BUILDING INNOVATION
Conference

Building Beyond Code

Lifeline Infrastructure and the Case for Coordinated Resiliency

Dale L. Crawford, *MBA, LEED GA*

Executive Director - Steel Tube Institute

Dale oversees the STI organization's efforts to promote the growth and competitiveness of steel pipe and tubular products throughout North America. In addition, he leads the strategies, programs, and activities of the institute's Conduit Section, which includes North America's leading steel conduit manufacturers. Before joining STI, Crawford worked as director of marketing and business development for Intermountain Wind and Solar, an electrical contractor. Prior to this Dale worked 9 years with Cerrowire, an electrical wire manufacturer, where he held roles in production supervision, marketing, and business development.

Crawford earned his BS in business administration from Weber State University and his MBA from Utah State University. Dale is currently a doctoral student in the University of South Florida's Doctor of Business Administration (DBA) program studying business strategy.

Casey F. Robb, *FCSI, CCPR, LEED AP*

Business Development Consultant

Casey brings 4 decades of construction experience to STI. He is a business development consultant with specific expertise in architectural promotion, commercial market strategy, and specification influence. He has worked with multiple "Fortune 100" building product manufacturers and industry associations and is well known for his connections with numerous AEC firms and building product manufactures. In 2017, he started an independent advisory services firm and is currently serving with RDH Building Science Consulting and the Steel Tube Institute.

Casey has a Bachelor of Science degree in Construction Technology from Murray State University. He is a professional member of IIBEC, ABAA, and RAiNA. He is a former Institute President of the Construction Specifications Institute (CSI). In 2021, he was awarded CSI's highest honor becoming a Distinguished Member.

Introduction & Learning Objectives

- Defining lifeline infrastructure and its critical role in resilience.
- Showcasing steel conduit as a case study in practical resilience through data and real-world applications.
- Exploring how buildings connect to broader community infrastructure and prevent system failures.

Introduction & Learning Objectives

- Highlighting public policy opportunities and the impact of federal priorities on infrastructure investment.
- Providing actionable strategies for developers, engineers, and policymakers to advocate for and implement resilient design.

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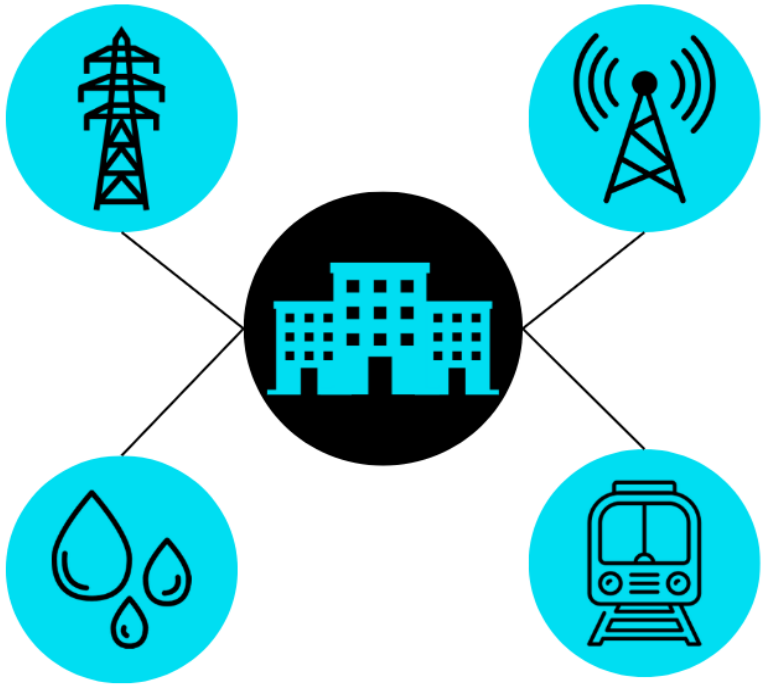
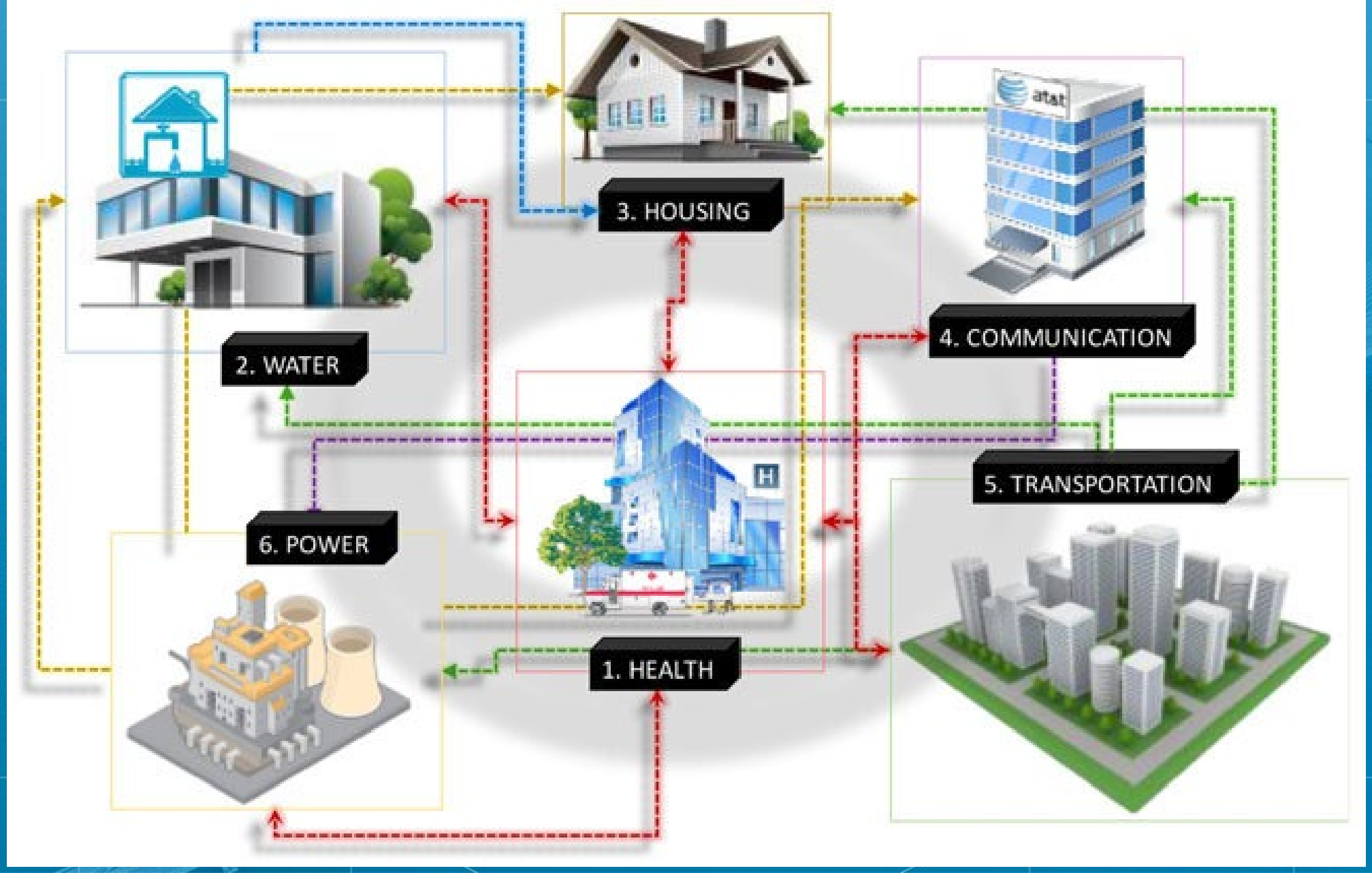
What is Lifeline Infrastructure?



