Decarbonization Zero-Over-Time (ZOT) Audit Protocol: A Comprehensive Framework

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Introduction

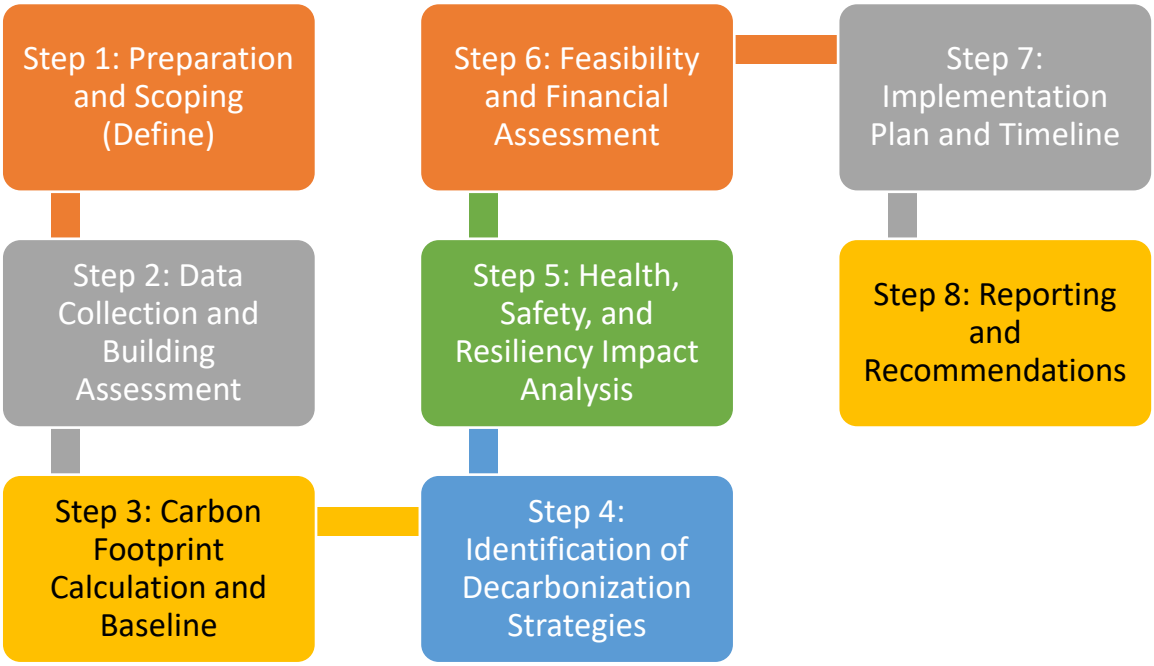
A decarbonization audit, based on an ASHRAE Level 2 Energy Audit, evaluates a building or facility's current carbon footprint, identifies opportunities for emission reductions, and outlines pathways to achieve net-zero carbon emissions. The audit aims to reduce emissions by at least 30% in the initial phase, achieve an Energy Star score of 75 or higher, and set a roadmap to fully electrify the building within 20 years. Throughout the process, a strong emphasis is placed on ensuring the integration of health, safety, and resilience features, ensuring that the decarbonization strategy not only reduces environmental impact but also promotes long-term building performance and occupant well-being.

Key Objectives of a Decarbonization Audit:

1. Assess Carbon Emissions: Evaluate current carbon emissions from all scopes (Scope 1 & 2).
2. Identify Decarbonization Opportunities: Highlight energy-saving measures and low-carbon alternatives (e.g., renewable energy, electrification, energy efficiency).
3. Ensure Health and Safety: Incorporate health and safety metrics, especially in changes to building systems or energy infrastructure.
4. Enhance Resiliency: Understand property climate vulnerabilities, and evaluate strategies for greater durability and resilience, and energy system flexibility.
5. Address Barriers: Identify conditions under which the full decarbonization protocols may not be applicable or feasible.

Enterprise

Step-by-Step Decarbonization Audit Process



Step 1: Preparation and Scoping (Define)

Objective: Define the boundaries of the audit, stakeholder involvement, and high-level decarbonization goals.

Key Actions:

- Review building documentation
  - Previous audits (e.g., ASHRAE Level 1, Level 2, or energy benchmarking)
  - Capital Needs Assessments (CNA)
  - Applicable drawings
- Identify scope of the audit (building systems, energy use, emissions)
- Collect and review relevant documents (energy bills, building plans, equipment lists)
- Establish baseline carbon emissions (Scope 1 & 2)
- Set decarbonization targets (Initial phase 30% reduction of emissions)
  - Identify health, safety, and resiliency goals (e.g., indoor air quality, system reliability)

Output: Scoping document with clear goals, team assignments, and timelines

Step 2: Data Collection and Building Assessment

Objective: Gather data to assess current energy use and carbon emissions

Key Actions:

