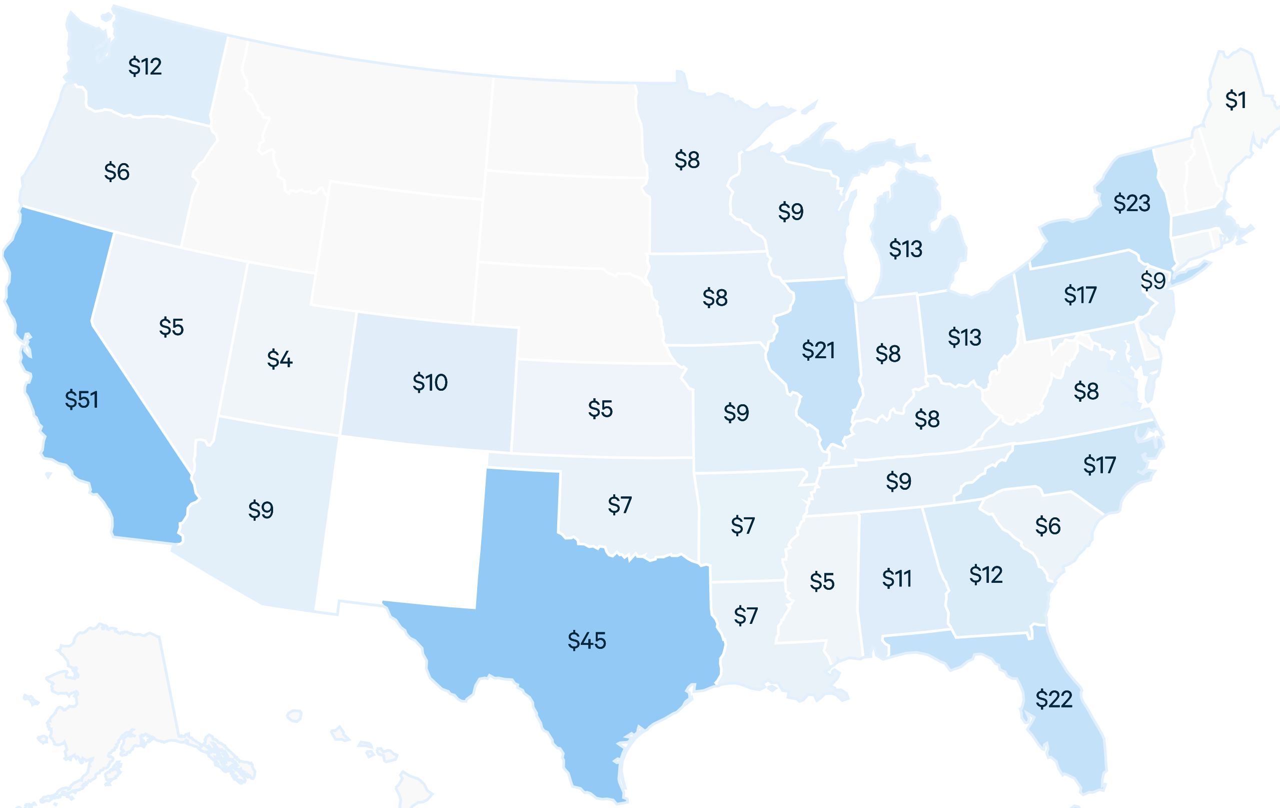
DWSRF projects support activities to address drinking water quality, including water sources and treatment processes, water storage and distribution, and other projects to protect public health. EPA allocates funds based on findings from a periodic survey and assessment process, the most recent of which identified $473 billion in needed capital improvements from 2015 through 2034, with the largest need being water

Figure 9. 2020 Clean Water State Revolving Fund Allotments (Million $)



Data Source: EPA (2020d). Amounts not shown for MA ($54), PR ($21), CT ($20), NH ($16), AS ($9), DE ($8), DC ($8), GU ($6), VI ($5), MP ($4), and tribes ($33).

