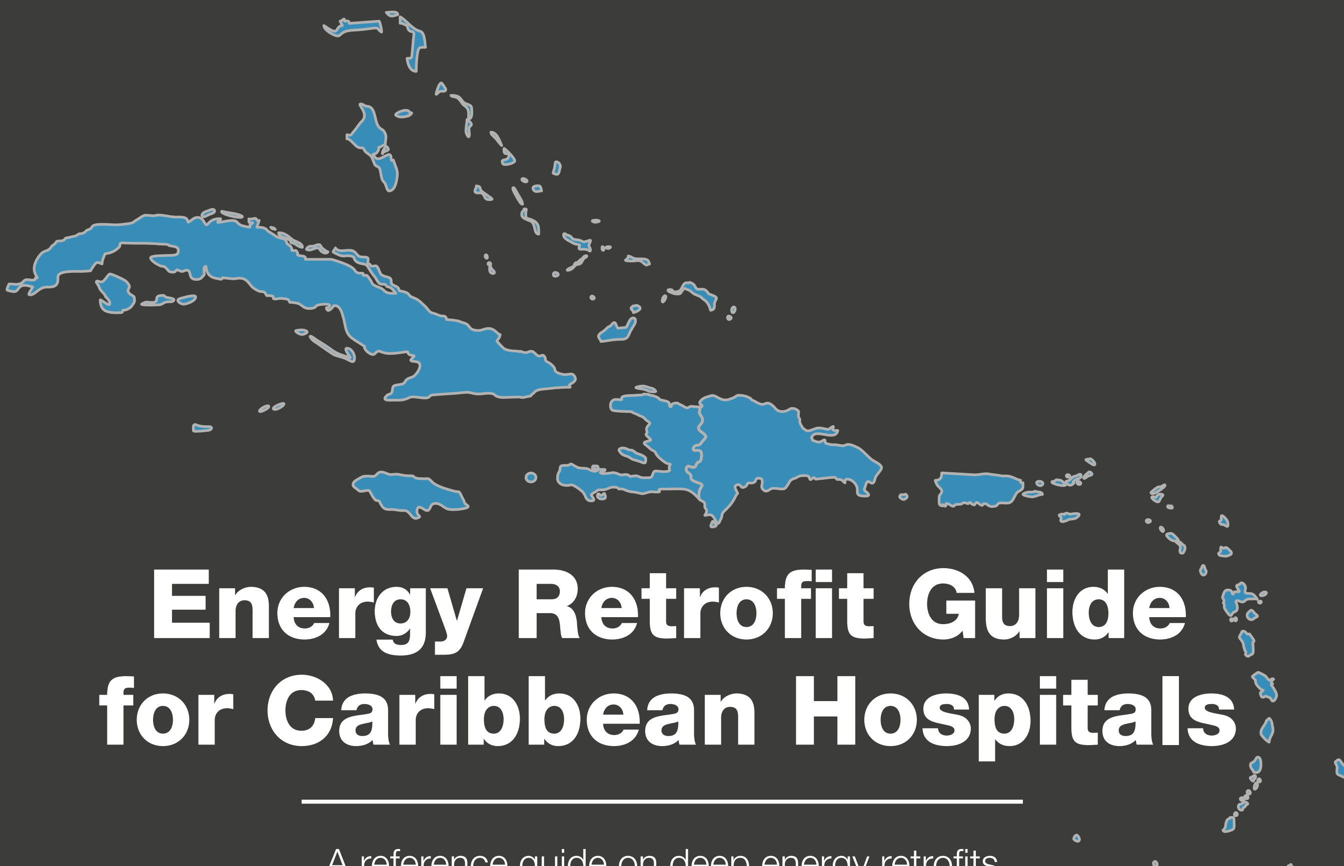

Energy Retrofit Guide for Caribbean Hospitals

A reference guide on deep energy retrofits for Caribbean hospital administrators

1820 Folsom Street | Boulder, CO 80302 | www.rmi.org

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ARUP

Caribbean Community Climate Change Centre

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Disclaimer

About this Guide

This guide was developed to provide healthcare administrators in the Caribbean islands the resources necessary to find energy savings for their facilities, finance those savings, and follow through with the activities necessary to realize those savings.

The guide has an accompanying website (www.hospitalretrofits.org) that serves as an easy-to-use tool to break through the barriers of complex engineering and financing models; and gets to real and actionable savings that can be tailored to a specific facility.

Authored jointly by Arup, Carbon War Room, the Caribbean Community Climate Change Centre, and Rocky Mountain Institute, the guide supports the mission to accelerate the adoption of business solutions that reduce carbon emissions and advance the low-carbon economy. It should be noted this work would not be possible without a number excellent industry texts that set out clear processes for implementation and wider guidance. A full list of references is outlined in Appendix B.

About the Partners

Arup is an independent consultancy providing professional services in management, planning, design and engineering.

The **Caribbean Community Climate Change Centre** (CCCCC) coordinates the Caribbean region's response to climate change, working on effective solutions and projects to combat the environmental impacts of climate change and global warming.

Rocky Mountain Institute (RMI)—an independent nonprofit founded in 1982—transforms global energy use to create a clean, prosperous, and secure low-carbon future. It engages businesses, communities, institutions, and entrepreneurs to accelerate the adoption of market-based solutions that cost-effectively shift from fossil fuels to efficiency and renewables. In 2014, RMI merged with **Carbon War Room** (CWR), whose business-led market interventions advance a low-carbon economy.

The **Clinton Climate Initiative** serves as a partner to RMI and CWR to accelerate energy transition in the Caribbean.

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Executive Summary

How much does the energy to run your healthcare facility cost you? Chances are it is a significant amount, as energy is a critical piece of running an effective and resilient operation. After years of work with hospitals, clinics, and campuses around the world, we have yet to find one that couldn't reduce its energy consumption to save money.

But the opportunity in the Caribbean is even larger because, compared with many places in both the developed and the developing world, the cost of energy in the Caribbean is quite high. For example, in the U.S. the average kilowatt-hour costs about $0.12, compared to $0.38 in the Caribbean. As such, we see great potential to dramatically reduce the operating costs associated with running hospitals and clinics by systematically reducing the energy that these facilities require to function at their best.

Consider a primary care clinic in Aruba. A few years back, specialized reflective coating was installed on the building's roof to minimize the transfer of solar heat to indoor spaces. By limiting the amount of solar heat passing through, the roof coating helped to moderate interior temperatures, thus reducing the need for air conditioning and improving occupant comfort. With lower air conditioning needs, the clinic was able to save $3,300 in electricity costs and reduce overall energy use by over 4 percent the following year. This is not an isolated or unattainable example.

Credit: Healthcitycaymanislands.com

This guide is intended to help Caribbean healthcare facility stakeholders, with the assistance of qualified professionals, harness cost savings by laying out a clear process for implementing energy efficiency measures with high returns on investment (Figure ES-1). In the simplest form, the steps are:

1. **Find:** Identify potential retrofit opportunities at your facility.
2. **Finance:** Identify the funding options that make the most sense for you.
3. **Follow-through:** Implement your deep energy retrofit project and maintain improved performance by following industry best practices.

The opportunity is there for your facility to implement an energy retrofit program that maximizes savings and suits your needs.

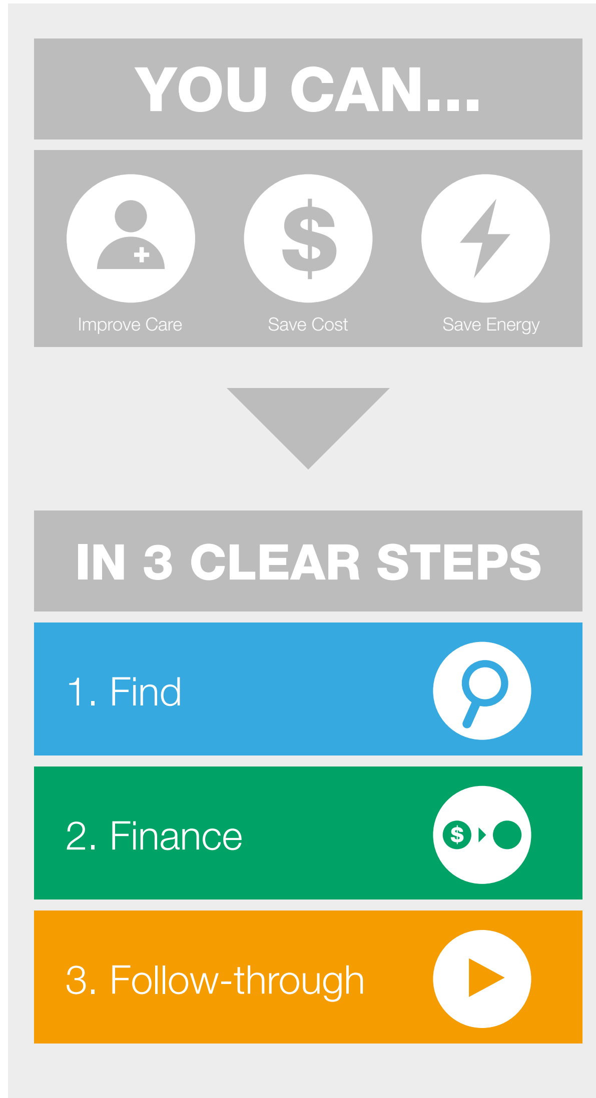


Figure ES-1: Simplified steps to the retrofit process

Putting this Guide into Action

You can unlock your facility's savings potential and start the deep energy retrofit process by following the instructions in the "Find", "Finance", and "Follow-through" steps found in this guide and its complementary online tool (see box at right).

