Appendices

GSA Green Building Advisory Committee Advice Letter

Federal Building Decarbonization: Integrated Electrification Solutions

Appendix A

Prioritization of Electrification Projects

Decarbonizing the large and diverse GSA portfolio requires a deliberate strategy for project identification and prioritization to achieve climate goals in accordance with federal budgets and with maximum cost-effectiveness. Prioritization also informs programmatic and delivery mechanisms. Key prioritization factors include, but are not limited to:

- **Normalized and total energy consumption** – Normalized energy consumption, often measured in kBtu/sqft/yr, allows facilities to be compared to each other and to benchmarks, identifying lower performers that may be ripe for significant and cost-effective savings. Total energy consumption is integral to tracking portfolio-level progress. It is also a key factor in determining where and how to prioritize planning and project delivery efforts for maximum impact on a timeline. Facilities with high energy consumption may warrant higher levels of scrutiny, customization and innovation. Facilities with lower absolute energy consumption will likely require bulk analysis and delivery approaches to achieve decarbonization and/or receive lower priority status. These factors and several others have been previously described in the November 2022 GBAC Advice Letter, *Recommendations for Advancing Greenhouse Gas Reductions in Existing Federal Buildings*.
- **Equipment Age** – Deep decarbonization is often most financially viable at moments in an asset lifecycle where there is already planned investment or other relevant activity, where sunk costs and/or avoided capital costs fundamentally change the cost effectiveness calculation. Equipment end-of-life is perhaps the most obvious and prevalent trigger and can be a major, gradual forcing function for electrification across the portfolio. In many cases, enabling work will be required for electrical infrastructure, distribution systems or energy efficiency in the building. Waiting until equipment requires emergency replacement can make electrification challenging or prohibitive. Therefore, ideally electrification planning and execution starts before equipment end-of-life. Varying equipment lifespans within a single building may point toward phasing strategies to achieve zero emissions over time. Scanning the portfolio for equipment approaching replacement will be a key prioritization factor.
- **Other investment triggers** – Equipment replacement is not the only asset investment trigger. Other triggers include: new space fit-outs, refreshes or reconfigurations; space consolidation; ventilation improvements; new space cooling; other HVAC improvements; code compliance updates; and building wall, glazing or roof maintenance.
- **Grid emissions factor** – While Executive Order 14057 will drive a shift to 24/7 carbon-free electricity across the federal portfolio, grid emissions can still be a factor in the interim. This includes consideration of both the general utility grid emissions factors as well as location-based progress toward procuring 24/7 carbon-free energy. *Marginal* grid emissions factors are often considered the most accurate

measure of emissions additionality from electrification but will be subject to change over the clean energy transition.

- **Climate zone** – A building's climate zone can be a factor for projecting operational heat pump efficiency and economics of electrification, including any considerations for supplementary heat equipment in extreme weather. Heat pumps generally perform at higher efficiency in more temperate climates, though in recent years specific cold-climate heat pumps in some product categories are breaking through the operational cost barrier even in extreme cold climates and can operate down to heating season design temperatures in most U.S. climate zones.
- **Energy prices** – Energy prices are another key factor in electrification economics. Particularly the "spark spread" metric for evaluating power plant profitability and the comparative ratio of electricity and fossilfuel heating costs will determine the impact on operational energy costs. Such comparisons can be very nuanced including: utility rate classes; demand charges; distribution and other fixed charges; energy supplier options or renewable power purchase agreements; distributed renewable energy metering rules; electricity and fossil fuel price projections, volatility, and risk.
- **Electrical upgrade requirements** – Electrification may require electrical improvements at multiple levels: within the buildings electrical system; at the building's service or utility transformer; and at scale even upstream in the utility's distribution system. Electrification feasibility studies and project prioritization ideally takes these factors into account.
- **HVAC electrification compatibility** – Buildings with steam or high temperature hot water (180°F+) distribution systems today typically require conversions to be compatible with off-the-shelf heat pumps, which generally output lower supply temperatures. Facilities on district heat may have to convert the central plant (if GSA-owned), engage the district energy provider (if a third party) or transition to distributed heating systems at the building.
- **Regulations** – Local or state regulations may be a major driver of decarbonization, for example in the increasing number of jurisdictions with building performance standards. While GSA is not directly subject to state and local regulations, they may affect supply, cost, etc. of different energy sources and technologies.
- **Supply chain** – While GSA can be a partner and driver of supply chain and capacity development, the current status of local or regional supply chains and workforces may change the nature and speed of decarbonization efforts, particularly where work may be executed by small enterprises.
- **Planning and delivery approaches** – Decarbonization project planning and delivery approaches will differ depending on size, energy consumption, building typology and/or HVAC system types. Projects may be broadly categorized into two approaches:
    - **Custom / Semi-Custom** – Facilities with high absolute energy consumption *and* relatively complex systems can warrant individualized assessment, planning and delivery approaches. This may be a traditional design and delivery approach for individual buildings or could be a semi-customized approach to project planning across a set of buildings in the portfolio.
    - **Prescriptive** – Facilities with low absolute energy consumption *and/or* relatively simple systems will likely be addressed through prescriptive assessment, planning and delivery approaches.
- **Bulk purchasing** – Bulk purchasing or standardized specification of electrified equipment (e.g., heat pumps) can be a strong mechanism for supply chain development, cost compression, quality control and other benefits. Once established, these programs and standards can become factors for project prioritization and bundling.