Essential services that underpin daily life:

- Critical physical systems provide the **power, water, telecommunications,** and **transportation** that buildings and communities rely upon
- Buildings don't exist in isolation—**they are part of an interconnected infrastructure ecosystem** essential to public health and safety
- Mutual dependencies mean a fault in one lifeline can cascade to other critical services – resilience of these systems is paramount



https://www.researchgate.net/institution/Colorado_State_University?_tp=eyJjb250ZXh0Ijp7ImZpcnN0UGFnZSI6Il9kaXJlY3QiLCJwYWdlIjoicHJvZmlsZSIsInByZXZpb3VzUGFnZSI6Il9kaXJlY3QifX0

Community Lifelines

FEMA

2005 New Orleans Levee System

Quick Facts

Location: New Orleans, Louisiana

Year Constructed: 1727-2008

Drainage Area: 9,700 sq. mi.

Type: Other Dam Type

Height: 20-30 Ft.

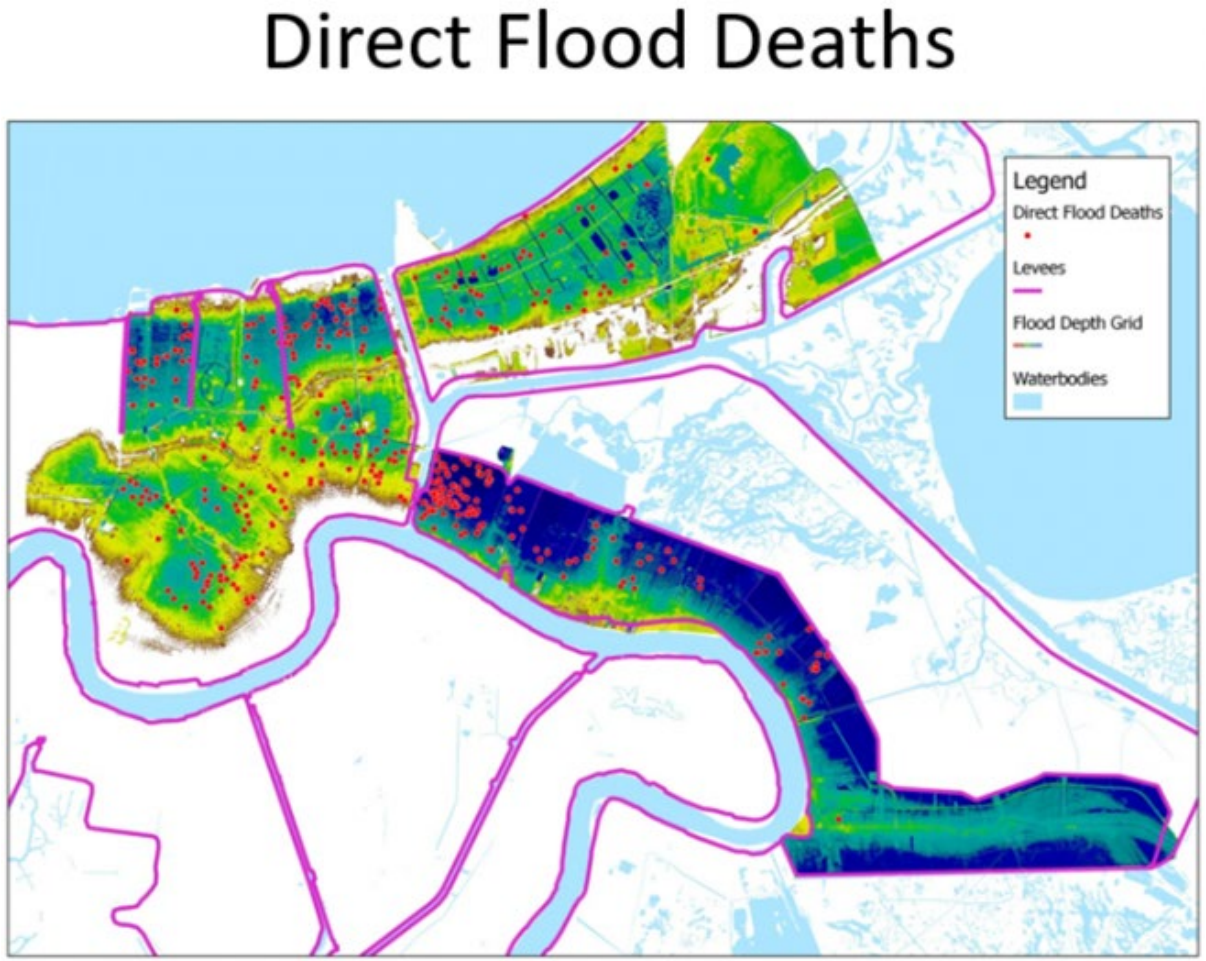
Primary Purpose: Flood Protection

Date of Incident: 2005

Evacuation: Yes

Fatalities: 1,883

Property Damage: $81 billion in direct damages, an estimated total of $160 billion in economic impacts



https://damfailures.org/case-study/new-orleans-levee-system-louisiana-2005/

FRAMING THE ISSUE:

BEYOND CODE IS THE NEW BASELINE

Beyond Code

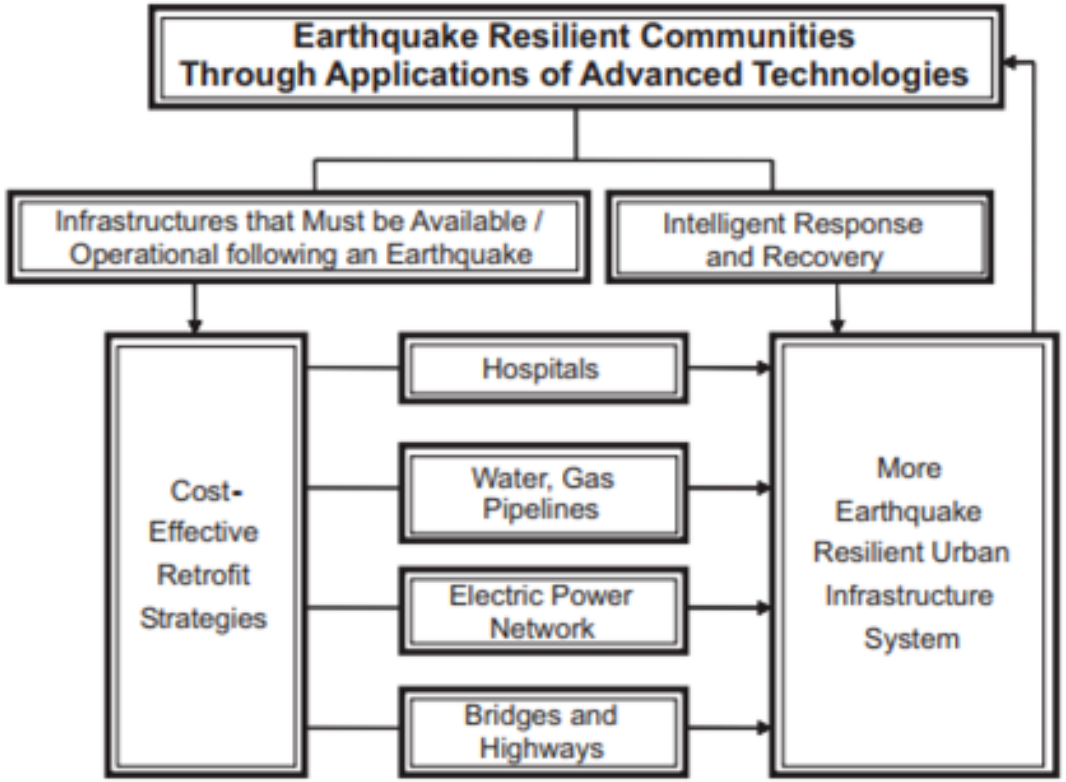
“Minimum codes are not enough to address disaster risks.”