To quickly get started requires just a few simple actions:

1. Begin the process by determining the project champion.
2. Next, use the online tool to identify potential retrofit opportunities at your facility.
3. Enlist the technical expertise of energy professionals to incorporate these retrofit opportunities into a project plan that defines the project's scale, scope, and goals.
4. With retrofit opportunities identified and a plan outlined, contact RMI and CWR at hospitalretrofits@rmi.org for assistance with finding the right financing option for your project.
5. After securing the necessary funding, hire qualified professionals to implement your retrofit project and maintain your facility's ongoing performance.

By following these steps you can lead your facility to the significant savings, return on investment, and improved level of care that can only be achieved through a deep energy retrofit.

A Free Online Tool for Identifying Retrofit Opportunities

We've developed an easy-to-use online tool to be used in tandem with this guide. The tool helps hospital administrators benchmark and assess their facility's current performance and identify potential energy efficiency measures while targeting overall potential savings. The tool is intended to complement a detailed analysis performed by an energy professional. Please go to www.hospitalretrofits.org to learn more and get started.

Introduction

The following serves as an introduction to the concepts and workflow behind the deep energy retrofit assessment

Introduction

Global dependence on fossil-based fuels is unsustainable. The Caribbean islands highlight this more than any other region in the world. Almost exclusively reliant upon imported fossil-based fuels, the people of the Caribbean live with rising energy costs and food prices, and are particularly vulnerable to the effects of global climate change. Experts predict that climate change will likely result in a greater likelihood of higher intensity and more frequent storm events, as well as increased flood risk from rising sea levels. For Caribbean economies that are driven largely by tourism, it is more important than ever to ensure the resilience of critical services infrastructure.

Few services are more critical to resiliency than healthcare. Healthcare facilities play a vital role in the communities they serve, both during times of calm and times when natural disasters threaten residents' way of life. Protecting the viability and security of healthcare services will be crucial to ensure the well-being of Caribbean residents in the face of climate change impacts.

Perhaps the best strategy to ensure resilience of Caribbean communities is to decrease reliance on fossil-based fuels through efficiency and renewable energy. To date, renewable energy generation and energy efficiency programs have had limited market penetration in the Caribbean—especially among healthcare facilities—due to challenges associated with local permitting, lack of local experience, and legislative obstacles.

The purpose of the *Energy Retrofit Guide for Caribbean Hospitals* is to provide existing healthcare facility owners and decision makers in the Caribbean a comprehensive manual and interactive tool that will enable them to realize the myriad benefits of deep energy retrofits, ensuring the long-term viability of the healthcare services in the region.

What are deep energy retrofits?

> *A deep energy retrofit is a whole-building analysis and construction process that achieves much larger energy cost savings—sometimes more than a 50 percent reduction—than those of individual energy efficiency retrofits, and fundamentally enhances the building value. Deep energy retrofits help healthcare facilities reduce operating costs, increase resilience, and improve overall quality of care through better-run facilities. The significant savings that deep energy retrofits create can often be spread out, as with proper planning the measures can be implemented over several years.*

At scale, the opportunity to maximize benefits from deep energy retrofits in healthcare facilities is enormous, and has the potential to produce transformative results across the Caribbean region. However, such a transformation can only take place if individual facilities take action.

This guide will assist individual healthcare facility operators in identifying opportunities for deep energy retrofit strategies. In combination with the provided online tool, it provides a range of specific, actionable energy efficiency measures (EEMs) based on the facility's specific attributes, potential return on investment, and available budget. The guide will also help operators develop a roadmap for procurement and implementation of those EEMs while determining which measures, and bundles of measures, have the highest potential return on investment. It clearly outlines each step of the energy retrofit process, thus easing the pathway for healthcare managers to obtain capital and invest in deep energy retrofits for their facilities.

Context

The assessment of energy- and cost-saving opportunities for Caribbean healthcare facilities required detailed energy performance evaluations of individual existing facilities. To support these evaluations, data were collected from a sample of sovereign and non-sovereign Caribbean countries during the development of this guide (Figure 1). These countries were selected based on RMI and CWR's prior experience and partnerships in the region.

As shown in Figure 2, data were collected from 118 public and private healthcare facilities in these countries, ranging from large in-patient hospitals with 600 beds providing a full suite of medical services 24 hours a day, to small local primary care clinics that offer basic diagnostics and care for patients with common ailments and medical conditions.

The data points surveyed included annual energy consumption, building floor area, and year of construction, among many others. The data were used to determine building typologies, make comparisons between facilities, and establish energy use benchmarks.[1]

Building vintages of the identified healthcare facilities varied, however most were constructed using concrete blocks at a time when building codes were much less stringent or nonexistent. In fact, the average facility in the sample was over 40 years old. Older facilities tend to possess high energy use and significant operations and maintenance costs, and may also negatively affect patient outcomes and staff safety.

Buildings with poor energy performance suggest ample opportunities to reduce energy costs, improve the overall quality of care, and ensure facility resilience. This is especially true in the Caribbean, where energy prices are high and healthcare facility budgets may be tight. Analysis shows that there are many facilities in the Caribbean that are poised to significantly reduce operating expenses by implementing an energy retrofit.

This guide seeks to assist healthcare facility stakeholders in harnessing these cost-saving opportunities through identification of energy-saving measures, defining a repeatable process to implement improvements, and establishing access to capital to reduce investment costs.

1. For further information on the methodology used to collect and analyze the data, please refer to Appendix B.

Figure 1: Caribbean islands and nations selected for the development of this guide and the online tool

20+ islands represented

118 facilities surveyed

40 years average facility age

Type of facilities surveyed
Percentage by facility type

- Inpatient Facility
- Primary Care Facility
- Outpatient Facility

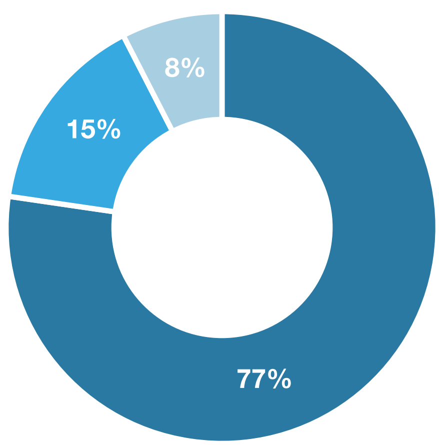


Figure 2: Characteristics of healthcare facility data used to inform this guide

Business Case

With an average electricity rate of $0.38 USD per kilowatt-hour in the region, Caribbean residents pay over two times more for electricity than the average Brazilian, and over three times more than the average person in the United States (Figure 3).[2] High electricity rates, coupled with always tight healthcare facility budgets, present a significant opportunity for healthcare facility managers to improve their operating equation through energy efficiency retrofits. The business case for deep energy retrofits of healthcare facilities is an easy sell.

Although the potential for savings is sizeable, certain market barriers such as local permitting, lack of local experience, and legislative obstacles have stymied efforts to complete deep energy retrofits on many of the Caribbean islands. This guide aims to help transform the market by providing Caribbean healthcare facility owners and operators a comprehensive roadmap for carrying out deep energy retrofits.

2. U.S. Energy Information Agency, *Electric Power Annual*, 2011; and Caribbean Electric Utility Services Corporation, *2012 Annual Report*, 2012.

For example, suppose a typical 100-bed in-patient hospital in Grenada can achieve energy reductions upwards of 20 percent. This translates to over $250,000 in savings against its bottom line every year! The United States Environmental Protection Agency estimates that for not-for-profit healthcare organizations, $1 saved in energy performance translates into $20 in new revenues. For a for-profit healthcare company, a five percent reduction in energy use translates into a one-cent increase in earnings per share.[3]

These savings can then be reinvested into additional energy efficiency upgrades, used to improve patient care, and utilized to expand the workforce to address growing healthcare needs. Energy efficiency retrofits positively impact more than a healthcare facility's bottom line; several studies indicate that energy efficiency upgrades such as enhanced daylighting in patient rooms and improved ventilation can help patients heal faster and reduce hospital stays.[4]

3. United States Environmental Protection Agency, *Boosting Your Bottom Line through Improved Energy Use*, 2005.
4. World Green Building Council, *Greener Buildings, Better Places, Healthier People*, 2013.

