

Decarbonizing Hospital Buildings

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Optimizing health care facilities

Decarbonizing Hospital Buildings

This publication was prepared under the auspices of ASHRAE's Task Force for Building Decarbonization (TFDB).

For more information from the ASHRAE TFBD, visit www.ashrae.org/decarb.

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Foreword 1

In the context of global greenhouse gas emissions, the health sector represents a major global contributor to global greenhouse gas emissions, accounting for approximately 8.5% of all emissions nationally (Dzau et al. 2021). US healthcare emissions have increased substantially over the past decade, representing the highest rate among all industrialized nations, accounting for almost 25% of global health sector emissions (Eckelman et al. 2020). These emissions contribute significantly to climate change, triggering irreversible environmental changes and causing an array of catastrophic health impacts—food insecurity, the spread of vector-borne disease, decreased air quality leading to increased respiratory diseases, heat-related illnesses, and more.

Healthcare facilities, entrusted with the noble mission of healing, have unwittingly contributed to this carbon emission through energy consumption, waste generation, and resource utilization. As the authors of this crucial guide point out, hospitals are responsible for caring for people in extreme states of illness and disability and must be fully operational around the clock, guaranteeing that, without substantial intervention, hospitals will remain some of the highest producers of emissions. Hospitals are energy-intensive facilities, requiring electricity for lighting, heating, ventilation, air conditioning (HVAC), medical equipment, and other operational needs. They generate substantial amounts of waste, including hazardous and nonhazardous materials, and frequently engage in energy-intensive processes for safe disposal. The treatment and heating of water for purposes such as sterilization, cleaning, and patient care contribute to emissions, as does wastewater disposal. Hospital energy demands are proportional to the complexity of their mandate—to care for the most vulnerable. However, because of the resulting emissions, healthcare facilities are paradoxically increasing the health risks for the communities they serve. Alarmingly, the adverse health impacts resulting from pollution within the US healthcare system are estimated to rival the annual harms attributed to preventable medical errors.

The case for hospital decarbonization, spanning from design to operations, is grounded in the imperative to reconcile the essential role of these facilities with the global commitment to environmental sustainability and underscored by the historical mantra of medicine: First, do no harm. To mitigate and prevent further health impacts due to climate change and to build healthcare facilities that remain resilient in the face of a changing climate, hospitals must strive for decarbonization in the near term. However, the magnitude of this goal is significant. Decarbonization poses a long list of unique challenges that must be addressed without sacrificing the quality of care or substantially increasing costs at a time when many health organizations are already operating on razor-thin margins.

While individual facilities and systems have begun to make positive progress—as the case studies included in this guide demonstrate—it is time for a systematic push for net zero. Fortunately, this guide provides a clear, comprehensive road map for achieving this goal. Never before has the health sector had a pathway to decarbonization illuminated in such clear, detailed steps, covering each of the three types of emissions—Scopes 1, 2, and 3—and discussing how to maintain reductions in the long term. The authors recognize that decarbonization does not just require infrastructure changes but long-term updates to building management, staff training, and operations, all within the context of the current US policy and regulatory environment.

As President of the National Academy of Medicine (NAM) and co-chair of the NAM's Action Collaborative on Decarbonizing the US Health Sector, I commend ASHRAE, ASHE, and the authors for their impressive efforts in producing this guide, which will provide significant benefit to hospitals at each stage of their decarbonization journey. Many expert individuals and organizations made invaluable contributions to this book. I hope the guidance shared here assists hospitals across the globe in progressing toward net zero and contributes to improving the health of the global population.

Victor J. Dzau
President of the National Academy of Medicine

Foreword 2

In 2022, the Intergovernmental Panel on Climate Change Sixth Assessment Report, on which I served, concluded with very high confidence that climate change is increasing climate-related illnesses, premature deaths, malnutrition in all its forms, and threats to mental health and well-being. These impacts are often interconnected and unevenly distributed across and within societies and will continue to be experienced inequitably due to differences in exposure and vulnerability. Climate change is ultimately an issue of social justice. The burden of climate-sensitive health outcomes will increase over the coming decades, even with increased investments in adaptation, putting more stress on poor and marginalized communities.

Health risks are expected to increase over this century with each additional unit of warming, depending on the extent of timely and effective investments in adaptation (e.g., public health measures) and mitigation (e.g., reduction of greenhouse gas [GHG] emissions), and on the development pathway followed, within the context of aiming to achieve the Sustainable Development Goals.

At the same time, health services (e.g., health facilities) contribute to climate change through GHG emissions. The health sector is responsible for 4.5% to 5% of worldwide emissions, largely owing to the energy consumption associated with infrastructure, equipment, and supply chains. Appropriately managed, the strategies for transitioning to low-carbon health systems, coupled with effective and efficient adaptation interventions, will also increase health system and community resilience to climate-change-related shocks and stresses.