- **Capital and financing approach** – Decarbonization project types can be planned and delivered with varying combinations of capital funding, O&M funds and/or third-party (ESPC) financing. The nuances of such funding and contracts, the types of contractors and the bundling of projects will be elements of portfolio transition planning and will likely become a practical factor in identifying and prioritizing projects.

Electrification Audits

Electrification or decarbonization audits support a holistic approach to reducing Scope 1 greenhouse gas emissions, while also reducing electric demand and Scope 2 greenhouse gas emissions.

- **Data Collection and Target Setting**
  - This step includes compiling building documentation and energy data. It is recommended that GSA also consider interviewing stakeholders to assess the current condition of systems, equipment, and facilities. Calculation of Scope 1 emissions and Scope 2 emissions is also recommended.
  - Building-level GHG emissions reduction targets should be set. Targets may be based on a building specific performance standard or may be stated as a blanket reduction for all buildings such as eliminating all on-site fossil fuels.
- **On-site Inspections**
  - This step includes conducting an existing equipment assessment by conducting surveys of building systems. Personnel should also determine electrical service capacity and take an inventory of all combustion equipment. There should also be an on-site renewable energy assessment and a categorization of the entire portfolio of facilities. The resulting categorization may list properties in a certain order of priority based on emissions output or ranked by a scoring strategy through empirical formula.
  - A detailed analysis of building substation capacity, as well as its distribution typology are key for early development. Electrical load analysis should include study of past metered data, recognizing demand reductions for existing buildings from such improvements as LED lighting and more efficient IT equipment.
  - This information will contribute to an initial assessment report.
- **Analysis and Reporting**
  - Analysis of the inspection and survey data may result in the organization setting emission reduction measures and determining a range of electrification options. These options should be included in a technical feasibility study which may include system monitoring, modification or system replacement options to move closer to the goal of electrification. The study should include an analysis of on-site renewable energy and low-emissions measure packages. The key deliverable should be an Emissions Reduction Audit report that will assist with determining future investments.
- **Selection and Implementation by Owner**
  - The Owner should evaluate the data included in the emissions reduction audit report and the scenarios included in the technical feasibility study to help determine the best strategy for achieving the organization's electrification goals. The reports and scenarios identified and selected may be gathered into an Emissions Reduction Plan.
  - Explore the use of calibrated digital twins to investigate the impacts of a collection of buildings and their local utility grid. Consider use of tools

developed by national research labs, such as NREL's URBANopt analytics platform, which was used for a study of Ithaca, NY. (Initial results showed a peak demand increase by a factor of 2 to 3 if full electrification with air source heat pump technologies was in place, prompting the local utility to prepare for grid upgrades.)

