America's Top Infrastructure Challenges

A look at the costs and impacts of the most pressing infrastructure issues facing society

For years, American infrastructure has required substantial maintenance and investment. The problems run deeper than repairing potholes or storm walls. In some cases, systemic flaws in funding have led to chronic underspending on maintenance. For some, regulatory barriers hinder market forces from resolving an issue. Elsewhere, new regulation may be needed to remedy vulnerabilities impacting large populations and communities.

This policy brief surveys five of the top infrastructure challenges facing America today. While unranked, these five issues all stand out as urgent challenges draining the U.S. economy, harming communities, and degrading critical infrastructure. To help understand the scale and scope of these issues, we stack up their estimated costs, present the number of people impacted, and discuss the implications for other systems.

How does Aii define infrastructure?

In•fra•struc•ture: the physical systems and structures that facilitate transportation, transmission, distribution, and storage for people, resources, energy, information, and goods.

While often referred to rhetorically as infrastructure, many systems are not truly infrastructure. These may include software, healthcare, or climate policy, which are not physical systems nor primarily intended for transportation, transmission, or storage. They often rely on infrastructure, such as roads, bridges, telecommunications cables, electrical distribution, and more to carry out their objectives. Other examples, like *digital infrastructure* – when not referring to the hard components that make Internet or computer networks function – help paint a picture of the way software can organize, analyze, store, or distribute information, yet serves as an analogy, not an example, of infrastructure.

Rhetorical and metaphorical uses of infrastructure actually serve to emphasize how critical real infrastructure is. Many plans and policies group additional topics into a broad infrastructure tent to highlight the criticality of infrastructure to other systems. This importance is why proper attention must be paid to these challenges today. Regardless of who builds and pays for it, the underlying physical systems and structures – *infrastructure* – make most modern service and movement possible.

The five top U.S. infrastructure challenges:

- Road and Bridge Infrastructure
- Damage Prevention
- Infrastructure Resilience
- Electrical Grid Modernization
- Cybersecurity

We assess these by presenting estimated economic and human impacts, systemic barriers to improvement, and potential innovative solutions.

Road and Bridge Infrastructure

There may be no more obvious example of America's infrastructure crisis than poor road conditions. Whether on a daily commute, cross-country drive, or commercial route, the deficiencies in road infrastructure are stark. Potholes, construction zones, damaged medians, and cracked bridges are only a few examples Americans see every day. These have implications for everything from vehicle maintenance costs to travel times and even the cost of goods.

The percentage of road miles considered to be in poor condition has risen in the last decade to over 17 percent.[1] Meanwhile, 46,154 bridges are classified as structurally deficient, and concerningly, these still facilitate 178 million daily crossings.[2]

Addressing these challenges takes money, which itself has two challenges: revenue and allocation. Adequately maintaining roads requires both raising the funds for repair and sending that money to the right places. One state transportation authority explained that its road conditions are the result of "three decades of underfunding."[3] In many states, funding has gone to issues such as *expansion* of roads rather than repair and maintenance. States account for around 75 percent of all public spending on highways and roads, with the federal government providing a quarter of the funds. While states also struggle, the federal government demonstrates both intake and outlay problems through the Highway Trust Fund (the "Fund").

The Fund collects a federal excise tax on gasoline and diesel fuel, which is charged per gallon at the pump. The gas tax is only paid by drivers using gasoline or diesel and has not increased since 1993. This presents a clear revenue-side problem, as both inflation and innovation have devastated the revenue and purchasing power of the Fund.[4]

Over time, the Fund has required hundreds of billions of dollars in infusions from the general fund, and is now once again facing insolvency.[5] Even if revenue was sufficient, the allocation side has a problem as well.

The Fund includes two accounts: the Highway Account and the Mass Transit Account. Money primarily comes in from road use through the gas tax, but not all is allocated back to roads for maintenance, as a portion is allocated to mass transit, railways, subways, ferries, and other transit projects, as well as beautification, bike trails, expansions, and other non-maintenance expenditures.

[1] American Society of Civil Engineers. *2021 Report Card for America's Infrastructure*. (2021). Retrieved from https://infrastructurereportcard.org/wp-content/uploads/2020/12/National_IRC_2021-report.pdf.

[2] *Id*.

[3] South Carolina Department of Transportation. *Multimodal Transportation Plan 2040*. (2020). Retrieved from https://dc.statelibrary.sc.gov/bitstream/handle/10827/34829/DOT_Multimodal_Transportation_Plan_2020-07.pdf.

