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Issue Brief

Growing Sunbelt Cities Are the Future of Urban Life. They Need a Resilient Power Infrastructure

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Introduction

Decay is pervasive throughout U.S. infrastructure. The unsafe drinking water, dangerous bridges, crumbling structures, and damaged roads are seen and experienced writ large. Public policy experts and researchers often point to the poor levels of government investment[1] and call attention to our peer nations' infrastructure spending, which, as a share of GDP, is 50% higher than Americans' investment.[2] Some even characterize U.S. infrastructure as shameful in comparison with that of our peers in the developed world.[3] Of course, domestic spending advocates use the same reasoning to justify higher non-infrastructure spending of all kinds.

Notwithstanding our relative infrastructure investment, the U.S. can track its infrastructure needs through comprehensive assessment tools such as the American Society of Civil Engineers (ASCE) infrastructure report card.[4] This quadrennial report provides a detailed analysis of the condition and financial requirements for restoring infrastructure across 17 categories within the 50 states and the District of Columbia. The ASCE 2021 infrastructure report card is an exceptional tool for addressing the significant infrastructure challenges of the United States. By identifying specific shortfalls, the report offers a framework for targeted improvements, making the debate over the percentage of GDP spent on infrastructure less relevant. The analysis provided in this study will use the ASCE report card to identify challenges and solutions regarding U.S. infrastructure in the existing population hubs and, more specifically, in the growing Sunbelt.

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Assessing the U.S. Infrastructure Landscape

This issue brief relies on various data sources to frame the challenge of revamping U.S. infrastructure. The literature review and census data help produce and support the hypothesis on resource priorities.[5] Key literature included the ASCE infrastructure report card, the Infrastructure Investment and Jobs Act (IIJA),[6] the White House's publication *Building a Better America* (BBA),[7] the Census Bureau's annual estimates, and the National Aeronautical and Space Administration (NASA) Science Data.

ASCE's comprehensive assessment detailed the condition and financial requirements for restoring infrastructure across 17 categories within the 50 states and the District of Columbia. IIJA and BBA outlined the strategic framework establishing national objectives and funding allocations for infrastructure modernization, climate resilience, and sustainability. The Census Bureau's annual estimates provided insights into population growth, migration trends, and urbanization patterns, particularly focusing on the Sunbelt region. NASA Science Data provided statistics on extreme weather events and their impacts on infrastructure, specifically focusing on extreme heat.

For convenient comparisons, I used ASCE's infrastructure report card to assess the condition of various infrastructure categories across different states. States served as the unit of analysis. This comparison included reviewing the grades assigned to infrastructure categories (e.g., overall grade, energy [the power grid], roads, rail, and drinking water).

I examined census data to identify demographic trends, particularly the migration between the largest U.S. cities. This descriptive statistics analysis helped identify regional infrastructure needs and the potential impacts of population shifts on existing infrastructure systems. This phenomenon informed the central focus of this study.

The "Building a Better America" Overview for Modernization and Resilience

In November 2021, President Biden signed the $1.2 trillion IIJA, better known as the Bipartisan Infrastructure Law.[8] To help implement the law, the Biden administration released *Building a Better America* [BBA]: *A Guidebook to the Bipartisan Infrastructure Law for State, Local, Tribal, and Territorial Governments, and Other Partners*.[9] BBA outlines 13 infrastructure issue areas within four major categories: (1) transportation; (2) climate, energy, and the environment; (3) broadband; and (4) other programs. The principal goals of BBA are to: 1) modernize infrastructure; 2) ensure climate resilience and sustainability; 3) create economic opportunity; 4) address equity and inclusion; and 5) promote U.S. manufacturing. BBA seeks to accomplish these aims through a series of competitive grants, formula grants, loans, cooperative agreements, contracts, rebates, and other federal spending mechanisms.

Among the five main goals of BBA, infrastructure modernization and climate resiliency focus on *what* actions should be taken to improve U.S. infrastructure. The other three goals—economic opportunity, equity and inclusion, and promoting U.S. manufacturing—highlight the Biden administration's priorities regarding *who* will be involved in the construction and *who* will benefit from these efforts. This issue brief focuses on the "what." Specifically, it addresses the modernization and resiliency of power generation, which is the infrastructure system associated with climate, energy, and the environment.

