Sustainable Construction Services Playbook

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First Solar, Inc.	Sterling Site Access Solutions	Meiden America Switchgear (MAS)
G&S/TCI Companies	Sunbelt Solomon Corporation	
Goodwill's Green Works, Inc.	Supreme Industries, Inc.	

[1] These are Supplier Affiliate Members as of May 2022. For an up-to-date list please visit https://web.euissca.org/search

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Introduction

Construction Services typically represent over a third of utility supply chain spend and associated Greenhouse Gas (GHG) emissions.[2] Beyond carbon emissions there are numerous additional impacts from material consumption, community implications, biodiversity considerations, end of life options, etc. The scale and nature of the majority of these impacts are set at the design phase of the project but may last decades. The purpose of this document is to inform value chain stakeholders, suppliers, specifiers, buyers, users, etc. of emerging alternative technologies and processes and hopefully inspire additional efforts to reduce the environmental and social life cycle impacts of projects.

The report starts with practices that that should be considered across all Construction Services in each project. Then for each section of the report there will be an overview of the key considerations and references to potential alternatives. Finally, the report provides a list of valuable resources to research these topics and practices further.

General Construction Services Practices

Construction Services Practice Prioritization

Step 1 - Reflect on the questions asked at the beginning of this document

Step 2 - Adopt the General Construction Service practices across as many projects as possible

Step 3 - Incorporate service specific best practices when able, and continually analyze existing construction services processes and emerging technologies to identify areas for improvement

Given the nature of utility projects, Construction Services will inevitably play a significant role in the scale and nature of its infrastructure related environmental and social impacts. The related sustainability impacts and opportunities cover a widespread scope of issues including:

- Community impacts from siting, sourcing, and engagement practices
- Material consumption from design choices including size, structural needs, material choices, etc.
- A range of construction impacts including fuel consumption, roadbuilding, vegetation management, noise pollution, and biodiversity loss
- Both financial and stakeholder value creation
- End of life impacts from design for long term needs to design for disassembly, and opportunities to repurpose, upgrade, or adapt the infrastructure to meet future needs.

Beyond the immediately clear impacts and implications of construction projects it is important to consider how the needs and potential uses of the infrastructure may evolve over time.

[2] Based on EUISSCA 2020 Greenhouse Gas Hotspot Assessment that reviewed the aggregated spend of members and mapped that spend to carbon emissions using an economic input output model.

To start addressing the sustainability of the project it is recommended to consider the following questions amongst others (e.g., US Army Corps of Engineers Alternatives Analysis). For example, these may be included in a project development stage gate process, project definition agenda, request for proposals, etc.

- Is the project necessary? Are there opportunities to repair or adapt the existing infrastructure to meet the need at a lower environmental and social cost?
- Is there a more sustainable way to do this project?
- What is the life cycle cost comparison of various design options considering capital costs, operating costs/value creation, and disposition costs?
- How can we design the project to have the lowest environmental and social impact? Can we use existing standards, such as Institute for Sustainable Infrastructure's (ISI) Envision Standard, to guide our decisions?
- What are the potential environmental and social impacts of the project? Can we use life cycle assessment, social impact studies, etc. to better understand the sources and nature of those impacts?
- Can we use less material and/or lower impact materials to achieve the same outcome (e.g., repurpose waste materials, lower carbon concrete, renewable materials)?
- How can we design the project to meet both the immediate but also potentially long-term evolving needs (e.g., increased electrification needs, new technologies, community changes)?
- With evolving weather patterns, natural disasters and other contextual considerations how can we best ensure the longevity, appropriateness, and climate resiliency of the project through design, material selection, and maintenance?
- What data and information do we need to collect and share across the value chain to support the sustainability of the project (e.g., embodied carbon, material content for end of life, etc.)?

Sample RFP Language: *"How do you propose to dispose of the existing structures, especially the wood content? Include in your response your proposed final sustainable end use disposition of the wood content thru all subcontractor tiers."*

The following resources have been identified as particularly valuable in supporting a deeper understanding of sustainable construction service practices. They are referenced throughout this document, but we encourage you to explore them further.

- The Sustainable Facilities Tool (SFTool)- a collection of resources that is used by the United States General Services Administration to incorporate sustainability into project planning and design, procurement, operations, and maintenance.
- The Whole Building Design Guide (WBDG)-provides up-to-date information and resources on integrated 'whole building' design techniques and technologies. Resources include design tools, federal mandates, government and non-governmental standards, and in-depth technical summaries on various topics. Additionally, sample specification language can be found for a multitude of materials and topics.
- The Supply Chain School- a free resource out of the United Kingdom that provides a wealth of trainings, informational articles, and learning opportunities to strengthen the sustainability of supply chain operations and procurement practices specific to the construction industry.
- The Institute for Sustainable Infrastructure (ISI)- an education and research non-profit organization that developed and manages Envision, a framework that encourages systemic changes in planning, design, and delivery of sustainable, resilient, and equitable civil infrastructure through education, training, and third-party project verification.
- The Environmental Protection Agency's Sustainable Management of Construction and Demolition Materials- guidance on construction and demolition (C&D) materials generated during the construction, renovation, and demolition of buildings, roads, and bridges.
- The USACE Sustainable Infrastructure Practices Guidebook- a guidance document crafted by the U.S. Army Corps of Engineering to support the implementation of economically and environmentally sustainable practices in civil works construction and infrastructure.

Successful General Construction Practice Case Studies:

Taking full advantage of an existing developed site, the construction of a new rental car hub at the Portland International Airport managed to reduce potable water consumption by an impressive 99.5%. They did this by harvesting and reusing rooftop rainwater and additionally boosted stormwater storage capacity by 180%. Furthermore, use of automatic lighting and state of the art LED bulbs aided in a 31% reduction of overall energy use. (Source: Institute for Sustainable Infrastructure "Rental Car Quick Turnaround QTA Facility" April 2021. Learn more here)

The development of Albion Riverside Park in Los Angeles, California, utilized best practices in siting, design, and soil remediation processes to turn 6 acres of contaminated industrial land into a safe outdoor space for the neighboring community. Through decontamination and implementation of bioswales, permeable pavement, underground infiltration galleries, and bioretention areas the Albion Riverside Park increased water management to divert 85% of annual rainwater in a safe and pollution free manner. (Source: Institute for Sustainable Infrastructure "Albion Riverside Park Project" March 2020. Learn more here)

Below are key practices that should be considered in all Construction Services elements. These may be aligned with or go beyond federal, state, local, or municipal regulations that should always be reviewed and met at a minimum.

