NYU STERN

Center for Sustainable Business

ROSI™ Project on Decarbonizing Healthcare Delivery Systems

The Commonwealth Fund

Decarbonization Framework

October 2023

A BETTER WORLD THROUGH BETTER BUSINESS

Decarbonization Framework

U.S. Health Sector's Greenhouse Gas Emissions & Current Efforts

- The healthcare system accounts for 8.5% of total U.S. GHG emissions. Only 18% of U.S. healthcare emissions are from Scope 1 and 2[1].

- Large integrated healthcare delivery systems are among the early adopters of decarbonization and they are sharing their experiences on platforms provided by the Commonwealth Fund, Practice Greenhealth/Health Care Without Harm, NAM Collaborative, Office of Climate Change and Health Equity (OCCHE), and others.

- Recent initiatives such as the White House/Department of Health and Human Services (HHS) **Health Sector Climate Pledge** are efforts to get healthcare systems to commit and take steps to reduce their environmental footprint. The **Inflation Reduction Act** has decarbonization incentives to further encourage immediate action.

- Challenging macroeconomic conditions of high inflation and interest rates, nursing staff shortages, increased demand for medical services, mounting costs, and supply chain disruptions have resulted in some hospitals deprioritizing decarbonization and other sustainability issues.

[1] Health Care's Climate Footprint (Health Care without Harm & ARUP, 2019)
[2] https://www.healthaffairs.org/doi/10.1377/hlthaff.2020.01247 (Eckelman et al., 2020)

Healthcare Delivery Systems Decarbonization Project Goals

With support from the Commonwealth Fund, NYU Stern CSB developed the Decarbonization Framework for Healthcare Delivery Systems utilizing the Return on Sustainability Investment (ROSI™) Framework and Methodology with the following goals:

1. Development of a **strategy map and monetization framework** to support Decarbonization in the Healthcare Industry with a focus on healthcare delivery systems, including new research and analysis that will aid in **increasing the rate of adoption of decarbonization practices by highlighting the financial implications** of the tangible and intangible benefits of the actions that healthcare delivery systems can take

2. Development of **open source tools** that hospitals of all sizes can use for calculations for a subset of decarbonization practices - these will be available November 2023

3. Case studies that highlight some of the monetization process for a subset of decarbonization practices - these will be available December 2023

The Commonwealth Fund

Decarbonization Framework

NYU Stern Center for Sustainable Business (CSB) has developed a ROSI^{TM} framework for decarbonization in Healthcare delivery systems with publicly available monetization tools to help the industry understand where and how decarbonization can unlock financial value.

Based on research, experience, and engagement with industry leaders, we have identified the **following decarbonization strategies and enablers** that are being used by the industry:

Strategies

Energy Management	Building Design & Maintenance	Sustainable Sourcing	Food Service Optimization
Low Emissions Clinical Care	Waste Reduction	Responsible Investments	Reduced Transportation

Critical Enablers

Leadership	Financing	Education

Decarbonization Framework - Strategies

Energy Management	Implement practices that reduce energy required and switch to renewable energy sources
Building Design & Maintenance	Design and build hospitals and clinics that require less energy, incorporate renewable energy sources, and enhance resilience to extreme weather
Sustainable Sourcing	Utilize sourcing practices that minimize waste and toxic chemicals, incorporate circularity, and reward suppliers that help achieve decarbonization goals
Food Service Optimization	Implement practices that procure foods from local sources, produce less waste, and incorporate plant-based options
Low Emissions Clinical Care	Use clinical care solutions that minimize the carbon footprint of anesthetic gases and patient travel
Waste Reduction	Produce less waste through circularity, proper sorting of waste, and using waste for energy production
Responsible Investments	Prioritize investments focused on sustainability and with portfolios of companies that show progress towards carbon reduction goals
Reduced Transportation	Implement practices that optimize and decarbonize hospital-related transportation

Decarbonization Framework - Critical Enablers

These three enablers help healthcare systems speed the adoption of decarbonization practices and ensure that they are maintained over time

Leadership	Financing	Education
● Setting decarbonizing goals[1] ● Creating a decarbonization team focused on delivery of goals ● Completing an emissions inventory and defining a baseline year[2]	● When starting small, create a revolving fund from savings from practices with short payback periods ● Green carbon fund / gain sharing ● Inflation Reduction Act - apply soon to secure maximum funding[3,4] ● State utility Incentives including financial rebates, design assistance etc.,	● Develop in-house education programs for hospital executives and staff to raise awareness ● Support ongoing clinical staff education on lower carbon practices ● Reinforce behavior changes through training

[1] NAM's Key Actions on Decarbonization (NAM, 2023)
[2] Carbon Accounting (NAM, 2023)
[3] Summary of Inflation Reduction Act provisions related to renewable energy (EPA, 2023)
[4] FACT SHEET: Four Ways the Inflation Reduction Act's Tax Incentives Will Support Building an Equitable Clean Energy Economy (US Department of Treasury, 2022)

Return on Sustainability Investment (ROSI™) Framework

ROSI™ Mediating Factors

The following slides define the ROSI™ Mediating Factors as they apply to healthcare delivery systems

Mediating Factors	
Risk Management (RM)	Encourage risk mitigation and resilience
Stakeholder Engagement (SE)	Improve goodwill among the broader stakeholder community
Operational Efficiency (OE)	Optimize facilities, clinical, and supply chain efficiencies to lower costs and improve financial performance without compromising quality of care
Talent Management (TM)	Attract and retain high-quality talent
Supplier Relations (SR)	Improve upon the relationships between the healthcare delivery system and its suppliers
Media Coverage (MC)	Increase the media coverage a healthcare delivery system receives through new and continued sustainability and social impact commitments

ROSI^{TM} Mediating Factors [cont.]

The following slides define the ROSI^{TM} Mediating Factors as they apply to healthcare delivery systems

Mediating Factors	
Customer Loyalty (CL)	Improve retention of existing patients & attract new patients that are more conscious of environmental impacts
Sales and Marketing (SM)	Increase volume of sales through expanding patient access to health services
Innovation (IN)	Create new revenue streams using sustainable business models

Layout of the Decarbonization Framework

Strategies

- Energy Management
- Building Design & Maintenance
- Food Service Optimization
- Sustainable Sourcing
- Low Emissions Clinical Care
- Waste Reduction
- Responsible Investments
- Reduced Transportation

Several sub-practices identified within each of above strategies*

Applying ROSI Mediating Factors, identified benefits, and provided guidance on monetization

ROSI™ Mediating Factor	ROSI™ Benefits to explore	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Operational Efficiency	Energy costs avoided	Calculate the number of electrical/thermal energy units and the price per unit purchased for a base year. Forecast a scenario of future costs based on the units consumed, normalizing for weather and the projected price per unit. Consider the investment made and the energy credits received in lieu of the generation from the renewable power source. Calculate the new costs by multiplying the consumption from the grid with the applicable price per unit and forecast a scenario. Subtract the new actual and projected cost from the old actual and projected cost to calculate the savings.	Energy generation from the renewable energy source potentially offsets (partially or in whole) the overall energy units consumed from the grid	CSB ROSI Project Research

***Sub-practices impacting hospitals/healthcare providers' Scope 1, 2 and some influenceable Scope 3 are included**

Decarbonization Framework Strategies

Overview of Decarbonization Framework Strategies

Based on research, experience, and engagement with industry leaders, we have identified the **following decarbonization strategies** used by the industry for inclusion in the framework:

Energy Management	**Building Design & Maintenance**	**Sustainable Sourcing**	**Food Service Optimization**
Low Emissions Clinical Care	**Waste Reduction**	**Responsible Investments**	**Reduced Transportation**

Applying the ROSI methodology, practices and sub-practices have been identified within each of above strategies and the associated benefits are discussed in the next slides

Energy Management

Strategies				
	Energy Management	Building Design & Maintenance	Sustainable Sourcing	Food Service Optimization
	Low Emissions Clinical Care	Waste Reduction	Responsible Investments	Reduced Transportation

Sub-practices

Implement practices that reduce energy required and switch to renewable energy sources

Energy efficiency

I: Implement energy efficiency retrofits within the building

Energy transition

II: Switch from non-renewable to renewable energy source by entering into a Physical or a Virtual Power Purchase Agreement

III: Purchase Renewable Energy Credits

IV: Install a new source of renewable energy (onsite or offsite)

Energy storage

V: Add battery storage on existing renewable energy sites (if it did not exist previously)

Benefits Assessment and Monetization Development

Practice: Energy efficiency

I: Implement energy efficiency retrofits within the building. Examples include switching to LED lighting, installing real-time monitoring systems and occupancy sensors, limiting use of equipment in non-peak hours, using valves to isolate boilers, insulating pipes, etc.

ROSI™ Mediating Factor	ROSI™ Benefits/Costs	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Operational Efficiency	Energy Cost Savings	Using data from utility meter readings and bills calculate weather-normalized annual energy usage and costs before switching to energy efficient lighting and equipment. Calculate weather normalized* usage after switching and subtract to get the difference between the two. Consider the investment made on the retrofits. Note that energy usage of equipment worsens over time if not sufficiently retrofitted . Hence, waiting vs. acting now can be more expensive	Implementing energy retrofits saves energy and associated costs	• CSB ROSI Project Research • Energystar.gov
Operational Efficiency	Reduced repairs and maintenance expenses	Estimate the annual material cost of replacing fixtures, equipments etc. Estimate the labor cost by apportioning staff time spent on repair and replacement and multiplying the hours with an average hourly staff cost. Similarly, estimate the material and labor cost of replacing energy efficient equipment e.g. LED bulbs. Calculate the difference between the two scenarios for the annual net saving	Longer lasting equipment such as LED lights does not require as much maintenance	

*__Weather normalized energy__ is the energy a building would have used under average weather conditions. The Energy Star Portfolio Manager tool provides technical guidance on weather normalized energy consumption here (Accessed Oct 13, 2023). Refer to the Glossary section for more information

Benefits Assessment and Monetization Development

Practice: Energy efficiency

I: Implement energy efficiency retrofits within the building. Examples include switching to LED lighting, installing real-time monitoring systems and occupancy sensors, limiting use of equipment in non-peak hours, using valves to isolate boilers, insulating pipes, etc.

ROSI™ Mediating Factor	ROSI™ Benefits/Costs	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Risk Management	Lower emissions	Calculate the energy consumption by energy type before and after the retrofitting measures and multiply by the related emission factors* to get the associated emissions by energy type under both scenarios. Multiply the emissions with a carbon offset price or an internal cost of carbon to calculate the savings in carbon offsets or a carbon tax	Lower energy consumption from nonrenewable sources potentially lowers GHG emissions	• CSB ROSI Project Research
Stakeholder Engagement	State and federal incentives could offset costs	Estimate the total investment required for the projects. Consider the state and federal incentives available (e.g. Inflation Reduction Act, State Utility incentives and Rebate programs) that may offset the investment amount partially	For example, the Section 179D commercial buildings energy efficiency tax deduction may be available for eligible retrofits	• Energy efficient commercial buildings deduction (Internal Revenue Source, 2023)

*An **emission factor** represents the quantity of a pollutant released into the atmosphere corresponding to the activity/source. Emission factors for purchased electricity from eGRID, mobile combustion, upstream and downstream transportation, business travel, product transport, and employee commuting can be obtained in EPA's GHG Emission Factors Hub here. The emissions can be converted into equivalent amount of carbon dioxide (CO_2) emissions by using the Greenhouse Gas Equivalency Calculator (Accessed Oct 12, 2023). Refer to the Glossary section for more information

Benefits Assessment and Monetization Development

Practice: Energy efficiency

I: Implement energy efficiency retrofits within the building. Examples include switching to LED lighting, installing real-time monitoring systems and occupancy sensors, limiting use of equipment in non-peak hours, using valves to isolate boilers, insulating pipes, etc.

ROSI™ Mediating Factor	ROSI™ Benefits/Costs	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Stakeholder Engagement	Reinvestment benefit	Estimate the annual savings from “quick win” retrofits that can be reinvested into installing additional energy efficiency measures, and how much additional savings year over year can be generated. Subtract the opportunity cost of funds (i.e. market interest rates that funds if invested could earn). The difference is the reinvestment benefit	The EPA’s Energy Star Portfolio Manager recommends investing rather than waiting to use from a future budget as that may be more beneficial	• CSB ROSI Project Research • EPA Portfolio Manager Tool (EPA, 2023)

Benefits Assessment and Monetization Development

Practice: Energy transition

II: Switch from non-renewable to renewable energy sources by entering into a Physical or a Virtual Power Purchase Agreement (PPPA or VPPA)*

ROSI™ Mediating Factor	ROSI™ Benefits/Costs	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Operational Efficiency	Energy costs avoided (applicable to Physical PPA)	Calculate the number of electrical/thermal energy units and the price per unit purchased for a base year. Forecast a scenario of future units to be consumed, normalizing for weather**/other factors as relevant, and multiply by the projected grid's energy price per unit to calculate the total costs***. Consider the # of units of energy generated from the renewable energy source and forecast it. Multiply these renewable energy units by the offtake price agreed within the PPA. Subtract the new costs from the old costs to calculate the savings in energy costs	Energy generation from the renewable energy source potentially offsets (partially or in whole) the overall energy units consumed from the grid	CSB ROSI Project Research Systems

*A **Power Purchase Agreement (PPA)** is a type of contract that allows consumers, typically large commercial entities, to enter into an agreement with an energy generating unit, to purchase energy for a long term, usually for a steady cost. A PPA can be a Physical PPA or a Virtual PPA. In a physical PPA, the purchaser and the energy generation unit are within the same physical location/same grid while in the case of a virtual PPA, the purchaser and the energy generation unit do not necessarily have to be in the same region. The buyer will get **Registered Energy Certificates** (RECs) representing their investment in renewable energy. Depending on the location and availability of renewable energy projects, hospitals could consider the option of entering into a VPPA if local generation units are not available.
Source:https://betterbuildingssolutioncenter.energy.gov/financing-navigator/option/power-purchase-agreement (accessed 2023)

**Weather normalized energy is the energy a building would have used under average weather conditions. The Energy Star Portfolio Manager tool provides technical guidance on weather normalized energy consumption here. (accessed 2023)
***Recommended forecasting period of 10+ years to assess payback and full value of the benefit, however it may vary for each system.