Design Considerations

- **General**
    - Grid emissions factor: buildings with electrical supply from a utility grid with a high GHG emissions factor (>200 kg CO2e per MMBTU) and without a local or state renewable portfolio standard should consider a phased roll-down of use of fossil fuel, to minimize abandonment of existing equipment with significant remaining useful life.
    - Operations and maintenance: as buildings utilize a diverse blend of heating equipment, including electric boilers and heat pumps, the required O&M knowledge will need to evolve. Invest in updated training programs and bring in specialists familiar with all-electric technology and advanced building energy management.
    - Design conditions: the selection of appropriate heating equipment is dependent on factors including climate assumptions, electrical capacity, performance curves for a range of heating technologies, and terminal devices, such as fin-tube heating and reheat coils. The P100 should evolve to consider these factors, including further descriptions of the use of low temperature hot water systems (<140F) and low intensity heating systems, such as radiant floors or ceilings.
    - Electric resistance heating: the use of these sources should be limited, but may be considered as a component of a hybrid solution. In cold climates, hourly load profile analysis may show the benefit of having a higher intensity electric resistance source for covering peak load conditions, such as during morning warm-up or prolonged cold climate conditions where air-source heat pump technology declines in performance (<20F).
    - Modelling: load shifting to times of less congestion on the grid is a key component of an all-electric HVAC strategy. The P100 should evolve to include schematic design phase modelling requirements for hourly cooling and heating load profiling, as well as hourly electric demand calculations.
    - Refrigerant selection: many heat pumps on the market still utilize HFC refrigerants with a relatively high global warming potential (e.g. R-410a). GSA should continue to monitor market availability for refrigerant alternates for key equipment classes, such as variable refrigerant flow, packaged rooftop units, and water-source heat pumps. Lifetime refrigerant leakage should be included in overall lifecycle emissions analysis.
- **Reasons to Employ a Whole System Approach**
    - It is easier to financially justify incorporating other important improvements rather than just replacement of failed equipment, such as EUI reduction through envelope upgrades, daylight harvesting and efficient mechanical systems. GSA examples:
        - Ronald Reagan Building – Energy efficiency first, then electrification. EUI reduced from 93.2 to 48.6; 14-year payback.
        - Denver Federal Center Building 48 – Envelope insulation, daylight harvesting, then efficient mechanical systems resulting in an EUI of 23 kBtu/sq. ft. and a 9-year payback.

    - GSA will typically get better long-term financial results with integrated holistic solutions.
    - The City of Denver includes the social cost of carbon in its cost estimates.
    - 40% of the benefits from federal clean energy investments are required to flow to disadvantaged communities per the White House's Justice 40 initiative from EO 14008.
- **Reasons to Use the Current Component Approach**
    - The OMB currently budgets for as-needed replacement on an annual basis.
    - Future technological advancements support a more phased approach.
    - In cases where replacement requirements are small, a whole systems approach may be too costly.
    - Even when economically more beneficial, up-front costs are higher.

Building Enclosure

- Adapt the P100 to link BA54, BA55, and BA64 (budget categories for different levels of repair and alteration) scope to building envelope requirements more directly.
- In the event of a power outage, a high performance building envelope reduces temperature drift and enhances overall resiliency and occupant comfort.
- Quantifying existing building enclosure performance and condition will support electrification phasing projects, with a focus on demand reduction prior to systems replacement. The goal is to right-size mechanical and electrical equipment, leading to financial savings of capital expenditures (CapEx) and operating expenditures (OpEx) in the long term.
- BA80 (Reimbursable Work Authorization) projects should require envelope evaluation, including a focus on the following components: insulation and uniformity, air sealing, fenestration and glazing, and window and door assemblies. Align performance targets with P100 Chapter 3.2 BUILDING ENCLOSURE PERFORMANCE ATTRIBUTES.
- Consider development of a streamlined approach for 179D tax deduction transfer to design consultants to support development of integrated enclosure solutions with robust financial and energy analysis.
- The P100 does not extensively address project phasing. Consider adding rationale for phasing decisions in Chapter 1.3.3 ENERGY AND SUSTAINABLE DESIGN.

Appendix B: Estimating Integrated Building and Portfolio Electrification Impacts

Integrated Electrification Analysis

Stand-alone electrification projects, while reducing energy use and Scope 1 direct emissions, have a number of challenges which can be largely addressed through an integrated, whole building retrofit approach. The following recommendations are supported by a Building Decarbonization Prioritization Methodology analysis of 13 natural-gas heated GSA office buildings using data provided by GSA's Public Buildings Service for the GBAC Federal Building Decarbonization Task Group's second Advice Letter (November 2022).

Challenges with stand-alone electrification projects at a building level

- Stand-alone electrification projects will often have a poor return on investment. This is due to a combination of an expensive installation and, in some cases, an increase in energy operating expenses (based on local electricity to gas prices). Of the 13 GSA office buildings analyzed using the Prioritization Methodology, none have a positive net present value on a stand-alone basis and only two resulted in an estimated cost reduction.
- Even incorporating a $250 social cost of carbon value doesn't result in a positive net present value for any of the 13 buildings.
- The average electricity usage increase was 17.3%, which could result in additional investment requirements for electrical infrastructure capacity in addition to the heat pump and other system investments.