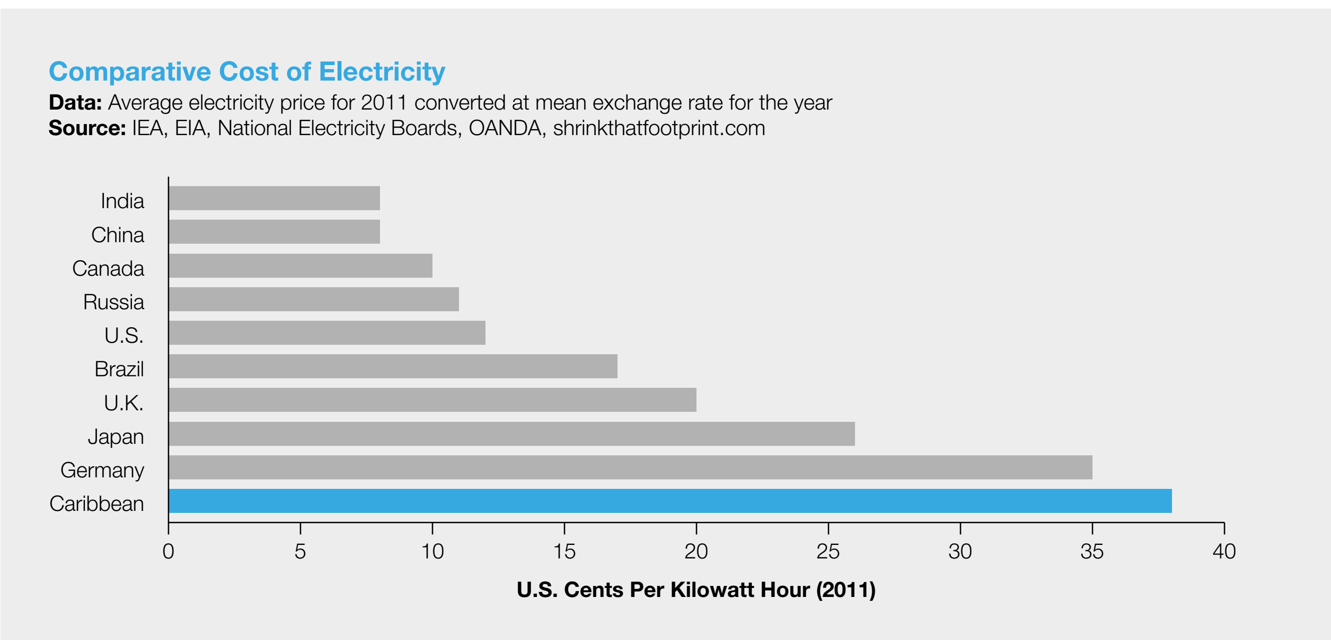


Figure 3: Comparison of average electricity prices

Key Steps

Deep energy retrofit projects require careful planning and earnest commitment from the start of the process through its completion. As shown in Figure 4, the retrofit process requires three steps:

1. **Find:** Identify potential retrofit opportunities at your facility.
2. **Finance:** Identify the funding options that make the most sense for you.
3. **Follow-through:** Implement your deep energy retrofit project and maintain improved performance by following industry best practices.

Careful consideration, planning, and commitment from key decision makers throughout all three steps are required to ensure the retrofit project successfully maximizes savings. Subsequent sections of the guide outline each of the steps in the retrofit process and can be used as a handbook for implementing deep energy retrofits. More detailed technical information and reference materials can be found in the guide's appendices.

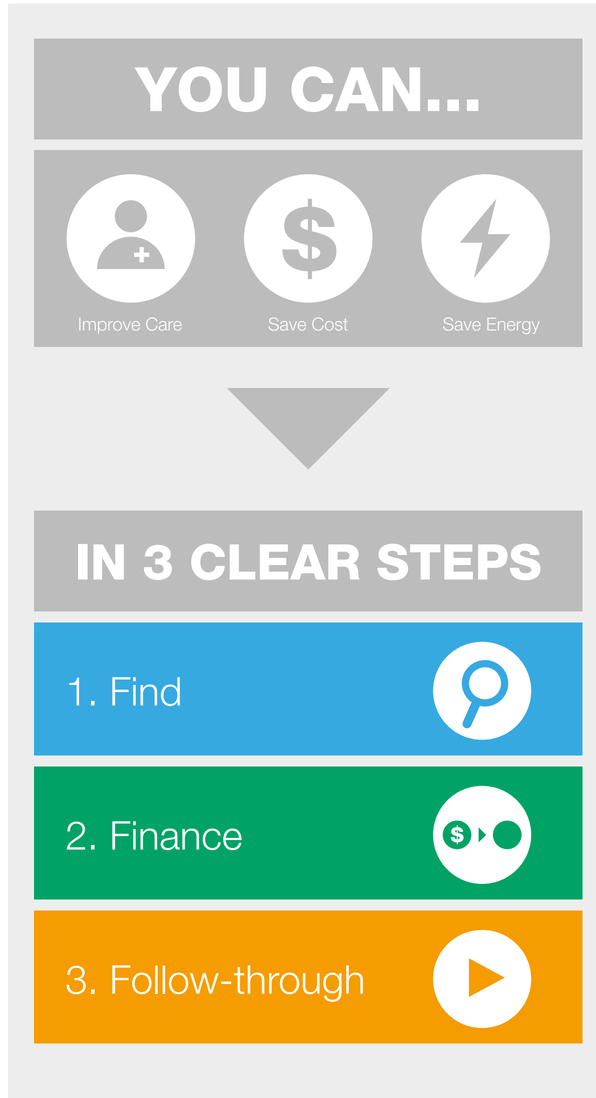


Figure 4: Simplified steps to the retrofit process

Find

Identify potential retrofit
opportunities at your facility

Getting Started

The success of a hospital retrofit project depends on the commitment of key decision makers across the organization. Hospital administrators, facility managers, or a team of senior level staff have an opportunity to lead by serving as project champions throughout the retrofit process. A project champion is responsible for overseeing the entire retrofit process, promoting the project, and ensuring that project goals are consistently met.

A critical role of the project champion is to garner and maintain support from across the organization. Ongoing commitment from management and senior leadership is important for the funding and implementation of retrofit measures, and encourages buy-in from all staff. To solidify the broad base of support that's needed, engagement is required at all levels, including maintenance personnel, facilities operators, medical staff, and administrative staff.

In the "Find" step of the retrofit process, the project champion will guide the team through several tasks necessary to uncover cost-effective energy retrofit opportunities at their facility (Figure 5).

Planning

A comprehensive planning exercise must be completed in order to establish a scope, schedule, and budget to meet all project stakeholder requirements. During planning, engagement with key stakeholders across the entire facility is required to provide valuable input on the facility's existing conditions while also informing the healthcare facility's overall energy goals. Active staff participation creates a strong sense of ownership, thus enabling staff to become increasingly committed to ensuring the project is successful through the entire retrofit process. This is especially important for retrofit projects that involve continued maintenance and oversight for years to come.

Once the planning task is complete, the identification of specific energy retrofit opportunities can begin.

Benchmarking

Identifying opportunities for retrofit projects begins by comparing your facility's energy performance to similar facilities—this process, known as benchmarking, is outlined in Figure 6. Benchmarking can be used to provide an estimate of potential energy and cost savings for a facility based on how it compares against peer facilities. If your facility uses significantly more energy than a peer facility, there is a good chance your facility could save significantly in terms of cost and energy.

Find

1	**Planning**	Relevant decision makers commit to the project and complete planning exercises to define the scale, scope, and goals.
2	**Benchmarking**	Compare the facility's energy performance to similar peer facilities and identify savings potential.
3	**Energy Audit**	Assess existing facility conditions to determine where and how energy is being used and establish reduction strategies.

Figure 5: Key steps to finding potential retrofit opportunities

Benchmarking

Define Audit Scope	Select qualified energy professional(s) to perform benchmarking and ensuing energy audit.
Develop Audit Plan	Identify similar healthcare facilities to compare against your facility's performance.
Collect Data	With the assistance of an energy professional, define the desired performance metrics (e.g., total energy consumption per building floor area) that you would like to measure and compare your facility against.
Preliminary Analysis	Collect data from your facility while the energy professional collects data on peer facilities.
Analysis	The energy professional will perform the analysis and submit a summary report of your facility's performance against the selected benchmark metrics. Look for insights in the analysis which will help guide decisions for your project.
Revisit Assumptions	Review your OPRs and RFPs in light of the benchmarking analysis to ensure you're still on track.

Figure 6: Overview of the building energy benchmarking process

Energy Audit

Define Audit Scope	Work with the audit team to identify the scope of the audit (i.e., what systems and building components will be investigated).
Develop Audit Plan	Work with the audit team to define what's going to be measured/analyzed and how.
Collect Data	Collect existing data on past energy usage (e.g., energy bills, etc.), then complete a walk-through and survey of existing building and systems with the audit team.
Preliminary Analysis	The energy audit team will analyze energy usage patterns.
Identify Retrofit Opportunities	Based on analysis, your energy audit team should identify a range of energy efficiency measures and retrofit options based on your facility's attributes, available budget, and return on investment.

Figure 7: Overview of the energy audit process

This guide was developed to be used in tandem with a complementary web-based tool designed specifically for Caribbean healthcare facilities. This free tool, found at www.hospitalretrofits.org, helps hospital administrators benchmark and assess their facility's current performance. The tool also identifies potential energy efficiency measures while targeting overall potential energy and cost savings based on the specifics of that facility. While the tool provides a comprehensive analysis, it is intended to complement a detailed analysis performed by an energy professional. Outputs from the tool help guide the retrofit process and identify the best path to measurable savings. Please refer to Appendix A for a detailed guide to using the tool.

Energy Audit

After completing the facility performance assessment, identifying possible EEMs, and determining potential savings through the online tool, an energy audit of the facility needs to be performed to verify the identified opportunities. During an energy audit, an energy professional surveys the facility's utility bills and building systems. A thorough energy audit will confirm much of the analysis completed through the online tool and may even provide new strategies and approaches to save cost and energy in your facility. Figure 7 provides an overview of the energy audit process.