– FEMA, Building Codes Save: A Nationwide Study

Beyond Code

Resilient lifeline infrastructure design

- Natural disasters are becoming more frequent and more damaging
- Essential services must be protected to ensure functional recovery and accelerate the return to pre-disaster service level
- Strengthening lifeline infrastructure connections through retrofits or upgrades with resilient solutions like steel conduit improves reliability, reduces downtime, and enhances safety



Beyond Code

As the frequency and severity of natural disasters increases, investing in resilience protects building value and reduces the cost impact of damages

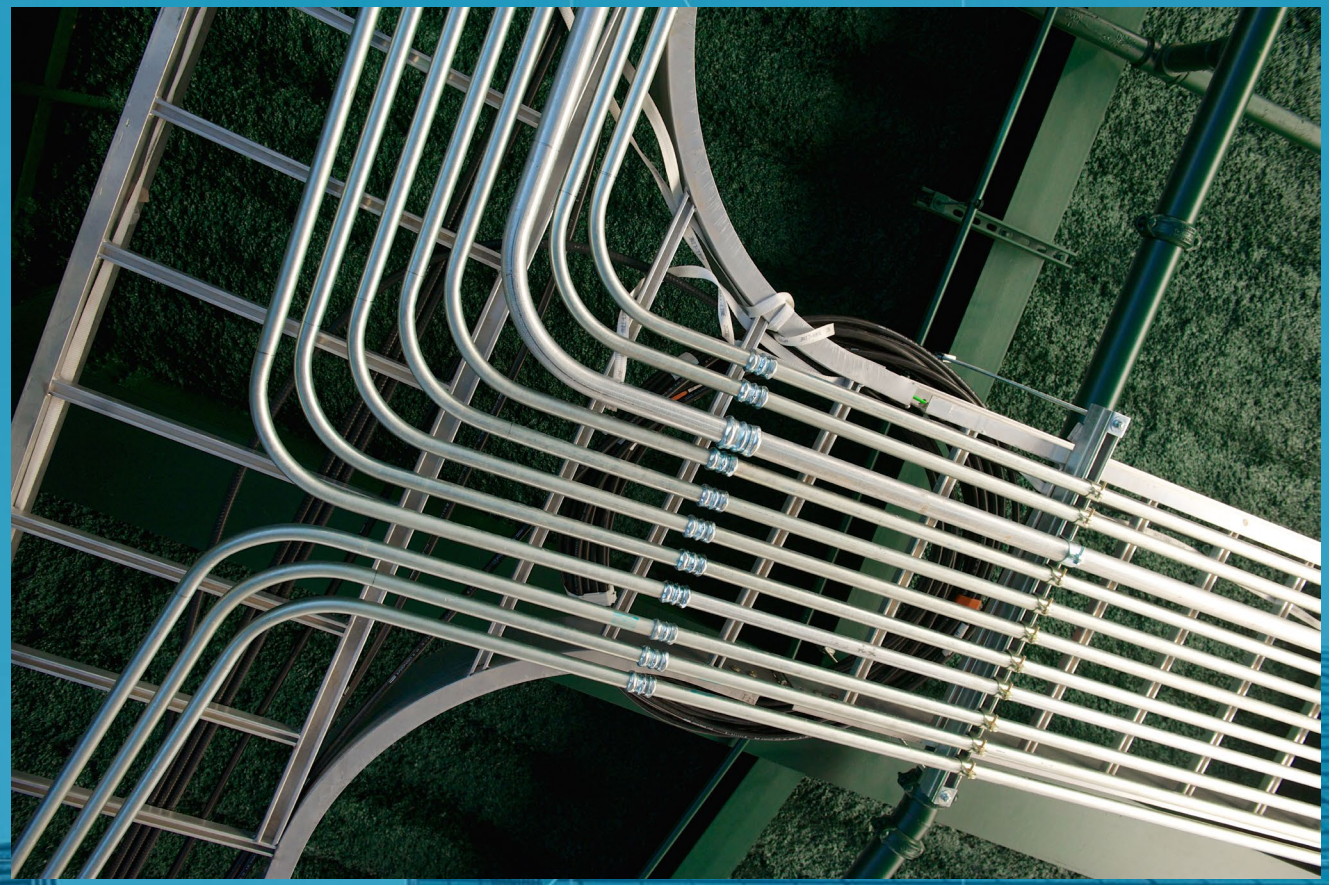
National Institute of BUILDING SCIENCES™

	ADOPT CODE	ABOVE CODE	BUILDING RETROFIT	LIFELINE RETROFIT	FEDERAL GRANTS
Overall Benefit-Cost Ratio	11:1	4:1	4:1	4:1	6:1
Cost ($ billion)	$1/year	$4/year	$520	$0.6	$27
Benefit ($ billion)	$13/year	$16/year	$2200	$2.5	$160
Riverine Flood	6:1	5:1	6:1	8:1	7:1
Hurricane Surge	not applicable	7:1	not applicable	not applicable	not applicable
Wind	10:1	5:1	6:1	7:1	5:1
Earthquake	12:1	4:1	13:1	3:1	3:1
Wildland-Urban Interface Fire	not applicable	4:1	2:1	not applicable	3:1

TABLE 1. Nationwide average benefit-cost ratio by hazard and mitigation measure. BCRs can vary geographically and can be much higher in some places. Find more details in the report.

STEEL CONDUIT AS A CASE STUDY:

PRACTICAL RESILIENCE



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Enhanced Fire Safety

- Steel conduit systems provide a durable, non-combustible enclosure that ensures fire rating compliance for electrical wiring
  - Galvanized steel RMC, IMC and EMT are considered non-combustible by building codes
- Metallic construction resists high temperatures, prevents flame and smoke spread, and protects wiring integrity during fires
- Ensures fire-resistance rating of sealed penetrated assemblies without additional firestop system

https://steeltubeinstitute.org/steel-conduit/steel-conduits-fire-resistance/

Corrosion Prevention & Resilience

- Galvanized steel conduit can be used in concrete, direct burial, and areas with severe corrosive influences without degrading
- Thick zinc coating acts as a robust physical barrier
- Cost-efficient protection for harsh environments or extreme weather events including flood or submersion

https://steeltubeinstitute.org/resources/a-deep-dive-into-the-corrosion-prevention-capabilities-of-hot-dip-galvanizing/

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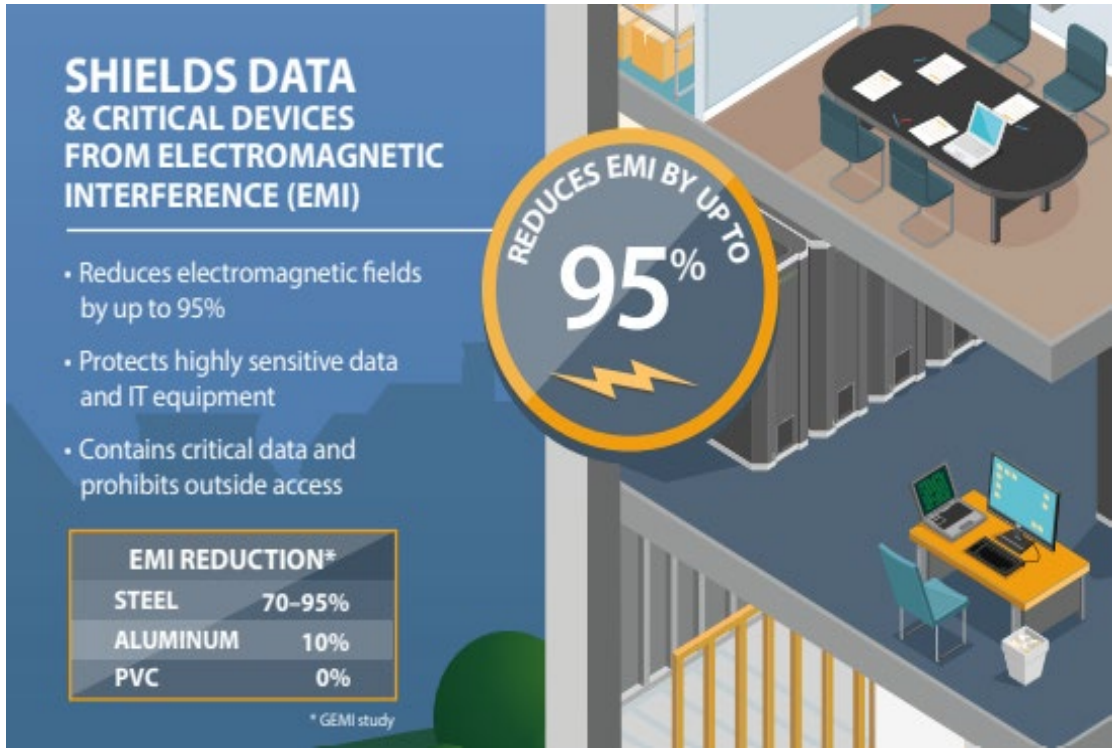
EMI Protection and Security