BBA provides a resource to catalog the infrastructure programs that flow from IIJA. By including information on available funding, eligible recipients, and planning activities, the BBA guidebook provides policymakers and industry experts access to its opportunities. It is designed to help reduce bureaucratic delays and expend taxpayer dollars sensibly. BBA does not prioritize specific infrastructure projects, nor does it provide a national, holistic strategy to produce tangible, measurable results from infrastructure improvements. In its own words: "This publication is not an attempt to capture every possible Federal infrastructure program, authorization, or expenditure—rather, it provides our partners with a deeper view into funding available under the law."[10]

To modernize infrastructure, BBA outlines how funding is allocated for significant investments in the various categories of infrastructure. In a chapter on environmental remediation and resiliency, BBA explores strategies to mitigate the hazards of extreme weather events. Additionally, BBA focuses on cybersecurity, which is addressed more than 70 times in the specific programs outlined in the report, as a principal consideration in modernizing the U.S. infrastructure. Because cybersecurity breaches present immense and evolving dangers to the economy and public safety, the topic deserves extensive examination and research. Although cybersecurity threats also present vital challenges to national security, a discussion of cybersecurity is outside the scope of this paper.

Among the most discussed extreme weather events, extreme heat poses a unique and often underestimated threat to infrastructure.[11] Extreme heat may not cause immediate damage to infrastructure facilities in the same way as other extreme weather events do, but it does have lasting and visible effects on roads and rail systems throughout the United States. Some building materials expand in heat and contract in the cold, leading to visible damage on roads. More concerning are the latent damages caused to metals in infrastructure, particularly rail systems.[12] Even when the effects of extreme heat are not obvious, it places significant strain on the power grid and the nation's increasingly limited water resources.[13] Most important, extreme heat causes significant death in the country. According to data from NOAA, extreme heat consistently results in more annual fatalities than tornadoes, floods, or hurricanes.[14]

In addition to its five stated goals, BBA addresses the need to rebuild much of the public infrastructure and to remedy real and pervasive safety concerns.[15] Its best policy imperatives prioritize opportunities to rebuild and replenish collapsing public structures such as bridges, roads, railways, and waterways, and it is concerned with addressing the needs of the broadest number of citizens. In focusing on these two policy imperatives—collapsing public structures and maximizing the number of citizens served—BBA contributes to saving lives and improving standards of living.

In analyzing the effectiveness of BBA's infrastructure policy in saving lives, we must consider the largest, most populated urban centers today, as well as the cities and regions experiencing the greatest population growth. The long-term view is necessary because much of the public infrastructure may exist decades from now.

Table 1 uses census data to list the 25 most populated U.S. cities as of July 2023. New York City, with 8.3 million residents, and Los Angeles, with 3.8 million, are the most populous and are expected to remain so despite experiencing annual net population declines.[16] Other iconic metropolises, such as Chicago, Philadelphia, and Boston, also continue to rank among the top 25 largest cities but face similar declines.[17]