Energy audits should only be conducted by experienced energy professionals who are knowledgeable in building operations and systems. Procuring the services of qualified energy professionals is typically accomplished through the development of owner project requirements (OPR) and a request for proposal (RFP).[5]

The energy professional selected to perform the audit should use the EEMs proposed by the online tool as a starting point for his or her analysis. This will save time and help drive the retrofit process forward. Based on data collected during the building survey, the energy professional will be able to identify which EEMs are technically feasible, how favorable they will be in terms of energy savings, and their estimated associated cost. Additionally, through the energy audit, the energy professional may also identify other EEMs to reduce energy use and cost at the facility.

To maximize savings and value, EEMs should be bundled together to form a true deep energy retrofit. Many different criteria can be used to bundle EEMs, and factors such as the cost effectiveness and the complexity of implementation of each individual EEM need to be considered. The online tool provides a starting point by automatically suggesting EEM bundles. However, the bundling criteria should be dependent on the individual facility's priorities and maintain consistency with the overall project vision. Savings and capital costs also change as different combinations of measures are grouped together. To ensure the best possible combination of retrofit measures, the energy auditor should iteratively analyze and adapt the EEM bundle options based on the facility's needs.

Accurate energy savings and capital cost estimates are necessary to ensure financial calculations are valid. This becomes especially important if the facility may seek funding through private financiers. The project champion and healthcare facility team should confirm that the energy auditors are using qualified cost-estimators and that the estimates have been thoroughly vetted. Contractors may also be brought onto the project during the energy audit stage to provide more accurate guidance on capital costs of upgrades. Cost estimates can often vary widely; therefore special care should be taken to ensure the accuracy of estimates used in the financial calculations.

5. An OPR is created by the facility owner in order to define the project's overall goals and an RFP is a document released to the public asking companies to submit bids for completing a specific project. Examples are provided for download at www.hospitalretrofits.org/resources.

Finance

Identify the funding options
that make the most
sense for your facility

Identify Funding Sources

Energy efficiency offers significant cost-saving opportunities for healthcare facilities in the Caribbean islands. Cost savings from energy efficiency projects open up new opportunities to invest in better patient care through expansion of a facility's staff, nurses, and doctors. Healthcare facility managers can use these savings to invest in facility upgrades and invest in new medical equipment. Despite the potential for year-on-year savings that can be realized through energy retrofits, many healthcare facilities struggle to find available capital for the initial investment required. How can a healthcare facility, already tight on budget, find money to invest in building renovations or new energy-saving equipment?

The purpose of this guide is to support the development of well thought-out, bankable energy retrofit projects in healthcare facilities that can get the necessary capital to move forward. Financiers are beginning to realize that energy efficiency pays back—as demonstrated by the numerous finance programs supporting retrofit projects, which have dramatically expanded in the last decade.

Where a facility owner does not have available capital to fund a retrofit project, this guide, and the accompanying online tool, are designed to help project champions sufficiently develop their project's scope, risk, and return analysis to unlock investment opportunities from external financiers. These financiers typically require accurate and thorough analysis of the facility's energy consumption, costs, and the savings associated with retrofit activities. The required calculations and analyses for deep energy retrofits can be completed using a combination of the steps outlined in the "Find" section of this guide and the online tool. These findings will need to be robust and accurate so they can be presented to external financiers who have access to the required capital for retrofit projects.

Experience with hospital energy retrofits has shown that energy efficiency pays back, and then some. For example, it took only two years for a hospital to recoup the $25,000 that was spent replacing existing single speed drives with high-efficiency variable speed drives on the facility's water pumps (Figure 8). After two years, the hospital was able to use the energy cost savings from the retrofit project to implement additional EEMs; cost savings like these can even help pay for new medical equipment in the future.

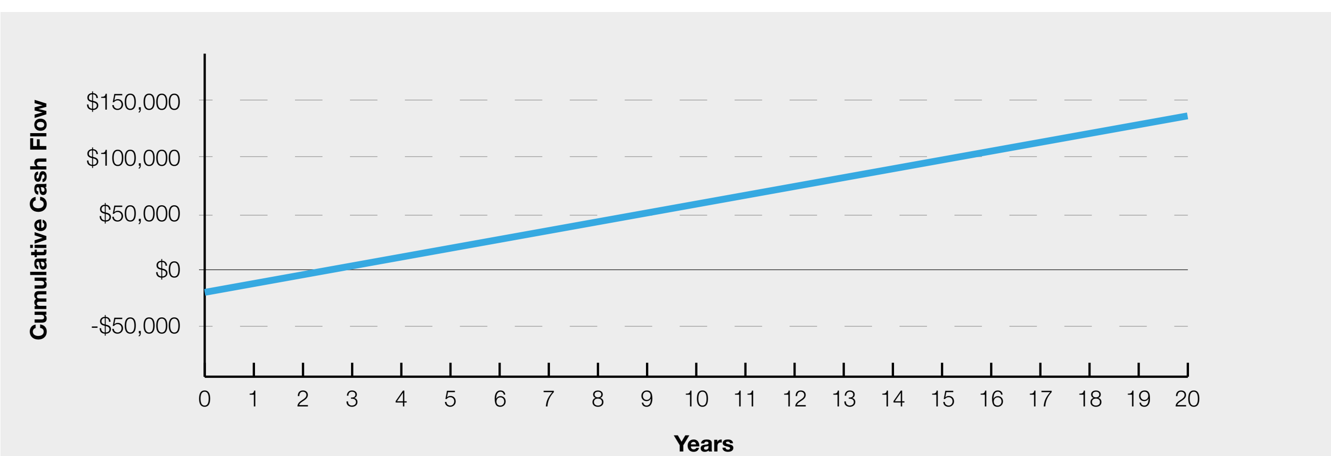


Figure 8: Example of simple payback on installing variable speed drives on pumps

Specific Financing Opportunities

By providing potential investors with bankable energy efficiency projects, healthcare administrators and project champions can tap into the numerous available financing programs to secure the capital necessary for implementation.

Because of differences in both building ownership structures, scope of efficiency projects, availability of grants and/or concessionary resources, and local business environments, the specific financing mechanism to pursue will vary from facility to facility in the Caribbean. To finance energy efficiency projects, the first step that a healthcare facility should take is to use the online tool to identify both retrofit opportunities and financing options for your specific situation.

A combination of the funding sources found in Table 1 can be used to help healthcare facilities acquire financing for deep energy retrofit projects that are planned and developed using this guide and the complementary online tool.

The investor landscape is constantly changing, and RMI and CWR are actively working with financiers to develop targeted programs for Caribbean hospital energy retrofits. After completing the steps outlined in this guide and the online tool, contact RMI and CWR at hospitalretrofits@rmi.org for assistance with procuring financing for your project.

Owner-financed Energy Efficiency

When capital is available, owner-financed energy efficiency projects typically have the greatest potential for you to maximize the savings from your investment.

Incentives and Development Funds

Where available, development and aid funds have proven to be a reliable, low-cost source of capital for energy efficiency projects. Examples of these funds and incentives include:

Bilateral and multilateral aid funds

Alliance of Small Island States — *SIDS DOCK*

Caribbean Development Bank — *Basic Needs Trust Fund (BNTF)*

European Union — *Caribbean Investment Facility (CIF)*

Inter-American Development Bank — *Sustainable Energy for All (SE4ALL)*

Overseas Private Investment Corporation — *AIC Caribbean Fund*

U.K. Department for International Development — *UK Aid*

United Nations Development Program

U.S. Agency for International Development (USAID) — *Clean Energy Finance Facility for the Caribbean and Central America (CEFF-CAC)*

World Bank — *Energy Sector Management Assistance Program (ESMAP)*

Federal, state, and local governments

Barbados — *Sustainable Energy Investment Programme (Energy SMART Fund)*

Columbia — *Energy Efficiency Financing Program for the Services Sector*

Utility incentives and programs

Third-Party Financing Opportunities

Financing models that have proven successful in other regions and may soon become available in the Caribbean. These models include:

Commercial banks — energy service company (ESCo), managed energy service agreement (MESA), and energy service agreement (ESA) models

Community development financial institutions (CDFIs)

Institutional investors

National development banks and local credit unions

Philanthropy

Private equity, venture capital, and venture philanthropy

Table 1: Potential funding sources for hospital energy retrofits in the Caribbean

Follow-through

Implement your deep energy retrofit project and maintain improved performance by following best practices

Follow-through

Once your team has identified retrofit opportunities and financing options, it is now time to design, engineer, and install your selected energy efficiency measures so you can begin to reap the benefits of a better performing building. This section will help guide you through the process of implementing your project(s). Figure 9 provides an outline of the "Follow-through" process.

EEM implementation will require the following professionals:

- **Engineer:** An engineering firm to design the measures and produce drawings/construction documentation.
- **Contractor:** A contractor to follow the drawings/construction documentation and install the measures.
- **Commissioning Agent:** A commissioning agent (CxA) to verify the measures have been installed correctly.
- **M&V Professional:** A measurement and verification (M&V) professional to confirm that the efficiency upgrades are performing as expected and that predicted savings are achieved (while M&V is always recommended it is not critical and should be included to the extent possible based on available capital).

In order to determine which professionals are best suited for the project, develop and publish an RFP that outlines the project goals and scope for each of the required professionals. Standard RFP language is provided at www.hospitalretrofits.org/resources.

Responses to the RFPs should be evaluated based on the respondents' relevant experience, the breadth and thoroughness of their previous work, and the cost of services. The RFPs for the engineering, commissioning, and M&V scope of work must be developed and published first, so the contractor can accurately estimate construction costs.