- Steel is uniquely capable of maintaining EMI protection for applications with highly sensitive communications systems and sophisticated equipment
- Retains its ability to protect against electromagnetic interference (EMI) over time
- Cost-effective installation compared to after-the-fact shielding

https://steeltubeinstitute.org/resources/a-deep-dive-into-the-corrosion-prevention-capabilities-of-hot-dip-galvanizing/

Real-world retrofit scenarios

Healthcare

Public Safety

Data Centers

Operating Room: EMI Mitigation

- Operating rooms rely on properly grounded steel conduit systems to shield wiring from EMI, which can interfere with sensitive medical equipment and compromise patient safety.

Real-world retrofit scenarios

Healthcare

Public Safety

Data Centers

Public Safety Building: Physical Protection & Future Flexibility

- Steel conduit offers robust wiring protection and flexible design for future upgrades in modern public safety buildings.

https://steeltubeinstitute.org/resources/public-safety-building-physical-protection-future-flexibility/

Real-world retrofit scenarios

Healthcare

Public Safety

Data Centers

ASCO: Data Center EMI Mitigation

- EMI can corrupt digital signals, causing errors and downtime. The ASCO Data Center uses grounded steel conduits as a Faraday cage to shield sensitive wiring.

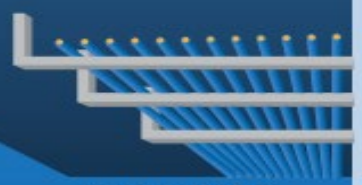
Steel Conduit Case Study

EMT vs. MC Cable: A 10-Year Lifecycle View

- This shows that while EMT has a higher initial installation cost than MC Cable, its lower long-term labor, material, and downtime expenses save **approximately $33,700**, making EMT the more cost-effective option for commercial building wiring.
- Lower labor, less disruption, longer life.

MOST FLEXIBLE AND AFFORDABLE!

As buildings change and expand over time, other wiring solutions have to be removed and reinstalled — but steel conduit can be reused again and again. It might cost more upfront, but steel conduit delivers significant savings over time!



INITIAL OFFICE BUILDING INSTALL

Materials	$25,373
Labor	$11,318

YEAR 4 — SHORT CIRCUIT

Materials	$2,192
Labor	$1,341
Business Downtime	$20,000
Removed Wire Scrap Value	-$444

YEAR 7 — LIGHT R&D CONVERSION

Materials	$4,783
Labor	$2,232

YEAR 10 — HEALTH CARE CONVERSION

Materials	$2,113
Labor	$24,070
Removed Wire Scrap Value	-$373

$92,605

INITIAL OFFICE BUILDING INSTALL

Materials	$13,347
Labor	$27,451

YEAR 4 — SHORT CIRCUIT

Materials	$352
Labor	$484
Business Downtime	$5,000
Removed Wire Scrap Value	-$107