[4] Alliance for Innovation and Infrastructure. *The Revenue Failure of the Highway Trust Fund.* (2020, February).

[5] Congressional Budget Office. *Reauthorizing Federal Highway Programs: Issues and Options*. (2020). Retrieved from https://www.cbo.gov/system/files/2020-05/56346-CBO-Highway-Reauthorization.pdf.

Problems and Impact

Poor road conditions present at least three clear problems: vehicle repair costs, lost productivity, and risk of fatalities.

Neglected surface infrastructure cost Americans nearly $130 billion per year in repair and operating costs. Maintenance costs add up to $558 annually for the average American, with the average pothole-specific cost totaling $306 per repair.[6] [7]

Unmaintained roadways lead to extensive delays, culminating in an average of 97 hours per driver in traffic in 2018.[8] The national cost of sitting in traffic exceeds $166 billion each year due to lost productivity, time, and fuel wasted in traffic delays and detours.[9]

These costs impact not only the drivers paying for repairs, but commuters stuck in traffic and commercial vehicles late on deliveries. Moreover, poor roadways and traffic create dangerous conditions. In fact, the fatality rate in rural areas, which receive significantly less maintenance funding, is disproportionately higher than all other roadways.[10] Nearly one-third of traffic fatalities are attributed to potholes alone, and rubberneck fatalities are a common result of congestion and traffic incidents.[11]

While states bear the main responsibility to address these issues through raising revenue and appropriately allocating it, the role of the federal government demands heightened attention.

The gas tax and Fund collecting it need dire reform. Failing to raise the gas tax has led to falling revenue. Even with an inflation-indexed gas tax, innovation toward fuel efficient vehicles and non-gasoline vehicles undermine the revenue strategy while wear and tear compounds. Vehicle weight is also not accounted for in a gas tax, despite being one of the most significant factors for road impact.

Commercial vehicles, while often paying additional fees and permits, also make a disproportionate impact on roadways for their

---

[6] *White House Releases State-by-State Fact Sheets to Highlight Nationwide Need for the American Jobs Plan. (2021).* Retrieved from https://www.whitehouse.gov/briefing-room/statements-releases/2021/04/12/white-house-releases-state-by-state-fact-sheets-to-highlight-nationwide-need-for-the-american-jobs-plan.

[7] *Potholes and Vehicle Damage*. AAA Exchange. Retrieved from https://exchange.aaa.com/automotive/automotive-trends/potholes-and-vehicle-damage/.

[8] Inrix. *Congestion Costs Each American 97 hours, $1,348 A Year*. (2019, February). Retrieved from https://inrix.com/press-releases/scorecard-2018-us/.

[9] Schrank, D., Eisele, B., & Lomax, T. *2019 Urban Mobility Report*. (2019, August). Retrieved from https://static.tti.tamu.edu/tti.tamu.edu/documents/mobility-report-2019.pdf.

[10] *Supra* note 1.

[11] Adrienne, E. *Rubbernecking: A form of distracted driving*. Life Lanes. (2019, January). Retrieved from https://www.progressive.com/lifelanes/on-the-road/auto-rubbernecking/.

share of revenue under the current system.[12] [13] This compounds maintenance needs and costs, which can indirectly lead to more dangerous roads, more traffic, and higher costs for commercial goods. At the same time, the current road-use tax scheme creates a lack of parity or modal equity in the movement of freight, as commercial vehicles paying the non-proportionate gas tax gain the benefit of publicly funded roads, while competitors like rail largely fund their infrastructure privately.

Reforming the user-pay system to capture actual road use and vehicle weight, rather than a disproportionate, imprecise proxy of gasoline will help shore up revenue into the Fund. That in turn will provide the resources needed to maintain and repair roadways, reducing vehicle repair costs, mitigating traffic, and ensuring safer transportation.

Solution

America's roadways are underfunded due to inadequate user-pay taxes and inefficient fund allocation at the state and federal levels.

Each state has to manage its own solution, but reforming the Highway Trust Fund may serve as a model for state reforms. For the Highway Trust Fund, both revenue and outlays must be addressed. An eventual departure from the gas tax is needed, as it fails to account for actual use or impact on roadways. A new system should account for actual road use and vehicle weight, rather than use a proxy like fuel, which will be disproportionate and require revision as technology changes.

An alternative road usage charge should, over time, include the full passenger fleet as well as commercial vehicles, capturing the actual impact from driving.