The CxA needs to be a third-party consultant working under an independent contract with the owner. This ensures the facility's interests are the prime concern. By including CxAs in the design phase, they are able to provide valuable insight into design parameters and constructability. This will lead to improved performance and additional cost savings.

The CxA will also develop operations manuals and training procedures, so that facility staff have the necessary resources and skills to operate the building systems correctly for many years. Continuous commissioning of the building on an annual basis is also highly recommended to verify building systems are being maintained and operated properly. A robust commissioning effort can ensure that

Figure 9: Key steps in the "Follow-through" process

anticipated savings are realized over the entire life of the building, thereby protecting the long-term profitability of the project and the healthcare facility.

The M&V process should begin as EEMs are being selected for implementation, to assist the designers and engineers with the installation of metering and controls equipment. Engineers should develop an M&V plan that includes the project's goals and objectives, a list of individuals responsible for implementing the plan, and the equipment and systems requiring installed meters. The M&V process, while important for strategic, operational, and financial planning, can often be an added expense. For many facilities in the region, this may extend beyond the scope of a deep energy retrofit project.

After the engineering firm, CxA, and M&V teams are selected and the construction documentation for the project is complete, the healthcare facility team will need to develop and release the RFP for the contractor. As with the other RFPs, contractors' responses should be evaluated based on their relevant experience, the breadth and thoroughness of their previous work, and the cost of services. Due to the critical nature of healthcare facilities, contractors must develop implementation plans and construction schedules to allow the healthcare facility to remain operational during the retrofit process. The contractor should also take careful consideration with construction sequencing in a collaborative effort with key healthcare facility professionals. This will minimize operational disruptions and ensure the community has consistent access to meet its healthcare needs.

Conclusion

The following is a summary of next steps and critical actions to be facilitated by hospital administrators

Conclusion

Healthcare administrators across the Caribbean are faced with rising energy costs and underperforming buildings, making their facilities prime candidates for deep energy retrofits. The savings potential is there; it just needs to be unlocked. Now that you've read this guide it is time to unlock those savings and start the deep energy retrofit process by following the instructions in the "Find", "Finance", and "Follow-through" steps found in this guide. You can quickly move through the process with a few simple actions:

1. Begin the process by determining the project champion.
2. Next, use the online tool at www.hospitalretrofits.org to identify potential retrofit opportunities at your facility.
3. Enlist the technical expertise of energy professionals to incorporate these retrofit opportunities into a project plan that defines the project's scale, scope, and goals.
4. With retrofit opportunities identified and a plan outlined, contact RMI and CWR for assistance with finding the right financing option for your project.
5. Finally, hire qualified professionals to implement your retrofit project and maintain your facility's ongoing performance.

By following these steps you can lead your facility to the significant savings, return on investment, and improved level of care that can only be achieved through a deep energy retrofit.

Appendices

More detail and clear examples to help you through the process

Appendix Contents

Appendix A

Using the Online Tool

Using the Guide

This Appendix contains an instructional guide on how to use the online Energy Retrofit Tool and highlights the tool's many features.

The Energy Retrofit Tool, which can be accessed at www.hospitalretrofits.org, was created to help eliminate barriers to the development of retrofit projects for healthcare facilities. Built by a team of global experts, the goal of this tool is to provide a quick and simple estimate of energy saving potential, using basic information you should have close at hand. This is the first step to unlocking widely available financing, and moving forward to take back operational savings from underperforming buildings.

General Information

After opening the guide in your web browser, you will first be directed to the General Information Screen, which collects information on the physical and operational characteristics of your facility. This helps determine the potential savings of energy retrofits.

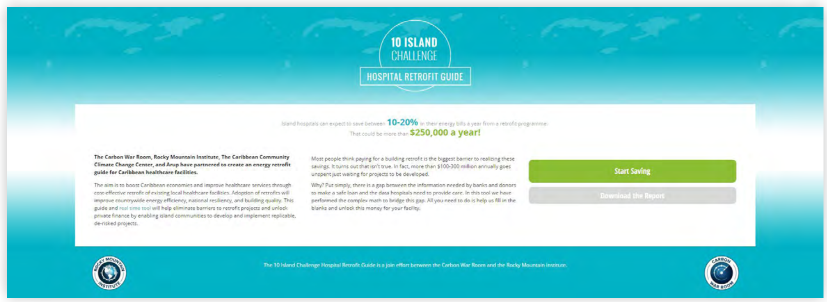
A: Basic information identifies your hospital in the tool database.

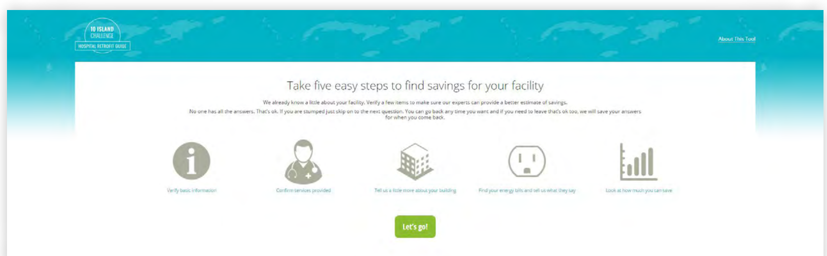
B: Operational information, such as number of beds and floor area, help estimate annual energy use.

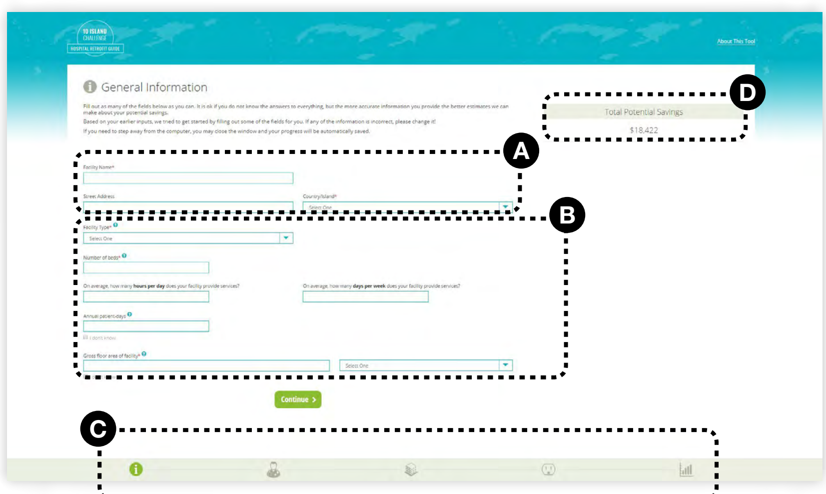
C: The navigation pane at the bottom at the screen displays your progress.

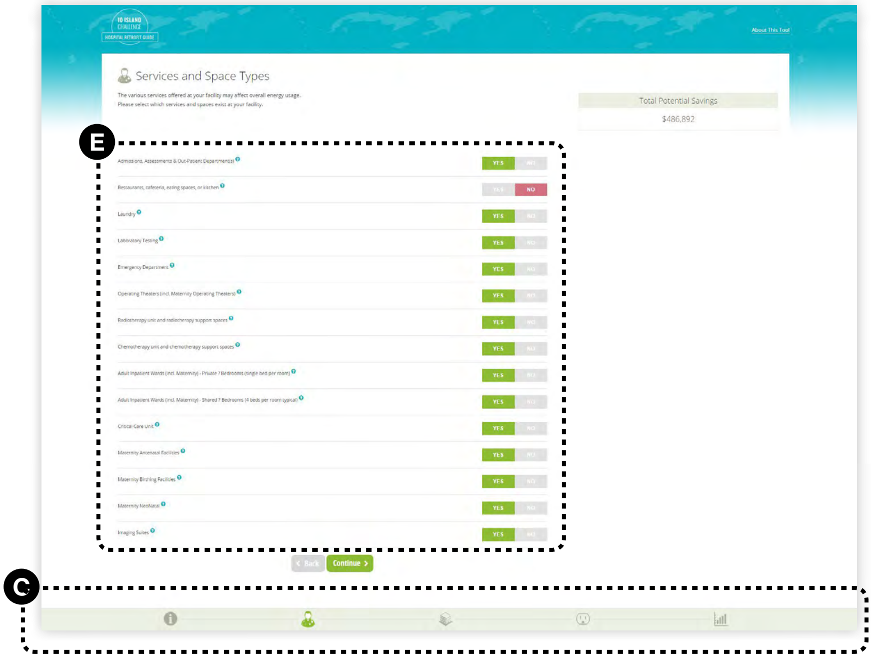
D: Potential energy cost savings from energy retrofits is constantly updated as new information is added.

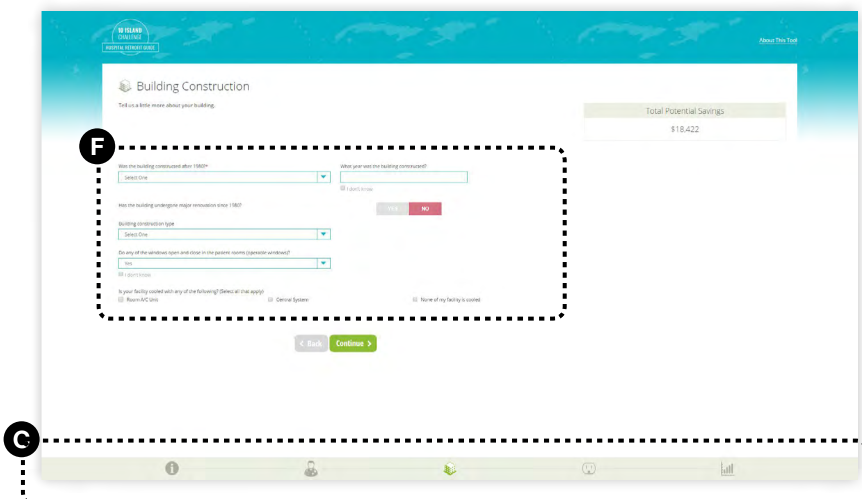
By clicking "Continue" at the bottom of the General Information screen, you will be directed to the Services and Space Types section.