Benefits Assessment and Monetization Development

Practice: Energy transition

II: Switch from non-renewable to renewable energy sources by entering into a Physical or a Virtual Power Purchase Agreement (PPPA or VPPA)* [cont.]

ROSI™ Mediating Factor	ROSI™ Benefits/Costs	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Risk Management	Lower price volatility	Calculate the volatility of historical energy prices paid and project volatility based on future PPPA/VPPA prices. Calculate the difference in volatility under the two time periods and estimate the cost saving by multiplying the difference in the average price volatility with an average of the number of units consumed	PPAs are typically fixed price longer term contracts	• Power Purchase Agreements (Retrieved Oct 9, 2023)
Risk Management	Reduction in carbon emissions	Calculate the energy consumption units by energy type before and after entering into the PPPA/VPPA and multiply the total units with the applicable emission factor to get the associated emissions by energy type under both scenarios, forecasting for the life of the PPA contract. Multiply the emissions with a price of a carbon offset or an internal carbon price to calculate the savings in carbon offset costs or a carbon tax	Lower energy consumption from non-renewable sources potentially lowers GHG emissions	• CSB ROSI Project Research • GHG equivalency Calculator (Retrieved Oct 9, 2023) • GHG Emission Factors Hub (EPA, 2023) • Tracking Progress Toward the Cool Food Pledge (Waite, Vennard & Pozzi, 2019)

Benefits Assessment and Monetization Development

Practice: Energy transition

II: Switch from non-renewable to renewable energy sources by entering into a Physical or a Virtual Power Purchase Agreement (PPPA or VPPA)* [cont.]

ROSI™ Mediating Factor	ROSI™ Benefits/Costs	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Risk Management	Lower risk of penalties	Determine the risks associated with not reducing emissions to allowed limits or not meeting related commitments e.g. penalties imposed by regulatory authorities. Calculate the avoided penalty cost by prorating the potential penalty based on the percent of the commitment to switch to renewable energy that the PPA/VPPA allows the entity to achieve	Some governments are encouraging decarbonization through imposing penalties. For example, NYC will impose penalties on buildings that don't reduce their emissions to the allowable limits in the future	• Decarbonization Compass (NYU Stern CSB, 2023) • Enhancement and Standardization of Climate-Related Disclosures by the SEC (Retrieved Oct 9, 2023)
Media Coverage	Co-branding or naming rights to a power project may provide branding benefits	Calculate the number of media mentions after the investment in the project is made and multiply by corresponding cost of paid media	Co-branding a project creates brand awareness	• Interviews with healthcare delivery systems • Physical PPA (EPA, 2022)

Benefits Assessment and Monetization Development

Practice: Energy transition

III: Purchase Renewable Energy Credits (RECs)*

ROSI™ Mediating Factor	ROSI™ Benefits/Costs	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Risk Management	Reduction in carbon emissions	Calculate the energy consumption units by energy type before and after buying RECs, forecasting for a long term period. Multiply the total units with the applicable emission factor to get the associated emissions by energy type under both scenarios. Multiply the emissions with a price of a carbon offset or an internal carbon price to calculate the savings in carbon offset costs or a carbon tax	RECs can replace non-renewable energy consumed	• CSB ROSI Project Research • GHG equivalency Calculator (Retrieved Oct 9, 2023) • GHG Emission Factors Hub (EPA, 2023)

*A **renewable energy certificate** or a **REC** is a tradeable, market-based instrument that represents the legal property rights to a “renewable” or non-power attribute—of renewable electricity generation. A REC is created for every megawatthour (MWh) of electricity generated and delivered to the grid from a renewable energy resource. Electricity cannot be considered renewable without a REC to substantiate its renewable-ness. (Renewable Energy Credits - EPA, 2023)

Benefits Assessment and Monetization Development

Practice: Energy transition

III:Purchase Renewable Energy Credits (RECs)* [cont.]

ROSI™ Mediating Factor	ROSI™ Benefits/Costs	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Risk Management	Lower risk of penalties	Determine the risks associated with not reducing emissions to allowed limits or not meeting related commitments e.g. penalties imposed by regulatory authorities. Calculate the avoided penalty cost by prorating the potential penalty based on the percent of the commitment to switch to renewable energy that the PPA/VPPA allows the entity to achieve	Some governments are encouraging decarbonization through imposing penalties. For example, NYC will impose penalties on buildings that don't reduce their emissions to the allowable limits in the future	• Decarbonization Compass (NYU Stern CSB, 2023) • Enhancement and Standardization of Climate-Related Disclosures by the SEC (Retrieved Oct 9, 2023)

Benefits Assessment and Monetization Development

Practice: Energy transition

IV: Install a new source of renewable energy (onsite or offsite) - solar heater; solar panels; geothermal wells or tubes; biomass boiler; wind turbines; capture of landfill waste biogas, install a cogeneration plant

ROSI™ Mediating Factor	ROSI™ Benefits	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Operational Efficiency	Energy costs avoided	Calculate the number of energy units that the renewable energy source can generate. Determine the current per unit cost based on energy bills. Subtract the new per unit cost from the current per unit cost and multiply by the number of energy units generated by the renewable energy source. Subtract the cost of installation (amortized capex) and any annual procurement cost of renewable source e.g. biomass (opex) to calculate the net savings	Energy generation from the renewable energy source potentially offsets (partially or in whole) the overall energy units consumed from the grid	CSB ROSI Project Research
Risk Management	Lower price volatility	Calculate the volatility of historical energy prices paid and project energy price volatility based on future price outlook. Calculate the difference in volatility under the two time periods and estimate the cost saving by multiplying the difference in the average price volatility with an average of the number of units consumed	Lower energy consumption from the grid potentially reduces price volatility	

Benefits Assessment and Monetization Development

Practice: Energy transition

IV: Install a new source of renewable energy (onsite or offsite) - solar heater; solar panels; geothermal wells or tubes; biomass boiler; wind turbines; capture of landfill waste biogas, install a cogeneration plant [cont.]

ROSI™ Mediating Factor	ROSI™ Benefits	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Stakeholder Engagement	Reduced Cost of Capital	Estimate the costs avoided or interest cost savings by floating green/sustainability/social bonds or taking advantage of sustainability-linked financing to finance the projects	Projects that meet the definition of the Green Bond principles or sustainability milestones could attract lower cost of financing and other benefits	• Green Bonds (Retrieved Oct 9, 2023) • What are sustainability linked bonds and how can they support the net-zero transition? (WEF, 2022) • Green Bonds (Retrieved Oct 9, 2023) • Municipal Bonds and Green Bonds (US EPA, 2023)
Stakeholder Engagement	State and federal incentives could offset project costs through investment and production tax credits	Estimate the total investment required for the projects. Consider the state and federal incentives available (e.g. Inflation Reduction Act, State Utility incentives and Rebate programs) that may offset a portion of the investment amount	For example, a 30 percent investment tax credit is available for qualifying investments in wind, solar, energy storage, and other renewable energy projects if certain criteria are met)	• FACT SHEET: Four Ways the Inflation Reduction Act's Tax Incentives Will Support Building an Equitable Clean Energy Economy (US Department of Treasury, 2022)

Benefits Assessment and Monetization Development

Practice: Energy transition

IV: Install a new source of renewable energy (onsite or offsite) - solar heater; solar panels; geothermal wells or tubes; biomass boiler; wind turbines; capture of landfill waste biogas, install a cogeneration plant [cont.]

ROSI™ Mediating Factor	ROSI™ Benefits to explore	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Risk Management	Reduction in carbon emissions	Calculate the energy consumption by energy type before and after investing in the project and multiply by the related emissions factors to get the associated emissions by energy type under both scenarios. Multiply the resulting emissions with a carbon offset price or an internal cost of carbon to calculate the savings in carbon offsets or a carbon tax	Lower energy consumption from non-renewable sources potentially lowers GHG emissions	• CSB ROSI Project Research
Risk Management	Lower risks of penalties	Determine the risks associated with not lowering emissions to allowed limits or not meeting energy related commitment e.g. penalties being imposed). Calculate the avoided penalties based on % of commitment that the renewable energy project covers	Some governments are encouraging decarbonization through imposing penalties. For example, NYC will impose penalties on buildings that don't reduce their emissions to the allowable limits in the future	• Decarbonization Compass (NYU Stern CSB, 2023) • Enhancement and Standardization of Climate-Related Disclosures (Retrieved Oct 9, 2023)

Benefits Assessment and Monetization Development

Practice: Energy transition

IV: Install a new source of renewable energy (onsite or offsite) - solar heater; solar panels; geothermal wells or tubes; biomass boiler; wind turbines; capture of landfill waste biogas, install a cogeneration plant [cont.]

ROSI™ Mediating Factor	ROSI™ Benefits/Cost	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Media Coverage	Environmental stewardship can help create positive media mentions that may attract partners	Determine the number of media mentions of the environmental projects after the investments are made and multiply by what it would have cost to buy the mentions to estimate the benefit of free media	Interviews and research have shown media coverage for larger, impactful environment projects	• Interviews with healthcare delivery systems
Talent Management	Environmental stewardship can motivate employees leading to higher retention rates and lower voluntary turnover.	Compare the organization's staff turnover rates with industry's average turnover after implementation and communication of environmental programs to employees. Design and institute employee surveys to understand the impact of your organization's sustainability efforts on staff morale, productivity, and willingness to continue work for the organization. Use survey data to assign an attribution % to the reduction in turnover and the associated savings in hiring costs	National Environmental Education Foundation found a positive relationship between sustainability engagement and employee engagement. Nearly 90 percent of employees that were engaged in their company's sustainability efforts said that it enhances their job satisfaction	• Winning in the Marketplace and the Workplace (NEEF, 2017)

Benefits Assessment and Monetization Development

Practice: Energy transition

IV: Install a new source of renewable energy (onsite or offsite) - solar heater; solar panels; geothermal wells or tubes; biomass boiler; wind turbines; capture of landfill waste biogas, install a cogeneration plant [cont.]

ROSI™ Mediating Factor	ROSI™ Benefits/Cost	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Customer (Patient) Loyalty	Environmental stewardship has the potential to increase loyalty from sustainability conscious patients	Track patient value of hospital's environmental sustainability efforts through surveys. Estimate whether there are improvement trends in Patient Satisfaction or Net promoter scores that can be attributed to sustainability. If there are, capture the organization's revenues from repeat patients before and after implementing and communicating about their environmental stewardship efforts	We have found this linkage in other industries-food & ag, apparel. However within healthcare, this is more anecdotal	• Interviews with healthcare delivery systems
Operational Efficiency	Reinvestment benefit	Estimate the annual savings from installing new sources of renewable energy that can be reinvested into new additional energy efficiency measures and how much additional savings year over year can be generated. Subtract the opportunity cost of funds (i.e. market interest rates that funds if invested could earn). The difference is the reinvestment benefit	The EPA Portfolio Manager tool finds that investing rather than waiting to use from a future budget may be more beneficial	• CSB ROSI Project Research

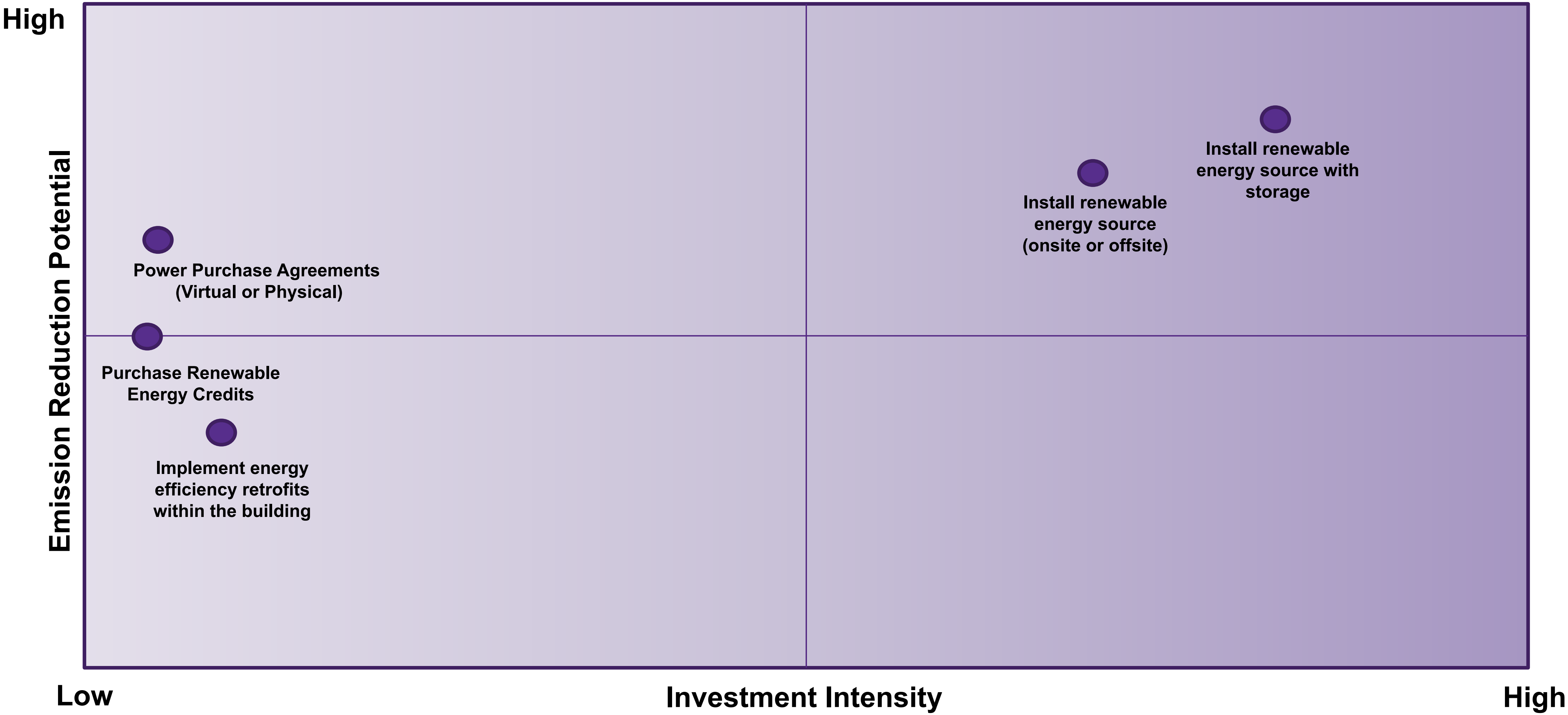
Benefits Assessment and Monetization Development