Allocating resources also demands attention. Revenue raised from the roadways should go to maintain the roadways, and the Mass Transit Account may be best served coming from another revenue source. Additionally, focusing resources on actual maintenance rather than expansion is important. Otherwise the gas tax is not a user-pay system at all, but a way to fund new road projects at the expense of existing roadways.

From an engineering standpoint, advancements in the materials used to build our roads is needed. Road and pothole repair are crucial to the well-being of our transportation infrastructure. Policy should incentivize private investment in innovative methods and materials that work best in varying conditions and stress levels. Public policy should also prioritize road quality and longevity over simply cost-competitive bids when evaluating contracts for road work.

---

[12] "Although a single commercial truck generally contributes larger amounts to the Highway Trust Fund through federal diesel fuel and other taxes, FHWA has estimated that commercial trucks pay less than their share for their use of our nation's roadways in relation to the road damage they impose" *See* https://www.gao.gov/assets/660/651182.txt

[13] Congressional Budget Office. *Issues and Options for a Tax on Vehicle Miles Traveled by Commercial Trucks*. (2019, October). Retrieved from https://www.cbo.gov/system/files/2019-10/55688-CBO-VMT-Tax.pdf.

Damage Prevention

Infrastructure is all around us, so visible damaged may be obvious. Yet, there are costly infrastructure challenges that are harder to see. The underground infrastructure in the United States – including pipelines, water lines, and electrical and internet cables – is under constant threat. Protecting subsurface infrastructure is known as *damage prevention*.

Damage prevention is a collaborative stakeholder process, that includes defined practices as well as communication between excavators, locators, utility operators, and the One-Call centers tying them all together. An excavator can be anyone from a homeowner planting a tree to a professional contractor working with heavy machinery.

Everyday digging risks striking what is below. This leads to delays, serious injury, death, and loss of service in communities.

Knowing what is below starts with calling 8-1-1, a national call-in line that connects to state or regional One-Call centers. There, dig-site information is entered into a database with digital maps of local subsurface utilities. If the dig site overlaps with known subsurface utilities, the One-Call center sends a notifying transmission to the utility operators. Then, the utility operator sends in-house or third-party contract locators to walk the area with detecting tools and mark the ground with spray paint, stakes, or flags to designate what is below. Once three days have passed, the excavator is able to break ground, avoiding the marked areas, where sensitive infrastructure lies just below the surface.

That process only works if communication is clear and thorough. While there are many procedures and practices to ensure safe digging projects, including best practices, trainings, and awareness campaigns, damage prevention currently has systemic problems.

Problems and Impact

Every year, half a million or more damage incidents occur to underground infrastructure. In fact, damage has increased in each of the last five years, culminating in 532,000 damage incidents in 2019, costing the country an estimated $30 billion that year alone.[14] Other estimates place the annual cost of subsurface infrastructure damage between $50 billion and $100 billion.[15]

These enormous economic costs include the direct costs of facility damage and repairs, lost product, damage to equipment, and project suspension. Indirect costs, which often impact innocent bystanders and local communities uninvolved in the construction process, are estimated to be as much as 30 times higher than direct costs.[16] The indirect costs include injuries and medical bills,

---

[14] Common Ground Alliance. *Damage Information Reporting Tool, Volume 16*. (October, 2020).

[15] Zeiss, G. *Reducing Damage to Underground Utility Infrastructure during Excavation: Costs, benefits, technical advances, case studies, and recommendations*. (2020, April 16). Retrieved from https://energycentral.com/c/pip/reducing-damage-underground-utility-infrastructure-during-excavation-costs.

[16] *Supra* note 14.

project delays, loss of business, traffic delays, and loss of services like water, power, and telecommunications.

Millions of people in the U.S. are impacted by excavation damage annually. On any given day, tens of thousands of people are at risk of losing their power or internet, or even sustaining injury due to a natural gas explosion. The ripple effects include larger population when considering the indirect impacts like traffic, shuttering streets and intersections, and loss of service or work for communities and those involved in construction during repair and maintenance.

Solution

There are three relevant contributors to the damage prevention process: industry stakeholders, state policymakers, and federal officials.

The solution, no matter who institutes it, must focus on the use of innovative technology and better adherence to best practices.

If spearheaded by industry participants and member organizations, closer adherence to best practices is the best way to reduce damage. This means not only having well-defined and proven best practices, but implementing them systemwide with accountability. A certification program for stakeholder groups regularly employing best practices and techniques would be one step forward. Additionally, industry participants must take advantage of existing technological solutions like enhanced positive response (EPR), which facilitates more information sharing to the excavator on site. This collaborative communication tool has been shown to reduce damage by as much as 67 percent[17] and can be implemented through One-Call centers to become a standard feature for most or all excavation projects.