Services and Space Types

The Services and Space Types section allows you to identify which services are offered at your facility. This helps the tool generate more accurate energy use estimates for certain procedures and services, such as laboratories and imaging.

E: Use the toggle buttons to select which services your facility offers.

Building Construction

The Building Construction screen collects more in-depth information on the physical characteristics of your facility, such as construction materials.

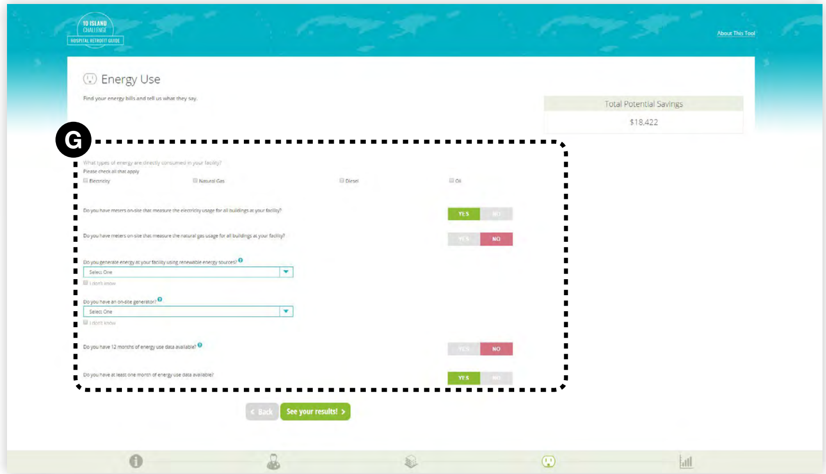
F: Building information helps the tool determine energy used for lighting and mechanical systems.

This information can be changed at any time by using the navigation pane (**C**) located on the bottom of the screen, or by simply clicking the “Back” button.

Energy Use

The Energy Use section is used to collect more information on how that energy is provided to your facility, and helps the tool identify the most appropriate strategies for energy use reduction.

G: Energy use information allows the tool to adjust its estimates to more accurately reflect your facility.



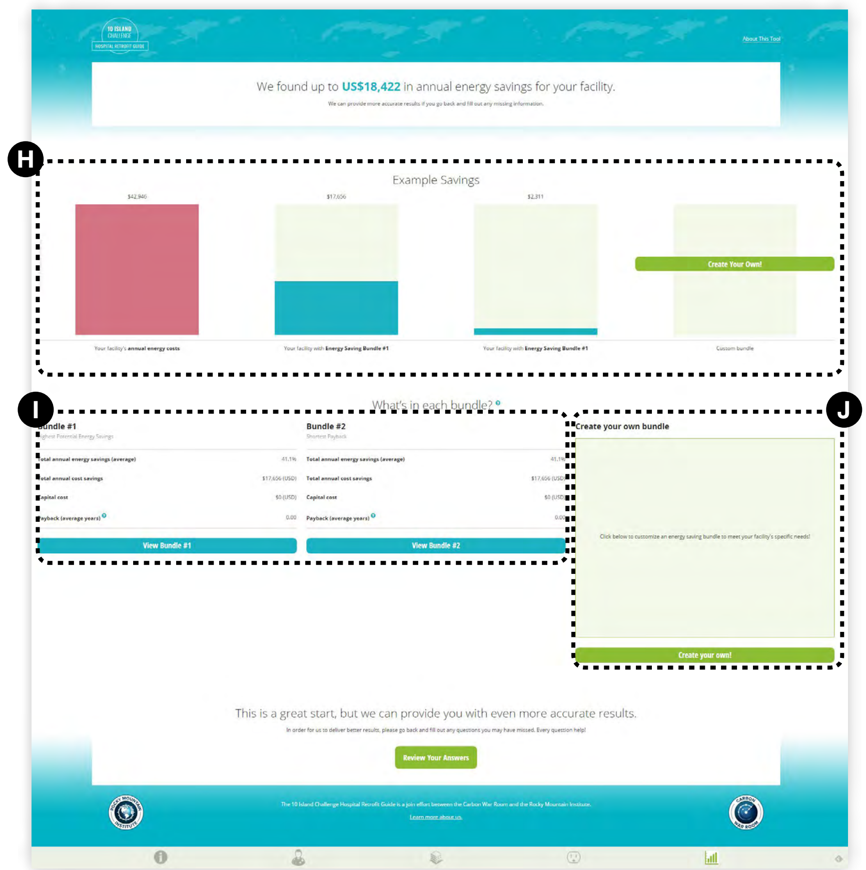
Results

The Results section displays energy cost savings, and provides two bundles of actions for energy use reduction. The individual actions in each bundle are based on user inputs, so more accurate information generates better solutions for energy savings.

H: Potential energy savings are compared to an energy use baseline derived from user information.

I: Energy savings bundles created by the tool provide the highest annual energy savings with the lowest capital cost.

J: You can also create your own bundle and quantify the results.



Appendix B

Building Energy Analysis
Methodology

Overview

This Appendix contains descriptions of the resources used to develop this guide, the data collection process, and the methodology and assumptions used to perform the energy analysis behind the Energy Retrofit Tool.

Resources Used

A wide range of resources, including, regional and local reports, geographic information system (GIS) databases, and government and private-sector websites, were thoroughly reviewed to assess the existing conditions of healthcare facilities on the islands listed above. Additionally, resident experts were interviewed to gain local context and insight.

The Caribbean Community Climate Change Center also surveyed healthcare facility managers, administrators, and local officials to obtain data on individual facilities. Annual energy consumption, building floor area, and year of construction were among the data points surveyed for development of the guide. The complete survey can be found at the end of this appendix for reference.

A literature review was conducted to identify relevant documentation and existing resources. Notable existing resources referenced in the guide include:

- Rocky Mountain Institute and American Institute of Architects, *Deep Energy Retrofits: an Emerging Opportunity*, 2013, www.aia.org.
- American Society of Heating, Refrigerating, and Air-Conditioning Engineers, *The ASHRAE Guide for Buildings in Hot and Humid Climates*, 2009, www.ashrae.org.
- Lawrence Berkley National Laboratory, *Hospital Energy Benchmarking Guidance - Version 1.0*, 2009, eetd.lbl.gov.
- Pan American Health Organization, *Smart Hospital Toolkit*, 2013, www.paho.org.
- Pan American Health Organization, *Health in the Americas: Regional Outlook and Country Profiles*, 2012, www.paho.org.
- U.S. Department of Energy, *Advanced Energy Retrofit Guide for Healthcare Facilities*, 2013, buildingdata.energy.gov.

Data and Methods

The most common way to assess a building's energy performance is by determining its energy use intensity (EUI). A building's EUI is calculated by taking the total annual energy consumed by the facility and dividing it by the building's total floor area.

This metric allows stakeholders to compare a building's performance to other similar buildings. Such a comparison can be used to determine if there are opportunities for energy savings and if a building is a suitable candidate for an energy retrofit. Based on the collected data, the average EUI for existing Caribbean healthcare facilities is approximately 156 kWh/m^2-year.

One of the challenges of working in the Caribbean is access to reliable energy consumption data of healthcare facilities. This is due to a lack of publicly available information and limited success in reaching out to local healthcare contacts. Furthermore, much of the data collected may be unreliable. Incomplete and inaccurate data were removed to prevent outliers from skewing the entire data set.

Building Energy Profiles

Energy efficiency measures (EEMs) can include items related to lighting upgrades, fan or motor pump energy reductions, cooling system efficiency improvements, and more. In order to estimate the magnitude of these energy improvements we need to know the proportion of a facility's overall annual energy usage that is dedicated to each type of end use.

Typical energy end uses include:

- Internal Lighting
- External Lighting
- Fan Energy
- Pump Energy
- Cooling
- Heat Rejection
- Heating
- Domestic Hot Water
- Specialist Equipment (non-reducible plug loads)
- Non-specialist Equipment (reducible plug loads)

Estimating the proportion of energy that can be assigned to each of these end uses, allows us to more accurately apply the energy savings from the EEMs to specific energy end uses.

Hospital Services, Spaces and Typologies

Different space types within a building will have different energy end-use profiles so it is important to analyze the different spaces that go into making up a hospital.

The United Kingdom National Health Service (NHS) Health Building Design Guidance notes contain information such as room data sheets for different service departments within modern U.K. hospitals. The U.S. Department of Energy (DOE) also provides guidance on the different space types that make up a number of different hospital types in their energy benchmark models. These sources and others allow us to tag certain space-use types to certain services that might be provided by a hospital.