Practice: Energy storage

V: Add battery storage to existing renewable energy sites (if it did not exist previously)

ROSI™ Mediating Factor	ROSI™ Benefits/Cost	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
All of the benefits within IV and additionally the following:				
Risk Management	Lowers risk of business disruption	Estimate the probability of a business disruption event due to loss of power. Estimate the financial losses that could occur based on cancelled appointments, procedures, staff needing to work overtime etc., Estimate how many hours of backup power the storage can provide and calculate the losses that can be potentially avoided	The ability to store power will extend the time that the system can continue functioning in the event of a loss of power to the facility	• Grid Systems (Retrieved Oct 10, 2023)

Relative Ranking of the Identified Energy Management related Sub-practices



Note: The emission reduction potential and the Investment intensity of the sub-practices is highly dependent type of healthcare delivery system, its scale of operations and its geographic location

Building Design & Maintenance

Strategies

Energy Management	**Building Design & Maintenance**	Sustainable Sourcing	Food Service Optimization
Low Emissions Clinical Care	Waste Reduction	Responsible Investments	Reduced Transportation

Sub-practices

Design and build hospitals and clinics that require less energy, incorporate renewable energy sources, and enhance resilience to extreme weather

Building Design and Construction

Include energy efficient measures into the design and construction of a new building such as:

I: Maximizing energy efficient windows/daylighting

II: Maximizing insulation

III: Installing passive ventilation systems

IV: Increasing metering and automation through installation of real time energy monitoring systems and sensor controls

V: Incorporating eco-friendly/low VOCs finishes, flame retardants among others

Building Design & Maintenance

Sub-practices

Include energy efficient measures into the design and construction of a new building such as:

VI: Heat harvesting systems

VII: Include a solar thermal heating source to augment the conventional hot water system into the design and construction of a new building

VIII: Installing a green roof

IX: Installing a white roof

X: Creating a biking infrastructure

XI: Designing buildings to withstand extreme climatic conditions

Building Maintenance

I: Conduct regular maintenance to prevent leakage of nitrous oxide (N_2O) from pipes

II: Eliminate pesticides from landscaping on premises

Building Certification

I: Obtain recognized certifications such as LEED

Benefits Assessment and Monetization Development

Practice: Building design and construction

I: Maximize energy-efficient windows/daylighting in the design and construction of a new building*

ROSI™ Mediating Factor	ROSI™ Benefits to explore	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Operational Efficiency	Energy cost saving	Calculate the consumption of electrical/thermal energy units using benchmarks* under different energy efficiency options, for example standard efficiency that meets minimum building code requirements vs. energy efficiency measures that can reduce the building's energy use. Multiply the energy consumption with the price per unit, forecasting into the future. Compare the costs under the standard efficiency scenario vs. the energy efficiency scenario to calculate potential savings	Energy losses from windows contribute to almost 1 gigaton of CO_2 emissions a year globally	• The Energy Saving Potential of Wide Windows in Hospital Patient Rooms (Cesari et al., 2020) • Windows Key to Increased Energy Efficiency in Buildings (US DOE, 2022)

*Builders can choose between ASHRAE code-compliant designs and designs that incorporate higher energy efficiency. The sub-practices elaborated under "Building Design" suggest the higher energy efficiency design and construction

**Benchmarks could be obtained from comparable buildings, public tools from the EPA, or hospital systems can create simulation examples by working with energy modelers/utility provider

Benefits Assessment and Monetization Development

Practice: Building design and construction

I: Maximize energy-efficient windows/daylighting in the design and construction of a new building* [cont.]

ROSI™ Mediating Factor	ROSI™ Benefits to explore	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Risk Management	Reduction in carbon emissions	Calculate the consumption of electrical/thermal energy units using benchmarks under different energy efficiency options, for example, standard efficiency that meets minimum building code requirements vs. energy efficiency measures that can reduce the building's energy use intensity. Multiply the energy consumption with the emission factors* forecasting total emissions into the future. Multiply the emissions by a carbon offset price or an internal price of carbon to calculate the savings in carbon offsets costs or a carbon tax (if implemented)	Lower energy consumption potentially lowers GHG emissions	• CSB ROSI Project Research • Healthcare emissions Impact Calculator (Practice Greenhealth, 2023)

***Note:** An emission factor represents the quantity of a pollutant released into the atmosphere corresponding to the activity/source. Emission factors for purchased electricity from eGRID, mobile combustion, upstream and downstream transportation, business travel, product transport, and employee commuting can be obtained in EPA's GHG Emission Factors Hub here. The emissions can be converted into equivalent amount of carbon dioxide (CO_2) emissions by using the Greenhouse Gas Equivalency Calculator (Accessed Oct 13, 2023)

Benefits Assessment and Monetization Development

Practice: Building design and construction

I: Maximize energy-efficient windows/daylighting in the design and construction of a new building* [cont.]

ROSI™ Mediating Factor	ROSI™ Benefits to explore	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Risk Management	Lower risk of penalties	Determine the risks associated with not reducing emissions to allowed limits or not meeting energy-related commitments e.g. penalties imposed by regulatory authorities. Calculate the avoided cost or lower risk based on the % reduction likely to be achieved by the system	Some governments are encouraging decarbonization through imposing penalties. For example, NYC will impose penalties on buildings that don't reduce their emissions to the allowable limits in the future. For example Local Law 97 of New York City mandates civil penalties for non compliant entities	• Decarbonization Compass (NYU Stern CSB, 2023)

Benefits Assessment and Monetization Development

Practice: Building design and construction

I: Maximize energy-efficient windows/daylighting in the design and construction of a new building* [cont.]

ROSI™ Mediating Factor	ROSI™ Benefits to explore	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Customer Loyaltys	Improved patient outcomes	Calculate the increase in revenue due to reduced length of stay per patient. Apply the operating profit margin % to the revenue and calculate the additional earnings to the operations	Natural lighting improves circadian rhythm, 'nature' views decrease lengths of stay	• Current views of healthcare design and construction: practical implications for safer, cleaner environments (Bartley, Olmsted & Haas, 2010)
Talent Management	Enhanced employee productivity	Calculate the current number of absentee or sick days per staff in the building. Based on research or actual data collated, estimate the reduction in absenteeism attributed to improved working conditions. Multiply this reduction by the cost per employee per sick day, or lost productivity, to calculate the gain from enhanced employee productivity	Studies confirm that appropriate lighting has a relationship with decreased staff stress, improved staff effectiveness and staff satisfaction (Bartley, Olmsted et al. 2010)	

Benefits Assessment and Monetization Development

Practice: Building design and construction

II: Maximize insulation in the design and construction of a new building

ROSI™ Mediating Factor	ROSI™ Benefits/Costs	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Operational Efficiency	Energy cost saving	Calculate the consumption of electrical/thermal energy units using benchmarks under different energy efficiency options, for example, standard efficiency that meets minimum building code requirements vs. energy efficiency measures that can reduce the building's energy use). Multiply the energy consumption with the price per unit, forecasting into the future. Compare the costs under the standard efficiency scenario vs. the energy efficiency scenario to calculate potential savings	Helps create the desired temperature and is very energy efficient. Heating and cooling accounts for a significant amount of energy used in hospitals	• Methodology for Estimated Energy Savings from Cost-Effective Air Sealing and Insulating (Retrieved Oct 10, 2023)

Benefits Assessment and Monetization Development

Practice: Building design and construction

II: Maximize insulation in the design and construction of a new building [cont.]

ROSI™ Mediating Factor	ROSI™ Benefits/Costs	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Risk Management	Reduction in carbon emissions	Calculate the consumption of electrical/thermal energy units using benchmarks under different energy efficiency options, for example, standard efficiency that meets minimum building code requirements vs. energy efficiency measures that can reduce the building's energy use intensity. Multiply the energy consumption with the emission factors , forecasting total emissions into the future. Multiply the emissions by a carbon offset price or an internal price of carbon to calculate the savings in carbon offsets costs or a carbon tax (if implemented)	Lower energy consumption potentially lowers GHG emissions	• CSB ROSI Project Research • GHG Reduction Programs & Strategies (EPA, 2023) • Scope 2 Guidance (Retrieved Oct 12, 2023) • Healthcare emissions Impact Calculator (Practice Greenhealth, 2023)
Risk Management	Lower risk of penalties	Determine the risks associated with not reducing emissions to allowed limits or not meeting energy related commitments e.g. penalties imposed by regulatory authorities. Calculate the avoided cost or lower risk based on a % reduction likely to be achieved by the system	Some governments are encouraging decarbonization through imposing penalties. NYC will impose penalties on buildings that don't reduce their emissions to the allowable limits in the future	• Decarbonization Compass (NYU Stern CSB, 2023)

Benefits Assessment and Monetization Development

Practice: Building design and construction

III: Include passive ventilation systems in the design and construction of a new building

ROSI™ Mediating Factor	ROSI™ Benefits/Cost s	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Operational Efficiency	Energy cost saving	Calculate the consumption of electrical/thermal energy units using benchmarks under different energy efficiency options, for example, standard efficiency that meets minimum building code requirements vs. energy efficiency measures that can reduce the building's energy use). Multiply the energy consumption with the price per unit, forecasting into the future. Compare the costs under the standard efficiency scenario vs. the energy efficiency scenario to calculate potential savings	Lower consumption of energy can potentially lower the energy costs	• Methodology for Estimated Energy Savings from Cost-Effective Air Sealing and Insulating (Retrieved Oct 10, 2023)
Risk Management	Reduction in carbon emissions	Calculate the consumption of electrical/thermal energy units using benchmarks under different energy efficiency options, for example, standard efficiency that meets minimum building code requirements vs. energy efficiency measures that can reduce the building's energy use intensity. Multiply the energy consumption with the emission factors , forecasting total emissions into the future. Multiply the emissions by a carbon offset price or an internal price of carbon to calculate the savings in carbon offsets costs or a carbon tax (if implemented)	Lower energy consumption potentially lowers GHG emissions	• CSB ROSI Project Research

Benefits Assessment and Monetization Development

Practice: Building design and construction

III: Include passive ventilation systems in the design and construction of a new building [cont.]

ROSI™ Mediating Factor	ROSI™ Benefits/Costs	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Risk Management	Lower risk of penalties	Determine the risks associated with not reducing emissions to allowed limits or not meeting energy related commitments e.g. penalties imposed by regulatory authorities. Calculate the avoided cost or lower risk based on a % reduction likely to be achieved by the system	Some governments are encouraging decarbonization through imposing penalties. For example, NYC will impose penalties on buildings that don't reduce their emissions to the allowable limits in the future	• Decarbonization Compass (NYU Stern CSB, 2023) • Local Law 97 likely to impose civil penalties for non compliant buildings (Retrieved Oct 10, 2023)
Risk Management	Avoided cost of Hospital Acquired Infections	Track the number of airborne Hospital Acquired Infections (HAIs) in comparable building(s) that do not have a similar ventilation system. Determine a reduction % based on research or actual findings and an attribution factor based on any other initiatives that may have affected HAIs. Calculate the savings based on reduced number of HAIs multiplied by the average costs of HAI cases	Research findings show that high ventilation rate is shown to be effective for reducing cross-infection risk of airborne diseases in hospitals and isolation rooms. Natural or passive ventilation can deliver much higher ventilation rate than mechanical ventilation in an energy-efficient manner	• Natural ventilation for reducing airborne infection in hospitals (Qian et al., 2010)

Benefits Assessment and Monetization Development

Practice: Building design and construction

IV: Increase metering and automation through installation of real time energy monitoring systems and sensor controls included in the design and construction of a new building

ROSI™ Mediating Factor	ROSI™ Benefits/Costs	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Operational Efficiency	Energy cost saving	Calculate the number of electrical/thermal energy units and the price per unit purchased for a base year. Forecast a scenario of future costs based on the units likely to be consumed, normalizing for weather and the projected price per unit. Calculate the new costs by multiplying the energy consumption from the grid with the applicable price per unit and forecast a scenario. Subtract the new actual and projected cost from the old actual and projected cost to calculate the savings	Lower energy consumption from nonrenewable sources potentially saves energy costs	• CSB ROSI Project Research
Risk Management	Reduction in carbon emissions	Calculate the energy consumption using benchmarks with and without the efficiency measure and multiply with the emission factor to get the associated emissions by energy type under both scenarios. Multiply the emissions with a carbon offset price or an internal cost of carbon to calculate the savings in carbon offsets or a carbon tax	Lower energy consumption from nonrenewable sources potentially lowers GHG emissions	

Benefits Assessment and Monetization Development

Practice: Building design and construction

IV: Increase metering and automation through installation of real time energy monitoring systems and sensor controls included in the design and construction of a new building [cont.]