Other innovative techniques are needed, like virtual white-lining for clear delineations and use of ticket risk assessment software.

For state and federal officials, the solutions also center on implementation of innovative technological solutions. From a regulatory standpoint, requiring the use of proven communication tools is the first step in establishing a new minimum safety threshold.

Allowing the damage prevention process to be industry-run is important, but five years of rising damages and costs make clear that more oversight is needed. Elevating certain best practices into law to ensure a minimum standard of communication and information sharing is the best way to reduce damage, beginning with mandatory systemwide physical or virtual white-lining and enhanced positive response, implemented through One-Call centers.

Localized reforms about ticket requests, timing and permissible area size for locates, and delineations may also be necessary.

---

[17] United States, Department of Transportation, Pipeline and Hazardous Material Safety Administration. *A Study on Improving Damage Prevention Technology*. (2017). Retrieved from https://www.phmsa.dot.gov/sites/phmsa.dot.gov/files/docs/news/18351/reporttocongressonimprovingdamagepreventiontechnologyaug2017.pdf.

Infrastructure Resilience

Infrastructure protects us and facilitates transportation, services, and commerce. It encompasses assets from roadways to sea walls to wind turbines and more. Over time, infrastructure degrades from the wear and tear of regular use as well as environmental impacts. The stronger that infrastructure is, the more lasting it is.

We need long-lasting infrastructure not only because our use will degrade it, but because it must be able to withstand foreseeable and unanticipated disasters. This is especially true in coastal regions, where seawalls, levees, and similar features protect communities and business from being overwhelmed by both routine and rare weather events. Potentially stronger or more frequent storms would mean ever greater risk for coastal communities, including enormous costs and fatalities.

Importantly, resilient infrastructure extends beyond coastal infrastructure. Transportation, energy, and other infrastructure needs to be able to withstand weather events and the passage of time. Increasingly, resilience must also include the ability to withstand intentional harm or adversarial attacks.

Focus on infrastructure resilience begins at the planning and building stage, but is just as critical during rebuilding and repair.

Problems and Impact

Much of the nation's infrastructure has approached the end of its useful life cycle or was not built for the threats of tomorrow. This presents a clear problem for an unknown future, in which heavier vehicles, more traffic, stronger storms, or a growing population combine to add stress to our infrastructure.

America's roads and bridges must be built and maintained with resilience in mind. Part of that is the inclusion of proper drainage, medians, fencing, and other features to keep the roads clear of water and debris. Because roads experience the most wear of any infrastructure from direct human action, building stronger surface infrastructure and funding maintenance efforts must be top of mind. Over a million weather-related vehicle accidents occur annually.[18] These include flooded roads and related pavement conditions. In fact, potholes are a common weather-exacerbated issue, due to water and ice filling cracks from vehicle wear.

Other infrastructure that is routinely worn down or simply not built sturdy enough is storm infrastructure. Estimates show that between 2010 and 2020, the U.S. experienced more than $2 trillion in weather-related infrastructure damage from around 1,300 storms.[19] That is over $180 billion annually.

---

[18] United States Department of Transportation Federal Highway Administration. *How Do Weather Events Impact Roads?* (2020). Retrieved from https://ops.fhwa.dot.gov/weather/q1_roadimpact.htm#:~:text=The%20estimated%20cost%20of%20weather,to%203.5%20billion%20dollars%20annually.

[19] *Supra* note 6.

Flooding alone is estimated to have cost $900 billion in nationwide damage since 2000.[20] Flooding is believed to be the highest cost natural disaster. In fact, U.S. levees hold water back from approximately $2.3 trillion in property value.[21] Levees and storm infrastructure are critical because if absent or overwhelmed, water will invade below doorways and into homes and businesses – causing water damage, spoiling food, ruining appliances, and shorting out power, in addition to carrying disease and directly leading to death, injury, and illness.

Importantly, flooding is not simply a coastal issue. The cause and extent of flooding may be different along the coast, but inland areas are also in need of appropriate flood infrastructure. One small example is over-concretization from urban sprawl covering a wide surface areas, even on top of certain ecological features which naturally absorb water. Roads, sidewalks, and parking lots hold and channel water, keeping it from its natural retreat and adding to urban damage.[22]

In addition to the impact of degrading use and weather, another problem is that rebuilding efforts are often limited to putting the infrastructure back in its original state. Rather than rebuild with greater strength and resilience, bridges, dams, or roads are often repaired to their prior condition. The obvious problem is that the need for repair is evidence of its lack of resilience. Rebuilding without modifying underlying vulnerabilities simply invites the same issue down the road.