YEAR 7 — LIGHT R&D CONVERSION

Materials	$1,703
Labor	$2,527

YEAR 10 — HEALTH CARE CONVERSION

Materials	$1,012
Labor	$7,142
Removed Wire Scrap Value	N/A

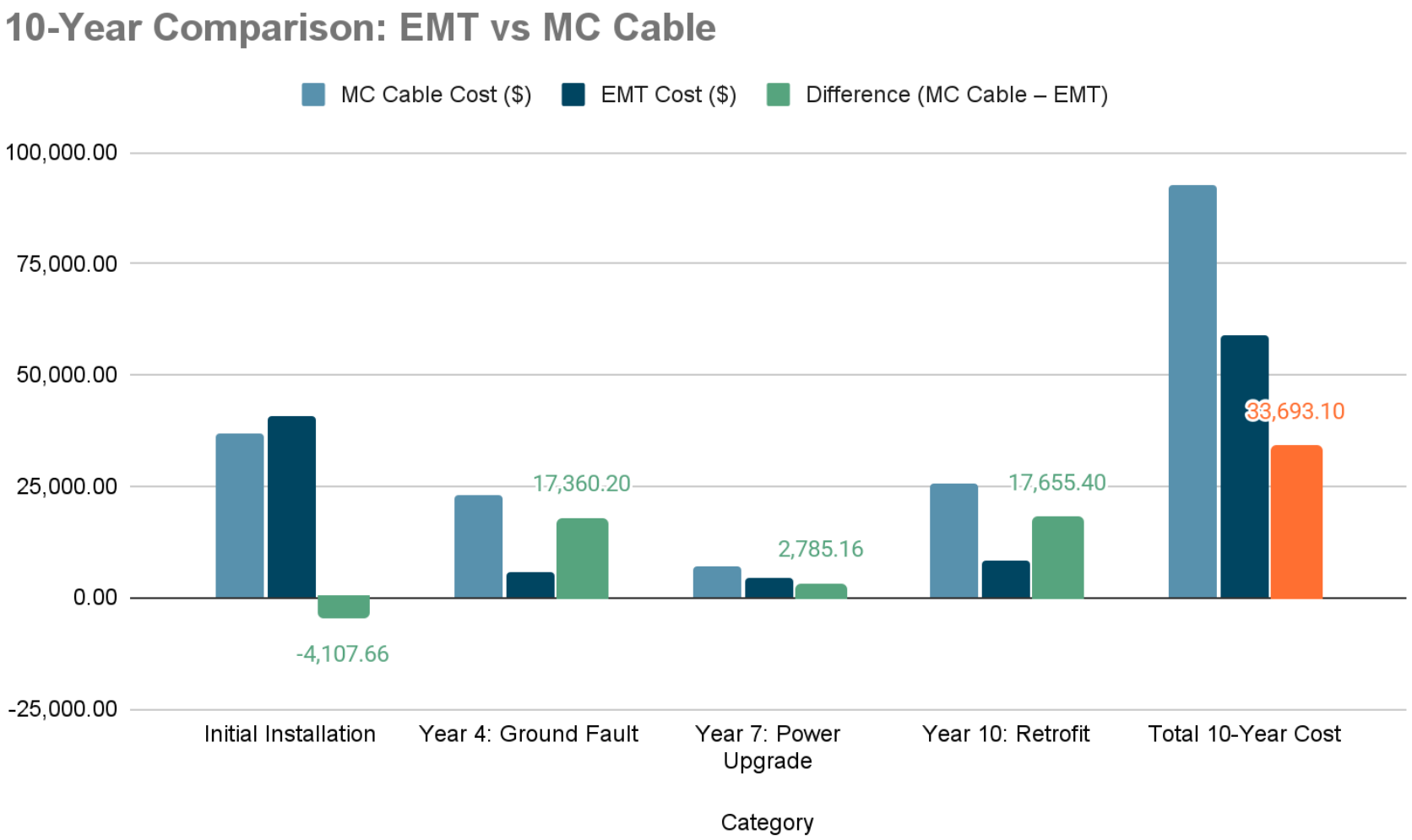
$58,912

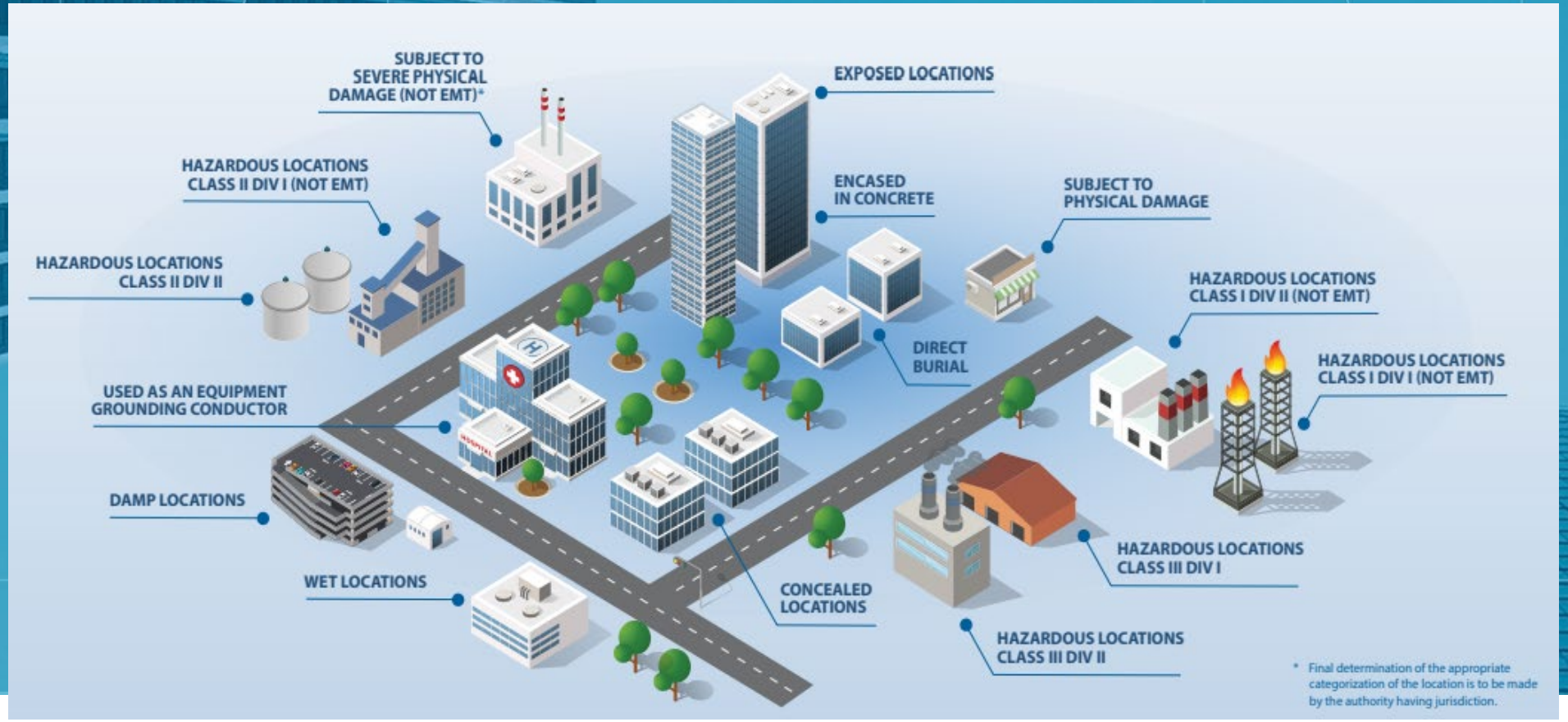
$33,693 SAVINGS

EMT vs. MC Cable:

A 10-Year Lifecycle View

Total savings:
$33,693.10





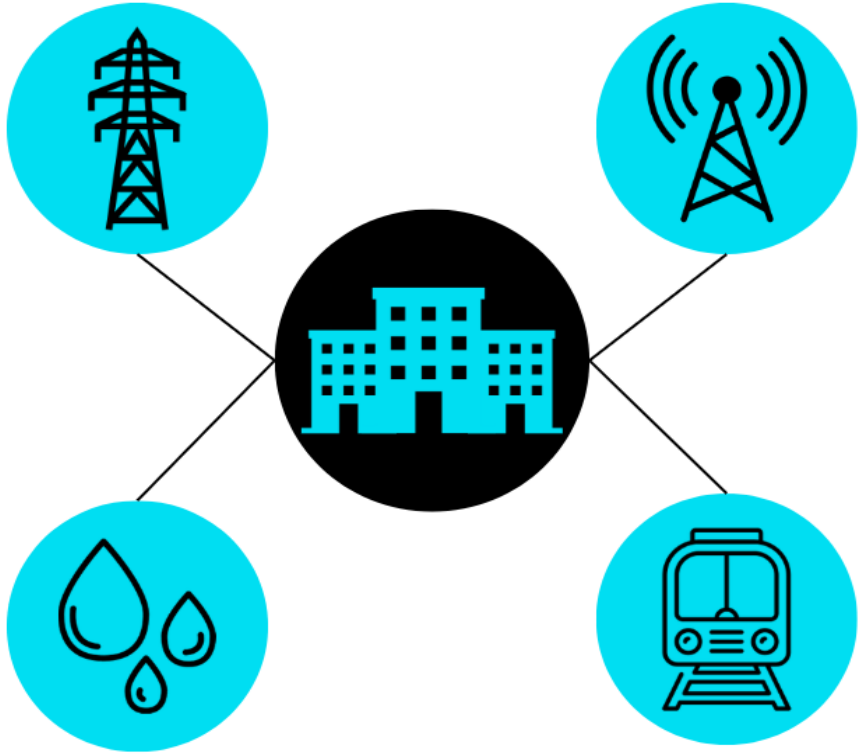
- Provides superior protection from physical damage, whether by plant equipment or disaster-related debris
- Durability supports longer functional life spans and reduced maintenance requirements of buildings & infrastructure
- Steel conduit and tubing is repairable, replaceable, and universally allowed for all building types – future-proofing structures as needs change

https://steeltubeinstitute.org/resources/steel-conduit-and-tubing-sustainability-fact-sheet/


CONNECTING BUILDINGS
TO COMMUNITIES

- Community resilience depends on the continuation of lifeline services, accessed via community buildings:
  - communications to coordinate response
  - water to activate protection
  - and energy to ensure safety and support recovery
- Resilience is critical to prevent system-wide failures and ensure the reliable operation of essential services for public health and safety, most especially in a crisis
- Resilience is established through lifeline infrastructure codes, guidelines, and standards development and unifying consensus on procedures and performance requirements

The building as a node in critical infrastructure



Connecting Buildings to Communities

Lifeline infrastructure is the integration point for community & building resilience

Community Resilience Plans

Resilient Lifeline Infrastructure

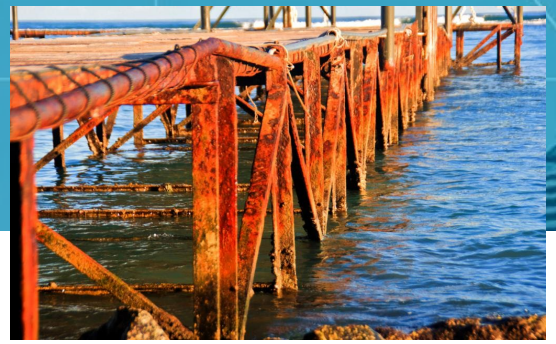
Building Resilience Design

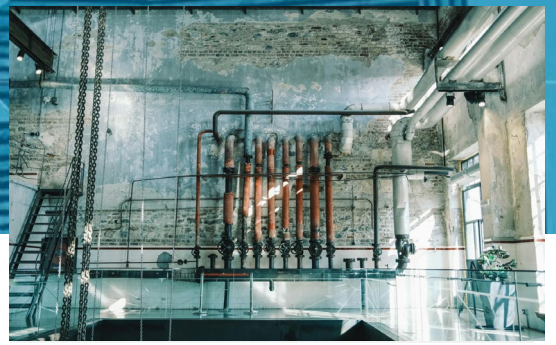
Connecting Buildings to Communities

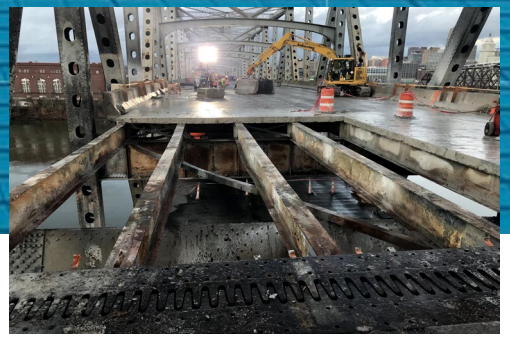
The role of community resilience planning