Service Category	General Construction Service Successful Practice Description
Design	Consider opportunities to incorporate sustainability into the design of the project. Most impacts will be determined by decisions made in the design phase. Once the design is set, reducing those impacts becomes increasingly difficult. Key considerations include siting, material selection, material reduction strategies, design for longevity, efficiency of use or repair, community contributions, design for end of life, etc. Successful practices include requiring designs to meet sustainability criteria (e.g. Envision V3 standard), requesting more sustainable options or recommendations, or setting internal goals such as reduced material consumption.
Siting	Avoid constructing on a site that has been identified as being of high ecological or cultural value. Project teams unsure of whether their site is of high ecological value should consider the factors outlined on page 127 of the Envision Guidance Manual V3. *"Through construction, noise, light pollution, removal of vegetation, and other practices, infrastructure projects can have negative impacts on these areas as well as the local biodiversity. Problems associated with a poorly sited project are difficult to correct after construction. Preventing impacts by selecting appropriate sites during planning is significantly more effective."*[3] Siting properly

[3] Institute for Sustainable Infrastructure, 'Envision Sustainable Infrastructure Framework', *The Institute for Sustainable Infrastructure, 2018, https://isi-projects-*

can ensure that minimal impact to the local ecosystems is made through construction. Additionally, appropriate site management can reduce erosion, light pollution, the heat island effect, and construction-related pollution.[4] Organizations may also want to consider revitalizing land that is considered a brownfield[5]. "*It is estimated that there are more than 450,000 brownfields in the U.S.. Cleaning up and reinvesting in these properties increases local tax bases, facilitates job growth, utilizes existing infrastructure, takes development pressures off of undeveloped, open land, and both improves and protects the environment."*

Understand the potential impacts of siting locations from an environmental justice perspective. "The principles of environmental justice call for fairness, regardless of race, color, national origin, or income, in the development of laws and regulations that affect every community's natural surroundings, and the places people live, work, play and learn."[6] Review considerations from state and/or federal government to identify communities with high pollution and vulnerability.

Site Access and Road Building

Matting

Creating mat-covered pathways/roads for vehicles and equipment to traverse can significantly reduce the risk of soil erosion, soil compaction, and soil mixing. Minimization of habitat disturbances will protect drain tile in agricultural fields, wetlands, endangered species, and avoid job-site to job-site transfer of invasive species. A major reduction of safety incidents will be gained by protecting labor forces from injury and equipment from premature wear and tear. Utilities can expect contractors to work 365 days a year, maintaining the quoted construction schedule by avoiding imminent weather delays only because they matted the Right-Of-Way (ROW). Considering alternative matting such as cross laminated timber (CLT) –also known as glue laminated mats and plastic mats – that can reduce carbon emissions by up to 50% from reduced trucking and transportation impacts. Matting should be chosen specifically for each site, as specialty matting may be needed for more sensitive and challenging terrains including wetlands and uneven terrain.

Fuel Consumption – up to 50% reduction in fuel consumption for site access construction is gained using CLT or plastic mats.

Noise Pollution – a 40-50% reduction in site access construction noise can be gained from the use of glue laminated CLT or plastic mats due to a faster installation through more mats being moved down the ROW at one time.

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documents.s3.amazonaws.com/prod/files/static/31/k9ohYfnYjZkVkLTZ/Envision%20Guidance%20Manual%20%28v3%29.pdf, (accessed 18 April 2022)

[4] Sustainable Facilities Tool, 'Sustainable Sites', *The Sustainable Facilities Tool,* 2019, https://sftool.gov/learn/about/46/sustainable-sites (accessed 18 April 2022)

[5] Environmental Protection Agency, 'Overview of EPA's Brownfields Program', *epa.gov,* 2021, https://www.epa.gov/brownfields/overview-epas-brownfields-program, (accessed 18 April 2022)

[6] Environmental Justice Program | CalEPA

End-of-Life – CLT mats can be ground up into mulch and sold off as such, left in the ROW as ground cover and filler sediment control, or sent to a Bio-Fuel producer like Mid-Michigan Recycling, a Consumers Energy owned company, for turning into energy. [7]

Sustainable material alternatives

Road building for construction typically relies on asphalt, cement, or other carbon-intensive materials. Using sustainable or recycled materials (Recycled Concrete Aggregate, Reclaimed Asphalt Pavements, etc.) or alternate methods (permeable pavement, etc.) can reduce the impact of this aspect of construction.[8]

Jobsite Planning and Management

Jobsite Safety

Projects can only be considered truly sustainable when the safety, health, and welfare of their workers is ensured. Project planning should include a thorough jobsite hazard analysis (JHA) to protect all crew members by mitigating hazards through activity planning & procedures and specified personal protection equipment. Each crew leader should be required to conduct a daily JHA with their crews.

Pollution prevention

Potential pollutants brought to or generated on the jobsite should be managed to prevent coming into contact with rainwater. Spill kits must be fully stocked and readily available. Chemicals stored onsite should be off the ground and covered. Dumpsters should be covered when not in use. All concrete and associated wash should be collected in an impervious concrete washout located in an upland area. Drill slurry should be managed to prevent discharge into water ways and wetlands. Personal trash should be removed daily from site, and construction debris collected. In ecologically sensitive areas extra measures should be specified to prevent and catch leaks from equipment.

Temporary Erosion and Sediment Control (ESC)

Besides being a basic requirement of most construction permits, ESC prevents sediment and other potential pollutants from entering storm sewers or storm

[7] Sterling Cross-Laminated Timber "CLT (Cross-Laminated Timber) MATS 101", *Sterling Solutions,* 2022, https://www.sterlingsolutions.com/blog/clt-mats-101-cross-laminated-timber/, (accessed 25 April 2022)

[8] The Remi Network, 'The green alternative to traditional asphalt', *The Remi Network,* 2013, https://www.reminetwork.com/articles/the-green-alternative-to-traditional-asphalt/, (accessed 18 April 2022), Electric Utility Industry Sustainable Supply Chain Alliance, 'EUISSCA Construction Materials Playbook', 2021, https://www.euissca.org/construction-playbook-09-2021.html, (accessed 18 April 2022), Journal of Cleaner Production, 'Sustainable Road Paving: Materials, Design, Construction, and Maintenance', *Science Direct,* 2019, https://www.sciencedirect.com/journal/journal-of-cleaner-production/special-issue/10Q9D5Q33JP, (accessed 18 April 2022), World Highways, 'Sustainable road construction: current practices and future concepts', *World Highways,* 2015, https://www.worldhighways.com/wh3/wh5/wh6/feature/sustainable-road-construction-current-practices-and-future-concepts, (accessed 18 April 2022)

drains, waterways, and wetlands. Incorporating ESC into the project design should include minimization and timely stabilization of ground disturbance, managing flow of stormwater across the jobsite, thoughtful placement of controls to treat sediment-laden water, and prompt removal of controls. Additionally, ensure crew foremen are trained in the installation, maintenance, and removal of ESC.

Permanent Site Stormwater Management

The final layout of the project site should consider changes in hydrology, addressing both water quality and quantity. Water quality measures such as bioswales or bioretention can be very effective in removing pollutants from the first ½ -1" of runoff while providing some ecological benefit. If the design results show an increased runoff from the site, some form of retention or detention may be required to control flooding and minimize impacts to receiving bodies of water, water ways, and private neighboring property.

Natural and Cultural Resource Protection

The project design should identify and avoid natural and cultural resources through planning for access, equipment pads, and laydown areas; establishing and flagging buffers around resources; avoiding impacts to threatened or endangered species; and prevention of transporting invasive species to or from the jobsite. Procedures should be in place to stop work and report any archeological or historical resources discovered during construction.