ROSI™ Mediating Factor	ROSI™ Benefits/Costs	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Risk Management	Lower risk of penalties	Determine the risks associated with not reducing emissions to allowed limits or not meeting energy related commitments e.g. penalties imposed by regulatory authorities. Calculate the avoided cost or lower risk based on a % reduction likely to be achieved by the system	Some governments are encouraging decarbonization through imposing penalties. For example NYC will impose penalties on buildings that don't reduce their emissions to the allowable limits in the future	• Decarbonization Compass (NYU Stern CSB, 2023) • Local Law 97 likely to impose civil penalties for non compliant buildings (Retrieved Oct 10, 2023)

Benefits Assessment and Monetization Development

Practice: Building design and construction

V: Incorporate eco-friendly/low VOCs finishes, flame retardants, etc. into the design and construction of a new building

ROSI™ Mediating Factor	ROSI™ Benefits/Costs	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Risk Management	Reduction in carbon emissions*	Calculate the embodied carbon within the low VOC finish vs. the higher VOC finish and multiply by the quantity used. Calculate the difference to get the emissions avoided. Multiply the total emissions avoided with a carbon offset price or an internal cost of carbon to calculate the savings in carbon offsets or a carbon tax	Embodied carbon is potentially lower in low VOC finish vs. the higher VOC paint	• Evaluation of the seasonal variation of VOC surface emissions and indoor air concentrations in a public building with bio-based insulation (Braish et al., 2023) • Volatile Organic Compounds (VOCs) as Environmental Pollutants: Occurrence and Mitigation Using Nanomaterials (David & Niculescu, 2021)
Talent Management	Improve productivity/reduce risks (sick building syndrome)	Identified as a research gap	Lots of toxic chemicals in standard building finishes; green design advocates for sourcing responsible paint, carpets, etc.	• Characterisation of volatile organic compounds in hospital indoor air and exposure health risk determination (Riveron et al., 2023) • VOCs concentrations and emissions rates in hospital environment and the impact of sampling locations (Hyttinen et al., 2021)

***Note:** Using paints with low VOCs lowers the release of harmful chemicals into the atmosphere making it an environment friendly practice. However, the extent of decarbonization impact is relatively small as compared to other sub-practices listed.

Benefits Assessment and Monetization Development

Practice: Building design and construction

VI: Include heat harvesting systems into the design and construction of a new building

ROSI™ Mediating Factor	ROSI™ Benefits/Costs	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Operational Efficiency	Reduction in energy consumption	Calculate the number of electrical/thermal energy units and the price per unit purchased for a base year. Forecast a scenario of future costs based on the units likely to be consumed, normalizing for changing weather*/other factors and the projected price per unit. Calculate the new costs by multiplying the consumption from the grid with the applicable price per unit and forecast a scenario. Subtract the new actual and projected cost from the old actual and projected cost to calculate the savings	Multistack heat recovery chiller system for reheating, high-efficiency variable speed drive chillers, and variable air volume devices to ensure conservation when waste heat from fan coil units will be used as the energy source for cooling	• Hospital conserves energy by 27% with heat recovery chiller system (Roulo, 2010)
Risk Management	Reduction in carbon emissions	Calculate the energy consumption under the scenarios described above (with and without the efficiency measure) and multiply with the emission factor[2] to get the associated emissions by energy type under both scenarios. Multiply the emissions with a carbon offset price or an internal cost of carbon to calculate the savings in carbon offsets or a carbon tax	Lower energy consumption potentially lowers GHG emissions	

*Weather normalized energy is the energy a building would have used under average weather conditions. The Energy Star Portfolio Manager tool provides technical guidance on weather normalized energy consumption here. (accessed 2023)

Benefits Assessment and Monetization Development

Practice: Building design and construction

VI: Include heat harvesting systems into the design and construction of a new building [cont.]

ROSI™ Mediating Factor	ROSI™ Benefits/Costs	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Risk Management	Lower risk of penalties	Determine the risks associated with not reducing emissions to allowed limits or not meeting energy related commitments e.g. penalties imposed by regulatory authorities. Calculate the avoided penalty cost by prorating the potential penalty based on the percent of the commitment that heat harvesting systems allow the entity to achieve	Some governments are encouraging decarbonization through imposing penalties. For example, NYC will impose penalties on buildings that don't reduce their emissions to the allowable limits in the future	• Decarbonization Compass (NYU Stern CSB, 2023) • Local Law 97 likely to impose civil penalties for non compliant buildings (Retrieved Oct 10, 2023)

Benefits Assessment and Monetization Development

Practice: Building design and construction

VII: Include a solar thermal heating source into the design and construction of a new building to augment the conventional hot water system [cont.]

ROSI™ Mediating Factor	ROSI™ Benefits/Costs	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Operational Efficiency	Reduction in energy consumption	Calculate the amount of energy associated with heating water via the grid vs. heating water with thermal energy. Multiply the difference by the cost per kW to get the savings. Subtract costs for installing the solar panels/heating system	Solar thermal technology, which uses energy from the sun to heat water, has been adopted in health care institutions and can be economically beneficial for heating water and buildings,augmenting conventional steam or hot water systems in terms of cost and years to pay back etc.	• Solar thermal water heating from Gundersen Health System (Retrieved Oct 10, 2023)
Operational Efficiency	Extended life equipment	Improves return on capital equipment as equipment can potentially last longer. Replacement of equipment can be extended out lowering the annual capital expenditure budget	Reduction in the usage of regular water heating equipment extends its uselife life	
Risk Management	Reduction in carbon emissions	Calculate the energy consumption under the two scenarios i.e. amount of energy associated with heating water via the grid vs. heating water with thermal energy. Multiply with the relevant emission factors to get the associated emissions by energy type under both scenarios. Multiply the total emissions with a carbon offset price or an internal cost of carbon to calculate the savings in carbon offsets or a carbon tax	Lower energy consumption potentially lowers GHG emissions	• GHG Reduction Programs & Strategies (EPA, 2023)

Benefits Assessment and Monetization Development

Practice: Building design and construction

VII: Include a solar thermal heating source into the design and construction of a new building to augment the conventional hot water system [cont.]

ROSI™ Mediating Factor	ROSI™ Benefits/Costs	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Risk Management	Lower risk of penalties	Determine the risks associated with not reducing emissions to allowed limits or not meeting energy related commitments e.g. penalties imposed by regulatory authorities. Calculate the avoided cost or lower risk based on a % reduction likely to be achieved by the healthcare system	Some governments are encouraging decarbonization through imposing penalties. For example, NYC will impose penalties on buildings that don't reduce their emissions to the allowable limits in the future	• Decarbonization Compass (NYU Stern CSB, 2023) • Local Law 97 likely to impose civil penalties for non compliant buildings (Retrieved Oct 10, 2023)

Benefits Assessment and Monetization Development

Practice: Building design and construction

VIII: Incorporate a green roof into the design and construction of a new building

ROSI™ Mediating Factor	ROSI™ Benefits/Costs	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Operational Efficiency	Reduction in energy consumption	Calculate the number of electrical/thermal energy units and the price per unit purchased for a base year. Forecast a scenario of future costs based on the units likely to be consumed, normalizing for changing weather/other factors and the projected price per unit. Calculate the new costs by multiplying the consumption with the applicable price per unit and forecast a scenario. Subtract the new actual and projected cost from the old actual and projected cost to calculate the savings	Green roofs provide better roof insulation	• Green Roofs (US GSA, 2021)
Risk Management	Reduction in carbon emissions	Calculate the energy consumption using benchmarks with and without the efficiency measure and multiply with the emission factor to get the associated emissions by energy type under both scenarios. Multiply the emissions with a carbon offset price or an internal cost of carbon to calculate the savings in carbon offsets or a carbon tax	Lower energy consumption potentially lowers GHG emissions	• GHG Reduction Programs & Strategies (EPA, 2023)

Benefits Assessment and Monetization Development

Practice: Building design and construction

VIII: Incorporate a green roof into the design and construction of a new building

ROSI™ Mediating Factor	ROSI™ Benefits/Costs	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Risk Management	Lower risk of penalties	Determine the risks associated with not reducing emissions to allowed limits or not meeting energy related commitments e.g. penalties imposed by regulatory authorities. Calculate the avoided cost or lower risk based on a % reduction likely to be achieved by the healthcare system	Some governments are encouraging decarbonization through imposing penalties. For example, NYC will impose penalties on buildings that don't reduce their emissions to the allowable limits in the future	• Decarbonization Compass (NYU Stern CSB, 2023) • Local Law 97 likely to impose civil penalties for non compliant buildings (Retrieved Oct 10, 2023)
Talent Management	Increase in employee productivity	Identified as a research gap	Green roofs provide positive healing benefits for patients, and improved patient and staff satisfaction, particularly in urban settings Green roofs provide positive healing benefits for patients, and improved patient and staff satisfaction, particularly in urban settings	• The Sustainable Prescription: Benefits of Green Roof Implementation for Urban Hospitals (O'Hara et al., 2022)
Customer Loyalty	Improved patient outcomes	Identified as a research gap		

Benefits Assessment and Monetization Development

Practice: Building design and construction

IX: Incorporate a white roof into the design and construction of a new building

ROSI™ Mediating Factor	ROSI™ Benefits/Costs	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Operational Efficiency	Reduction in energy consumption	Calculate the number of electrical/thermal energy units and the price per unit purchased for a base year. Forecast a scenario of future costs based on the units likely to be consumed, normalizing for weather/other factors and the projected price per unit. Calculate the new costs by multiplying the consumption with the applicable price per unit and forecast a scenario. Subtract the new actual and projected cost from the old actual and projected cost to calculate the savings	White roof increases albedo of the building, reduces cooling load also known as cool roof, and increases the reflectiveness of the roof	• Using Cool Roofs to Reduce Heat Islands (EPA, 2023) • Cool Roofs (Retrieved Oct 10, 2023)
Risk Management	Reduction in carbon emissions	Calculate the energy consumption using benchmarks with and without the efficiency measure and multiply with the emission factor to get the associated emissions by energy type under both scenarios. Multiply the emissions with a carbon offset price or an internal cost of carbon to calculate the savings in carbon offsets or a carbon tax	Lower energy consumption potentially lowers GHG emissions	• GHG Reduction Programs & Strategies (EPA, 2023)

Benefits Assessment and Monetization Development

Practice: Building design and construction

IX: Incorporate a white roof into the design and construction of a new building [cont.]

ROSI™ Mediating Factor	ROSI™ Benefits/Costs	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Risk Management	Lower risk of penalties	Determine the risks associated with not reducing emissions to allowed limits or not meeting energy related commitments e.g. penalties imposed by regulatory authorities. Calculate the avoided cost or lower risk based on a % reduction likely to be achieved by the healthcare system	Some governments are encouraging decarbonization through imposing penalties. For example, NYC will impose penalties on buildings that don't reduce their emissions to the allowable limits in the future	• Decarbonization Compass (NYU Stern CSB, 2023) • Local Law 97 likely to impose civil penalties for non compliant buildings (Retrieved Oct 10, 2023)

Benefits Assessment and Monetization Development

Practice: Buildings design and construction

X: Create a biking infrastructure

ROSI™ Mediating Factor	ROSI™ Benefits	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Talent Management	Increase in employee retention	Include questions on how bike infrastructure contributes to job satisfaction on employee surveys. Determine if employee retention changed pre- and post-building the infrastructure and calculate the associated savings in rehiring costs, applying an attribution factor based on the % of employees who started biking to work. Use survey data to assign an attribution % to the reduction in turnover and the associated savings in hiring costs	Creating walking/biking infrastructure onsite may allow more employees to bike to the facility, improving job satisfaction and engagement	• Why are cyclists the happiest commuters? Health, pleasure and the e-bike (Wild & Woodward, 2019)
Risk Management	Reduction in employee and patient travel-related emissions	Calculate the emissions reduction based on miles traveled to work pre- and post building the infrastructure for employees and patients who switch to biking to the facility. Use an emissions per gasoline mile, average of 400 grams/mile per EPA	Creating walking/biking infrastructure onsite may allow more employees and patients to bike to the facility	• Intermountain Utah Valley Hospital Bike Accessibility Project Completed: Benefiting Patients, Employees, and the Community (Greener, 2022)
Operational Efficiency	Rationalize capital expenditure planning (dependent on local commute characteristics)	Consider the capital investments on new infrastructure/expansion avoided (e.g. not building a parking garage) and net off costs relating to the biking infrastructure created	Creating walking/biking infrastructure onsite may reduce the onsite parking garage facility and related facilities	• Seattle Children's Hospital: Employee Commuting (Retrieved Oct 10, 2023)

Benefits Assessment and Monetization Development

Practice: Buildings design and construction

XI: Design buildings to withstand extreme climatic conditions such as severe storms, heat waves