Figure 10. Estimated Drinking Water Infrastructure Needs by State, 2015–2034 (Billion 2015$)



Data Source:: EPA (2018). Data not available for states shown in gray. Amounts not shown for MA ($12), MD ($9), CT ($4), PR ($4), and DC ($2).

distribution and transmission (EPA 2018). The largest needs are found in California ($51 billion) and Texas ($45 billion), as shown in Figure 10.[4]

Both programs allow state governments to offer targeted principal forgiveness and below-market (in some cases, negative) interest rates to support projects in disadvantaged communities. This design element offers the potential for water infrastructure projects to target specific communities, including communities that may be at risk from water pollution due to historical fossil energy production or consumption.

For these communities, additional investment could help lay the groundwork for future economic growth. While clean water does not, by itself, produce prosperity, a lack of clean water makes long-term objectives for JT communities such as public health and economic growth difficult, if not impossible, to achieve.

4 On a per capita basis, the states with the largest needs (greater than $2,000 per person) are Iowa, Washington DC, Arkansas, and Alabama. Unfortunately, investment need estimates from some key coal producing states such as West Virginia and Wyoming are not available.

A considerable number of cases have demonstrated how coal mining and coal ash, in particular, can have widespread impacts on local water resources (e.g., Johnson and Hallberg 2005; Harkness et al. 2016; Northern Plains Resource Council 2019; Vengosh et al. 2019; EPA 2020f). However, we are unaware of any regional or national assessments that characterize the potential health and economic benefits of improving water resources in these communities, making it difficult to estimate the level of investment necessary to improve water quality in JT communities. Nonetheless, it is very clear that ensuring clean water in these communities will be a necessary precondition for future prosperity.

How effective are these programs in improving water quality and incentivizing new water infrastructure investments? Previous RFF research has found that increased CWSRF funding was associated with higher water quality for jurisdictions receiving funding. However, it is not clear whether these grants were the cause of improved water quality, and it is possible that grants were flowing to localities where water quality was already relatively high, prior to CWSRF grants (Harrington and Malinovskaya 2015).

Other recent empirical work has examined whether federal grants lead to increased expenditures on local water systems or simply displace other funding sources. Mullin and Daley (2018) find that each dollar of federal funding increases wastewater spending by $2.84 over the six years following the federal grant. However, for drinking water systems, they find that each federal dollar is associated with no statistically significant increase in overall spending. The reasons for this discrepancy are not clear, and the authors suggest several future research questions to address the issue.

From an employment perspective, Larsen et al. (2020) use input-output modeling to estimate that a one-time expenditure of $30 billion in these two programs would lead to 32,000 direct jobs annually over five years, or roughly 5.3 direct jobs per $1 million. However, the skills match between energy jobs and water infrastructure jobs is unclear and worthy of future research.

5. Conclusion

Environmental remediation and infrastructure spending each have a significant potential role in supporting workers and communities in transition. This review has examined major federal policies related to each area, seeking out the existing evidence on program effectiveness across multiple metrics.

Environmental remediation programs can provide near-term job opportunities and restore sites to economic use in regions with a history of pollution, including pollution caused by energy extraction and consumption. The evidence is strong that cleaning up polluted sites increases nearby property values and provides job opportunities during cleanup. Depending on their design and implementation, increased efforts in this area could benefit energy communities and communities affected by the legacy of environmental injustice.

Recent research suggests that some of these programs, including remediating abandoned oil and gas wells, can provide direct jobs at relatively low cost, but the evidence on the cost-effectiveness of job creation for remediation programs such as Superfund and Brownfields is mixed. An important question regarding the employment effects of remediation is whether they persist over time, and which workers and communities benefit most from these job opportunities.

Infrastructure programs for highways, public transport, and clean water also have the potential to support employment and economic growth in communities heavily dependent on fossil energy. Although economists have debated whether public infrastructure investment increases overall economic activity or merely redistributes it, the latter outcome may be valuable in the context of an energy transition, particularly if new infrastructure serves communities negatively affected by a shift away from fossil energy.

Some infrastructure projects, particularly those providing clean water, can address the legacy of surface and groundwater pollution that exists in some fossil energy producing and consuming communities. In addition, infrastructure investment—depending on its design and implementation—has the potential to reduce a legacy of environmental injustice.

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