Jobsite Waste Management

Management of site waste should be incorporated into jobsite management, planning, and overall project design. These site management plans should strive to avoid, re-use, minimize, or recycle all wastes generated on-site. For example, provide multiple bins to enable material separation and recycling, engage vendors to takeback packaging on return trips and/or reduce the amount of packaging needed for materials, etc..

Testing Services

Building materials testing

Building materials often contain harmful chemicals like lead or formaldehyde and can also be significant sources of volatile organic compounds (VOCs) (shown to be harmful to humans). Tests can be done to ensure materials are safe for humans and the environment.[9]

Environmental materials testing

[9] SGS, 'Building Materials Testing', *SGS*, 2022, https://www.sgs.com/en/industries-and-environment/buildings-and-infrastructures/material-production/materials-testing/building-materials-testing, (accessed 18 April 2022)

	Construction can often negatively impact the surrounding natural environment , commonly by contaminating soil, water, or air. Samples of these from the construction site can be regularly tested to ensure minimal negative impact.[10]
Source Locally	Although not specific to infrastructure or electric construction, the U.S. Green Building Council (USGBC) LEED manual is a valuable source of construction best practices. Amongst other practices the USGBC encourages sourcing within a 100-mile radius from the project site.[11] Procuring materials from local suppliers has the potential to reduce the transportation distances to project sites resulting in reduced transportation costs and carbon footprint while supporting the local economy and community relationship.[12]
Shipping	Using low carbon shipping options Several common methods of shipping are significant sources of emissions. Choosing low carbon options (cargo ships, trains, EVs, bundled shipping, etc.) rather than high carbon options (planes, trucks, etc.) can have a significant impact.[13]
Energy Efficiency	Utilizing low energy and long-lasting technologies reduce emissions greatly. Using LED lighting options for site and warehouse operations can create a safe and efficient work environment. Solar powered signage can be used rather than diesel generator powered options to lower emissions.
Fuel Switching	Choosing the lowest carbon-intensity option Depending on the context where fuel switching is applied, moving from propane or fuel oil to natural gas or electric power (in operations, equipment, etc.) can represent significant carbon savings. Biofuels are also increasingly economical for use in heavy equipment.[14]

[10] Atlantic Environmental, 'Air Sampling/ Testing at Construction Sites', 2019, https://www.atlenv.com/air-monitoring-at-construction-sites, (accessed 18 April 2022), Environmental Testing, 'Environmental Testing', 2022, https://www.intertek.com/testing/environmental/, (accessed 18 April 2022)

[11] LEED, 'LEED v4 for BUILDING DESIGN AND CONSTRUCTION', *United States Green Building Council,* 2019,https://www.usgbc.org/sites/default/files/LEED%20v4%20BDC_07.25.19_current.pdf, (accessed 18 April 2022)

[12] T&D World, 'CL&P Explores Sustainable Substations' *T&D World,* 2012, https://www.tdworld.com/substations/article/20955734/clp-explores-sustainable-solutions, (accessed 18 April 2022)

[13] H. Ritchie, 'Which form of transport has the smallest carbon footprint?', *Our World in Data,* 2020, https://ourworldindata.org/travel-carbon-footprint, (accessed 18 April 2022), Time for Change, 'C02 emissions for shipping of goods', *Time for Change,* 2019, https://timeforchange.org/co2-emissions-for-shipping-of-goods/, (accessed 18 April 2022)

[14] International Finance Corporation, 'Fuel Switching', *International Finance Corporation,* 2022, https://timeforchange.org/co2-emissions-for-shipping-of-goods/, (accessed 18 April 2022), Government of Canada, 'Fuel Switching Opportunities in Canadian Industrial Sectors', *Government of Canada,* 2018, https://www.nrcan.gc.ca/energy-efficiency/transportation-alternative-fuels/fuel-switching-opportunities-canadian-industrial-sectors/21266 (accessed 18 April 2022), CONEXPO, 'The Death of Diesel? Alternative Fuels for Construction Equipment' *CONEXPO,* 2022, https://www.conexpoconagg.com/news/the-death-of-diesel-alternative-fuels-for-construc, (accessed 18 April 2022)

	Reducing overall fuel consumption Other practices to reduce fuel consumption include reducing number of deliveries; minimizing unnecessary idling of vehicles and equipment, reuse of soils or other materials on-site to decrease truck traffic to and from site; and waterborne/rail transportation of materials instead of trucking, where available. Additionally, purchasing updated vehicle models with higher fuel efficiency and/or electric vehicles reduces overall fuel consumption.
Additional Procurement Practices	• When evaluating new suppliers/contractors, give meaningful weight to the quality of their environmental management. • When evaluating new suppliers/contractors, give meaningful weight to the sustainability and carbon avoidance of their products and/or services. • Specify use of environmentally preferable asphalt, concrete, and cement in all geographies it is available. • Specify that project design includes environmentally preferable equipment/ materials/ design elements. • Prohibit procurement of chemicals identified in local regulatory and recognized international "chemicals of concern" lists. • Lubricants: Specify environmentally preferable alternatives for proven applications. • Paints and coatings: Prohibit lead-based paints and specify environmentally preferable alternatives for proven applications. • Purchase products in appropriate quantities to minimize excess waste. • Seek ideas from prospective suppliers on how to improve and track environmental impact reductions on the specific scope of work.

Additional General Construction Resources

- Institute for Sustainable Infrastructure Envision- Guidelines, checklists, and other resources that help infrastructure projects consider climate resilience, the natural world, resource allocation, leadership, and quality of life throughout the design, build, and maintenance phase of construction.
- EPA Environmental Justice- Guiding principles of environmental justice best practices across 10 regions of the United States.
- EPA Green Infrastructure Design and Implementation- Design manuals, design tools, design challenges, and implementation case studies to aid in construction of green infrastructure that benefits water resources and the greater community.
- EPA Brownfields and Land Revitalization- General information and technical resources on how to sustainably sanitize, revitalize, and reuse contaminated properties.
- EPA Green Infrastructure- Examples of green infrastructure that mitigate pollution and environmental contamination from runoff water through thoughtful and scientifically informed construction that absorbs rainwater where it falls.
- Sterling Solutions Case Studies- Collection of projects that highlight sustainable and efficient site access strategies revolving around the matting process.

- Sterling Solutions White Papers- Industry white papers focusing on ground protection, the environment, and how matting solutions can be used to increase productivity and minimize site contamination.
- Flock Freight- A shared truckload approach to improve delivery times and minimize carbon footprint of shipping.
- Supply Chain School Construction Learning Pathways- The Supply Chain School's resource hub for all things construction related. Learning pathways include short lessons on carbon reporting, resource efficiency, and carbon reduction and offsetting.
- SFTool Erosion Control Materials- Procurement information for federally preferred erosion control products and materials.
- SFTool Alternative Fuels- Procurement information for federally preferred fuel alternatives, fleet maintenance, alternative fuel vehicles, and energy in various forms.
- SFTool Sustainable Sites- Guiding principles and suggestions to incorporate sustainability into site selection and development.
- SFTool Sustainable and Alternative Materials and Resources- Guidance and resources related to commonly used sustainable building materials.