ROSI™ Mediating Factor	ROSI™ Benefits/Cost	Potential metrics to monetize	Types of Information	Relevant resources
Operational Efficiency	Reduced insurance premiums	Compare the property insurance premium paid on a building that has resiliency measures incorporates/retrofitted in the building vs. the insurance premium paid on a standard building. The difference in the premium represents the cost saving	Properties that incorporate resilient construction methods or have been retrofitted to reduce potential climate impacts, could reduce potential post-disaster damages	• Addressing the Insurance Crisis Through Property Resilience (Liou, 2023)
Risk Management	Avoided costs of business disruption	Consider the probability of an extreme weather event occurring in hospital's operating area, the severity of the loss that would occur to the building (such as repair costs of damage, destruction of material and supplies, loss of productivity days) and multiply the probability by the severity to calculate the loss avoided due to improving resilience		• Safe Haven in the Storm:Protecting lives and margins with Climate Smart Healthcare (Retrieved Oct 10, 2023)

Benefits Assessment and Monetization Development

Practice: Building maintenance

I: Conduct regular maintenance to prevent leakage of nitrous oxide (N_2O) from pipes. Decentralize nitrous oxide piping and utilize portable tanks, and close the tanks between uses to avoid continuous gas flow

ROSI™ Mediating Factor	ROSI™ Benefits/Costs	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Operational Efficiency	Reduction in Nitrous oxide (N_2O)	Calculate the annual N_2O usage before switch from pipes to tanks, and after the switch has occured - this captures any loss of N_2O to the atmosphere. Multiply the difference by the per unit N_2O cost. Subtract any costs associated with tank distribution Calculate loss of N_2O when not in use due to leaving the tanks open. Multiply the quantity by the per unit cost to estimate the loss avoided	Nitrous oxide is lost to the environment due to leaks from centralized storage tanks and leaks while being piped to anesthesia machines	• Environmental Impact of Nitrous Oxide (Open Anesthesia, 2023) • Action guidance for addressing pollution from inhalational anaesthetics (Hegedus et al., 2022) • Discrepancy between procurement and clinical use of nitrous oxide: waste not, want not (Seglenieks et al., 2022)

Benefits Assessment and Monetization Development

Practice: Building maintenance

II: Eliminate pesticides from landscaping on premises

ROSI™ Mediating Factor	ROSI™ Benefits/Costs	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Operational Efficiency	Reduction in pesticide spend	Calculate the annual spend on pesticides prior to elimination for the savings. If additional maintenance/gardening is needed to replace pesticide use, subtract this for the net benefit	Saving on pesticide costs	• Providence Environmental Stewardship Report (Retrieved Oct 10, 2023)

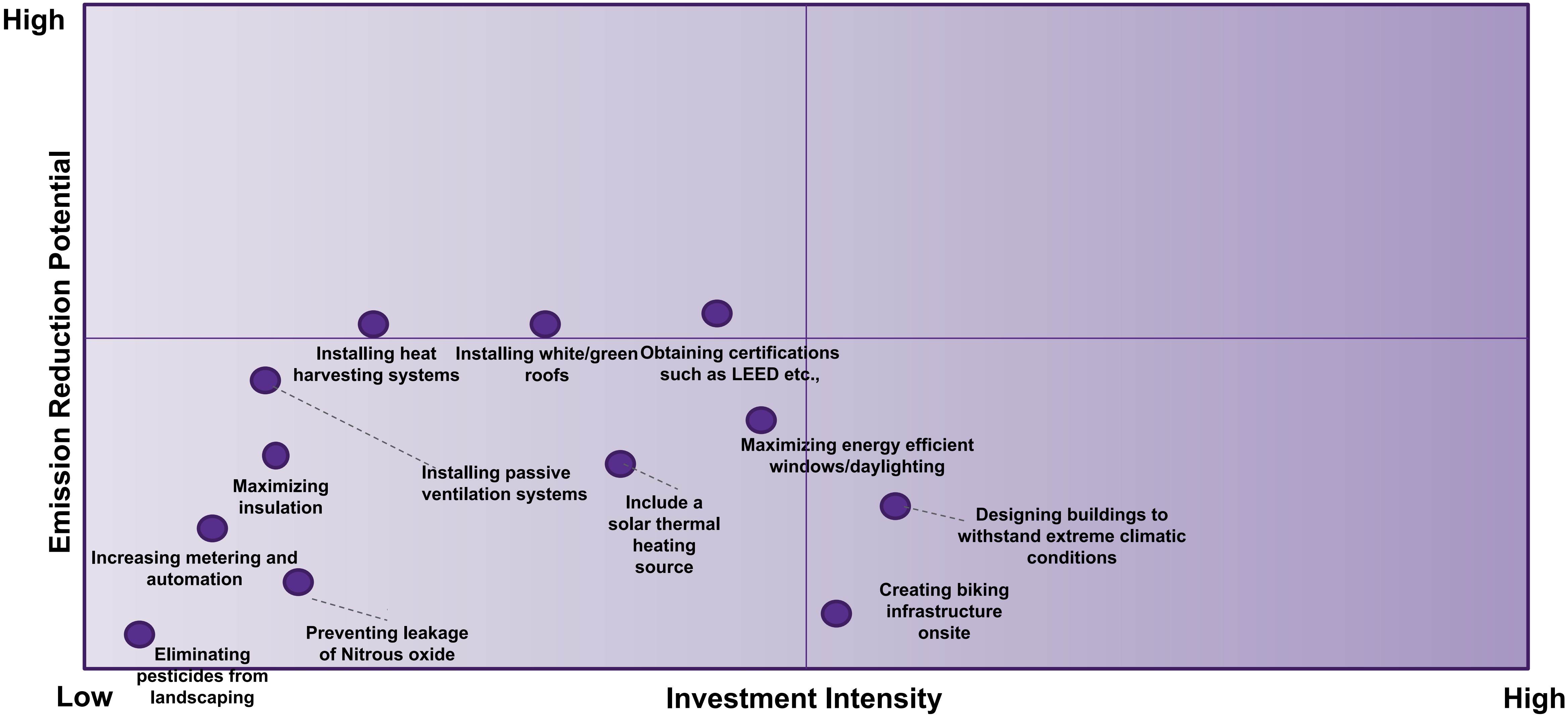
Benefits Assessment and Monetization Development

Practice: Building certification

III: Obtain recognized certifications such as LEED

ROSI™ Mediating Factor	ROSI™ Benefits/Costs	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Mediating factors vary based on the standards of the certification used	Benefits vary based on the standards of the certification	Refer to the certifying agency's standards and methodology to determine benefits	Green Building Rating Systems provide frameworks for healthy, highly efficient, and cost-saving green buildings, which offer a variety of intangible benefits that may include water efficiency and indoor air quality	• LEED Rating System (Retrieved Oct 10, 2023)
Media Coverage	Earned media exposure	Identify the unpaid media exposures following achievement of certification. Calculate cost per media exposure (i.e. what would have had to have been paid) and multiply by # of unpaid media exposures.	Establishes leadership in the industry	
Risk Management	Reduction in carbon emissions	Refer to the certifying agency's standards and methodology	Green Building Rating Systems provide frameworks for healthy, highly efficient, and cost-saving green buildings, which offer various sustainability benefits	

Relative Ranking of the Identified Building Design and Maintenance related Sub-practices



Note: The emission reduction potential and the Investment intensity of the sub-practices is highly dependent type of healthcare delivery system, its scale of operations and its geographic location

Sustainable Sourcing

Strategies

Energy Management	Building Design & Maintenance	**Sustainable Sourcing**	Food Service Optimization
Low Emissions Clinical Care	Waste Reduction	Responsible Investments	Reduced Transportation

Sub-practices

Utilize sourcing practices that minimize waste and toxic chemicals, incorporate circularity and reward suppliers that help achieve decarbonization goals

Practice: Optimize purchases

I: Optimize kit formulations including updating and standardizing procedure preference cards

Practice: Purchase green products

I: Identify green chemical alternatives for cleaning supplies

Practice: Buy circular products

I: Shift away from single-use supplies towards reusable alternatives

II: Purchase reprocessed medical devices

Benefits Assessment and Monetization Development

Practice: Optimize purchases

I: Optimize kit formulations including updating and standardizing procedure preference cards

ROSI™ Mediating Factor	ROSI™ Benefits to explore	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Operational Efficiency	Reduced spending on surgical/procedural kits	Determine the procurement cost per procedure based on the old procedural kits. Determine the procurement cost per procedure based on the optimized kits for the same procedure. Multiply the difference by the number of the corresponding procedures performed in a year. Subtract the cost of staff hours to plan and implement the program to determine the net savings	Surgical/procedural kits often have supplies that are never or hardly ever used. Kits can be reformulated so those items are no longer included. Reduced purchases means less emissions and limited wastage	• Optimizing the surgical instrument tray to immediately increase efficiency and lower costs in the operating room (Toor et al., 2022) • Surgical tray optimization as a simple means to decrease perioperative costs (Farrelly et al., 2017) • Physician Engagement in Improving Operative Supply Chain Efficiency Through Review of Surgeon Preference Cards (Harvey, Smith & Curlin, 2017) • Cost Savings in Urology Operations Rooms by Editing Surgeon Preference Cards (Pesigan et al., 2021)
Risk Management	Reduced surgical/procedural kit waste	Determine the amount of procedural kit waste before and after optimization based on data collected during the optimization process. Determine the average weight of the waste and multiply by the associated disposal cost to estimate the total savings		
Risk Management	Reduced emissions	Quantify the reduction in Scope 3 emissions as a result of purchasing less products in the kit and multiply by an internal price of carbon/carbon offset price to quantify the total carbon cost avoided		• Environmental Impact and Cost Savings of Operating Room Quality Improvement Initiatives: A Scoping Review (Sullivan et al., 2023) • GHG Protocol's Corporate Value Chain (Scope 3) Accounting and Reporting Standard (Retrieved Oct 10, 2023)

Benefits Assessment and Monetization Development

Practice: Purchase green products

I: Identify green chemical alternatives for cleaning supplies

ROSI™ Mediating Factor	ROSI™ Benefits/Costs	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Talent Management	Improved employee well-being	Using surveys, determine the effect on the improved air quality on employees' job satisfaction. Compare retention before and after changes and account for the difference in hiring costs. Attribute a % of this to improved air quality. Use survey data to assign an attribution % to the reduction in turnover and the associated savings in hiring costs	Cleaning products can have a variety of impacts on both human and environmental health throughout the product's life cycle. Where applicable, choosing green chemical alternatives over conventional cleaning supplies may minimize the negative impacts leading to improved human and environmental outcomes	• Identifying Greener Cleaning Products (EPA, 2023) • A Method for Assessing Greener Alternatives between Chemical Products Following the 12 Principles of Green Chemistry (Kreuder et al., 2017) • Why Buy Greener Products? (EPA, 2023) • Green Chemistry (Retrieved Oct 10, 2023) • GHG Protocol's Corporate Value Chain (Scope 3) Accounting and Reporting Standard (Retrieved Oct 10, 2023)
Customer Loyalty	Improved patient outcomes	Track key patient metrics on illnesses linked to indoor air quality over a period of time (applies to patients who have a longer duration hospital stay). Calculate variation before and after switching to green chemical alternatives if possible. Attribute a % of this to improved air quality and green chemicals. Monetize an improvement in patient related metrics by multiplying the reduction in infections with a profit margin/lower costs per patient visit		
Risk Management	Reduced Scope 3 carbon emissions	Quantify the reduction in Scope 3 emissions as a result of using green chemical products and multiply by an internal price of carbon/carbon offset price to quantify the total carbon cost avoided		

Benefits Assessment and Monetization Development

Practice: Buy circular products

I: Shift away from single-use supplies towards reusable alternatives

ROSI™ Mediating Factor	ROSI™ Benefits to explore	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Operational Efficiency	Lower procurement costs	Compare the procurement cost of items before switching to reusable products (eg. disposable foodware) with the costs of procurement after implementing the program. Account for repeat usage for the reusable products in calculations	The reuse of single-use medical devices is an established practice that has historically been proven to save on costs and reduce waste. Examples of supplies for reuse include reusable gowns. Particular attention should be placed on replacing single use plastics	• Environmental Impact and Cost Savings of Operating Room Quality Improvement Initiatives: A Scoping Review (Sullivan et al., 2023) • COVID-19 Solutions Are Climate Solutions: Lessons From Reusable Gowns (Baker et al., 2020) • Assessing the costs of disposable and reusable supplies wasted during surgeries (Chasseigne et al., 2018)
Operational Efficiency	Reduced medical waste	Compare the amount of medical waste produced (by product type & by weight, annually) before and after switching to reusable alternatives		
Risk Management	Reduced Scope 3 carbon emissions	Quantify the reduction in Scope 3 emissions due to reduced waste production from switching to more reusable medical supplies. Multiply the reduction by an internal price of carbon/offset	Reuse programs can lower the need for virgin material purchases, thereby lowering procurement costs	• The impact of switching from single-use to reusable healthcare products: a transparency checklist and systematic review of life-cycle assessments (Keil et al., 2023) • Category 5: Waste Generated in Operations (Retrieved Oct 12, 2023)

Benefits Assessment and Monetization Development

Practice: Buy circular products

I: Shift away from single-use supplies towards reusable alternatives

ROSI™ Mediating Factor	ROSI™ Benefits/Costs	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Risk Management	Increased supply chain resiliency	Estimate the probability of occurrence and the severity of costs of a supply chain disruption event for single-use products. Applying an attribution factor for reusable medical supplies, estimate how much of this risk can be avoided by being able to reuse what is in stock	The recent COVID-19 Pandemic demonstrated how important it is for hospitals to be prepared for supply chain interruptions. The incorporation of reusable medical supplies (e.g. reusable gowns) can help hospitals better withstand supply chain fluctuations in the future	• Sustainable Procurement Guide (Retrieved Oct 10, 2023) • COVID-19 Solutions Are Climate Solutions: Lessons From Reusable Gowns (Baker et al., 2020)