Table 1

Most Populated American Cities, as of July 2023

Population: April 1, 2020–July 1, 2023

Rank	Geographic Area	April 1, 2020 Estimates Base	Population Estimate (as of July 1, 2023)			
			2020	2021	2022	2023
1	New York, New York	8,804,199	8,740,292	8,462,216	8,335,798	8,258,035
2	Los Angeles, California	3,898,841	3,895,848	3,832,573	3,822,782	3,820,914
3	Chicago, Illinois	2,746,352	2,743,329	2,704,101	2,672,660	2,664,452
4	Houston, Texas	2,300,833	2,299,269	2,291,020	2,302,488	2,314,157
5	Phoenix, Arizona	1,608,215	1,612,459	1,625,187	1,643,899	1,650,070
6	Philadelphia, Pennsylvania	1,603,793	1,600,684	1,589,623	1,566,836	1,550,542
7	San Antonio, Texas	1,434,306	1,439,257	1,454,003	1,473,325	1,495,295
8	San Diego, California	1,386,972	1,386,292	1,376,142	1,387,378	1,388,320
9	Dallas, Texas	1,304,182	1,303,212	1,289,705	1,297,358	1,302,868
10	Jacksonville, Florida	949,618	951,880	957,410	971,777	985,843
11	Austin, Texas	961,893	965,827	969,608	975,418	979,882
12	Fort Worth, Texas	918,907	923,602	937,590	957,103	978,468
13	San Jose, California	1,013,241	1,009,319	981,214	972,082	969,655
14	Columbus, Ohio	905,939	906,418	903,184	908,238	913,175
15	Charlotte, North Carolina	874,629	875,752	883,012	895,704	911,311
16	Indianapolis, Indiana	887,648	887,177	882,325	880,397	879,293
17	San Francisco, California	873,950	870,518	811,935	807,774	808,988
18	Seattle, Washington	737,018	740,565	731,757	749,134	755,078
19	Denver, Colorado	715,524	717,606	711,467	713,453	716,577
20	Oklahoma City, Oklahoma	681,091	683,078	688,531	695,178	702,767
21	Nashville-Davidson, Tennessee	689,454	689,700	675,578	682,130	687,788
22	Washington, District of Columbia	689,548	670,839	669,037	670,949	678,972
23	El Paso, Texas	678,862	679,255	678,271	677,788	678,958
24	Las Vegas, Nevada	644,883	646,794	650,827	656,191	660,929
25	Boston, Massachusetts	678,617	675,466	657,283	653,243	653,833

Source: U.S. Census Bureau (2023b), *Metropolitan and Micropolitan Statistical Areas Population Totals: 2020–2023* (metro), U.S. Dept. of Commerce.

In contrast, **Table 2** identifies the top 25 U.S. "growth cities" based on net gains in population. These growth cities are the magnets attracting a significant influx of new residents, primarily from the declining iconic metropolises. Several cities, including Houston, Phoenix, San Antonio, Jacksonville, Fort Worth, Charlotte, Seattle, Oklahoma City, and Washington, DC, appear on both the list of the largest cities and the list of growth cities. Apart from Seattle, these cities are located in the Sunbelt, indicating a trend of population migration toward this region.

Table 2

Fastest-Growing Cities by Net Population Immigration, 2023

Rank	City	Growth from 2022 to 2023
1	San Antonio, Texas	21,970
2	Fort Worth, Texas	21,365
3	Charlotte, North Carolina	15,607
4	Jacksonville, Florida	14,066
5	Port St. Lucie, Florida	13,169
6	Atlanta, Georgia	12,052
7	Houston, Texas	11,669
8	Georgetown, Texas	9,250
9	Celina, Texas	9,110
10	Raleigh, North Carolina	8,872
11	Fulshear, Texas	8,678
12	Washington, District of Columbia	8,023
13	Denton, Texas	7,914
14	Oklahoma City, Oklahoma	7,589
15	Cape Coral, Florida	7,540
16	Conroe, Texas	6,689
17	Palm Bay, Florida	6,393
18	New Braunfels, Texas	6,229
19	Phoenix, Arizona	6,171
20	Henderson, Nevada	5,992
21	Seattle, Washington	5,944
22	Miami, Florida	5,910
23	McKinney, Texas	5,906
24	Lehi, Utah	5,849
25	Queen Creek, Arizona	5,839

Source: U.S. Census Bureau (2023a), *City and Town Population Totals: 2020–2023* (metro), U.S. Dept. of Commerce
Note: Queen Creek, Arizona, is a township, not a city.

This trend of Americans moving to the Sunbelt is supported by both the literature and the data.[18]

The U.S. demographics narrative is a story of realignment among metropolises, not urban decline. The data show the largest influxes of people into the metropolises of the Sunbelt regions (south, southeast, and southwest) as well as the West Coast and northwest regions. This growth can be attributed to several factors: higher birthrates among people of color, migration from smaller regions, and relocation from large urban areas in the Northeast and Midwest.[19] The smaller metro areas and their surrounding suburbs have been growing at an even faster rate than large metropolises.