Integrated electrification, energy efficiency and renewables at a building and portfolio level

- Incorporating energy efficiency and on-site renewables, using the guidance from the GBAC Building Decarbonization Prioritization Methodology in the November 2022 Advice Letter, results in three of the projects having a positive net present value and all projects having an improved return on investment.
- All projects except one (which has a high electricity price and is already highly efficient) had an energy cost reduction, averaging 18.8% annually.
- The average electricity usage at a project level dropped by 6.7%, with efficiency and on-site renewables more than offsetting the increased use of electricity for heating.
- Incorporating a $100 social cost of carbon value results in half of the stand-alone projects having a positive net present value and the entire portfolio having a positive overall net present value.

Incorporating additional health benefits along with the social cost of carbon in cost effectiveness analysis.

- A new Health Co-Benefits of the Built Environment (COBE) public-domain tool, from the Harvard T.F. Chan School of Public Health was used to estimate the climate (GHGs) and health-related ($PM_{2.5}$ and precursors) costs of office building emissions

for a single GSA building, with significant natural gas Scope 1 emissions located in a high carbon emissions grid.
- The estimated public health costs savings from an integrated energy efficiency retrofit, with electrification and on-site renewable energy was over $500,000 per year, with most of the benefit coming from air pollution reduction.
- Incorporating these climate and health cost savings into the net present value calculation reduced the project payback from 30.6 years to 10.8 years for the $8,353,000 investment - with a resulting net present value of over $3,100,000.

Incorporating environmental and health benefits in electrification project life cycle cost analysis.

- OMB CIRCULAR NO. A-94 - Guidelines and Discount Rates for Benefit-Cost Analysis of Federal Programs includes the following language which should be reviewed with OMB for guidance prior to application incorporating environmental and health benefits in life cycle cost analysis of GSA electrification projects:
    - A program is cost-effective if, on the basis of lifecycle cost analysis of competing alternatives, it is determined to have the lowest costs expressed in present value terms for a given amount of benefits. Both monetized and unmonetized costs should be considered to the extent feasible.
    - When analysts expect that the inclusion of nonmonetized costs or benefits are large enough to change the conclusion of the analysis, a threshold or break-even analysis should be considered for inclusion in the benefit-cost analysis.
    - Threshold or break-even analysis asks what magnitude unmonetized benefits and costs would need to have for the project or program to yield positive discounted net benefits, or alternative to overtake another in terms of discounted net benefits.
    - If benefits or costs that occur several decades or more in the future are important to a project, such as enhancing climate mitigation and adaptation or promoting other environmental benefits, agencies can consider using declining discount rates.

Appendix C: Summaries of Presentations to the Federal Building Decarbonization Task Group

- DOE Energy Justice
    - 4 most relevant priorities to electrification
        - Decreasing environmental exposure and burden for disadvantaged communities;
        - Increasing clean energy enterprise creation and contracting in disadvantaged communities;
        - Increasing clean energy jobs pipeline for individuals from disadvantaged communities;
        - Increasing energy democracy in disadvantaged communities.
- City of Denver
    - For existing buildings, mandatory replacement of certain fossil fuel fired equipment with heat pumps will be required by 2025 (air conditioning/ condensing units, gas furnaces, gas hot water heaters) and for other equipment by 2027 (Packaged Terminal Air Conditioners (PTACs), boilers, central hot water systems) where cost-effective. Cost estimates can include the social cost of carbon.
    - For its own municipal buildings, Denver is focusing on identifying when building equipment is scheduled for replacement in order to stage electrification investments as part of the capital planning process. The city is starting out piloting the replacement of rooftop HVAC units and water heaters. The agency will focus on the more challenging cases of replacement of boilers and the central system over the longer term, leaving time for needed technological and market advancements.
- Google
    - Google is prioritizing its buildings for decarbonization based on a range of factors including whether buildings are leased or owned, building size, climate zone and their electrification score, or percentage of building energy use that is electric. Preliminary results show air source heat pumps to be the technology applicable to most of Google's buildings, with electrification costs most commonly in the $100-150 per square foot range. Costs were highest where buildings needed significant electrical capacity upgrades. Electrification also often requires additional building space dedicated to equipment.
- DOE Better Climate Challenge
    - DOE's Better Buildings Program provides guidance on a five-step emissions reduction plan (ERP) process:
        - 1. Establish inventory and scope of work
        - 2. Categorize portfolio
        - 3. Assess measures