- "Disruptive events are best addressed by a community resilience plan that includes performance goals for the built environment…and preparedness strategies that incorporate activities related to prevention, protection, mitigation, response, and recovery" *NIST Community Resilience Planning Guide for Buildings and Infrastructure Systems*
- Significant existing research and investment into resources and guidelines for developing resilience plans at the neighborhood and/or city level:
  - NIST community resilience planning guidelines
  - FEMA functional recovery initiatives
  - National Public Infrastructure Pre-Disaster Hazard Mitigation Grant Program

Electrical Infrastructure Examples







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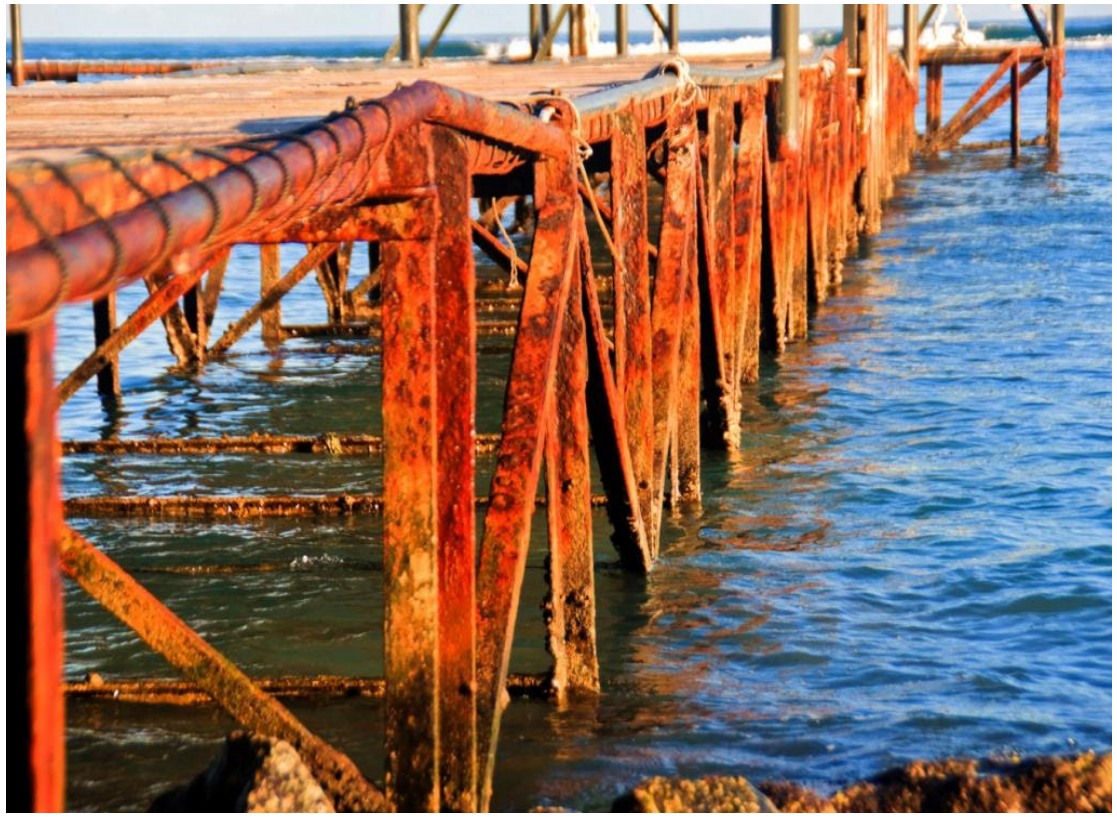
Corrosion in Coastal Setting



Example: In humid or coastal settings, regular conduits can corrode over time, exposing wiring to damage and failure.

Prevention: Stainless steel conduit offers superior corrosion resistance, ensuring the wiring remains safe and operational.

https://www.kenyaengineer.co.ke/challenges-of-corrosion-on-marine-structures/

Mechanical Damage in Demanding Environments

Example: In settings with significant physical stress or vibration, standard conduits can suffer damage that compromises wiring integrity.

Prevention: Stainless steel conduit, with its enhanced durability, provides robust protection against impact and abrasion, ensuring continuous electrical performance.

https://www.asce.org/publications-and-news/civil-engineering-source/civil-engineering-magazine/article/2021/01/brent-spence-bridge-important-conduit-between-kentucky-and-ohio-reopens

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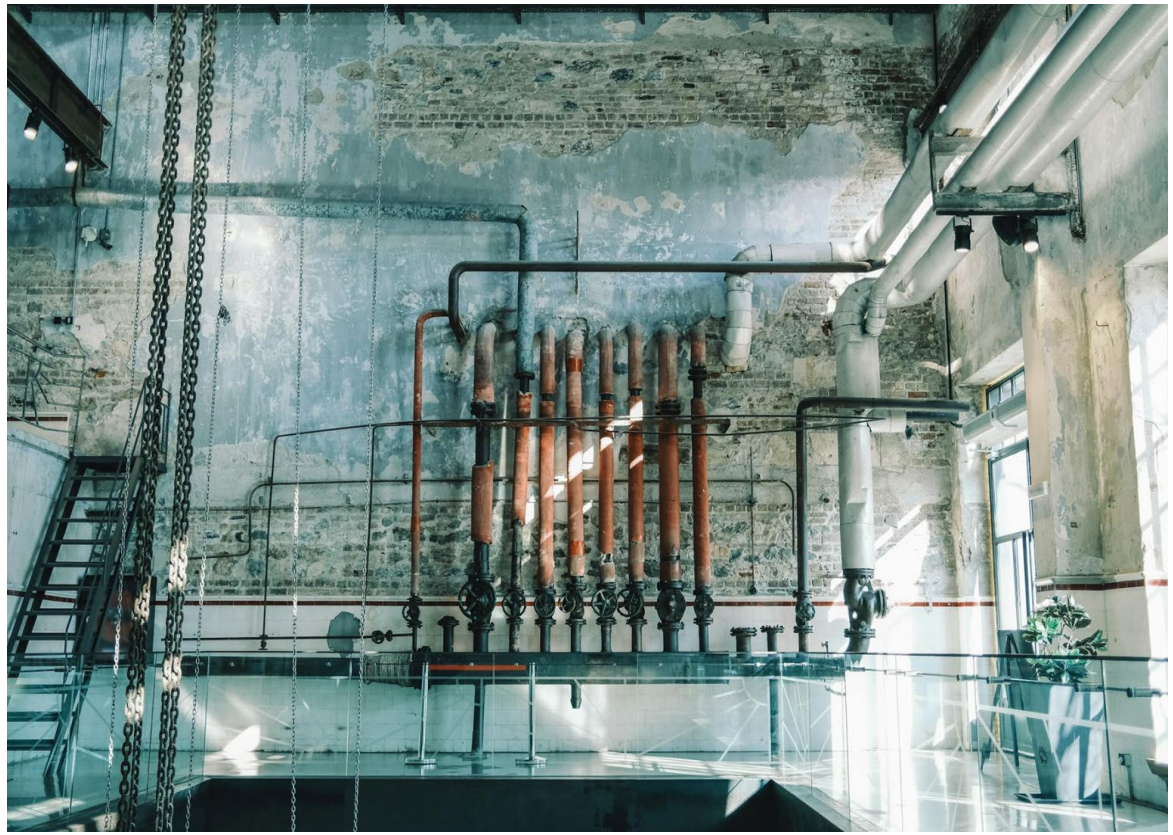


Exposure to Chemicals in Industrial Settings

Example: In industrial environments, exposure to harsh chemicals can degrade standard conduits, risking compromised insulation and electrical failures.