Benefits Assessment and Monetization Development

Practice: Buy circular products

II: Purchase reprocessed medical devices

ROSI™ Mediating Factor	ROSI™ Benefits to explore	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Operational Efficiency	Lower procurement costs and incentives	Estimate the total number of reprocessed products bought in the year by category of product. Calculate the cost differential between a new product sourced from an OEM and a reprocessed product. Multiply the number of products sourced with the cost differential to estimate the total savings. Add any additional rebates given by reprocessor and/or reduce any penalties imposed by OEMs (due to losing volume discounts etc.) Estimate operational costs of creating signage material to display onsite, staff time allocation to train staff/issue reminders; time allocation for negotiating reprocessing contracts and to manage shipping/collection logistics	Switching single use devices with reprocessed medical devices leads to saving in procurement costs	• CSB ROSI Project Research • Hospital Waste and Cost Prevention Potential of Reprocessing Medical Devices (Lichtnegger et al., 2023) • 2019 Reprocessing Annual Survey from AMDR (Retrieved Oct 10, 2023) • Transforming The Medical Device Industry: Road Map To A Circular Economy (MacNeill et al., 2020) • Reprocessed Single-Use Medical Devices (GAO, 2008)
Operational Efficiency	Lower costs of waste disposal and collection credit	Estimate the total weight of the products collected and sent for reprocessing on an annual basis. Multiply the weight by the average cost of waste disposal of the suitable category (e.g. red bag waste). Add any collection credit given by a reprocessor for the number of items collected	Collecting used medical devices and transporting them back to the reprocessor may reduce the amount of waste generated at the hospital site leading to saving in waste disposal costs and generate income through collection credits	

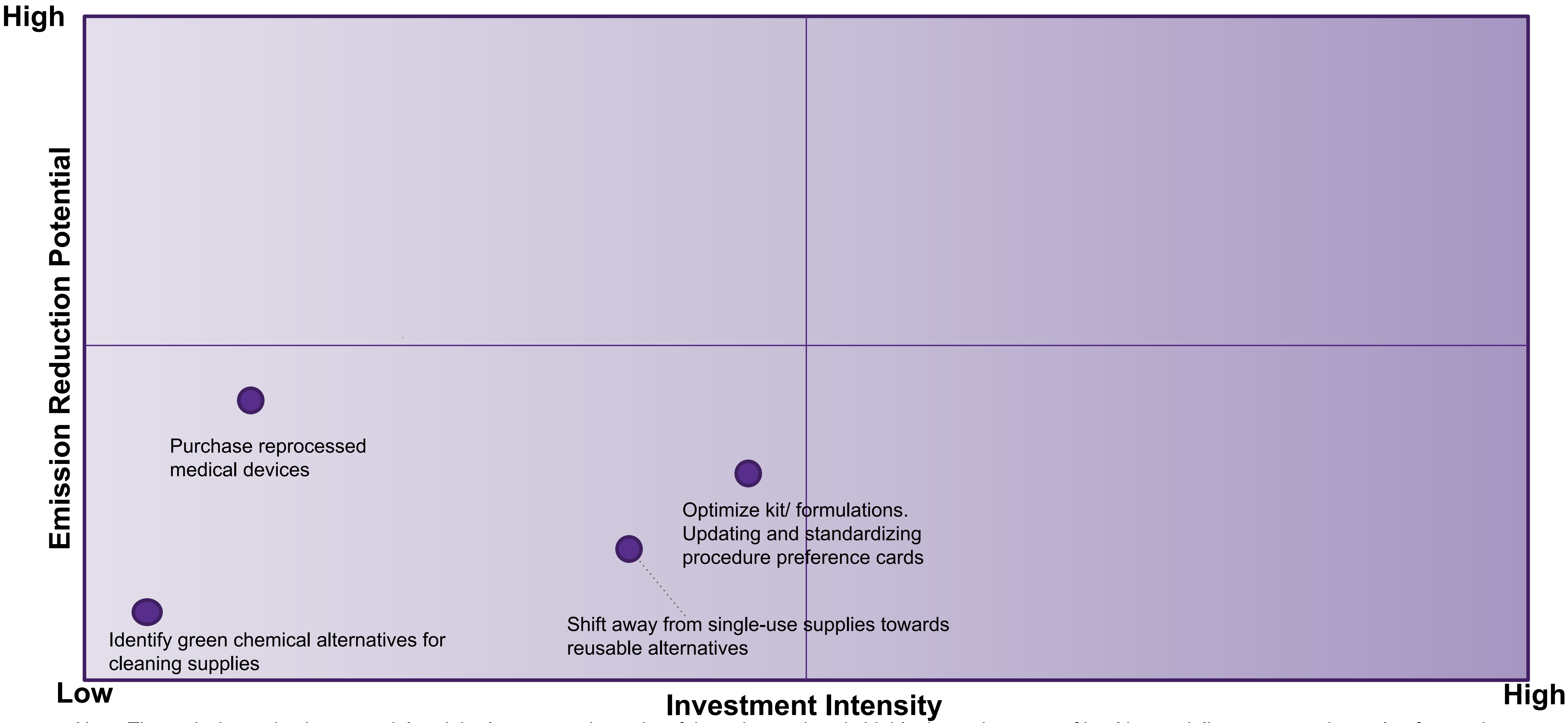
Benefits Assessment and Monetization Development

Practice: Buy circular products

II: Purchase reprocessed medical devices [cont.]

ROSI™ Mediating Factor	ROSI™ Benefits/Costs	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Risk Management	Lower risk of supply disruption	Estimate the probability of occurrence and the severity of costs of a device supply chain disruption event. Applying an attribution factor for reprocessing, estimate how much of this risk can be avoided by having an alternate supply source	Diversifying supplier base by also buying reprocessed medical devices may improve supply chain resiliency	• The resilience imperative for medtech supply chains (Behnam et al., 2020)
Risk Management	Lower GHG emissions	Obtain Life Cycle Assessment (LCA) studies if available or commission LCAs that provide the environmental footprint of the different category of devices. Using the findings, quantify the difference between the environmental footprint per device/category type. Multiply this difference by the total number of reprocessed devices purchased to estimate the average emissions avoided on an annual basis. Multiply the total avoided emissions by an internal price of carbon or price of carbon offset if being purchased to quantify the total cost savings	Reprocessed devices were found to have a lower footprint than new devices in all categories as per an LCA study conducted by Stryker Solutions	• CSB ROSI Project Research • Assessing the environmental, human health, and economic impacts of reprocessed medical devices in a Phoenix hospital's supply chain (Unger & Landis, 2016)

Relative Ranking of the Identified Sustainable Sourcing related Sub-practices



Note: The emission reduction potential and the Investment intensity of the sub-practices is highly dependent type of healthcare delivery system, its scale of operations and its geographic location

Food Service Optimization

Strategies

Energy Management	Building Design & Maintenance	Sustainable Sourcing	**Food Service Optimization**
Low Emissions Clinical Care	Waste Reduction	Responsible Investments	Reduced Transportation

Sub-practices

Implement practices that procure foods from local sources, produce less waste and incorporate plant-based options

Practice: Make a food related public commitment

I: Commit to & execute requirements of the Coolfood Pledge

Practice: Modify food ingredients and sourcing practices

II: Increase portion of locally/organically/seasonally sourced ingredients for cooked foods

III: Increase or introduce vegetarian/vegan food items and reduce the amount of meat in the diet being offered

IV: Implement sustainable procurement practices (particularly for meat)

Food Service Optimization

Sub-practices

V: Install rooftop gardens/farms and grow vegetables and fruits on own premises & provide opportunities for farmers markets, farm shares, etc.

Practice: Reduce food waste

VI: Institute sustainable internal policies & procedures to reduce food service waste (e.g. recycling programs, policies to eliminate the use of single-use plastics in food service, using reusable dishware)

VII: Implement a room service model to reducing food waste

Benefits Assessment and Monetization Development

Practice: Make a food related commitment

I: Commit to & execute requirements of the Coolfood Pledge

ROSI™ Mediating Factor	ROSI™ Benefits to explore	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Operational Efficiency	Lower procurement costs	Calculate total food procurement costs before and after implementing practices associated with the Coolfood Pledge	Planned food purchases helps lower the cost of food procurement. The cost savings depends on a variety of factors, including the specific type of product and local availability	• Is Buying Local Less Expensive? Debunking a Myth–Assessing the Price Competitiveness of Local Food Products in Canada (Charlebois et al., 2022) • The global and regional costs of healthy and sustainable dietary patterns: a modelling study (Springmann et al., 2021)
Media Coverage	Earned media	Calculate the costs that would have been expended for media coverage on a new sustainability campaign	Members of the Coolfood Pledge benefit from the pledge team's promotion of members' performance relative to SBTIs and achievements through press and social media channels	• The Coolfood Pledge (Retrieved Oct 10, 2023)

Benefits Assessment and Monetization Development

Practice: Make a food related commitment

I: Commit to & execute requirements of the Coolfood Pledge [cont.]

ROSI™ Mediating Factor	ROSI™ Benefits to explore	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Operational Efficiency	Lower food waste disposal costs	Calculate the cost of food disposal before and after implementing practices associated with the Coolfood Pledge	Depending on the municipality, the disposal of food waste may cost money–if it's available as an option. Considering the scale that hospitals operate at, the amount of food waste being disposed can result in significant costs. For example, in NYC, private carters can charge up to $24.21 per cubic yard of loose refuse or $15,89 per 100 lbs of refuse	• Food Waste Management Cost Calculator (Retrieved Oct 10, 2023) • Benefit-Cost Analysis of Potential Food Waste Diversion (NYSERDA, 2017)
Risk Management	Reduction in carbon emissions	Calculate the total carbon emissions pre- and post-committing to the Coolfood Pledge. Multiply the reduction by the associated emission factor* and by the related price of carbon offsets/internal price of carbon (suggested by research, or used by the entity) to get the total costs avoided	In 2020, the UNEP found that food loss and waste are responsible for approx 8% of global GHG emissions	• 2021 Coolfood Pledge Collective Climate Impact Report (Retrieved Oct 10, 2023) • Healthcare emissions Impact Calculator (Practice Greenhealth, 2023)

Note: An emission factor represents the quantity of a pollutant released into the atmosphere corresponding to the activity/source. Emission factors for purchased electricity from eGRID, mobile combustion, upstream and downstream transportation, business travel, product transport, and employee commuting can be obtained in EPA's GHG Emission Factors Hub here. The emissions can be converted into equivalent amount of carbon dioxide (CO2) emissions by using the Greenhouse Gas Equivalency Calculator (Accessed Oct 13, 2023).

Benefits Assessment and Monetization Development

Practice: Modify food ingredients and sourcing practices

II: Increase amount of locally/organically/seasonally sourced ingredients for cooked foods

ROSI™ Mediating Factor	ROSI™ Benefits to explore	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Operational Efficiency	Lower procurement cost	Calculate total food procurement costs before and after of increasing the portion of locally/organically/seasonally sourced food products	In some scenarios, local/organic/seasonally sourced food products may cost less while also being more sustainable. The cost savings depends on a variety of factors, including the specific type of product and local availability	• Is Buying Local Less Expensive? Debunking a Myth–Assessing the Price Competitiveness of Local Food Products in Canada (Charlebois et al., 2022)
Risk Management	Reduction in carbon emissions	Calculate the total carbon emissions before and after increasing the portion of local/organic/seasonal foods purchased. Multiply the reduction by the associated emission factor and by the related price of carbon offsets/internal price of carbon (suggested by research, or used by the entity) to get the total costs avoided	Li et al. found that global transportation of consumable produce accounts for 36% of total food-mile emissions (2022). In order to reduce the impact of food-systems, Li et al. recommend that more affluent nations aim to increase the amount of locally produced foods. The potential carbon emissions reduction depends on a variety of factors, including the specific type of product and local availability	• Global food-miles account for nearly 20% of total food-systems emissions (Li et al., 2022) • GHG Emission Factors Hub (EPA, 2023) • Modelling the Carbon Footprint of Various Fruit and Vegetable Products Based on a Company's Internal Transport Data (Gorny et al., 2021)

Benefits Assessment and Monetization Development

Practice: : Modify food ingredients and sourcing practices

III: Increase or introduce vegetarian/vegan food items and reduce the amount of meat in the diet being offered

ROSI™ Mediating Factor	ROSI™ Benefits to explore	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Operational Efficiency	Lower procurement costs	Calculate total food procurement costs before and after increasing the portion of vegetarian/vegan options and decreasing the portion of meat offerings	A 2021 Oxford study found that vegetarian and vegan diets are generally the most affordable (Springmann et al., 2021). Specifically, vegetarian and vegan diets that use legumes and whole grains in replacement of animal products are the most affordable	• The global and regional costs of healthy and sustainable dietary patterns: a modelling study (Springmann et al., 2021)
Risk Management	Reduction in carbon emissions	Calculate total carbon emissions before and after increasing the portion of vegetarian/vegan options and decreasing the portion of meat offerings. Multiply the reduction by the associated emission factor and by the related price of carbon offsets/internal price of carbon (suggested by research, or used by the entity) to get the total costs avoided	A 2023 Oxford study surveying 55,504 vegans, vegetarians, fish-eaters, and meat-eaters found that meat-eaters had the greatest environmental impact across all indicators (e.g. GHG emissions, land use, water use) (Scarborough et al., 2023)	• Vegans, vegetarians, fish-eaters and meat-eaters in the UK show discrepant environmental impacts (Scarborough et al., 2023) • From Farm to Kitchen: The Environmental Impacts of U.S. Food Waste (EPA, 2021)

Benefits Assessment and Monetization Development

Practice: : Modify food ingredients and sourcing practices

III: Increase or introduce vegetarian/vegan food items and reduce the amount of meat in the diet being offered [cont.]