- Energy Use and Carbon Emissions:
  - Collect utility data (electricity, heating, cooling, fuel consumption)
  - Energy Star Portfolio Manager
  - Perform a walkthrough of the building(s) to inspect HVAC, lighting, insulation, and other systems
  - Identify sources of on-site carbon emissions (e.g., gas boilers, diesel generators)
- Health and Safety Evaluation
  - Assess indoor air quality and water quality (ventilation rates, CO2 levels)
    - Air Quality Examples
      - Indoor Carbon Dioxide Levels
      - Radon testing (where appropriate)
    - Water Quality
      - Review domestic water piping for lead
      - Water Testing (Where appropriate)
  - Evaluate building materials for health risks (e.g., VOCs, asbestos, mold, moisture)
  - Check for compliance with relevant health and safety codes (OSHA, local regulations)
- Resilience Evaluation:
  - Assess vulnerability to climate risks (e.g., flooding, heat waves)
    - Federal Resources
      - FEMA Flood Maps - https://www.fema.gov/flood-maps
      - FEMA Resilience Analysis and Planning Tool (RAPT) - https://www.fema.gov/about/reports-and-data/resilience-analysis-planning-tool
    - State Resources (eg)
      - Resilient Mass Climate & Hazards Viewer - https://resilientma-mapcenter-mass-eoeea.hub.arcgis.com/
      - Massachusetts Flood Zone Mapping Tool - https://matracking.ehs.state.ma.us/planning_and_tools/flood-zones/flood-zones-tool.html
  - Review building structure for disaster preparedness (e.g., seismic, wind)

Output: Data collection report with a detailed assessment of energy use, emissions, and health/safety and climate vulnerability conditions

Step 3: Carbon Footprint Calculation and Baseline Report

Objective: Calculate the current carbon footprint and set the baseline for the decarbonization strategy.

Key Actions:

- Calculate emissions from electricity (Scope 2), direct emissions from on-site combustion (Scope 1).
    - NREL Cambium Datasets, Portfolio Manager Emissions Factors, eGRID
- Break down emissions by systems (HVAC, lighting, process equipment)
- Quantify potential emissions reductions through existing efficiency programs

Output: Carbon footprint baseline report detailing emissions by scope and source.

Step 4: Identification of Decarbonization Strategies

Objective: Identify feasible strategies to reduce carbon emissions

Key Actions:

- Electrification and Low-Carbon Alternatives:
    - Recommend electrification of heating and cooling systems and transition to low-carbon fuels
    - Consider energy storage systems (batteries, thermal storage)
- Building Performance:
    - Propose building envelope upgrades (e.g., windows, insulation)
    - Optimize energy management systems (e.g., building automation, smart meters)
    - Building Envelope
        - High-Performance Insulation: Enhance thermal performance with upgraded wall insulation, attic insulation, and high R-value windows.
        - Air Sealing: Ensure airtightness to minimize energy losses due to drafts, using advanced weather-stripping and sealing techniques around windows, doors, and penetrations.
        - High-Performance Windows: Install windows with low U-values to minimize heat transfer and reduce heating and cooling loads.
        - Thermal Bridging: Address thermal bridging by using continuous insulation (e.g., insulated sheathing) and framing methods that reduce heat transfer.
    - Energy-Efficient HVAC Systems
        - Energy-Efficient Heating and Cooling: Use high-efficiency, centrally controlled HVAC systems (e.g., heat pumps, ERVs, and HRVs) to provide comfort without excessive energy use.
        - Smart Thermostats: Install smart thermostats to optimize energy use across common areas and individual units, offering control over heating and cooling.

        - Zoned HVAC: Implement zoning strategies that allow for heating/cooling only in occupied spaces, reducing energy consumption in unoccupied areas.
    - Renewable Energy Systems
        - Solar Photovoltaic (PV): Design the building for solar panel installation on the roof or other available spaces to generate electricity.
        - Community Solar: In cases where roof space is limited, explore community solar options, where residents can purchase or lease solar energy.
        - Battery Storage: Incorporate energy storage systems to maximize the use of on-site renewable energy by storing excess solar power for use during non-sunny hours.
        - Solar-Ready Infrastructure: Ensure that the building's electrical systems are designed to accommodate solar panels and future upgrades to renewable energy systems.
    - Water Heating Efficiency
        - Low-Flow Fixtures: Install low-flow faucets and showerheads to reduce water consumption and the energy needed to heat water.
            a. WaterSense Labeled
        - Water Heating Systems: Use energy-efficient water heaters such as heat pump water heaters, or solar thermal systems.
- Electrical Capacity and Grid Integration
    - Upgraded Electrical Panels: Ensure the electrical panels can accommodate building electric upgrades, renewable energy systems, electric vehicle chargers, and high-efficiency appliances.
    - Smart Metering: Install smart meters to monitor energy use in real-time, allowing for better load management and integration with renewable energy.
    - Demand Response: Implement demand response strategies that reduce electricity consumption during peak times by automatically adjusting HVAC, lighting, and appliances.
- Indoor Air Quality (IAQ)
    - Ventilation Systems: Use energy recovery ventilators (ERVs) or heat recovery ventilators (HRVs) to provide continuous fresh air while retaining energy.
    - Low-VOC Materials: Use paints, finishes, adhesives, and flooring materials that emit low or no volatile organic compounds (VOCs) to ensure a healthy indoor environment.
    - Moisture Control: Prevent moisture buildup and mold growth through proper drainage, ventilation, and moisture-resistant materials.
- Energy Management and Automation
    - Building Energy Management Systems (BEMS): Implement a central system to monitor and control energy use across the building, optimizing performance and identifying inefficiencies.