        - 4. Develop scenarios
        - 5. Define emissions reduction plan
    - Resources: Greenhouse Gas Emission Reduction Planning Better Climate Challenge Framework and Greenhouse Gas Emissions Reduction Audit.
- DOE Building Technologies Office (BTO)
    - DOE has laid out several goals for development, evaluation and deployment of low-GWP refrigerants:
        - Short term: deploy alternative refrigerant systems with a GWP lower than 700.
        - Mid term: develop advanced systems that can handle GWP less than 150.
        - Long term: develop non-vapor compression systems with GWP less than 10.
    - DOE has also focused on packaged HVAC rooftop units (RTUs). RTUs provide ample opportunity for efficiency upgrades given that RTUs cool 60% of commercial space. To pursue this, DOE established a partnership to overcome technical and market barriers for RTU solutions, particularly air conditioning units. DOE put out a public proposal and several manufacturers competed against one another to design and build better units.
    - DOE has been exploring the efficacy and application of Cold Climate Heat Pumps (CCHP) that can maintain their capacity and efficiency at low ambient temperatures. DOE started a residential CCHP research program in 2009, expanding to include commercial heat pump research starting in 2012, with manufacturers participating in the CCHP Challenge currently testing units with the potential for commercialization in 2024.
- Institute for Market Transformation (IMT): Very High Efficiency (VHE) Commercial HVAC System
    - The optimized, high-performance approach to HVAC combines high-efficiency equipment with design best practices, including:
        - High efficiency heat/energy recovery ventilator (HRV/ERV)
        - High-performance heating and cooling
        - Ventilation fully separated from heating and cooling
        - Right-sized heating and cooling equipment
    - IMT has found that the efficiency of the heat recovery equipment is paramount to the optimization of the system. A 15% efficiency difference can reduce HVAC energy consumption by 50%.
    - When looking at a whole system renovation and optimization, there can be some challenges: separate capital and O&M budgets, separate chains of commands, capital expenditure (CapEx) planning being based on 1-for-1 equipment swaps (not whole systems), failure to capture reductions in operating costs, existing contractors/inertia, and making the business case

when tenants pay the utility bills can all interfere with the system optimization.

    - IMT provided multiple documented examples of installations where fossil fuel space heating was replaced with heat pumps and both electricity use and peak demand either remained the same or decreased.

- Denver Federal Center Building 48 Modernization Case Study
    - Will save nearly $6 million dollars annually by lease cost avoidance with return-on -investment (ROI) of less than 9 years;
    - Conducted a program development study listing prescriptive and performance requirements with different P-100 tier levels and developed a proposal.
    - The project team is proceeding with an all-electric design, with three 240 kW Electric Boilers. The water source heat pump (WSHP) system returns cool temperatures to the boiler (50-60F), allowing the boilers to operate at reduced loads and provide required BTUs at any time.
    - They are keeping the building under 400-amp service to limit electrical load.
- Buro Happold: Engineering All-Electric Buildings
    - The electrification study modelled and compared five local areas in diverse climate zones (and with diverse grid carbon emissions levels), four building sectors (residential, lab, office, higher education), and based on a combination of building envelope standards and HVAC and water heating technologies. All-electric buildings were found to outperform fossil fuel-powered buildings in lifetime greenhouse gas (GHG) emissions reductions in almost all cases and climate zones, and in energy efficiency across all instances.
    - The study also analyzed potential risks to the resilience of the electric grid associated with electrification. A key finding is that while building electricity demands are typically driven by cooling systems in summer, these load patterns may shift to winter in all-electric buildings. As a result, managers of electrified buildings will need to focus on reducing their peak heating loads in addition to employing overall demand management strategies. Many existing buildings also will require design changes (e.g., increased insulation) to reduce peak heating loads.
- GSA Blanket Purchase Agreements
    - BPAs are most beneficial for recurring and future purchase requirements. BPAs simplify recurring federal purchasing needs, with buyer's specific requirements in mind, taking advantage of quantity discounts, saving administrative time and paperwork.
    - Two additional advantages to a BPA is that it can be delegated to the customer agencies (the EVSE BPA was the first time PBS did so) and it can send a message to the marketplace as to federal purchasing priorities.
- GSA Green Proving Ground
    - Has received submissions from around 1000 vendors over the past 12 years, with about 100 technologies selected. A little over a quarter of the tested

technologies have delivered a result that would lead the agency or GSA to move to widespread deployment across the portfolio. GSA has had 700 projects using 23 proven GPG technologies and it's delivering about $18 million in annual savings to the agency.