Solution

There is both a state and federal role in bolstering infrastructure resilience. This begins with adequate funding from taxes and user fees being collected and well allocated, along with substantial private investment.

New projects should have longterm viability, including ratings for rare but statistically possible weather events, as well as projected wear and tear and population growth. Repair and rebuilding should also put infrastructure into a better state than it was when damaged.

Upgrade investments and modernization should ideally come before damage. For example, flood prevention measures averted some $208 billion in costs from 1991 to 2000.[23] If investments are not made before a disaster, they should be part of rebuilding immediately following relief efforts.

Infrastructure resilience for pipe, cables, and wires may include burying, where utilities are protected from winds, floods, and debris. This resilience method does come at substantial upfront costs and requires robust damage prevention efforts.

---

[20] State Resilience Partners. *Announcing The State Resilience Partnership*. Retrieved from https://stateresilience.org.

[21] *Supra* note 1.

[22] Alliance for Innovation and Infrastructure. *Infrastructure Resiliency: Preventing Damage Through Critical Investments.* (2016) Retrieved from https://www.aii.org/wp-content/uploads/2016/07/Flooding-Policy-Brief.pdf.

[23] Diggs, J., Mikolajczyk, S., Naismith, L., Reed, M., & Smith, R. (2021). *Flood Management in Texas: Planning for the Future*. Fort Worth, Texas.

Electrical Grid Modernization

The U.S. power grid, not unlike the Interstate Highway System, is a feat of engineering in both its complexity and scale. It allows electricity to flow long distances and short routes into homes, businesses, hospitals, schools, and more. This system could reasonably be considered one of the most important stand-alone pieces of infrastructure, as it heats and cools homes, preserves and helps us cook food, powers healthcare and education systems, and brings the Internet online. Energy is an essential element for life, and the electrical grid allows us to generate it and move it where that energy is needed.

Unfortunately, our existing power grid is imperfect. Its flaws range from vulnerability environmental impacts to inability to redirect power around downed infrastructure, to older forms of technology not well suited to graft in new technology and power sources.

In order to promote growth, provide safety, and reduce environmental impacts, updates to the grid are necessary to help decentralize it, bolster it, and make it more resilient.

Problems and Impact

The electrical grid exists in three synchronous sections, or interconnections: the Eastern, Western, and Texas. These connected systems transmit electricity at the same frequency across three regions of the U.S.

While the grid has been an enormous success for growth and flourishing, over $150 billion in annual costs are incurred from power losses.[24] This includes spoiled food, lost productivity, injuries, and more. That amounts to around $500 per person, or nearly $1,200 per household each year. Beyond these are unknown and unreported costs estimated to be in the hundreds of billions in inefficiency and grid underperformance.[25]

Power outages and inefficiencies in the grid are a function of energy generation, transmission, and distribution. The infrastructure that makes all of that possible is broadly referred to as the grid. The energy mix itself is not necessarily part of the grid; it is a blend of private action and public policy. But the implication for the grid is substantial.

Failure to maintain base load means an outage, while oversupply can potentially harm the grid, in limited cases overwhelming equipment or disrupting service. That means that storage is needed unless grid operators and software are able to precisely monitor power demand, alter real-time generation, and allocate power efficiently.

As technology evolves, new generation sources must also be able to tie into the grid to send electricity to where it can be used.

Two standout examples of the need for grid modernization are Texas and California.

---

[24] United States Department of Energy. *The Smart Grid: An Introduction*. Retrieved from https://www.energy.gov/sites/prod/files/oeprod/DocumentsandMedia/DOE_SG_Book_Single_Pages%281%29.pdf.

[25] *Id*.

Recently in Texas, a rare winter storm overwhelmed the grid. Not only was power generation disrupted, but also components of transmission and distribution infrastructure. This resulted in nearly 70 percent of the 29-million-person state with power, with an average blackout time of 42 hours during single digit conditions.[26] Estimated costs top $295 billion from February alone, and included over 100 deaths, thousands of injuries, lost productivity, and more.[27]

Failure to winterize for exceptionally rare conditions in the southwestern state was partially to blame. Additionally, declines in generation from West Texas wind and fossil fuels could not match demand. Yet as recently as June 14, 2021, Texas issued a conservation request[28] for power, marking a clear reliability issue extending beyond winterizing infrastructure. The existing conditions relate to generators being offline for repair and lower than optimal wind conditions. This may result in outages but it guarantees high utility costs as demand peaks.