ROSI™ Mediating Factor	ROSI™ Benefits to explore	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Risk Management	Reduction in carbon emissions	Calculate total carbon emissions before and after increasing the portion of vegetarian/vegan options and decreasing the portion of meat offerings. Multiply the reduction by the associated emission factor and by the related price of carbon offsets/internal price of carbon (suggested by research, or used by the entity) to get the total costs avoided	A 2023 Oxford study surveying 55,504 vegans, vegetarians, fish-eaters, and meat-eaters found that meat-eaters had the greatest environmental impact across all indicators (e.g. GHG emissions, land use, water use) (Scarborough et al., 2023)	• Vegans, vegetarians, fish-eaters and meat-eaters in the UK show discrepant environmental impacts (Scarborough et al., 2023) • Environmental Impacts of Food Production (Ritchie, Rosado & Roser, 2022) • Modelling the Carbon Footprint of Various Fruit and Vegetable Products Based on a Company's Internal Transport Data (Gorny et al., 2021) • Healthcare Emissions Impact Calculator (Practice Greenhealth, 2023)

Benefits Assessment and Monetization Development

Practice: Modify food ingredients and sourcing practices

IV: Implement low carbon procurement practices (particularly for meat)

ROSI™ Mediating Factor	ROSI™ Benefits to explore	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Operational Efficiency	Lower procurement costs	Calculate total food procurement costs before and after increasing the portion of vegetarian/vegan options and decreasing the portion of meat offerings. The difference are the cost savings	A 2021 Oxford study found that vegetarian and vegan diets are generally the most affordable (Springmann et al., 2021). Specifically, vegetarian and vegan diets that use legumes and whole grains in replacement of animal products are the most affordable	• The global and regional costs of healthy and sustainable dietary patterns: a modelling study (Springmann et al., 2021)
Risk Management	Reduction in carbon emissions	Calculate total Scope 3 carbon emissions before and after switching to low carbon procurement practices. Compare carbon emissions reductions and monetize by calculating the equivalent cost of carbon offsets or social cost of carbon	One approach is to source meat from livestock ranchers that engage in more sustainable and low carbon practices. For example, White Oak Pastures in Clay County, Georgia practices multispecies pasture rotation (MSPR) where multiple forms of animal production coexist on the same landscape. Compared to conventional ranching methods, Rowntree et al. found that MSPR had a 66% smaller environmental footprint (2020)	• Ecosystem Impacts and Productive Capacity of a Multi-Species Pastured Livestock System (Rowntree et al., 2020) • Category 1: Purchased Goods and Services (Retrieved Oct 12, 2023)

Benefits Assessment and Monetization Development

Practice: Modify food ingredients and sourcing practices

V: Install rooftop gardens/farms and grow vegetables and fruits on own premises & provide opportunities for farmers markets, farm shares, etc.

ROSI™ Mediating Factor	ROSI™ Benefits to explore	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Operational Efficiency	Lower procurement costs	Estimate how much of the organization's total annual vegetables and fruits requirements are met from the rooftop garden and multiply by average price per unit to calculate the total procurement cost savings Estimate the costs of setting up the garden/farm installation and ongoing operations and maintenance expenses of the garden	For example, Boston Medical Center has a rooftop farm that grows 5000 lbs of produce for the hospital every year which translates to approximately $18,000 worth of fresh produce that the facility has access to and does not need to purchase from elsewhere	• Boston Medical Center - Rooftop Farm (Retrieved Oct 10, 2023) • Implementation of a Rooftop Farm Integrated With a Teaching Kitchen and Preventative Food Pantry in a Hospital Setting (Musicus et al., 2019)

Benefits Assessment and Monetization Development

Practice: Modify food ingredients and sourcing practices

V: Install rooftop gardens/farms and grow vegetables and fruits on own premises & provide opportunities for farmers markets, farm shares, etc. [cont.]

ROSI™ Mediating Factor	ROSI™ Benefits to explore	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Risk Management	Reduction in carbon emissions	Compare the total Scope 3 emissions associated with food procurement before and after implementing a rooftop garden/farm. Compare the emissions reduction to the equivalent cost of carbon offsets or social cost of carbon Depending on the size and design of the building, there may be opportunities to include more complex solutions for reducing carbon	By producing fresh produce on-site, hospitals can reduce the emissions associated with miles travelled to ship produce from other vendors. Rooftop gardens and farms can also sequester carbon	• Enhancing crop growth in rooftop farms by repurposing CO2 from human respiration inside buildings (Buckley et al., 2022) • An overview of carbon sequestration of green roofs in urban areas (Shafique, Xue, & Luo, 2020) • Quantifying carbon sequestration of various green roof and ornamental landscape systems (Whittinghill et al., 2014) • Using Green Roofs to Reduce Heat Islands (EPA, 2023) • CO2 Payoff of Extensive Green Roofs with Different Vegetation Species (Kuronuma et al., 2018)

Benefits Assessment and Monetization Development

Practice: Modify food ingredients and sourcing practices

V: Install rooftop gardens/farms and grow vegetables and fruits on own premises & provide opportunities for farmers markets, farm shares, etc.

ROSI™ Mediating Factor	ROSI™ Benefits to explore	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Media Coverage	Earned media	Track any free media mentions of the rooftop garden. Calculate the marketing costs that would have typically been expended to receive the same amount of media coverage	For example, the Boston Medical Center's rooftop farm has brought in significant media coverage for the farm, the associated sustainability practices, the associated social and community impact, and the Medical Center itself	• Boston Medical Center - Rooftop Farm (Retrieved Oct 10, 2023) • Implementation of a Rooftop Farm Integrated With a Teaching Kitchen and Preventative Food Pantry in a Hospital Setting (Musicus et al., 2019)

Benefits Assessment and Monetization Development

Practice:Modify food ingredients and sourcing practices

VI: Institute sustainable internal policies & procedures to reduce food service waste (e.g. recycling programs, policies to eliminate the use of single-use plastics in food service, using reusable dishware)

ROSI™ Mediating Factor	ROSI™ Benefits to explore	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Operational Efficiency	Lower procurement costs	Calculate the total costs associated with sourcing food service-related products (e.g. dishware, utensils) before and after shifting to a lower waste model (e.g. reusable dishware). Be sure to analyze the per use cost, not just the per unit cost	One option that hospitals can pursue to reduce procurement costs and emissions is to use reusable dishware/food service containers	• The potential impact of reusable packaging (Gruenwald et al., 2023) • Waste generation and carbon emissions of a hospital kitchen in the US: Potential for waste diversion and carbon reductions (Thiel et al., 2021)

Benefits Assessment and Monetization Development

Practice: Modify food ingredients and sourcing practices

VI: Institute sustainable internal policies & procedures to reduce food service waste (e.g. recycling programs, policies to eliminate the use of single-use plastics in food service, using reusable dishware) [cont.]

ROSI™ Mediating Factor	ROSI™ Benefits to explore	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Operational Efficiency	Reduction in food service waste	Calculate the total weight of landfill waste produced and the associated landfill cost before and after instituting more sustainable internal policies & procedures (e.g. recycling programs)	Even simple strategies, such as increasing recycling and composting have also proven to significantly reduce landfill waste and GHG emissions from hospital kitchens (Thiel et al., 2021)	• Waste generation and carbon emissions of a hospital kitchen in the US: Potential for waste diversion and carbon reductions (Thiel et al., 2021) • Category 5: Waste Generated in Operations (Retrieved Oct 12, 2023) • Category 12: End-of-Life Treatment of Sold Products (Retrieved Oct 12, 2023)
Risk Management	Reduction in carbon emissions	Based on the reduction in food service waste above, calculate corresponding Scope 3 emissions reductions by applying an emissions factor and calculating the related avoided cost of carbon credits/internal cost of carbon		

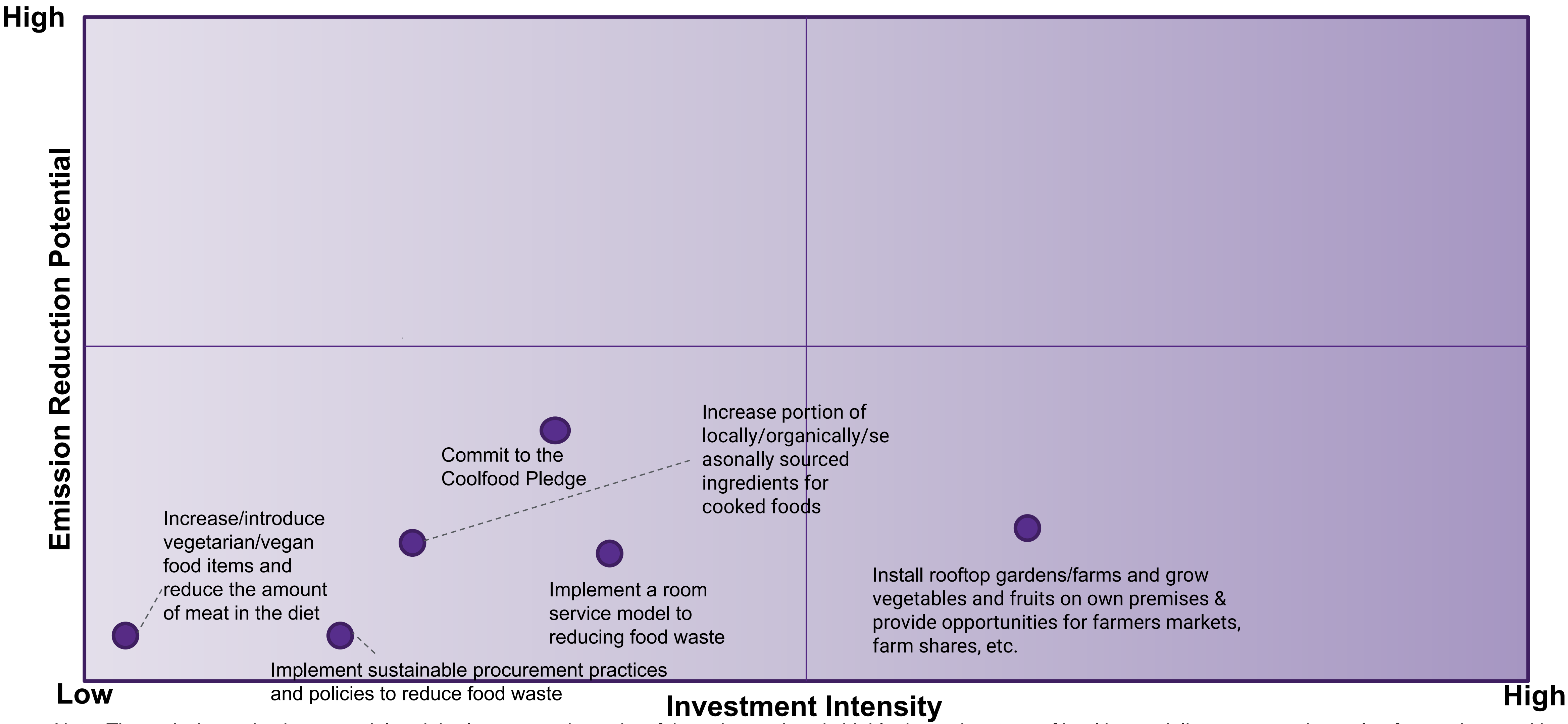
Benefits Assessment and Monetization Development

Practice: Reduce food waste

VII: Implement a room service model to reduce food waste

ROSI™ Mediating Factor	ROSI™ Benefits to explore	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Operational Efficiency	Lower patient meal costs	Calculate average cost per meal before implementing a room service model and after implementing a room service model. Compare the two per patient costs and multiply by the total number of meals served to calculate annual savings	When patients can choose what they eat, they would typically eat more of what they order. Therefore, by converting from pre-planned meal sets to a room service food service model where patients can select the food they want to consume, research shows that hospitals are able to reduce food waste and patient meal costs	• Room Service Improves Nutritional Intake and Increases Patient Satisfaction While Decreasing Food Waste and Cost (McCray et al., 2017) • How to Implement a Successful Room Service Program: Improving Patient Satisfaction & Reducing Waste (Carlisle FoodService Products, 2023)
Risk Management	Reduced food waste	Calculate the average weight of the food wasted per patient before implementing a room service model and after implementing a room service model. Compare the two per patient costs and multiply by the total number of meals served to calculate annual savings		
Risk Management	Reduced carbon emissions	Based on the reduction in food waste, calculate corresponding Scope 3 emissions reductions using emission factors		

Relative Ranking of the Identified Food Service Optimization related Sub-practices



Note: The emission reduction potential and the Investment intensity of the sub-practices is highly dependent type of healthcare delivery system, its scale of operations and its geographic location

Low Emissions Clinical Care

Strategies

Energy Management	Building Design & Maintenance	Sustainable Sourcing	Food Service Optimization
Low Emissions Clinical Care	Waste Reduction	Responsible Investments	Reduced Transportation

Sub-practices

Use clinical care solutions that minimize the carbon footprint of anesthetic gases and care delivery

Practice: Low emissions Clinical care - Anesthesia

I:Reduce Fresh Gas Flows (FGF) and Nitrous Oxide use

II: Remove desflurane as a standard inhaled anesthetic in operating rooms

III: Shift to intravenous anesthesia or regional anesthesia where clinically appropriate

IV: Recapture Waste Anesthesia Gas

V: Shift from Metered Dose Inhalers to Low carbon inhalers, such as Dry Powder Inhalers (DPIs), when clinically appropriate

Practice: Low emissions clinical care - delivery pathways

I: Transition away from Fee-For-Service (FFS) to alternative payment models or "Value-Based Care" reimbursement

II: Expanding telehealth options where medically appropriate

Benefits Assessment and Monetization Development

Practice: Low emissions clinical care - anesthesia

I: Reduce Fresh Gas Flows (FGF) and Nitrous Oxide use

ROSI™ Mediating Factor	ROSI™ Benefits to explore	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Operational Efficiency	Lower procurement costs	Calculate the per-procedure units of gas consumed before and after implementing the changes to reduce fresh gases/nitrous oxide consumption. Multiply the difference in the consumption units by the per unit cost of gas purchased and then by the number of annual procedures for the annual savings If currently installed anesthetic equipment does not provide options to monitor and control reduced flows an equipment upgrade or replacement may be needed. In such cases consider costs related to the investment	Research shows that more inhaled anesthetics are used during surgery than necessary. Reducing FGF could mitigate waste	• Evidence-Based Project: Cost Savings and Reduction in Environmental Release With Low-Flow Anesthesia (Edmonds et al., 2021) • Anesthetic gas how-to guide: A guide to climate-smart anesthesia care (Practice Greenhealth, 2023)

Benefits Assessment and Monetization Development

Practice: Low emissions clinical care - anesthesia

I: Reduce Fresh Gas Flows (FGF) and Nitrous Oxide use [cont.]