Civil Construction Overview

Civil construction is an industry comprised of diverse services, companies, and individuals that create or maintain infrastructure to support human-made and/or natural systems and structures. The industry directly interacts with water, earth, and humans, and has the potential to pose serious risks to each. Sustainability, as defined in the introduction, can be considered at each and every step of the civil construction phase in order to mitigate these risks: siting a construction site should involve consideration of environmental value of the area; bringing in construction equipment and choosing materials should consider the environmental impact of each; testing finished sites should involve an assessment of potential damages; building structures and landscaping should be done for maximum efficiency and minimal negative impact. Practices can potentially harm the health of local communities, ecosystems, and the monetary success of projects. Luckily each major element of the civil construction process for electric utilities has practices that can help address these sustainability risks. Whether it is using better insulating materials for foundations or using proven practices to minimize chemical and/or polluted water runoff and erosion, there are plenty of services and actions that can be easily implemented into civil construction work plans to protect your business, community, and environment. By implementing these, a supplier can boost their value in a time of heightened awareness on environmental impact, while also doing good for the planet and people. In the following section, the successful sustainability practices for several major civil construction actions will be explained and linked for further information.

SAMPLE SPECIFICATION: Aston University Sustainable Construction Specification – "6.2 Responsible Sourcing A Cradle-to-Cradle approach should be taken for the key building materials and furnishings that are used. A feasibility study must be done to look at sustainable alternatives and/or the sustainable standards of the building materials being recommended for use. These include of the following: Building Elements • Brick (including clay tiles and other ceramics) • Pavers (concrete, clay) • Resin-based composites and materials, including GRP and polymeric render • Concrete (including in-situ and pre-cast concrete, blocks, tiles, mortars, cementitious renders, etc.)…" see the full specification here

Successful Civil Construction Practice Case Studies:

Reconstruction of New York City pump station utilizing regionally sourced and recycled materials, sophisticated energy management systems, and strategic water capacity upgrades resulted in 93% improvement of water storage capacity and 10% overall energy reduction (Source: Institute for Sustainable Infrastructure "NYC 235th Street Pumping Station" August 2020. Learn more here)

Redevelopment of taxiways and runways at DTW incorporated heavily recycled materials to divert 90% of construction waste from landfills, planted unique and native seed mixtures at property line to deter wildlife from airfield and reduce need for mowing, and relied on stakeholder engagement in process from inception to reach a 10% reduction in GHGs throughout the project. (Source: Institute for Sustainable Infrastructure "Reconstruction of Runway 3L/21R and Associated Taxiways" November 2019. Learn more here)

Service Category	Additional Civil Construction Specific Practices
Foundation Building	**Concrete alternatives** There are several kinds of "environmentally friendly concrete" (EFC), which can minimize the use of highly carbon-intensive Portland cement. See specifyconcrete.org for an overview of a few common "eco-friendly" alternatives to traditional concrete as well as the EUISSCA Sustainable Construction Materials Playbook.[15] Additionally, the SFTool provides key information on sustainable construction products including ready-mix and site-mix concrete.[16] **Cement clinker substitution** Clinker substitutes (supplementary cementitious materials) consist of a variety of both naturally occurring and industrial byproduct materials that can be used to replace a proportion of the clinker in Portland cement. This reduces production cost, environmental impact and provides the added benefit of diverting industrial byproducts from landfill.[17] **Environmental Product Declarations** "Environmental Product Declarations (EPDs) are a way for manufacturers to take a comprehensive, third-party verified [life cycle assessment] LCAs, which are quite complex, and turn them into standardized declaration labels for their products."[18] The EPD provides the opportunity to compare specific materials or even suppliers for the project. **Insulated concrete forms** This building technique uses pre-made concrete forms to quickly build structures and foundations; the benefits include higher energy efficiency, better insulation, fewer natural resources used in the build, less construction waste, and less energy expended in construction.[19]

[15] Specify Concrete, 'Eco-Friendly Alternatives to Traditional Concrete', *Specify Concrete,* 2019,https://www.specifyconcrete.org/blog/eco-friendly-alternatives-to-traditional-concrete, (accessed 18 April 2022)
[16] Sustainable Facilities Tool, 'Key Sustainable Construction Products' *Sustainable Facilities Tool,* 2016, https://sftool.gov/greenprocurement/green-products/1046/key-sustainable-construction-products/1626/concrete-ready-mix-site-mix/9?addon=False&active=details, (accessed 18 April 2022)
[17] Global Cement and Concrete Association, 'Clinker Substitutes', *Global Cement and Concrete Association,* 2022, https://gccassociation.org/cement-and-concrete-innovation/clinker-substitutes/, (accessed 18 April 2022)
[18] Sustainable Facilities Tool, 'Environmental Product Declarations (EPDs)' *Sustainable Facilities Tool,* 2020, https://sftool.gov/learn/about/402/environmental-product-declarations-epds, (accessed 18 April 2022)
[19] Fox Blocks, 'Insulated Concrete Form Foundations Vs. Poured Concrete Foundation', *Fox Blocks,* 2022, https://www.foxblocks.com/blog/icf-vs-poured-

	Process efficiency in cement, aluminum, and plastics Increasing the amount of scrap used in existing electric arc furnaces can both divert demolition waste from landfill and abate associated emissions. Steel production Process improvements, such as switching steel production to less carbon-intensive processes can also significantly reduce construction emissions. One new process anticipated to be an important global alternative to current steel production is the transition from blast furnaces to using direct reduced iron in electric arc furnaces.[20]
Excavation	Hydro excavation This is a method of excavating earth that uses water and suction to break up dirt with water and extract it into a tank. It is useful in colder climates but has the added benefits of less soil being displaced, ease of transporting extracted material, and lower carbon-intensity than traditional excavation.[21] One may also consider on-site dewatering techniques to reduce transportation impacts and disposal fees.[22] Dry Vac excavation This is a method of excavating earth that uses high powered compressed air to disturb the earths soil. The soil is then vacuumed through a flexible hose to a truck-mounted debris-tank, which can be parked hundreds of feet away from the dig site to mitigate surface damage. Dry vac excavation, or air excavation, is most effective in geographies with dryer soil and is useful for safely exposing

concrete#:~:text=%20Insulated%20Concrete%20Forms%20Foundations%20%201%20ICFs,example%2C%20foundations%20built%20with%20Fox%20Blocks...%20More%20, (accessed 18 April 2022)https://www.foxblocks.com/blog/icf-vs-poured-concrete -:~:text=%20Insulated%20Concrete%20Forms%20Foundations%20%201%20ICFs,example%2C%20foundations%20built%20with%20Fox%20Blocks...%20More%20