Research demonstrates that the economic value of avoided hospitalizations and premature deaths from mitigation policies and technologies are of the same order of magnitude as the costs of implementing these mitigation policies and technologies. In other words, a major driver of decarbonization should be the health benefits from reducing GHG emissions, such as those from point and mobile sources of air pollutants. Appropriately timed and implemented, mitigation actions can increase the health and well-being of communities; reduce historic, current, and future inequities; and generate multiple co-benefits in sectors such as water, sanitation, food systems, and social protection.

ASHRAE, ASHE, and the authors have produced a practical and useful guide to support the design of decarbonized hospitals. Following this guidance will contribute to improving the health and well-being of people in the communities served by these facilities, across this country, and the world. And because the health sector is a powerful and trusted voice that increases confidence in science and institutions, health sector leadership can motivate broader societal changes towards a healthier and more sustainable and resilient future.

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Preface

The American Society for Health Care Engineering (ASHE) of the American Hospital Association (AHA), a partner in the creation of this guide and the largest professional membership group dedicated to optimizing the built environment, has adopted the following position with respect to decarbonization:

> Decarbonizing the US health care footprint is an important and necessary step to mitigating the effects of climate change. ASHE supports the decarbonization of health care and is dedicated to leading the field by providing tools and resources to both reduce the health care carbon footprint and to inform public policy. ASHE intends to advance thoughtful approaches to climate change that take into consideration the unique regulatory environment within which hospitals and health systems operate. ASHE is dedicated to helping health care organizations to become more sustainable by adopting environmental, social, and fiduciary practices that support healthy, equitable, and resilient environments and communities. (ASHE 2023a)

In January 2022, the ASHRAE Board of Directors passed the following motion: "That ASHRAE, as a matter of policy with BOD oversight, [will] address decarbonization of the global built environment with the same level of importance and urgency as ASHRAE tackled energy efficiency during the energy crisis."

During 2022, the ASHRAE Task Force on Building Decarbonization (TFBD) produced the Position Document on Building Decarbonization (PDBD) that was approved by the ASHRAE Board of Directors on June 26, 2022. In that document, ASHRAE adopted the #BuildingToCOP26 Coalition statement (WBCSD 2021) that:

> By 2030, the built environment should halve its emissions, whereby 100 percent of new buildings must be net-zero carbon in operation, with widespread energy efficiency retrofit of existing assets well underway, and embodied carbon must be reduced by at least 40 percent, with leading projects achieving at least 50 percent reductions in embodied carbon. By 2050, at the latest, all new and existing assets must be net zero across the whole life cycle, including operational and embodied emissions. (ASHRAE 2022a)

In the position document, ASHRAE committed to:

- Research and standards development
- Design and equipment applications
- Technical guidance and training
- Regulatory guidelines and measures
- Educational resources and outreach

Decarbonizing Hospital Buildings is an example of all five of these efforts. The ASHRAE Task Force on Building Decarbonization elected to produce only one design guide for a particular building type—new hospitals.

Hospitals are among the most complex of building types. They contain, within their walls, virtually every other type of building. They are filled with complicated technology systems and equipment. They contain multiple increasingly intricate, interacting, energy-intensive systems. They have the highest energy intensity of any building type other than food service. The people inside them are often in extreme states of disability and vulnerability, both physical and emotional. The risks of infection from both infectious aerosols and contact transmission in hospitals are higher than similar risks in any other building type. As critical facilities, hospitals must stay operational in almost all circumstances and must maintain high indoor air quality in all clinical spaces. They are highly regulated by many different authorities having jurisdiction. With this complexity, these buildings demand special attention if they are to meet the challenge of zero operational carbon.

In the experience of the authors, many do not understand what decarbonization means. Some may feel that accomplishing this outcome is impractical. Many others are willing but need guidance to help them. The purpose of this guide is to describe what it means to decarbonize a new hospital building—to show that it is practical to accomplish today and define a set of strategies to get it done.

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Many (too many to name) discussed their insights and experiences with the authors, providing critical insights to help healthcare decarbonize.

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The working group's efforts were guided by the Project Monitoring Subcommittee under the leadership of Tim Peglow, Associate Vice President at MD Anderson Cancer Center. The Project Monitoring Subcommittee provided the support needed to accelerate the time frame for publication of this guide, and ASHRAE staff members were instrumental in executing that vision.

Introduction

Scope of this Guide

The ASHRAE Position Document on Building Decarbonization (PDBD) recommends that all new buildings and major renovations built in 2030 and beyond be decarbonized. This guide focuses on the design, construction, and operation of decarbonized new hospital buildings and major renovations.