The Sunbelt metropolises offer the strong value proposition of lower housing costs without a spartan, rural lifestyle. Lower housing costs are the primary motive for migration, especially among young or growing families.[20] Any fear of widespread de-urbanization in the U.S. is unfounded. Nevertheless, infrastructure policy and urban planning must address the evolving needs of a shifting population as well as the deteriorating infrastructure left behind as Americans move toward the Sunbelt. While cities like New York, Los Angeles, and Chicago may experience a slow decline, they will continue to be significant hubs of American life and economic activity. Investing in infrastructure renewal in these iconic metropolises can still yield substantial returns; however, policymakers must carefully consider the impact of infrastructure investments on future U.S. population hubs, particularly the Sunbelt and its metropolises.

ASCE's detailed infrastructure report card highlights critical concerns, providing specific examples of failing public structures and systemic vulnerabilities nationwide.[21] Many contend that the U.S. has deferred infrastructure maintenance for so long that any investment in infrastructure would yield significant improvements.[22] This is true across all regions of the country, but investments should be targeted to deliver the greatest public value in each region. States in the Sunbelt, in particular, face common interconnected challenges related to power generation.[23] To address these issues, I will outline the basic principles of the U.S. power grid, explore the common power generation challenges in the Sunbelt, discuss best practices in addressing these problems, and examine the interconnection between these challenges and their potential solutions.[24]

The U.S. Power Grid

The Basic Principles of the U.S. Power Grid

A critical high-tech issue that must be managed to avoid debilitating power outages is the challenge of grid balancing.[25] Grid balancing, which requires highly technical software, equipment, and technical training, refers to the precise management of various power sources to match the fluctuating demand for electricity, ensuring that the generated power (inputs) equals the power consumed (outputs). Typically, the grid integrates power from "dispatchable generation" sources, such as coal, gas, hydro, and nuclear, which provide a consistent supply of electricity to meet baseline needs.[26] In grids using renewable energy technologies like wind and solar, these non-dispatchable sources must be balanced with dispatchable generation to maintain a steady flow and meet the significant electricity demand.[27] Understanding grid balancing involves grasping how these different power sources are managed to provide a reliable and stable electricity supply.

PBS's *Energy Switch* superbly described the power grid as follows:[28]

> Think of the grid as a huge lake that is exactly six inches deep throughout, and must stay six inches deep at all times. However, on one end of this lake are streams flowing into it; and on the other end, streams are flowing out of it. The electric grid operates in the same way. The power being used must be balanced by the same quantity being

> generated at all times of day. When it gets out of balance, either because too much power flows in on one end or too much power is consumed on the other end, the result is a system overload that trips off the rest of the grid, as the northeastern U.S. experienced in 2003 in the worst power blackout in history.

Presently, the U.S. relies on a complex system of Regional Transmission Organizations (RTOs) and Independent System Operators (ISOs) to manage electricity. These entities perform "grid balancing" across vast regions, which could include several states, and often there is overlap in the states they service. The Eastern Interconnection, one of the primary power grids in the U.S., includes multiple RTOs and ISOs that manage electricity across several states.

For the Sunbelt states of Alabama, Arkansas, Florida, Georgia, Kentucky, Louisiana, Mississippi, Missouri, North Carolina, Oklahoma, South Carolina, Tennessee, Texas, and West Virginia, along with the District of Columbia, there are several primary RTOs and ISOs.[29]

Midcontinent Independent System Operator (MISO) powers Arkansas, Kentucky, Louisiana, Mississippi, and Missouri. PJM Interconnection serves a key role in several Eastern states, including Kentucky, North Carolina, Virginia, and West Virginia, as well as the District of Columbia. The Southwest Power Pool (SPP) serves the Southern and Central regions, which largely align with the Central Time Zone, including the Sunbelt states of Arkansas, Louisiana, Missouri, and Oklahoma. Continuing westward across the Sunbelt, the Electric Reliability Council of Texas (ERCOT) manages the flow of electric power to 90% of Texas's electric load.[30] While largely independent, ERCOT does have some interaction with the Eastern Interconnection. These RTOs and ISOs provide a reliable supply of electricity, support market operations, and stabilize the power grid across these regions. They manage the complex flow of electricity across state lines, helping to balance supply and demand while maintaining grid security.[31]