[20] M. Kirschen, 'Process Improvements for Direct Reduced Iron Melting in the Electric Arc Furnace with Emphasis on Slag Operation', *processes,* 2021, https://www.mdpi.com/2227-9717/9/2/402/pdf, (accessed 18 April 2022), World Economic Forum, 'Net-Zero Challenge: The supply chain opportunity', *World Economic Forum,* 2021, https://www3.weforum.org/docs/WEF_Net_Zero_Challenge_The_Supply_Chain_Opportunity_2021.pdf, (accessed 18 April 2022)

[21] Ontario Exavac, 'Sustainable Environment', *Ontario Exavac,* 2022, https://ontarioexcavac.ca/sustainability/sustainable-environment/ , (accessed 18 April 2022), HydroExcavation, ' What is Hydro Excavation?', *HydroExcavation,* 2022, https://hydroexcavation.com/information/#:~:text=What%20is%20Hydro%20Excavation%3F%20Hydro%20Excavation%20is%20the,way%20to%20excavate%20soil%20and%20locate%20underground%20utilities., (accessed 18 April 2022)

[22] O'Loan, R. 'Solids Handling: A Piece of Cake' *Water and Waste Digest, 2021*, https://www.wwdmag.com/sludge-dewatering-equipment/solids-handling-piece-cake (accessed 18 April 2022)

underground utilities without damaging tree roots and existing human-made structures. [23]

Dust control by "damping down"

Damping down refers to using water or chemical spray on the ground to limit the disturbance of dust and particles sent into the air. These particles can have negative impacts on human and natural environments.[24]

Reuse of removed soil

Soil that has been removed can be tested and shared (if clean). The reuse of removed soil keeps it out of the landfill and therefore also reduces landfilling costs.

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[23] Utility Contractor Online, 'Air Excavation: A Growing Trend Among Utility Contractors' *Utility Contractor Online*,2020, https://utilitycontractoronline.com/air-excavation-a-growing-trend-among-utility-contractors/, (accessed 18 April 2022)

[24] Builders Safety, 'Method Statement for the control of Dust on Construction Sites', *Builders Safety,* 2014, https://buildersafety.org/method-statement-for-the-control-of-dust-on-construction-sites/, (accessed 18 April 2022) , United States Environmental Protection Agency, 'Managing Stormwater and Dust at Demolition Sites', *United States Environmental Protection Agency,* 2022, https://www.epa.gov/large-scale-residential-demolition/managing-stormwater-and-dust-demolition-sites, (accessed 18 April 2022)

Civil Construction Resources

- Sustainable Minds- A catalog of Environmental Product Declarations (EPDs).
- E3C Tool- Compares emissions of materials and plans to other projects of similar scopes.
- Asphalt Carbon Calculator- Measures emissions of asphalt carbon usage.
- Built Structures Carbon Measurement and Assessment: Provides carbon measurements for entirety of building life.
- ETool-A tool that provides scientifically rigorous measurements across water usage, emissions, cost, energy, land use, and ozone depletion.
- BRE Full Suite Consultation- BRE provides energy calculations, GHG forecasting, water usage information, and assistance in creating sustainable construction plans from the design stage to future refurbishing plans.
- Whole Building Design Guide (WBDG) Cast-in-Place Concrete Specification- A guidance document with sample specification language indicating best practices for specifications of cast-in-place concrete for various projects.
- Whole Building Design Guide (WBDG) Precast Concrete Specification- A guidance document with sample specification language indicating best practices for specifications of precast concrete procurement for various projects.
- Whole Building Design Guide (WBDG) Structural Steel Specification- A guidance document with sample specification language indicating best practices for specifications of steel procurement for various projects.
- Whole Building Design Guide (WBDG) Common Metals Sustainable Specifications- A guidance document with sample specification language indicating best practices for specifications of common metals procurement for various projects.
- United States Bureau of Reclamation Guide to Concrete Repair- A comprehensive list of concrete repair techniques, associated benefits and risks, and regional specifications.

Transmission and Distribution Overview

Transmission and Distribution (T&D) services are vital in the delivery of electric utilities to consumers. While core T&D infrastructure is constantly being built and maintained, there are concerns over the need for new investment to meet growing demand, and the limited ability of T&D systems to accommodate growing renewable-energy sources and electrification efforts. This modernization is already happening outside North America, where in China, India, and across Europe there is growing investment in high-power, renewable-compatible transmission and distributions (T&D) systems.[25][26] North American T&D infrastructure is likely to see similar investment to support the growth of sustainable energy, the protection of current electrical infrastructure, and the ongoing function of its grids. The best practices in this space involve upgrading the equipment itself (transformers, storage, etc.), as well as the measurement and control technologies that enable precise, efficient use of energy throughout the grid. If implemented, these best practices will allow North American electric utilities infrastructure to stand alongside the best in the world.

Successful Transmission and Distribution Practice Case Studies:

Southern California Edison utilized Ampjack America Ltd.'s tower raising service to undertake a 15-foot raise of an existing 220-kV single-circuit tangent tower with bundled conductors. With a small team (thirteen-person crew, four traffic controllers, two helicopter crew members, and a three-person scaffolding team,) and use of lightweight machinery, all equipment and personnel were able to be airlifted onto the working site, minimizing surface damage to surrounding area. The tower raise took a total of six days to complete, with three days being needed once all the Ampjack equipment was on site and wire tension mitigation was completed. (Source: TDWorld.Com "Ampjack America Ltd Completes Tower Raise for Southern California Edison" September 2020. Learn more here.)

[25] L. Ding, 'China Advancing Plan for $17 Billion Power Grid Equipment Giant', *Bloomberg,* 2021, https://www.bloomberg.com/news/articles/2021-08-12/china-advancing-plan-for-17-billion-power-grid-equipment-giant, (accessed 23 May 2022)

[26] T&D World, 'GE to Modernize India's Transmission Grid With New Technology', *T&D World,* 2019, https://www.tdworld.com/grid-innovations/article/20972370/ge-to-modernize-indias-transmission-grid-with-new-technology, (accessed 23 May 2022)

Service Category	Additional Transmission and Distribution Specific Practices
Advanced Equipment and Components	Advanced equipment and components include technologies for improving and controlling power flows, enabling greater efficiency in long-distance transmission, storage of electrical energy (to be dispatched into the grid as needed), and grid operation. Advanced electronic equipment is also used for smart metering and control in the distribution networks. This includes: • Power Electronics • Innovations in energy storage - Transmission systems require large-scale storage capacity with high power ratings (on the order of hundreds of megawatts) and long discharge times (hours to days). • Distribution Transformers - Improved materials used to form the transformer's core can reduce the losses.
Measurements, Communications, and Controls	A modern electric T&D system will need measurement, communications, and control technologies to gather real-time data on the state of the grid, communicate those data, and process them to enhance system controllability. Technologies Include: • Sensing and Measurements - Existing customer billing meters could be replaced with microprocessor-based meters which could provide the customer with new buying options such as time-of-day pricing and increase end-user efficiency.