The hospital service types used in this assessment include:

- Admissions, Assessments, and Outpatient Department(s)
- Restaurant and/or Cafeteria
- Laundry
- Laboratory Testing
- Emergency Department
- Operating Theaters (incl. Maternity Operating Theaters)
- Radiotherapy Unit
- Chemotherapy Unit
- Adult Inpatient Wards—Single-Bed Rooms (incl. Maternity Beds)
- Adult Inpatient Wards—Multi-Bed Rooms (4-Bed Rooms Typical; Incl. Maternity Beds)
- Critical Care Unit
- Maternity Antenatal Facilities
- Maternity Birthing Facilities
- Maternity Neonatal
- Imaging Suites

From the sources mentioned above, we estimated the different space-use types that go into providing each of the services listed above and also the proportional split of each of the space uses. All of the hospital services listed previously can have their spaces categorized into the following space-use types:

- Office / Receptions
- Lobby / Waiting / Meeting
- Pantry / Kitchen
- Circulation
- Storage / Plant
- Changing Rooms
- Water Closets / Showers
- Single Bedroom Wards
- Multi Bedroom Wards
- Laundry Room
- Cafeteria
- Post-Natal Incubation / Critical Care
- Intensive Care Bedrooms
- Critical Care Nurse Station
- Ward / Emergency Dept. Nurse Station
- Lab Testing
- Emergency Dept. Triage Room
- Emergency Dept. Trauma Room
- Consulting / Examination
- Imaging
- Operating Theater

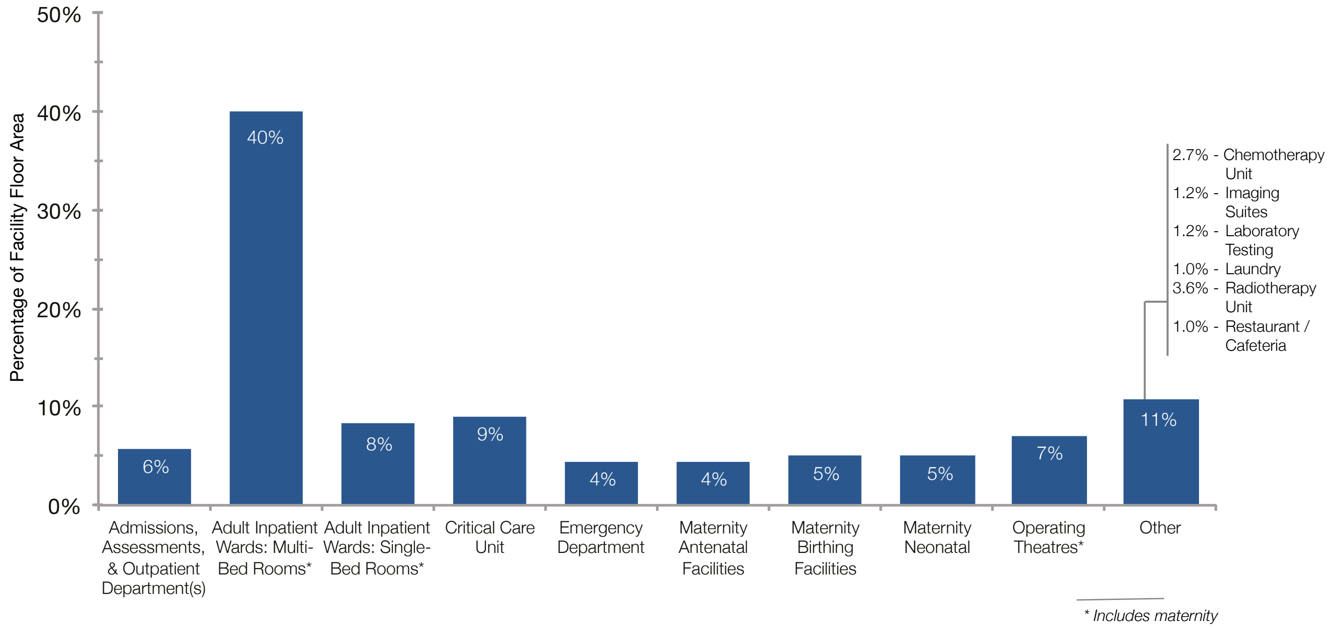


Figure 10: Breakdown of the area used by each service provided at a representative inpatient hospital.

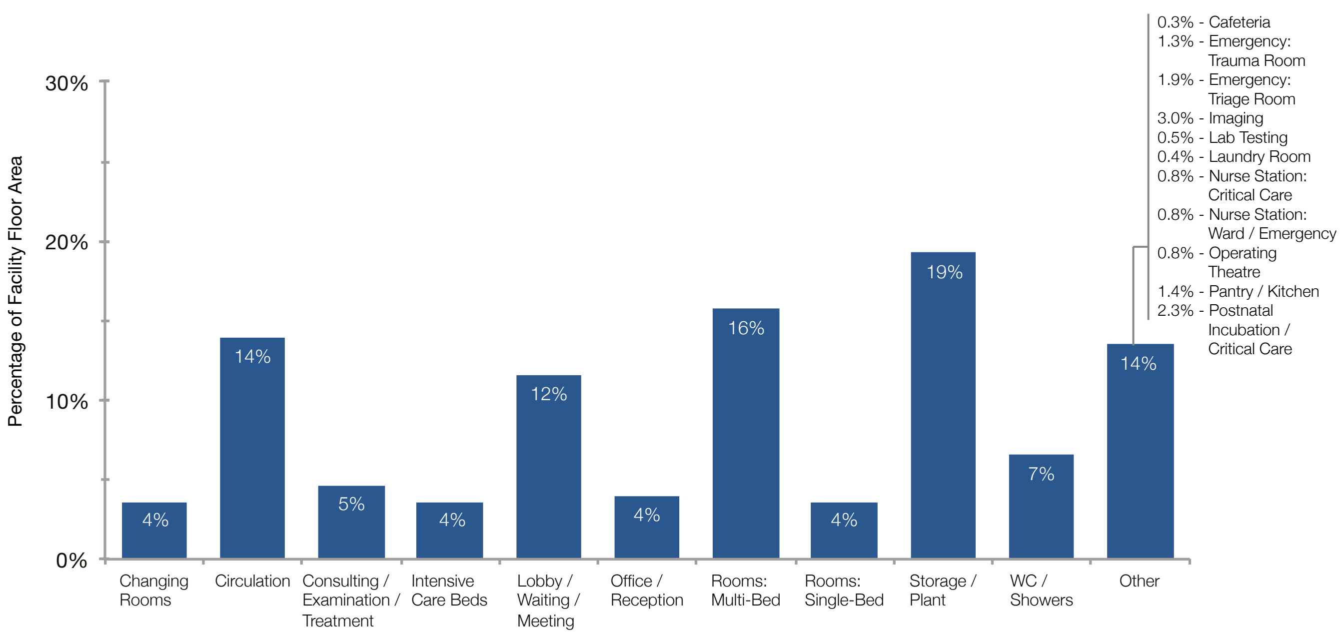


Figure 11: Breakdown of the area dedicated to each use-type at a representative inpatient hospital.

There is also a question of scaling involved with each of the hospital services. For example, a critical care unit with 16 beds will have less bedroom space than a unit with 24 beds. However, the floor area for nurses' stations will not increase in the same proportion. Therefore, a scaling factor was applied to each space type to account for this disproportion when calculating the areas and spaces associated with service units of various sizes.

Hospital Typologies

Because information on exact services provided at each hospital facility was difficult to collect, a number of services were allocated to three hospital typologies, and each facility will be assigned one of the typology tags. The typologies are:

- Inpatient Hospital
- Outpatient Surgery / Clinic
- Primary Care Clinic

Building System Standards

There is a broad variety when it comes to the standards of hospital buildings in terms of their HVAC systems, building envelope, opening hours, etc. For instance, a brand new state-of-the-art hospital may provide high levels of occupant comfort, advanced technological services, and comply with the latest building codes. These systems will typically consume high levels of energy—even if they are operating at maximum efficiency. A hospital of a much older vintage that provides the same type of services may still be using outdated HVAC systems and a building envelope built to less strict building codes. These buildings will have vastly different energy profiles. To account for this variation, three different standards of healthcare buildings (basic, medium, and advanced) were modelled based on the vintage and efficiency of the building systems.

Computerized Energy Simulation Modelling

The space-types listed above were modelled using eQUEST energy simulation software to develop energy use profiles. Factors that affect the energy end-use profile of the different spaces within a building include:

- Activity for which the space is used
- Occupancy rates and schedule
- HVAC systems used to serve it
- Equipment used in it
- Building envelope

The energy model uses the weather file for the facility location along with assumptions for all the factors listed above about each of the different space types. The information for these assumptions is mainly sourced from the U.S. DOE.

Annual EUI in kWh/m^2 was calculated for each of the different space-use types and used as the building blocks for calculating a facility's energy profile depending on its hospital typology, size, and building systems standard. The final step in the process of creating an energy use profile for the various hospital building types was to calibrate the modelled results using the actual annual energy consumption data that was collected from building surveys distributed to healthcare facilities around the Caribbean.

Energy Efficiency Measure Calculations

Once an energy profile has been established for a facility the effects of the various EEMs that apply at that facility can be calculated. Some EEM energy savings can be calculated using the energy simulation models, others will be based on separate system-by-system engineering calculations that compare typical baseline system performance to the improved EEM performance levels. There are case studies and reference papers that these calculations can be cross-checked against in order to validate that the results of the calculations are reasonable. There will be some EEMs that will not apply to facilities of a certain standard or typology. For example, a basic primary care clinic would not be eligible to implement variable speed drives on chillers because it is assumed that the facility would not contain any equipment that requires pumps. Detailed assumptions and calculations for each EEM can be found in Appendix C.