In California, the grid is strained by two issues: wildfires and a hastened move to renewables. Combined, these both heighten energy demand and diminish supply.

A modern, reliable grid should adjust to any energy mix. However, because wind and solar are more dilute relative to energy-dense fossil fuels, and intermittent due to weather variability, they cannot currently serve as base load to provide power 24/7 without far more generation sources and efficient storage to meet daily needs without incident.

California has shifted away from natural gas, coal, and nuclear plants to achieve a climate policy with primary reliance on solar, wind, and other renewables. This has at times decreased capacity, and when combined with weather, fire, and other demand-inducing events, necessitated rolling blackouts,[29] which can cost up to $2.5 billion in some instances, in both residential and business losses.[30]

Solution

Updating the grid is of top importance. To modernize the full system at once is not feasible. Smart public and private investments at local and regional levels, however, can hasten the needed move toward decentralized, reliable power transmission. Policymakers must allow for market-based energy mixes and private investments while encouraging innovative technology that allows for microgrids, new energy tie ins, storage, and dynamic power routing across the grid.

---

[26] The University of Houston Hobby School of Public Affairs. *The Winter Storm of 2021*. (2021, March). Retrieved from https://www.uh.edu/hobby/winter2021/storm.pdf.

[27] *Id*.

[28] The Electric Reliability Council of Texas. *Tight grid conditions expected due to high number of forced generation outages*. (2021, June) Retrieved from http://www.ercot.com/news/releases/show/233037.

[29] California Independent System Operator. *Final Root Cause Analysis Mid-August 2020 Extreme Heat Wave*. (2021, January) Retrieved from http://www.caiso.com/Documents/Final-Root-Cause-Analysis-Mid-August-2020-Extreme-Heat-Wave.pdf.

[30] Stevens, *P. PG&E power outage could cost the California economy more than $2 billion*. (2019) Retrieved from https://www.cnbc.com/2019/10/10/pge-power-outage-could-cost-the-california-economy-more-than-2-billion.html.

Cybersecurity

In a break with our traditional definition of infrastructure, we include cybersecurity for three reasons: (1) it utilizes physical systems, (2) it implicates critical physical infrastructure, and (3) it is currently one of the most pressing and costly policy issues facing the United States and even the world.

The interconnected state of the modern world means that devices and equipment are linked together, opening up enormous potential for efficiency while also creating truly unprecedented vulnerabilities for intrusion, manipulation, and destruction. The Internet is both a physical and virtual concept. There is very real hard infrastructure underpinning the internet, including a vast network of underground and underwater cables.

Cybersecurity is generally what takes place in cyberspace, or the virtual parts of the Internet, where code determines functionality, not physical pieces. But cybercrime can cripple physical computers and networks and that has broad implications for commerce, public safety, infrastructure, and national security.

Cybersecurity does rely on the physical infrastructure of the Internet and computer networks, as well as some other physical items. Cyber vulnerabilities pose a great risk for physical infrastructure, like risks to the grid or transportation networks. These intrusions are only getting worse. The costs of these disruptions can be catastrophic and may be the singular issue impacting more people and costing more than any other public policy challenge. This is due to the unique threat that cyber offenses pose to our nations physical infrastructure, economy, and security.

Problems and Impact

The global cost of cybercrime is estimated at $1 trillion for 2020, with projections of reaching over $10.5 trillion in 2025.[31] [32] With the U.S. constituting one quarter of the global gross domestic product, cybercrime disproportionately targets the home front.

Over 1,000 data breaches in 2020 exposed 155.8 million personal records.[33] The direct losses from cybercrime in 2020 totaled $4.1 billion, while indirect costs also include harm from loss of personal data, information, reputation harm, intellectual property, opportunity cost, and administrative costs.[34]

---

[31] Smith, Z., Lostri, E., & Lewis, J. *The Hidden Costs of Cybercrime*. (2020). Retrieved from https://www.mcafee.com/enterprise/en-us/assets/reports/rp-hidden-costs-of-cybercrime.pdf.

[32] Morgan, S. *Cybercrime To Cost The World $10.5 Trillion Annually By 2025*. Cybercrime Magazine. (2020, November). Retrieved from https://cybersecurityventures.com/cybercrime-damage-costs-10-trillion-by-2025/.

[33] Johnson, J. *Annual number of data breaches and exposed records in the United States from 2005 to 2020.* Statista. (2021, March). Retrieved from https://www.statista.com/statistics/273550/data-breaches-recorded-in-the-united-states-by-number-of-breaches-and-records-exposed/.