Prevention: Stainless steel conduit resists chemical attack, thereby protecting wiring and ensuring reliable performance.

https://steeltubeinstitute.org/steel-conduit/stainless-steel-conduit/

Fire Hazards from Overheated Conduits

Example: In some urban electrical systems, plastic or non-metallic conduits have contributed to fire hazards due to heat buildup and melting.

Prevention: Stainless steel conduit offers superior heat resistance, preventing conduit degradation and potential fire risks.

Connecting Buildings to Communities - Summary

Opportunities to work with utility companies: mandate vs incentives – more durable raceways

- Buildings account for 30-40% of primary energy consumption, according to a recent U.N. report.
- Experts promote green building standards to conserve energy and drive socially responsible, more resilient development.
- Local land use control and private property rights hinder a national approach, prompting proposals for state-level green mandates.

PUBLIC POLICY & INFRASTRUCTURE INVESTMENT

Public Policy & Infrastructure Investment

The Role of Federal Research & Grants

- **Driving innovation -** drive innovation in secure, resilient designs by supporting research and infrastructure projects
- **Breaking Financial Barriers -** cover initial costs to exceed standards and address future challenges and demonstrating incentivization structures that capture resilience value for market stakeholders
- **Aligns with federal priorities** - to strengthen and maintain national security, economic security, and public health or safety

Figure ES-1A – How Resilience Provides Value

NIBS MMC resilience incentivization roadmap 2023
https://www.nibs.org/files/pdfs/NIBS_MMC_resilience-incentivization-roadmap2_2023

Public Policy & Infrastructure Investment

- **Resilience requirements** enforce higher safety, redundancy, and performance standards for infrastructure
  - **Adopting the Latest Standards** - communities using the most recent code editions experience higher resilience and reduced costs from damage
  - **Raising Standards -** stricter requirements can improve life safety and speed functional recovery, with increased upfront costs offset by greater and longer term savings and protection in more severe hazard scenarios
  - **Mitigating Risks -** Upgrade requirements for the public sector and incentives for the private sector to take proactive retrofitting measures for vulnerable infrastructure to address threats and prevent system failures

Public Policy & Infrastructure Investment

- **Digital Twin Adoption**
  - **Pre-construction Performance.** Simulate system performance pre-construction.
  - **Design Optimization.** Predict failure points and optimize designs.
  - **Federal Support.** Supported by federal initiatives for resilient infrastructure
  - **Risk Reduction.** It enables rapid testing and iteration, reducing risks and enhancing infrastructure resilience.

https://www.nextgov.com/emerging-tech/2024/05/white-house-launches-digital-twins-funding-opportunity/396323/

Public Policy & Infrastructure Investment

Public Policy & Infrastructure Investment

Chicago Code Example

- **Encouraging Green Certifications:** Mandate that all eligible projects register with third-party organizations for certification at gold or emerald levels under ICC 700 standards.
- **Standardized Documentation Requirements:** Require submission of construction documents detailing compliance features to ensure transparency and accountability.
- **Timely Certification Enforcement:** Establish timelines (e.g., 180 days post-completion) for projects to achieve and report certification, reinforcing adherence to green building standards.
- **Incentives for Compliance:** Provide incentives, such as tax benefits or reduced permit fees, to encourage participation in sustainable building practices.
- **Education and Support:** Offer training and resources for builders and developers to understand and adopt green certification standards effectively.

https://codelibrary.amlegal.com/codes/chicago/latest/chicago_il/0-0-0-2699231

Public Policy & Infrastructure Investment

NEC Compliance

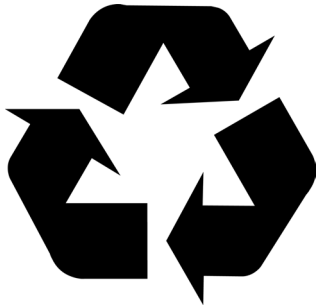
- **Adopt Clarified Safety Standards:** Update local codes to align with NEC's updated definitions of objectionable current, minimizing misinterpretations of grounding conductor currents and metal raceways.
- **Enforce Enhanced Protection Measures:** Mandate the new minimum clearances for cables and raceways under metal-corrugated roof decking to safeguard against installation damage.
- **Promote Industry Training:** Implement training programs for electrical professionals and inspectors on these NEC changes to ensure better compliance and safer installations.

https://steeltubeinstitute.org/resources/2023-national-electrical-code-nec-changes/