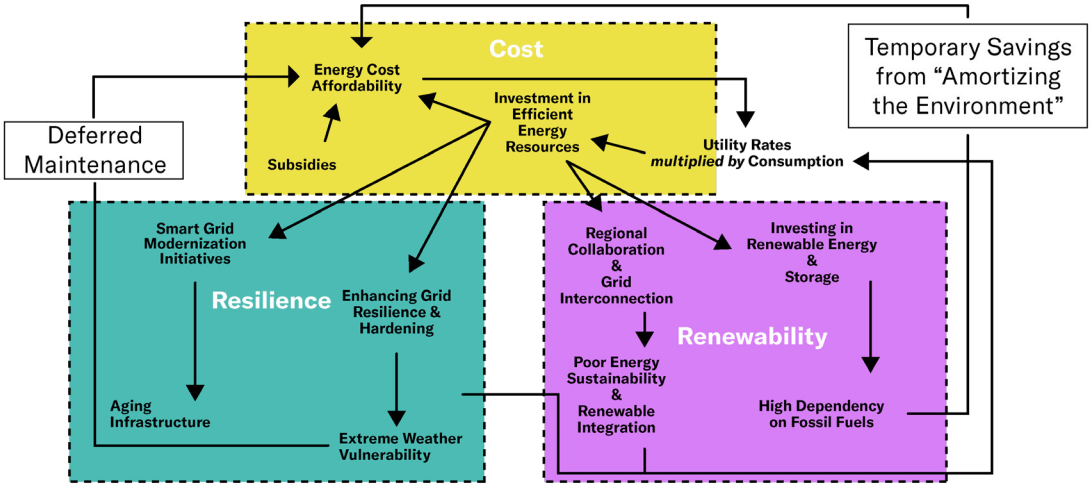
Common Challenges and Solutions for the Sunbelt

The Sunbelt region faces complex challenges to power generation, particularly concerning resilience, energy sustainability, and cost management.[32] These challenges are exacerbated by the region's frequent exposure to extreme weather events and an aging electrical grid that is often inadequately maintained or modernized.[33]

Figure 1 outlines the complex set of relationships. The figure has three sections, each representing resilience, renewability, or cost management, and the arrows between sections show the cyclical nature of these common challenges. This illustrates, for example, how deferred maintenance and temporary savings from "amortizing the environment" (i.e., using fossil fuels now and saving on energy costs in the short term, and delaying the eventual cleanup for the future) contribute to systemic issues throughout the Sunbelt's energy infrastructure. This issue brief explores the interconnectedness of these factors, discussing how grid resilience can be improved through hardening and smart grid technologies, the need for regional collaboration to enhance energy sustainability and renewable integration, and the critical balance required to maintain energy cost affordability while investing in efficient and sustainable energy resources. Each of these elements plays a crucial role in addressing the broader energy challenges faced by the Sunbelt and is essential for the region's transition to a more reliable, sustainable, and affordable energy system.

Figure 1

Power Generation Challenges in the Sunbelt: Cost, Resilience, and Renewability



Source: Author-generated figure

Resilience

The power generation systems of the Sunbelt region face significant resilience challenges from both the extreme weather events and the aging infrastructure that supports the region's electrical grid. In Figure 1, the resilience factors common to the Sunbelt's power generation systems appear inside the lower-left box (formed by a dotted line). Within the key resilience relationships, the diagram illustrates the use of grid hardening to address extreme weather vulnerabilities. It also illustrates the use of smart grid modernization to tackle aging infrastructure. The region's frequent exposure to hurricanes, tornadoes, and heat waves puts immense pressure on the grid, which is often not well maintained or modernized.