Transmission and Distribution Resources

- Ampjack Tower Raising Services- A service that allows utilities to raise towers without taking a power outage. Ampjack services utilize low footprint, small team, and small machinery processes to reduce costs and emissions.
- Electricity Metering with Low-Cost Microcontrollers- An article discussing the application and implementation of microcontroller-based electricity meters.
- Global Electronics Council EPEAT- A resource for searching for sustainable electronics in various industries.

Electrical Construction Overview

Electrical construction is a necessary element of maintaining, building, and expanding electric utilities infrastructure. Similar to the other areas of construction covered in this report, electrical construction can be energy intensive and destructive if not approached with sustainability in mind and the use of industry best practices. In addition to general practices, modern electrical construction should consider the sustainability of the materials used to build new transmission lines, maintain the old transmission lines, and connect electric substations. Sustainability should be considered in terms of carbon footprint of the material but also the lifespan and ultimate use of the material. Rather than repouring traditional concrete or replacing wires traditionally, there are options that provide longer lifespan for the project, contain less embodied carbon (the carbon required to make, ship, and implement an item), and are more suited to modern expectations about energy sustainability (renewables, reducing inefficiencies, etc.). Implementing these best practices can help reduce impacts on the environment.

Successful Electrical Construction Practice Case Studies:

Duke Energy, an electric utility capable of producing 51,000 megawatts through regulated utilities, partnered with Blackwood Solutions to decrease wood waste sent to the landfill. By recycling or repurposing 90% of their old power poles, pallets, reels, and other wood, from more than 200 operations centers and powerplants, Duke Energy prevented more than 22,000 tons of wood waste from going to the landfill. Since the inception of these recycling practices and the partnership with Blackwood Solutions, Duke Energy has increased the amount of recycled or repurposed waste from 52% in 2008 to 80% in 2021. (Source: csrwire.com “How Duke Energy Finds New Life for Old Power Poles” February 2022. Learn more here.)

Fiber-reinforced polymer (FRP) composites are a popular construction material made of high strength continuous fibers like glass, carbon, or steel wires embedded in a polymer matrix. FRP composites can be easily used to strengthen existing structures and can be manufactured on site, leading to FRP reinforcement gaining popularity among construction site designers compared to more conventional strengthening techniques. FRP applications are typically appropriate for flexural strengthening, shear strengthening, and column confinement and ductility improvement. Given the polymer wrap surrounding the continuous fibers, FRP composites are resistant to rust, general corrosion, and environmental wear in all seasons and geographies. In addition to the strength of these composites, they also boast reduced costs of labor, minimized use of additional equipment, and downtime during installation. (Source: Structure Magazine "Strengthening of Concrete Structures Using FRP Composites" June 2015, learn more here.)

Service Category	Additional Electrical Construction Specific Practices
Repair, Reuse, Upgrade, or Redesign	**Repair substation concrete footers** Repairing concrete footers using epoxy resin and wrapping in carbon fiber instead of destroying and repouring, eliminates the amount of concrete required, extends the asset's life, and leads to cost savings of ~1k per footer.[27] If concrete must be repoured, sustainable alternatives should be considered as per the section above on Civil Construction. **Reuse of waste materials** Reusing materials from demolition and decommission projects can significantly reduce emission levels. Wood poles from electrical infrastructure can be reused in new projects, re-milled for further use.[28] Local farmers and foresters can often use decommissioned wood poles and timber mats for fencing and other permitted uses.[29] **Repair electrical line equipment** Repairing or refurbishing electrical line equipment such as transformers can reduce emission levels, maintain existing spatial footprint, promote safety to personnel and equipment, and increase reliability throughout the electric system.[30] **Reducing spatial footprint of substation** Reducing and minimizing the spatial footprint of substations reduces the impact on the environment and leaves space for maintaining the natural biodiversity. Additionally, it is best practice to consider enhancing functional habitats around the site as outlined on page 146 of this ISI guidance manual.[31]

[27] PG&E – EUISSCA 2019 Cost Savings Database
[28] C. Clausen, 'Reuse and Disposal', *Forest Products Society,* 2011, https://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.467.1905&rep=rep1&type=pdf, (accessed 18 April 2022)
[29] FirstEnergy Corp, 'Mon Power Launches Utility Pole Recycling Program', *PR Newswire,* 2021, https://www.prnewswire.com/news-releases/mon-power-launches-utility-pole-recycling-program-301376217.html, (accessed 24 May 2022)
[30] A. Ober, 'Replacing Aging Transformers with Customized Drop-in Units', *Electric Energy Online,* 2017, https://electricenergyonline.com/energy/magazine/1066/article/Replacing-Aging-Transformers-with-Customized-Drop-in-Units.htm, (accessed 19 April 2022)
[31] Institute for Sustainable Infrastructure, 'Envision Sustainable Infrastructure Framework', *The Institute for Sustainable Infrastructure, 2018, https://isi-projects-documents.s3.amazonaws.com/prod/files/static/31/k9ohYfnYjZkVkLTZ/Envision%20Guidance%20Manual%20%28v3%29.pdf, (*accessed 18 April 2022*).*

Wire Replacement

Improved wire technology

There is ongoing and rapidly developing research on wire technologies that can reduce line losses and carry additional load. Investigating these may create additional design options or at least should be considered as future potential use cases for the infrastructure projects.

Non-wire alternatives

Non-wires alternatives use distributed energy resources and microgrids to defer or replace the installation of more traditional wires and poles infrastructure. From an environmental perspective, non-wires alternatives may cut carbon emissions through the use of renewable energy, can reduce line losses, boost efficiency, and shift loads. Furthermore, distributed energy resources lead to indirect carbon savings by providing flexibility, which can reduce curtailment.[32]

Soil Impacts & Considerations

Soil impacts such as compaction, contamination, and erosion are associated with electrical construction and at minimum the following should be considered:

- The use of temporary access roads to minimize the impact on wetlands, agricultural fields, cultural resources, underground pipelines, and lawns.
- Aggressive spill prevention including daily inspections and a well-prepared spill response plan.
- Implementation of erosion and sediment controls around disturbed areas.
- Collection of soil samples on topography may cause pollution of water source during sample collection.
- Ensure proper drainage, proper soil type to ensure minimum tower base footing due to contour, tower alignment, distance from trees, and sensitive areas.
- Restore the excess soil through ramming and ensuring the loose soil and construction material is removed from pole base so that it does not interfere with drainage of the area. Additionally, ensure lines do not cross the agricultural fields in manner that adversely affects the farmers.
- Long term impacts from potential equipment leaks
- Immediate impacts from cutting and filling that can lead to soil erosion, runoff, potential water logging, etc.
- Loss of agricultural land, and interference with other utilities and traffic may happen during erection process.

[32] L. Cohn, 'What are non-wires alternatives?' *Microgrid Knowledge,* 2019, https://microgridknowledge.com/non-wires-alternatives-are/, (accessed 18 April 2022)

Transformer Oil Recycling

Amongst other end of life considerations, transformer oil and material recycling can reduce the total lifetime impact of the project and system.