[34] Internet Crime Complaint Center. *Internet Crime Report 2020*. Federal Bureau of Investigation. (2020). Retrieved from https://www.ic3.gov/Media/PDF/AnnualReport/2020_IC3Report.pdf.

On the smaller end, ransomware attacks or data breaches can cost victims hundreds of dollars. On the larger end, a major U.S. pipeline company can be forced offline, to shutter service for days, pay out $4.4 million in ransom, cause a spike in the price of gasoline, and create a fuel shortage for half the Eastern Seaboard.[35]

The Colonial pipeline disruption demonstrates that foreign adversaries definitively do have the capability to disrupt or shut down portions of U.S. energy infrastructure. Russia, China, Iran, and North Korea are among those the U.S. intelligence community believes have this capability.[36] On this larger level, cybercrime is no longer a nuisance or concern over personal data breaches. It is a full-blown national security, energy security, and economic crisis.

Less than a month after the Colonial Pipeline incident, the world's largest meat supplier, and supplier of 20 percent of America's meat, JBS USA Holdings had a network intrusion.[37] This took several plants offline and resulted in a ransom payment of $11 million to restore service.

Criminal hackers have even disrupted state and local transportation networks across the country. Cyber intrusions affecting transit, energy, and supply chains can impact tens of millions of Americans at once. The full cost of these actions is not merely the ransoms paid or lost productivity for a company, but the potential for billions of dollars in power outages, economic restrictions, illness and injury, and the rippling indirect effects that come from losses of critical infrastructure.

Solution

There are obvious best practices for cybersecurity that individuals and businesses should take to avoid victimization. These include multi-factor authentication, password strength and variability, caution around hyperlinks and unknown senders, and monitoring software.[38] While these will help ward off minor intrusions, they are likely not the sole public policy solution needed to protect national infrastructure.

Part of the solution is already in place.[39] Agencies within the Departments of Justice, Homeland Security, and Defense collaborate to *protect, prevent, mitigate, respond, and*

[35] Kelly, S. and Bing, C. *Top U.S. fuel pipeline operator shuts whole network after cyber attack*. Yahoo Finance (2021, May) Retrieved from https://finance.yahoo.com/news/colonial-pipeline-halts-pipeline-operations-045443078.html.

[36] Fazzini, K. *China and Russia could disrupt US energy infrastructure, intelligence report warns on heels of Huawei indictments*. CNBC. (2019, January). Retrieved from https://www.cnbc.com/2019/01/29/china-russia-could-disrupt-us-infrastructure-with-cyber-attacks-odni.html.

[37] Bunge, J. *JBS Paid $11 Million to Resolve Ransomware Attack*. The Wall Street Journal. (2021, June). Retrieved from https://www.wsj.com/articles/jbs-paid-11-million-to-resolve-ransomware-attack-11623280781?mod=hp_lead_pos2.

[38] Wheeler, J. *How to stop a ransomware attack? Texas engineers believe they've found a solution*. WFAA. (2021, May). Retrieved from https://www.wfaa.com/article/money/business/right-on-the-money/texas-engineers-think-theyve-found-a-way-to-stop-most-ransomware-attacks/287-c6793d7f-1bf2-49f9-9faa-427cc4da0d85.

[39] Weed, S. *US Policy Response to Cyber Attack on SCADA Systems Supporting Critical National Infrastructure*. (2017). Retrieved from https://media.defense.gov/2017/Nov/20/2001846609/-1/-1/0/CPP0007_WEED_SCADA.pdf.

recover regarding cyber intrusions. The 2018 creation of a Cybersecurity and Infrastructure Security Agency also signaled a more engaged role by the federal government.[40] The Department of Justice recently demonstrated its ability to retrieve ransoms payments by recovering over half of the Colonial bitcoin payment.[41] This should be done aggressively for any intrusion to U.S. persons, corporations, or governments.

The immediate response to a cybercrime is also important. Until the government can assess and control the situation, victims should not pay ransoms, as this only incentivizes future attacks. Information sharing between and among private entities and government is also key.[42]

Next, the government should treat cyber crimes against U.S. infrastructure as acts of terror or even war. If the government is able to correctly identify the country of origin, we should immediately press that government, with sanctions if necessary. Targeted offensive attacks may be warranted, and should be aimed at taking adversaries offline and forcefully signaling that cyber attacks on U.S. citizens, entities, and infrastructure will not go unaddressed.