One practice seen in the Sunbelt is burying, or "undergrounding," power lines. Florida serves as a commendable example. Undergrounding has made the grid more resilient and has mitigated the impact of extreme weather events. Despite frequent hurricanes, Florida historically experiences the shortest outage durations in the nation, Hurricane Milton's landfall in October notwithstanding. In Georgia and South Carolina, smart grid modernization has enabled those states to address their challenges with aging infrastructure.[34]

Renewability

The Sunbelt region also experiences a common set of interconnected challenges that hamper its progress toward benefiting from renewable resources.

Figure 1 illustrates the interplay of the Sunbelt's common renewability factors (appearing inside the lower-right box). Within these renewability relationships, the diagram shows regional collaboration and grid interconnection as a driver to improving energy stability and renewable integration. Many states in the region, such as Texas, Oklahoma, and Louisiana, are heavily dependent on natural gas and coal. Though more affordable than other alternatives in the short run, these fuels expose the energy system to price fluctuations common to commodity markets. Renewable energy storage offers a potential solution for reducing dependency on natural gas and coal, but the Sunbelt's reliance on those fuels slows efforts to integrate renewable energy sources in the region's power grid.[35]

Regional collaboration and grid interconnection can mitigate these risks and provide for less variable energy prices. For example, the Southwest Power Pool (SPP) makes resource sharing across state lines easy. Moreover, it enhances grid stability and allows for better integration of renewable energy sources like wind and solar. Even when the funding, the technology, and the will exist, the transition to renewable energy in the Sunbelt is not without challenges. The intermittent nature of solar and wind power requires investments in energy storage and flexible grid management systems. States like Oklahoma and Texas have made advances in integrating large-scale wind energy into their power systems, but ensuring a stable energy supply from wind will require improved and cost-effective energy-storage technologies to provide steady power streams from these renewables.[36]

Cost

The transition from coal to a more diverse energy mix presents significant cost challenges for the Sunbelt states, particularly in terms of energy cost affordability. Figure 1 illustrates the Sunbelt's common cost factors (appearing inside the top-center box). A feedback loop connects investment in efficient energy resources, energy cost affordability, and utility rates. As energy efficiency improves, energy costs become more affordable. Energy cost affordability provides latitude to set lower utility rates. If the rates that customers pay enable the utility to recover its energy production costs and make meaningful profit margins, funding is available for further investments in efficient energy resources. If not, the utility may experience a disinvestment spiral unless another intervention in the system creates an infusion of capital. Figure 1 suggests potential interventions such as subsidies, deferred maintenance, or "amortizing the environment" by using inexpensive fuel types like coal.

An example from the Sunbelt may help illustrate the cost dynamics discussed above. Historically, regions and states like Kentucky have benefited from low energy costs due to the proximity of coal reserves. However, as these states shift toward natural gas and renewables, maintaining affordable energy prices becomes more challenging. Strategic planning and investment in cost-effective energy resources, along with energy-efficiency programs, are essential for managing these costs. States like Kentucky and Tennessee are exploring ways to balance their energy portfolios while keeping prices affordable for consumers. Nonetheless, the connection between the ability of consumers to afford energy costs and investments in efficient energy resources is critical. Without sufficient financial margins, utilities may struggle to fund necessary upgrades. Addressing the cost challenge requires a delicate balance between maintaining customer affordability and ensuring adequate investment in the infrastructure and technologies needed to transition to a sustainable energy system.[37]

Addressing the Sunbelt region's challenges requires a multifaceted approach that includes enhancing grid resilience, promoting regional collaboration, and investing in energy storage and grid modernization. While the region has made progress in integrating renewable energy sources, continued efforts are needed to ensure that the transition to cleaner energy does not compromise

grid reliability or affordability. By striking a balance between environmental goals and the need for a stable and affordable energy supply, the Sunbelt can achieve a sustainable energy future that meets the needs of its growing population and economy.

Subsidies, Reliability, and Renewable Integration

In the long term, investments should aim to modernize U.S. power grids by making them more resilient and incorporating new energy technologies, with a focus on increasing power generation from cost-effective renewable sources to stabilize energy prices. Resilience and the associated reliability are paramount; accordingly, this requires funding to upgrade grid infrastructure and to support clean energy solutions, ensuring a reliable power supply. Policymakers should consider the following steps to achieve these goals.