High quality recycling processes

It is essential that the recycling processes (usually proprietary based on the company) are producing high quality transformer oil by removing the maximal amount of moisture and contaminants. This ensures the product will last as long as possible.[33]

Proper waste disposal

The recycling process extracts impurities from the transformer oil which could be harmful to humans and the environment. The recycling facility in question must dispose of these contaminants safely in landfill, ensuring they are non-toxic.[34]

Electrical Construction Resources

- Design and Construction of Sustainable Substations- An academic white paper that highlights substation-specific practices to consider what is in line with existing LEED rating system.
- PG&E Electrical Substation Beautification and Construction- An example of how PG&E designed and upgraded a San Francisco substation to contribute to the community by incorporating tables and seating into the substation structure.
- AFL Swage Substation Connectors- An introduction to compression technology called 'swaging' that enables installation of aluminum bus accessories without welding.
- Blackwood Solutions Recycling and Biochar Services - Blackwood Solutions supports electric utilities in a variety of services and offers expertise in comprehensive wood, pallet, pole, and concrete recycling as well as biochar and carbonization services.

[33] Emerald Transformer, 'Refurbish, Remanufacture, and Recycle Your Way to a Better Transformer ROI', *Emerald Transformer,* 2022, http://www.emeraldtransformer.com/wp-content/uploads/2018/02/white-paper-Maximizing-Transformer-ROI-final.pdf, (accessed 18 April 2022)

[34] Hering-VPT, 'Transformer Oil Regeneration and Reclamation', *Hering-VPT,* 2020, https://www.hering-vpt.com/article/transformer-oil-regeneration-and-reclamation/, (accessed 18 April 2022)

Pipe Replacement

Pipe replacement carries with it some inherent challenges and impacts that require special consideration and action. Key amongst those are the life cycle impacts of the entire system including material production impacts, installation (e.g., excavation), leaching, durability, and potential leakage (e.g., gas emissions). Some types of pipes have higher environmental impact than others (based on lifespan, chemical leaching, recyclability, etc.). Selecting high quality, non-reactive, recyclable material (I.e., steel) can reduce that impact.[35]

Successful Pipe Replacement Practice Case Studies:

The New Madrid Power Plant provides affordable and reliable power to members of the Associated Electric Cooperative with two 600-mW coal fired plants. The water-cooling system began showing signs of wear after decades of use. Operators of the plant were looking for a replacement piping system that can be easily maintained and reliable for years to come. Using grooved mechanical couplings that could be prefabricated before arrival to the site allowed for a streamlined workflow that required 75% less time than a welded or flanged piping system. Additionally, the ease of installing grooved mechanical pipe joining allowed The New Madrid Power Plant to save nearly 50% in labor costs. (Source: Powermag.com "Critical Juncture: Collaboration Fast-Tracks New Madrid Power Station Plant Upgrade" May 2021. Learn more here.)

Service Category	Additional Pipe Replacement Specific Practices
PVC Piping	Where appropriate, the use of PVC piping can be a good alternative pipe material that is environmentally and economically competitive.[36] PVC provides ease of use, a low break rate, corrosion resistance, and long-lasting performance. The detailed Life Cycle Assessment (LCA) study which finds that PVC pipe has the lowest carbon footprint, along with other benefits of using PVC pipe, compared to other pipe products can be found in this LCA report.

[35] S. L Bosiljevac, 'Selecting Sustainable Pipe Materials', *The Military Engineer,* 2018, https://ccmis.psc.gov/Jarmanator/engineer/documents/PHEP-TME_No.715_SelectingSustainablePipeMaterials.pdf, (accessed 18 April 2022)

[36] Sustainable Solutions Corporation, 'Life Cycle Assessment of PVC Water and Sewer Pipe and Comparative Sustainability Analysis of Pipe Materials', *Uni-bell,* 2017, https://www.uni-bell.org/files/Reports/Life_Cycle_Assessment_of_PVC_Water_and_Sewer_Pipe_and_Comparative_Sustainability_Analysis_of_Pipe_Materials.pdf, (accessed 18 April 2022)

Grooved Mechanical Pipe Joining	The use of grooved mechanical pipe joining over welding can greatly reduce energy usage and thus lower carbon footprint. The simple design allows for the use of more efficient tools, such as impact guns when compared to welding equipment, an example of arc welding a 4" Schedule 40 carbon steel joint consumes 5KW of electrical energy with approximately 25% waste during the installation process. Mechanical pipe joining also allows for ease of modification and future expansion without having to rework the material in permanently welded pipes thus eliminating waste and stockpile materials for welding. Additionally, there is a reduction in the consumables, which accounts for roughly 9% of the cost of welding.[37]

Pipe Replacement Resources

- Victaulic- Grooved Mechanical Pipe Joining services for global infrastructure projects
- Sustainable Approach for The Replacement of Water Mains- An academic article detailing different sustainable strategies, technologies, and processes for pipe replacement and refurbishment.
- Getting Better Than "D+" on Our Pipe Infrastructure- A short article highlighting the importance of utilizing the best materials and practices in pipe laying and repair.

[37] S. Hughes, 'More Sustainable Construction- How to Use Less Resources in Pipe Installation', *BuildingTalk,* 2019, https://www.buildingtalk.com/blog-entry/guest-article-more-sustainable-construction-how-to-use-less-resources-in-pipe-installation/, (accessed 18 April 2022)

Vegetation Management Overview

One of the common outcomes of electric utilities construction and maintenance is the removal of vegetation at the project site, whether to clear space for a substation or remove trees that pose a hazard to utilities infrastructure. Removing this vegetation may damage the local ecosystem, decrease the visual appeal and utility of the area, and cause otherwise productive carbon sinks to be landfilled or burned. The best practices in this area aim to minimize vegetation loss or create replacement ecosystem features that also provide utility to the project (minimizing erosion, minimizing cost by reducing number of trees to be felled, etc.) or the community (e.g., trail networks). Overall vegetation management, while necessary on many utilities project sites, can be done in a way that minimizes impacts, promotes sustainability, and supports biodiversity.

Successful Vegetation Management Practice Case Studies:

A Fortune 500 power utility company with 50,000 miles of distribution lines was seeking an innovative solution to vegetation management. Through a partnership with AiDash, the power utility company was able to see satellite imagery of their entire distribution network and examine structures and vegetation at a 50-centimeter resolution. These detailed images paired with artificial intelligence recognition of species, knowledge of growth rate, and weather patterns enabled the power utility to create a 3–5-year trim plan for the entire distribution network with an accuracy rate of 85%. By utilizing this intelligent solution, the utility company was able to improve reliability by 15% and reduce the annual budget for vegetation management by 20%. (Source: UP42 "Satellite-Powered Utility Vegetation Management with AiDash," April 2021. Learn more here.)