Healthcare Facility Survey

Facility Name		
Street Address		
Country		
Facility Contact Person Name		
Title		
Phone		
E-mail		
Hospital or clinic		
Gross floor area of building (m^2 or ft^2)		
Number of floors		
Year building was constructed		
Year of last major renovation/addition		
Floor area renovated/added (m^2 or ft^2)		
Major building construction type (brick, concrete, steel, wood, other)		
Operable windows (yes/no)		
Air conditioning provided (yes/no)		
Floor area served by window/through-the-wall air conditioners* (%)		
Floor area served by split unit air conditioners* (%)		
Floor area served by central cooling system* (%)		
Central chiller type (air cooled or water cooled)		
Central cooling distribution type (chilled water or air)		
Number of hospital beds		
Patient occupancy rate (%)		
Hours of operation		
On-site laundry (yes/no)		
On-site cafeteria/kitchen (yes/no)		
Number of elevators		
Number of CT scanners		
Number of MRI machines		
Number of surgery suites		
Number of emergency rooms		
Energy data	**Value**	**Units**
Annual electricity consumption (kWh, MWh, etc.)		
Annual electricity cost (US Dollar, East Caribbean Dollar, etc.)		
Annual diesel consumption (litres, UK gallons, etc.)		
Annual diesel cost (US Dollar, East Caribbean Dollar, etc.)		
Annual natural gas consumption (therm, cubic meters, etc.)		
Annual natural gas cost (US Dollar, East Caribbean Dollar, etc.)		
Annual oil consumption (litres, UK gallons, etc.)		
Annual oil cost (US Dollar, East Caribbean Dollar, etc.)		
Water data	**Value**	**Units**
Annual water consumption (litres, UK gallons, etc.)		
Annual water cost (US Dollar, East Caribbean Dollar, etc.)		

***Notes**
- **Window/through-the-wall air conditioners** have vents on the inside and outside of the building to transfer air and are placed in a window or through an opening in an exterior wall.
- **Split unit air conditioners** consist of an outdoor unit that is installed outside of the room or space that you wish to cool and an indoor air outlet unit that provides cool air to the space. The two units are connected by pipes that carry refrigerant.
- **Central cooling systems** use large chiller units to provide cooling to multiple spaces through a network of ducts or pipes.
- **Central chillers** can be cooled using outdoor air (i.e. **air cooled chiller**) or water (i.e. **water cooled chiller**).
- **Central cooling systems** can use **air** and a network of **ducts** or **chilled water** and a network of **pipes** to provide cooling to individual spaces.

Table 2: Healthcare Facility Survey

Appendix C

Included Energy
Efficiency Measures

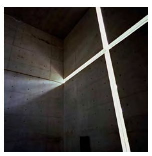
Energy Efficiency Measures

The energy efficiency measures that are included in the tool were selected based on extensive research coupled with Arup's experience working with hospitals and on-the-ground audits of Caribbean hospitals. Although there is a wide variety of EEMs included in the tool, energy professionals may recommend additional measures based on your facility's attributes and needs.

Building Envelope

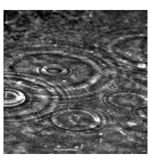
"Building envelope" describes the physical fabric of a building that separates the inside from the outside. The building envelope comprises the walls, roof, windows, doors, floors, and the building systems (e.g., ventilation) that are contained inside them. The building envelope influences indoor environmental quality, the comfort of building users, and the overall energy efficiency. Its quality is therefore fundamental to how the building operates.

Lighting



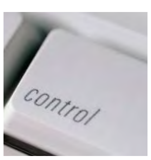
The functionality and energy consumption of a space is highly dependent on the lighting and daylighting design. Light transmission into and out of a space must result in appropriate illumination for the space and the surrounding environment. Suggested energy-saving measures cannot have an adverse impact on this function.

Domestic Hot Water



Conditioning, pumping, and treating water accounts for an average of 3 percent of energy consumption globally. Hospitals use far more than average and therefore reducing water use and more efficiently managing what is used are critical steps in energy savings.

Controls, Operations, and Maintenance



The resource use of a building is affected by the way in which it is used, how the systems are controlled, and the on-going maintenance it receives.

Energy Generation Systems

These are systems which generate energy on the property, typically from renewable sources such as the sun or wind. Fuel cell and cogeneration are also possible. These systems leverage local resources and building-specific solutions.

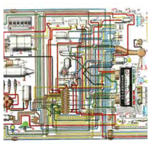
Plug and Process Loads

Sometimes called unregulated loads, these constitute the energy used as part of the day-to-day business of the hospital. This could include energy needed to run an MRI machine, a computer, an adjustable bed, or even a television. Many of these items can be added over time.

HVAC (heating, ventilation, and air conditioning)

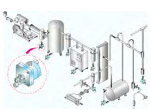
These systems condition and move air within the building and are the largest users of energy in hospitals. Because of the complexity of these systems, poorly running systems may go a long time without someone noticing things are wrong. These two factors make this one of the biggest areas for possible savings.

Electrical Systems



These systems provide power to or transfer power in a building. While the systems don't have many moving pieces they are the first point for systemic savings.

Compressed Air



These are systems used for medical gases. They require energy to keep them pressurized and distributed throughout the network.

Additional Information

ECM Type	ECM Description
Building Envelope	Install low solar gain window films
Building Envelope	Add a reflective roof covering
Building Envelope	Replace windows and frames with double-paned low-e, thermally broken, vinyl-framed windows, with high visible light transmittance
Building Envelope	Install automated louver shading systems on all sun-exposed windows
Building Envelope	Install exterior window shading
Building Envelope	Perform blower testing and sealing of envelope
Building Envelope	Install green roof
Lighting	Replace exit signs using incandescent lamps with LED exit signs
Lighting	Replace T12 fluorescent lamps and older T8 lamps and magnetic ballasts with high-efficiency T8 lamps and instant-start electronic ballasts
Lighting	Replace incandescent lamps with CFLs
Lighting	Install more efficient exterior lighting for façades and parking lots
Lighting	Install occupancy sensors for lighting in rooms that are used intermittently
Lighting	Install lighting timers in rooms that are used intermittently and for very short intervals
Lighting	Install photosensors and dimming ballasts to dim lights when daylighting is sufficient
Lighting	Install bi-level or dimming control for nighttime setback in corridors and at nurses' stations, with upgraded task lighting
Lighting	Use lighting controls that first switch power to 80%, with 100% requiring manual upswitching for examination rooms, nurses' stations, and other areas
Lighting	Install LED lighting for all patient rooms, examination rooms, and operating rooms
Domestic Hot Water	Add insulation to steam/hot water pipes
Domestic Hot Water	Install instantaneous domestic water heaters
Domestic Hot Water	Install low-flow shower heads
Domestic Hot Water	Install low-flow sink aerators
Domestic Hot Water	Reclaim laundry water
Controls, Operations, & Maintenance	Upgrade and optimize building control systems (HVAC, lighting, service hot water)
Controls, Operations, & Maintenance	Install high-efficiency drive belts
Controls, Operations, & Maintenance	Install an EMS and replace pneumatic controls with DDC
Controls, Operations, & Maintenance	Optimize chiller and cooling tower design and controls
Controls, Operations, & Maintenance	Perform recomissioning on building systems (HVAC, service hot water, envelope)
Energy Generation Systems	Install photovoltaic system for electricity generation
Energy Generation Systems	Install wind turbine system for electricity generation
Energy Generation Systems	Install solar hot water pre-heat
Plug and Process Loads	Replace cafeteria appliances with ENERGY STAR models

ECM Type	ECM Description
Plug and Process Loads	Install VSDs for demand control of kitchen hood exhaust fans
Plug and Process Loads	Specify medical equipment that has low standby mode electrical use, and equipment that can be powered down or off when not in use
Plug and Process Loads	Install occupancy sensor devices for workstation power control
Plug and Process Loads	Install drain water heat recovery on washing machines and clothes dryer heat recovery system
HVAC	Install VSDs on chilled-water and hot water pumps
HVAC	Replace oversized, inefficient fans and motors with right-sized NEMA premium efficiency motors
HVAC	Convert CV air handling system to VAV
HVAC	Replace DX cooling system with more efficient right-sized model
HVAC	Install a heat recovery chiller for process heating or reheat loads
HVAC	Install chilled beam cooling system for patient rooms
HVAC	Install high-efficiency chillers
HVAC	Install low-power, low-approach cooling towers
HVAC	Convert fans to VSDs (cooling tower, supply fan motor, etc.)
HVAC	Install energy efficient packaged air conditioning units
HVAC	Upgrade to demand-controlled ventilation to reduce OA flow during partial occupancy
HVAC	Install a dedicated outdoor air system
Electrical Systems	Replace electrical transformers with right-sized, higher efficiency models
Electrical Systems	Install static power factor correction (capacitors)
Electrical Systems	Install dynamic voltage optimization
Compressed Air	Install screw air compressors
Compressed Air	Reduce compressed air losses

Detailed descriptions, assumptions, and analysis of each EEM can be viewed at: www.hospitalretrofits.org/resources.

ARUP

Caribbean Community Climate Change Centre

Rocky Mountain Institute

Carbon War Room