Limit Energy Subsidies to Enable Efficient Market Pricing

The long-term goal of modernizing energy infrastructure is similar across the U.S., but the Sunbelt may have unique preferences for a particular set of short-term solutions while waiting for new technologies to become viable. One challenge is that subsidies are widespread in the energy sector, disrupting market dynamics and making it difficult to understand the relationships between technological solutions, market forces, and effective policy.

For example, Sunbelt states typically generate electricity from a balanced mix of nuclear energy, natural gas, coal, wind power, and hydropower. Additionally, as the region's name suggests, solar power is highly valued for electricity generation. However, it is unclear how much this balanced mix of sources is influenced by subsidies. States like Texas, which are significant fossil fuel producers, will continue to rely on natural gas sales to support their economies, regardless of whether their electricity consumption from coal, oil, and natural gas is subsidized. That said, the Sunbelt has embraced wind power, subsidies notwithstanding.

Subsidies can create market distortions by making certain energy sources appear cheaper or more attractive than they are in a nonsubsidized market. For example, subsidies for renewable energy sources like wind and solar can reduce their costs relative to coal, natural gas, oil, and nuclear power.[38] While this encourages investment in cleaner energy, it can also lead to an overreliance on intermittent energy sources. These sources, by nature, do not provide a consistent supply of electricity, which can compromise reliability if they constitute a significant portion of the energy mix without adequate backup. Accordingly, the Sunbelt states are unlikely to abandon the fuels that provide the baseload energy source to power the grid reliably.

Dispatchable generation sources, such as coal, natural gas, nuclear, and hydro, can provide a steady and controllable power supply. Again, when subsidies make intermittent sources (wind and solar) more financially attractive, it can undermine the economic viability of these dispatchable and necessary sources. As a result, there may be fewer investments in maintaining and upgrading dispatchable plants, or these plants may even shut down.[39] This reduction in reliable, controllable power sources can threaten the stability and reliability of the electric grid, especially during periods of high demand or low renewable output. A regional loss of power in the Sunbelt for a few days or even a few hours can easily imperil thousands of lives as air conditioners cease to operate.

Subsidies can encourage an overbuild of renewable energy capacity beyond what is needed for reliable grid operation. While this can lead to surplus generation during periods of high renewable output, it can also create challenges in balancing the grid. The inability to store excess renewable energy efficiently means that without sufficient backup or storage solutions, there can be periods where supply does not meet demand, thus compromising reliability.

Subsidies can cause states and regions to prioritize short-term goals, such as rapid deployment of renewable energy, over long-term grid reliability and resilience. While promoting cleaner energy addresses environmental concerns, ensuring that the grid remains reliable under varying conditions requires a balanced approach that considers both current and future energy needs.[40] While subsidies play a critical role in promoting renewable energy and other emerging technologies, they must be carefully designed to avoid unintended consequences that could compromise the reliability of the energy supply. A balanced energy policy that supports a diverse mix of energy sources and invests in grid infrastructure is essential to maintaining a reliable and resilient power system. The Sunbelt can maintain the reliable and resilient system that it needs by maintaining a balanced portfolio. At present, the region's best strategy for positive environmental impact and energy cost savings relies more on demand-side solutions.

Explore User Fees and Public-Private Partnerships

Infrastructure systems must rely on funding strategies that draw funds from all stakeholders until they provide enough resources for physical infrastructure. All stakeholders should have "skin in the game" if they are to behave as responsible stewards of the limited resources available for infrastructure.

User fees offer a promising way to allocate infrastructure resources. Recent national improvements in drinking-water management serve as a notable example among infrastructure categories. Borrowed from water plants across the nation, the asset-management approach allows water-utility managers to identify proactively the funding requirements, and the recent willingness to raise the cost of water service illustrates a "user fee" model that could be applied to other infrastructure components. This success story needs to be reproduced to address the costs of other systems of infrastructure, with attention paid to the potentially regressive impact of fees on low-income users. Additionally, some infrastructure improvements have emerged from an interest in private involvement or public-private partnerships, highlighting a trend toward innovative funding and management strategies.