    - Smart Lighting: Install motion-sensing, LED lighting in common areas and corridors to reduce energy use in unoccupied spaces.
    - Submetering: Provide submetering for individual units and common areas to encourage energy-efficient behavior by tracking consumption.
- Electrification of Systems
    - Electric Appliances: Shift from gas-powered appliances to electric alternatives (e.g., induction cooktops, electric dryers) to reduce carbon emissions and align with zero-emission goals.
    - Plan for Electrification of fossil fuel systems to remain
        - Necessary to avoid emergency replacement with new gas equipment
        - Panel Space and required capacities
        - Junction boxes near current equipment
- Community and Resident Engagement
    - Energy Education: Provide residents with information about energy-efficient living, how to optimize their energy use, and how to use smart thermostats and energy-efficient appliances.
    - Energy Monitoring Apps: Offer residents access to an app or dashboard to track their energy consumption and compare their usage against benchmarks or community averages.
- Health & Safety Integration
    - Propose air quality improvements (e.g., higher ventilation rates, filtration)
    - Implement resilience measures (e.g., backup power, flood prevention systems)

Output: List of decarbonization measures, including estimated energy and carbon savings and health and safety integration.

Step 5: Analysis of Health, Safety, and Resiliency Impacts

Objective: Evaluate how proposed decarbonization measures affect health, safety, and resiliency

Key Actions:

- Health Impacts:
    - Ensure compliance with ventilation and indoor air quality standards (ASHRAE 62.1, 62.2)
    - Hygrothermal, air quality, asbestos, vermiculite
- Safety Impacts:
    - Consider impacts of proposed technologies on fire safety (e.g., electrification of heating, battery storage)
    - Review electrical safety and system reliability during electrification or major system upgrades
- Resilience:

- Evaluate how energy systems can withstand climate events (e.g., backup power during storms, flood-resistant HVAC systems)
- Assess redundancy in critical systems (e.g., lighting, HVAC, refrigeration)

Output: Health, safety, and resiliency analysis report.

Step 6: Feasibility and Financial Assessment

Objective: Conduct a financial analysis of the proposed decarbonization strategies and assess technical feasibility

Key Actions:

- Perform cost-benefit analysis of each proposed measure (capital costs, O&M, energy savings)
- Evaluate available funding options (grants, tax incentives, green bonds)
- Assess payback periods, IRR (internal rate of return), and financial risks

Output: Feasibility and financial assessment report, including prioritized actions

Step 7: Implementation Plan and Timeline

Objective: Develop a roadmap for implementing and phasing decarbonization measures to achieve net-zero emissions over time (20 years or less).

Key Actions:

- Prioritize actions based on cost-effectiveness, impact on carbon emissions, and health/safety
- Develop a phased implementation plan with timelines, responsible parties, and resource allocations
- Incorporate monitoring and verification (M&V) protocols to track progress over time

Output: Detailed decarbonization implementation roadmap

Step 8: Reporting and Recommendations

Objective: Deliver a comprehensive report to stakeholders with actionable recommendations

Key Actions:

- Summarize findings from the audit, including emissions baseline, health/safety evaluation, and resiliency considerations

- Provide recommendations for each stage of the decarbonization journey, from short-term actions to long-term strategies, including guidance for responding to emergency system upgrades.
- Document conditions under which specific protocols or recommendations may not be feasible (e.g., financial limitations, technical barriers)

Output: Final audit report, including:
    - Emission reduction roadmap
    - Health, safety, and resilience considerations
    - Feasibility and financial analysis

Unique Considerations

In certain circumstance, the protocol outlined above may need to be revisited and / or revised by the developer as the conditions of the project change. A partial list of some considerations that may cause a development team to alter their pl\ans include:

- Financial Constraints: If the cost of decarbonization exceeds available funding or if the building is under significant financial stress
- Technical Limitations: Some building systems may not be compatible with electrification or energy efficiency upgrades (e.g., outdated infrastructure, building age)
- Health and Safety Concerns: Tightening envelope without ventilation
- Regulatory Barriers: Local building codes or regulations may limit the implementation of certain decarbonization technologies (e.g., restrictions on renewable energy installations, and electrification)
- Resiliency Issues: In areas with high vulnerability to climate change (e.g., flood zones), certain energy or infrastructure strategies may not be feasible

Conclusion

This framework provides a structured approach to conducting a decarbonization audit that integrates best practices in energy efficiency and carbon reduction, while considering the broader impact on health, safety, and resilience. It is adaptable to varying building types, local conditions, and organizational priorities.