Service Category	Additional Vegetation Management Specific Practices
Vegetation & wood recycling	Where vegetation needs to be removed from a site consider alternative uses (e.g., trail-bed, mulch, feed) over landfilling. Trees, brush, and other clean wood debris can be converted into a high-quality biochar that retains the carbon capture benefits in a stable material.[38]

[38] CSR Wire, 'How Duke Energy Finds New Life for Old Power Poles', *CSR Wire,* 2022, https://www.csrwire.com/press_releases/737416-how-duke-energy-finds-new-life-old-power-poles, (accessed 18 April 2022)

Dual use solar	Consider opportunities for dual use scenarios where the infrastructure integrates with the natural environment rather than replacing it. For example, Enel runs a successful Dual Use Solar program. Land occupied by a solar energy plant, or solar farm, can provide additional land value beyond renewable energy generation, whether that be agriculture or the provision of ecological services, such as pollinator habitat or watershed protection. This offers an opportunity for the land to produce additional economic, societal, and environmental benefits, while reducing the costs of development and operational management.[39]
Artificial Intelligence and Automated Drone Assessment	Taking advantage of unmanned aerial vehicles (UAVs) to monitor potential vegetation threats and conditions of infrastructure can be a cost, time, and emission saving practice for electric utilities during the design, build, and maintenance phase of utility projects. A French utility company partnered with a drone assessment company to examine hundreds of miles of powerlines and identify areas with high risk of vegetation-based outages based on analysis of weather patterns, tree health, and forest health data. This offers an opportunity for utilities to spend less time on identifying areas of risk and reallocate resources to proactive vegetation management to limit risks of outages and other damages.[40]

Vegetation Management Resources

- Vegetation Management: Key Levers for Cost Savings- An Accenture developed site providing strategies and recommendations for cost cutting vegetation management practices.
- Sharper Shape- A blend of remote satellite imagery, AI drone inspection, and customized prioritization tools make this resource helpful in preventing vegetation related damages and outages.
- Blackwood Solutions Brush & Vegetation Management- Blackwood Solutions supports electric utilities in a variety of services and offers expertise in comprehensive vegetation management services.

Additional Resources - General Guidance Documents

[39] Enel Green Power, 'Toward Sustainable Solar Energy', *Enel Green Power,* 2021, https://www.enelgreenpower.com/content/dam/enel-egp/documenti/solare/toward-sustainable-solar-energy.pdf, (accessed 18 April 2022)

[40] G. Zeiss, 'Identifying areas of high risk vegetation encroachment on power lines from satellite imagery', *Between the Poles,* 2021,https://geospatial.blogs.com/geospatial/vegetation-management-for-utilities/, (accessed 18 April 2022)

Electric Utility Industry Sustainable Supply Chain Alliance

"The Alliance is an organization of utilities and suppliers working together to advance sustainability best practices in utility supply chain activities and supplier networks."

Institute For Sustainable Infrastructure - Envision

"Envision provides a consistent, consensus-based framework for assessing sustainability, resiliency, and equity in civil infrastructure. Fundamentally, Envision is about supporting higher performance through better choices in infrastructure development. The framework provides a flexible system of criteria and performance objectives to aid decision makers and help project teams identify sustainable, resilient, and equitable approaches during the planning, design, and construction that will continue throughout the project's operations, maintenance, and end-of-life phases. Envision recognizes resource constraints and the diversity of mandates, schedules, budget cycles, and funding sources."

General Services Administration – Sustainable Design Principles

"The Design Excellence Program is the center for GSA's advocacy of quality in the federal built environment. It establishes nationwide policies and procedures for selecting the finest and most appropriate architects and integrated design teams for GSA commissions. The program also implements rigorous assessment processes to ensure enduring value in that work. Operating under the Design Excellence umbrella, the First Impressions, Interior Design, Lease Construction, Urban Development, and Sustainability initiatives review projects for superior performance in their respective disciplines. Equally notable, the Design Excellence Program manages national peers, distinguished private-sector design professionals appointed by the Commissioner of the Public Buildings Service to advise procurement and to critique concept designs under development. Exhibits and other events, publications, and videos underwritten by the program document the Design Excellence process as well as its most significant results: holistic environments that add contemporary form and meaning to America's rich legacy of public architecture."

Supply Chain Sustainability School

"The School is completely FREE and allows you to access training in 5 different areas Sustainability, Offsite, BIM, Lean and Management and offers you the opportunity to attend our training and networking events, gain CPD points, complete a self-assessment and get a bespoke action plan, complete e-learning modules and various training resources.

The School is an award-winning industry wide collaboration, led by our Partners and Members whose Vision for the School is to be "A world class collaboration to enable a sustainable built environment"."

US Green Building Council LEED Program

"LEED provides a framework for healthy, efficient, carbon and cost-saving green buildings. LEED certification is a globally recognized symbol of sustainability achievement and leadership."

USACE Civil Works Sustainable Infrastructure Practices Guidebook

"*US Army Corp of Engineers Civil Works Sustainable Infrastructure Practices Guidebook highlights how practices that reflect sustainability offer significant benefits to USACE and its partners, including improved quality and performance, resource efficiency, and environmental protection*."

Guiding Principles for Sustainable Federal Buildings

"The guidance document outlines six key sustainability considerations that inform development of federal buildings. Most recently updated in 2020, this document highlights standards and practices that the federal government are meeting and implementing with new construction and building renovations."

Additional Resources - Tools and Calculators

Building Transparency EC3 Tool

"EC3 Tool allows for companies to analyze their supply of construction materials and their carbon footprint as well as compare plans and buildings to other similar projects."

Built Structures Carbon Measurement and Assessment

"UK Based register for access tool that helps provide carbon measurements for entirety of building life, accessible to United States based corporations."

eTool Global

"A tool that provides scientifically rigorous measurements across water usage, emissions, cost, energy, land use, and ozone depletion."

BRE Full Suite Consultation

"BRE provides energy calculations, GHG forecasting, water usage information, and assistance in creating sustainable strategies, supply chains, and construction plans from the design stage to future refurbishing plans."

Asphalt Carbon Calculator

"A free-to-use tool that calculates expected carbon emissions based on mixes typically used in highway, parking lot, or foundational asphalt and concrete."

Additional Resources - Sample Specification Language

Hammerson's Sustainability Questionnaire for Contractors

"This document is an example of how large companies can gain an understanding of their contractor's commitment to sustainability and capacity to deliver on internal sustainable goals, as well as provide insight to the company regarding where more sustainability expertise may be needed."

Neste Responsible Sourcing Commitment

"Engineering services firm, Neste, exhibits a commitment to sustainability and responsible supplier sourcing by sharing this document with potential suppliers. This form of transparent communication with suppliers could be useful in practice everywhere to ensure chosen suppliers, contractors, and outsourced labor is in accordance with internal policies, goals, and commitments."

Aston University Sustainable Construction Specification

"An example document of the myriad of sustainability specifications required in construction process of new university building. Includes strategies and suggestions to incorporate at every step of the process, goal setting practices, and also mentions tools to measure against those goals."

Whole Building Design Guide (WBDG) Federal Green Construction Guide for Specifiers

"A comprehensive guide for the procurement of green building materials and construction services with specification language for various materials and services."

Whole Building Design Guide (WBDG) Procurement and Contracting RFP Specifications

"A guidance document with sample specification language intended to be inserted into project specifications where applicable. The WBDG partners with the EPA and the Federal Environmental Executive to develop materials that help agencies meet project-specific environmental goals and mandates."

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