  - Is benefitting from the $975 million allocated to GSA under the Inflation Reduction Act for “emerging and sustainable technologies,” which corresponds well with technologies approved by the GPG Program. This funding will help accelerate the process of GSA adopting these technologies. $30 million has been dedicated to the GPG program this year, a much greater funding level than it has received in the past. Whereas in recent years, the GPG evaluated around 4 technologies a year, this year it will be looking into 18 new technologies.

- New York State/NYSERDA Empire Building Challenge
  - Building owners need to take into account two baselines:
    - Technology Assessment (system failure, damage from an event, wasted heat, tenant loads, indoor air quality, etc.)
    - Real Estate/Building Assessment (asset conditions, recapitalization, capital cycle events, tenant turnover, etc.)
  - The Empire Building Challenge Program’s approach places emphasis on redirecting focus from electricity to heat, to stop wasting heat in buildings and reuse it. Buildings lose heat through a variety of processes. Holistic building decarbonization requires recovering and recycling wasted heat through various interventions:
    - Cooling produces heat - Capture the heat and apply it to other uses, like domestic hot water.
    - Heat goes down the drain - Extract heat from wastewater with heat pumps and redirect it to other uses.
    - Think twice about ventilation - Fresh air is fundamental to healthy buildings. Be certain to recover heat and cool from exhaust air.
    - Save it for later - Incorporate thermal storage technology into designs to save recovered heat for when it's most needed.
  - The way heat moves in a building is more important than how it's made. Building infrastructure must shift toward lower temperature heating distribution.
    - Choose technology neutral distribution systems and plug in low carbon technology over time.
    - Incrementally shift steam distribution systems to hydronic (water-based) distribution.
    - Embrace low temperature heating, which is more efficient and enables heat pumps, but does require changing terminal units to fan coils, radiant panels or similarly performing devices.
    - Strategically relocate or add distribution infrastructure to support other goals, like heat recovery.

Appendix D: Key Resources

- ACEEE
  - Building Electrification: Programs and Best Practices | ACEEE
- ASHRAE
  - Electrification Statement: https://www.ashrae.org/file%20library/about/government%20affairs/public%20policy%20resources/briefs/approved-ppib---building-electrification.pdf
  - ASHRAE 211 Evolution (RA2023):

    https://www.ashrae.org/technical-resources/standards-and-guidelines/read-only-versions-of-ashrae-standards
- Beneficial Electrification Toolkit
  - Beneficial Electrification Toolkit (betoolkit.org)
- C40 Cities
  - Cost of Fossil Gas: https://www.c40knowledgehub.org/s/article/The-cost-of-fossil-gas-The-health-economic-and-environmental-implications-for-cities?language=en_US
- GSA GPG Program
  - https://www.gsa.gov/climate-action-and-sustainability/center-for-emerging-building-technologies
  - https://sam.gov/opp/b3c03641c81247869fbea6a5319679b3/view
- Harvard School of Public Health
  - https://cobe.forhealth.org/
- NBI
  - Building Technology Electrification Roadmap: https://newbuildings.org/resource/the-building-electrification-technology-roadmap/
  - https://www.advancedwaterheatinginitiative.org/
- NIBS
  - Decarbonization Guidance: https://www.nibs.org/reports/2022-moving-forward-report
- NREL

    - Electrification Futures Summary: https://www.nrel.gov/analysis/electrification-futures.html

- NYSERDA
    - https://www.nyserda.ny.gov/All-Programs/Empire-Building-Challenge/Building-Decarbonization-Insights

- OMB
    - Social Cost of Carbon: https://www.whitehouse.gov/wp-content/uploads/2022/08/OMB-Analysis-Inflation-Reduction-Act.pdf

- RMI
    - Building Electrification Resources: https://rmi.org/our-work/building-electrification/

- Stanford
    - Decarbonization Education Resource: https://bdla.stanford.edu/

- U.S. Department of Defense
    - Electrification policy: USACE ECB 2023-08 Electrification, Decarbonization, And Executive Order (E.O.) 14057 -- Category: Directive And Policy: https://www.wbdg.org/ffc/dod/engineering-and-construction-bulletins-ecb/usace-ecb-2023-08

- U.S. Department of Energy:
    - Better Buildings program: https://betterbuildingssolutioncenter.energy.gov/carbon-hub/erp

- White House Climate Policy Office
    - Federal Emissions Definition: https://www.whitehouse.gov/briefing-room/statements-releases/2023/09/21/fact-sheet-biden-harris-administration-announces-new-actions-to-reduce-greenhouse-gas-emissions-and-combat-the-climate-crisis/