Public Policy & Infrastructure Investment

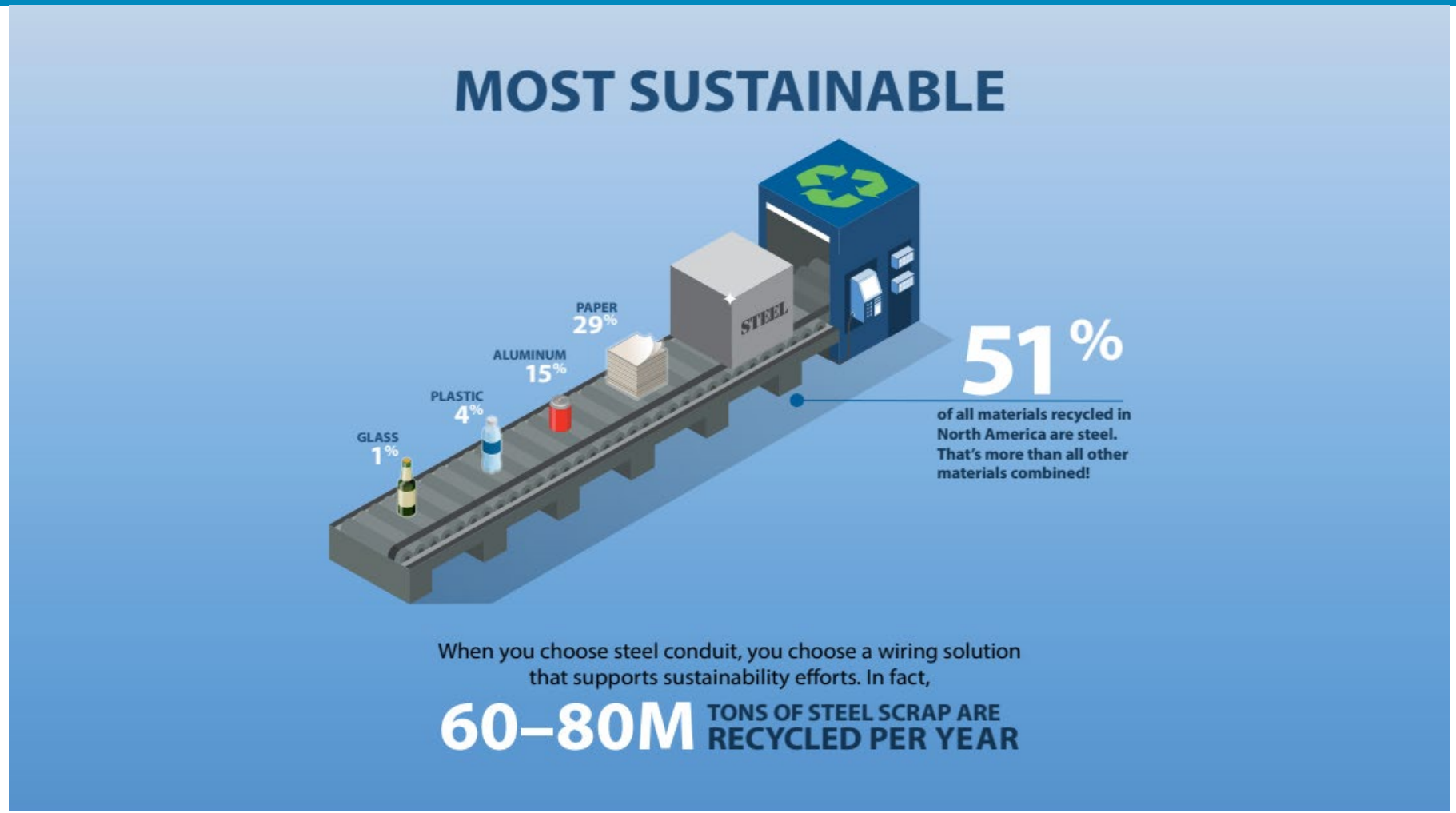
Green building frameworks

- **Minimum Recycled Content:** Require a set percentage of recycled material in key construction products.
- **LEED Incentives:** Offer bonus LEED points for using products with high recycled content
- **Standardized Labeling:** Mandate clear documentation of recycled content in building materials.
- **Building Code Integration:** Embed recycled material targets within local and national building codes.



https://steeltubeinstitute.org/faq/recycled-content-and-leed-points/

Public Policy & Infrastructure Investment



CONCLUSIONS

Lifeline Infrastructure and Resilience

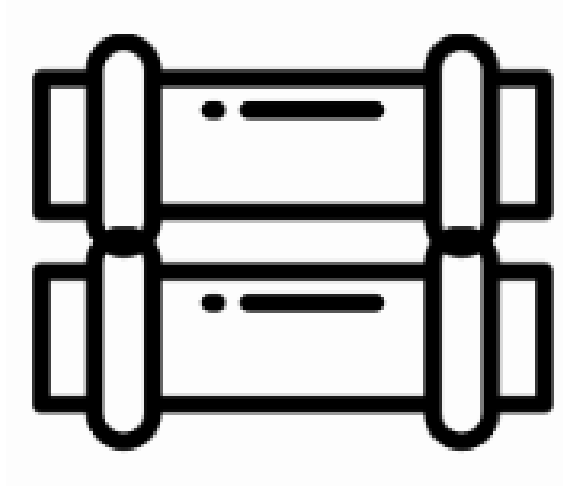
A fundamental takeaway is the importance of defining and understanding lifeline infrastructure (power, water, telecom, transportation) and its vital role in ensuring resilience against disruptions and disasters.

Building-Community Interconnection

Buildings are not isolated entities but are integral components of broader community infrastructure. A key takeaway is the need to explore and strengthen these connections to prevent system failures and ensure the reliable operation of essential services.

Steel Conduit as a Model

The presentation emphasizes steel conduit as a prime example of practical resilience. Key takeaways related to this include its fire resistance, cost-effectiveness, adaptability, and protective qualities, demonstrated through data and real-world applications.



Public Policy and Investment

Public policy and federal priorities significantly impact infrastructure investment and resilience. Key takeaways here involve understanding opportunities to influence policy, leverage funding, and promote resilient design through strategic investment.

Actionable Strategies for Stakeholders

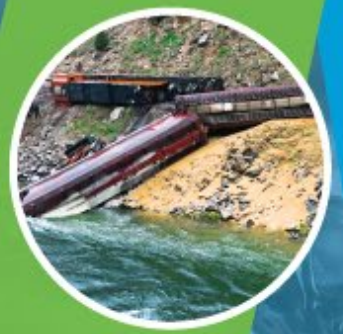
This presentation aims to provide developers, engineers, and policymakers with actionable strategies. Key takeaways in this area are the specific recommendations and approaches these stakeholders can adopt to advocate for and implement resilient design principles.

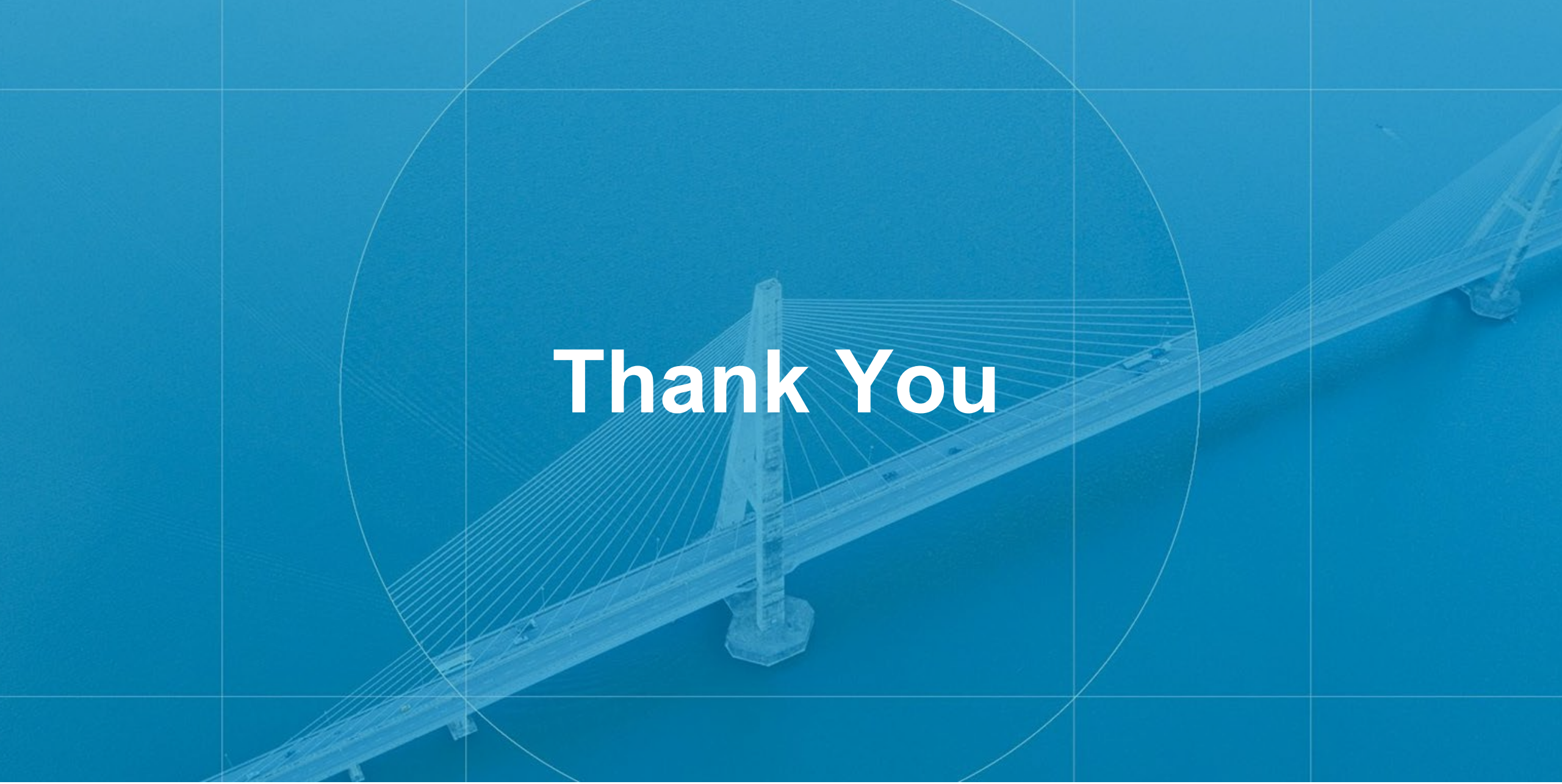
Lifeline Infrastructure Hub

A public-private partnership to assist the nation with community resilience and recovery after disasters







Thank You