Many organizations, including the US Department of Energy, have promulgated often overlapping and conflicting definitions for what a "zero emissions building" is (DOE 2023). All such definitions, measurement protocols, and so on, are helpful to their respective audiences, but their proliferation can cause confusion. Therefore, this document is targeted at the definition of a *decarbonized building* developed in the ASHRAE PDBD.

The PDBD defines a *decarbonized building* as *one with net zero emissions of operational greenhouse gases (GHG) and 40% lower embodied emissions* (presumably compared to an average building at the time of this publication). The PDBD states ASHRAE's position as, "By 2030, the global built environment must halve its 2015 GHG emissions, whereby all new buildings must be net zero GHG emissions in operation, widespread energy-efficiency retrofits of existing assets must be well underway, and embodied carbon of new construction must be reduced by at least 40%."

By 2050, at the latest, all new and existing assets must be net zero GHG emissions across the whole life cycle.

The Kyoto Protocol and the Greenhouse Gas Protocol define seven greenhouse gases: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), sulfur hexafluoride (SF_6), perfluorocarbons, hydrofluorocarbons, and nitrogen trifluoride (NF_3) (WRI and WBCSD 2013). Hospitals also emit other gases with high global warming potential (GWP), particularly inhaled anesthetics. Further, hospitals are responsible for some amount of residual emissions (Buck et al. 2023) that must also be either prevented or offset. For a hospital to be zero carbon in 2030, all emissions of all these gases must either be zero or must be offset through procurement of environmental attributes.

Operational emissions refer to *the emissions due to combustion, leakage, or other release directly from the building and the emissions due to the combustion, leakage, or other release from the generation of energy procured from off-site sources*. Note that these definitions roughly correspond to a portion of Scope 1 and Scope 2 emissions of the building, as defined by the Greenhouse Gas Protocol (WRI and WBCSD, n.d.).

Embodied emissions refer to *the emissions due to combustion, leakage, or other release from the production, transportation, and disposal of the materials used in the construction, ongoing maintenance, repair and renovation, and demolition of the building*. This definition represents a portion of the Scope 3 emissions of the building.

There are several common methods and standards for describing, categorizing, and accounting for greenhouse gases. The European Committee for Standardization's Standard EN 15978 applies specifically to buildings. The World Resources Institutes's (WRI) Greenhouse Gas Accounting Protocol (GHG Protocol) is widely recognized for emissions accounting and is currently in use by many healthcare organizations. The GHG Protocol defines emissions as falling into one of three "Scopes"—1, 2, and 3—which include building emissions, but also many other organizational emissions (WRI and WBCSD, n.d.). Thus, the decarbonized hospital building eliminates the portion of the Scope 1, Scope 2, and Scope 3 emissions for which buildings are responsible. This guide is organized around the GHG Protocol because most healthcare organizations' carbon accounting relies on these definitions of scope. Recognizing that many in the building industry typically calculate emissions based on building life-cycle phase—e.g., upfront embodied carbon and operational carbon—this guide also incorporates discussion of whole life carbon.

This guide pays particular attention to those elements of decarbonization that are most problematic: certain process loads, thermal energy, especially in cold climates, "emergency power;" and potential offsets available to achieve net zero.

This guide is intended for stakeholders in the design, construction, and operation of hospital buildings, including hospital facility managers, capital planners, hospital architects, engineering teams, sustainability leaders, builders, authorities having jurisdiction, and other related stakeholders.

ASHRAE Decarbonization Guides

This guide is one of seven being published by ASHRAE through the Task Force for Building Decarbonization. The other guides in this series are also helpful references for buildings, including those involved with hospital buildings (ASHRAE 2023b). This guide intends to complement the content from these guides. This guide builds upon the others with hospital-specific guidance in relevant sections. The other ASHRAE Decarbonization Design Guides include:

- ***Building Performance Standards: A Technical Resource Guide***, which provides a technical basis on implementing Building Performance Standards.
- **CIBSE TM65 for North America** which provides guidance for assessment of the embodied carbon of mechanical, electrical, and plumbing systems.
- ***Grid Interactive Buildings for Decarbonization: Design and Operation Resource Guide*** which provides techniques and practices to enable buildings to maximize benefits from the grid while minimizing the carbon impact of the grid and buildings.
- ***Whole Life Carbon Guide for Building Systems*** which provides strategies to minimize the whole life carbon emissions from building MEP systems with trade-offs between embodied carbon and operational emissions.
- ***Decarbonizing Hospital Buildings*** (this guide) which shows how to reduce GHG emissions specifically in hospital buildings.
- ***Building Decarbonization Retrofits for Commercial and Multifamily Buildings*** which provides a framework for decarbonizing existing commercial and multifamily buildings.
- ***Decarbonizing Building Thermal Systems: A How-To Guide for Heat Pump Systems and Beyond*** which provides insight on how heat pumps should be applied and operated in commercial and multifamily buildings to support decarbonization.