Additional Challenges

Infrastructure in the United States serves a population of over 330 million and facilitates the most dynamic economy the world has ever known. The passage of time and impact of regular use have created several additional challenges where funding, maintenance, or attention are needed.

Energy infrastructure is vital. Separate from the electrical grid, the raw resources and refined fuels needed for power and commodity inputs around the country need efficient transportation. Even as greater emphasis is placed on solar and wind projects, natural gas and other liquid fuels are critical, and pipelines remain the safest, cleanest, and most efficient method of transportation available. Approval of new pipeline projects is even more vital now with climate concerns shaping public policy.

Broadband access is important. Rather than a cost incurred, this challenge reveals gains not realized to the tune of over $180 billion annually. The potential of getting more citizens online with high-speed access would strengthen the economy, improve access to healthcare and education, and boost tax revenues for every level of government.

---

[40] *See*, U.S. Cybersecurity and Infrastructure Security Agency. https://www.cisa.gov.

[41] United States Department of Justice. *Department of Justice Seizes $2.3 Million in Cryptocurrency Paid to the Ransomware Extortionists Darkside.* (2021, June). Retrieve from https://www.justice.gov/opa/pr/department-justice-seizes-23-million-cryptocurrency-paid-ransomware-extortionists-darkside

[42] *See*, Clarke, R. A., & Knake, R. K. (2020). *The fifth domain: defending our country, our companies, and ourselves in the age of cyber threats*. Penguin Press.

A final infrastructure challenge is already being addressed slowly. Harbors, ports, and navigable waterways need dredging and maintenance; allowing ongoing spending of the Harbor Maintenance Trust Fund is vital.

Conclusion

America's infrastructure is under great strain from everyday use and the compounded stress of backlogs and inefficient governance. With weather and natural disasters looming on top of these concerns, addressing infrastructure challenges has never been more important.

The top five U.S. infrastructure challenges are

- Road and Bridge Infrastructure
- Damage Prevention
- Infrastructure Resilience
- Electrical Grid Modernization
- Cybersecurity

Each of these challenges has staggering impacts. Whether it is $166 billion in wasted time and fuel sitting in traffic or $120 billion in vehicle repairs, surface infrastructure needs attention.

Annual damage to underground utilities surpasses $30 billion, while storm-related damage hits the economy with more than $181 billion in losses each year. The electrical grid provides daily power, but each year disruptions cost at least $150 billion, with untold billions resulting from inefficiencies. The direct cost of cybercrime is $4.1 billion each year, but on a dramatically rising trend. Moreover, these costs only account for financial losses, not indirect harm, losses, and inefficiencies. Cyber threats to the nation's supply chain and its infrastructure vulnerabilities also threaten hundreds of millions of U.S. citizens with drastic consequences.

Together, these challenges are at least a $650 billion annual drag on the economy. Using the upper estimates and rising trends, the combined costs will unquestionably exceed a trillion dollars in harm every subsequent year if not addressed. At a time of unprecedented national debt and skyrocketing deficits, allowing such hindrances in the economy is unsustainable.

Repairing and addressing these infrastructure challenges will not only save hundreds of billions of dollars, but would unleash new innovation, commerce, and efficiency that would generate new wealth for the nation. The various government policy approaches must allow for innovative solutions, encourage private investment, and elevate standards to achieve safety goals.

The Alliance for Innovation and Infrastructure (Aii) is an independent, national research and educational organization dedicated to identifying our nation's infrastructure needs, creating awareness of those needs, and finding solutions to critical public policy challenges.

Author

Benjamin Dierker, JD, MPA
Director of *Public Policy,* Alliance for Innovation and Infrastructure

For more information or inquiries on this report, please contact the Aii Media Coordinator at comms@aii.org

Recommended Citation for this report

B. Dierker. (June, 2021). *America's Top Infrastructure Challenges: A look at the costs and impacts of the most pressing infrastructure issues facing society*. Alliance for Innovation and Infrastructure.

About Aii

The Alliance for Innovation and Infrastructure (Aii) is an independent, national research and educational organization that explores the intersection of economics, law, and public policy in the areas of climate, damage prevention, energy, infrastructure, innovation, technology, and transportation.

The Alliance is a think tank consisting of two non-profits: the National Infrastructure Safety Foundation (NISF), a 501(c)(4) social welfare organization, and the Public Institute for Facility Safety (PIFS), a 501(c)(3) educational organization. Both non-profits are legally governed by volunteer boards of directors. These work in conjunction with the Alliance's own volunteer Advisory Council.