Funding strategies must be adaptable and able to respond to emerging threats and technological advancements. They may also need to involve public-private partnerships, leveraging the strengths of both sectors to foster innovation and ensure the most efficient use of resources. By prioritizing both the physical and digital security requirements for infrastructure, the U.S. can build a resilient system capable of withstanding future challenges and maintaining the safety and security of its citizens.[41]

Increase Research and Development in Energy-Storage Technologies

Increasing reliance on renewable energy requires developing technologies that allow these intermittent sources, such as wind and solar, to function similarly to dispatchable sources.[42] While wind and solar power are intermittent, they are predictable to some extent, as we can forecast when winds will be strongest or when the sun will shine. However, we still face the challenge of balancing the energy input from these sources with the demand for power output. Solutions like batteries could help align the timing of renewable energy inputs with the power demand, but we cannot expect a viable battery solution in the near future.[43] Increased research and development in the private sector and public and private universities can accelerate more new cost-effective energy-storage solutions.

Integrate Advanced Monitoring and Detection in Infrastructure Components

Rebuilding infrastructure should be paired with a broad array of proactive measures, such as inventorying and monitoring the components of the infrastructure system and implementing advanced monitoring and detection systems. Sensors that continuously monitor corrosion conditions could, for example, facilitate more efficient resource allocation, addressing problems at an earlier stage, when they can be less expensive to ameliorate. Ongoing monitoring can ensure that U.S. infrastructure systems are sufficiently resilient and can operate or recover quickly in the face of extraordinary demand for services or extreme weather events.

Conclusion

This issue brief contends that evolving regional differences significantly influence infrastructure needs, investment priorities, and resource accessibility. Because of its relatively high inventory of inexpensive housing, the Sunbelt will experience rapid population growth and urbanization for the foreseeable future. Significant migration to the Sunbelt will demand infrastructure development to accommodate demographic shifts. This migration is creating a future need that U.S. infrastructure planning must anticipate. Infrastructure planners must apply the Gretzky principle: "Skate to where the puck is going to be, not where it has been."[44]

This brief argues that a general practice of "deferred maintenance" has resulted in widespread deterioration and extensive dysfunction of infrastructure across the United States. Our infrastructure has been operating on a "fix it when it breaks" approach—not as a strategy but as a funding reality. This funding reality has resulted in unsafe drinking water, crumbling roads, and structurally deficient bridges. The failure to make critical infrastructure maintenance a top priority jeopardizes the safe functioning of our infrastructure and puts lives and our economy at risk. It also produces the unintended consequence of driving up infrastructure costs over the long run. Moreover, policymakers must understand how the status quo affects disadvantaged communities, which often bear the brunt of deficiencies. More research is needed to examine and consider existing proactive efforts occurring at state, county, and municipal levels.

The theories explored in this study highlight a core principle essential for creating a resilient and enduring infrastructure. A well-maintained infrastructure is not just a foundation for economic growth and public safety but is also crucial to enhancing our overall quality of life. While it is critical for the U.S. to develop strategies to maintain and modernize the physical assets of the infrastructure, the true path forward lies in creating sustainable, integrated approaches that meet the immediate demands of infrastructure upkeep and future demands, given the growing population of the Sunbelt. This holistic focus will ensure that U.S. infrastructure remains functional, safe, and secure, while effectively addressing the increasing complexity of resource needs and physical challenges.

About the Author

Dr. Michael E. Wooten is a fellow at the National Academy of Public Administration and the National Contract Management Association. He is also a board member of the Procurement Round Table. In 2019, President Donald Trump appointed Dr. Wooten as administrator of the Office of Federal Procurement Policy, the highest-ranking procurement official in the federal government. He received Senate confirmation and served in that role until 2021. In his prior role as acting assistant secretary for career, technical, and adult education at the U.S. Department of Education, Dr. Wooten helped lead the president's national apprenticeship initiative, criminal justice reform, and other domestic policy initiatives.

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