ROSI™ Mediating Factor	ROSI™ Benefits to explore	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Risk Management	Reduced emissions from waste	Estimate the reduction in gas consumption pre- and post-changing and thus the reduction in gas wastage. Multiply the reduction by the associated emission factor and by the related price of carbon offsets/internal price of carbon (suggested by research, or used by the entity) to get the total costs avoided	Reducing Fresh Gas Flows (FGF) could reduce environmental release Evidence of no heightened health risk in a randomized comparative trial from the change	• Anesthetic gas how-to guide: A guide to climate-smart anesthesia care (Retrieved Oct 10, 2023) • Minimal fresh gas flow sevoflurane anesthesia and postoperative acute kidney injury in on-pump cardiac surgery: a randomized comparative trial (Lineburger et al., 2023)

Benefits Assessment and Monetization Development

Practice: Low emissions clinical care - anesthesia

II: Replace desflurane as a standard inhaled anesthetic in operating rooms

ROSI™ Mediating Factor	ROSI™ Benefits	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Operational Efficiency	Lower procurement costs	Compare the total gas quantity by type used per procedure before and after implementing the change (replacing desflurane with sevoflurane). Multiply the gas consumed with respective per unit costs and multiply by total # of procedures done in a year to estimate the total costs. Calculate the difference between the two costs to estimate the savings Consider if the installed anesthetic equipment provides options to switch the gas. An equipment upgrade or replacement may be needed. In such a case consider costs related to the investment	Costs of desflurane are higher than other anesthetics	• Comparing the costs of inhaled anesthetics (Weiskopf & Eger, 1993) • Anesthetic gas how-to guide: A guide to climate-smart anesthesia care (Retrieved Oct 10, 2023)

Benefits Assessment and Monetization Development

Practice: Low emissions clinical care - anesthesia

II: Replace desflurane as a standard inhaled anesthetic in operating rooms [cont.]

ROSI™ Mediating Factor	ROSI™ Benefits/Costs to explore	Potential metrics to monetize	Rationale for the Benefit/Cost	Relevant resources
Risk Management	Compliance with local regulations	Avoidance of potential fines or penalties if legislation is passed in the US that bans desflurane	Fir example, NHS of Scotland has banned the use of desflurane. NHS of the UK will phase desflurane out by 2023. Other regions may follow	• Making the NHS more environmentally friendly (NHS, 2023) • Greening the Operating Room and Your Budget by Reducing Desflurane Use (Retrieved Oct 10, 2023)
Risk Management	Reduced emissions	Estimate the type of each gas used per procedure before and after the switch based on purchase records. Multiply each type of gas and quantity used by the associated emission factor and by the related price of carbon offsets/internal price of carbon (suggested by research, or used by the entity) to get the total costs of carbon emissions avoided	Desflurane has a 15-20 times higher emission factor sevoflurane or isoflurane	

Benefits Assessment and Monetization Development

Practice: Low emissions clinical care - anesthesia

III: Shift to intravenous anesthesia or regional anesthesia where clinically appropriate

ROSI™ Mediating Factor	ROSI™ Benefits to explore	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Operational Efficiency	Reduced procedure costs	Compare total procedure costs before and after the change in process based on purchase costs and usage quantity	Some alternatives to general inhalational anesthesia cost significantly less	• Cost-effectiveness of propofol vs. inhalational anesthetics (Kampmeier et al., 2021) • Cost-effectiveness of spinal vs. general anesthesia (Morris et al., 2018)
Risk Management	Reduced emissions	Compare emissions pre- and post- changing and multiply with the related social cost of carbon or price of carbon offsets (suggested by research, or used by the healthcare system)	"Local, regional and intravenous general anaesthesia agents are associated with significantly fewer GHG emissions than inhalational general anaesthesia on a life-cycle basis (White et al., 2021)"	• Principles of environmentally-sustainable anaesthesia (White et al., 2021) • Carbon footprint of spinal vs. general anesthesia (Wang et al., 2022)

Benefits Assessment and Monetization Development

Practice: Low emissions clinical care - anesthesia

IV: Waste anesthetic gas recycling*

ROSI™ Mediating Factor	ROSI™ Benefits/Costs	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Operational Efficiency & Innovation	Cost reduction in procedure	Compare total procedure costs (essentially quantity of gas consumed per procedure multiplied by the price per unit and the total number of procedures performed) before and after the change in process (i,e, recapture should reduce new gas purchase quantities) Consider the costs of setting up the infrastructure to capture the gas such as the investment in the recapture system, transportation and purification of gas for reuse and net off from savings	Limited information presently. WAG recapture and condensation is possible, but the condensated drugs are not yet available for resale	• Waste Gas Scavenging System (Lahvic & Liu, 2023)
Risk Management	Emission reduction for Scope 1,3	Scope 1 and 3 emissions pre- and post- changing and the related social cost of carbon or an internal price of carbon/offset (suggested by research, or used by the entity)	Greenhouse warming potential of anesthetic gases	

*There is limited information on whether this practice is approved by the FDA in the U.S. (September 2023)

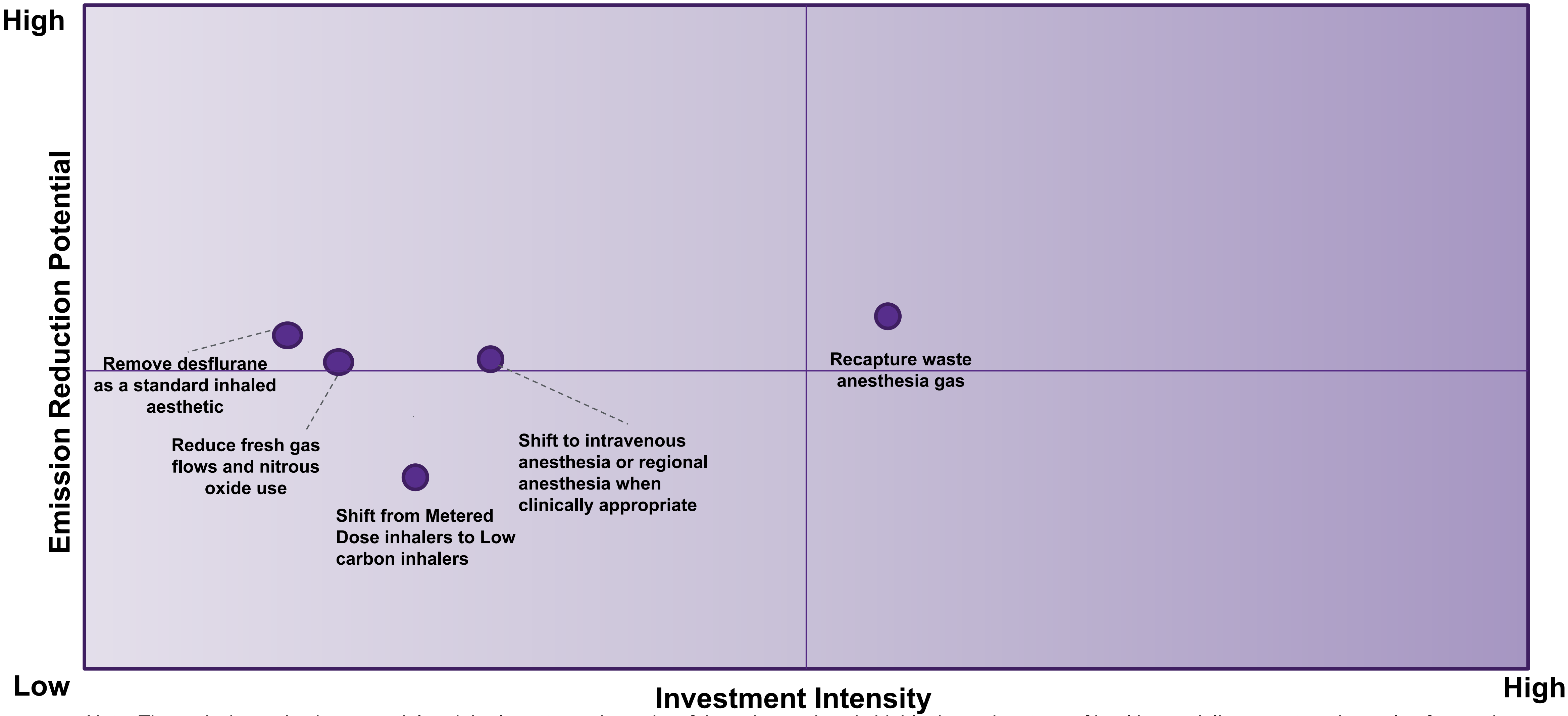
Benefits Assessment and Monetization Development

Practice: Low emissions clinical care - anesthesia

V: Shift from Metered Dose Inhalers to Low carbon inhalers, such as Dry Powder Inhalers (DPIs), when clinically appropriate

ROSI™ Mediating Factor	ROSI™ Benefits/Costs	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Risk Management	Reduced emissions	Determine the difference between the amount of emissions from metered dose inhalers vs. low carbon inhalers. Multiply the difference by the number of inhalers prescribed annually	Patients using DPIs were found to have reduced their carbon footprint as compared to using MDIs , without loss of asthma control	• Effects of switching from a metered dose inhaler to a dry powder inhaler on climate emissions and asthma control: post-hoc analysis (Woodcock A et al., 2022)

Relative Ranking of the Identified Low emissions Clinical Care-Anesthesia related Sub-practices



Note: The emission reduction potential and the Investment intensity of the sub-practices is highly dependent type of healthcare delivery system, its scale of operations and its geographic location

Benefits Assessment and Monetization Development

Practice: Low emissions-clinical care delivery pathways

I: Transition away from Fee-For-Service (FFS) to alternative payment models or "Value-Based Care" reimbursement

ROSI™ Mediating Factor	ROSI™ Benefits/Costs	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Operational Efficiency	Cost reduction per patient based on more focus on preventative care and less on procedures to address ailments	Calculate increased profit margin after implementing alternative payment models. Timeframe for monetization would have to be at least 5-10 years for value-based care as it typically includes more preventative care and results of this preventative care may take years to appear	Decarbonization is a secondary outcome for this intervention. The primary reasons are improved health outcomes and lower costs. However, because this incentivizes more efficient care delivery, it has the potential to reduce emissions	• Value-Based Care: What It Is, and Why It's Needed (Lewis et al., 2023)

Benefits Assessment and Monetization Development

Practice: Care delivery pathways

II: Expanding telehealth options where medically appropriate

ROSI™ Mediating Factor	ROSI™ Benefits/Costs	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Sales & Marketing	Higher patient revenues	When used appropriately, telehealth can increase revenue with greater patient access (i.e. calculate the additional number of patients that can be seen with the new options). It can also lower cost with decreased staff/overhead requirements. However, monetization is intimately tied to how the respective insurance companies reimburse telehealth consultations so hospitals will also have to determine the reimbursement allowances	Telehealth can make healthcare more accessible to patients who have limited mobility, time, or transportation options and those who live in rural or isolated communities	• National Survey Trends in Telehealth Use in 2021: Disparities in Utilization and Audio vs. Vide Services (Karimi et al., 2022) • How Telehealth Improves Revenue, Cost, and Quality (Caldwell, 2020) • Better Buildings: The State of Virtual Healthcare (Retrieved Oct 10, 2023) • NHS England Technology Enabled Care Services (TECS) Evidence Database TELEHEALTH EVIDENCE (Retrieved Oct 10, 2023)
Operational Efficiency	Cost efficiency			
Talent Management	Improved staff satisfaction leading to higher employee retention	Compare the organization's staff turnover rates with industry's average turnover after implementation of the specific program. Design and institute surveys with an objective to understand the impact of telehealth on staff morale and productivity over a period of time. Any favorable change should be monetized by multiplying with a productivity metric most relevant to the organization. Use survey data to assign an attribution % to the reduction in turnover and the associated savings in hiring costs		

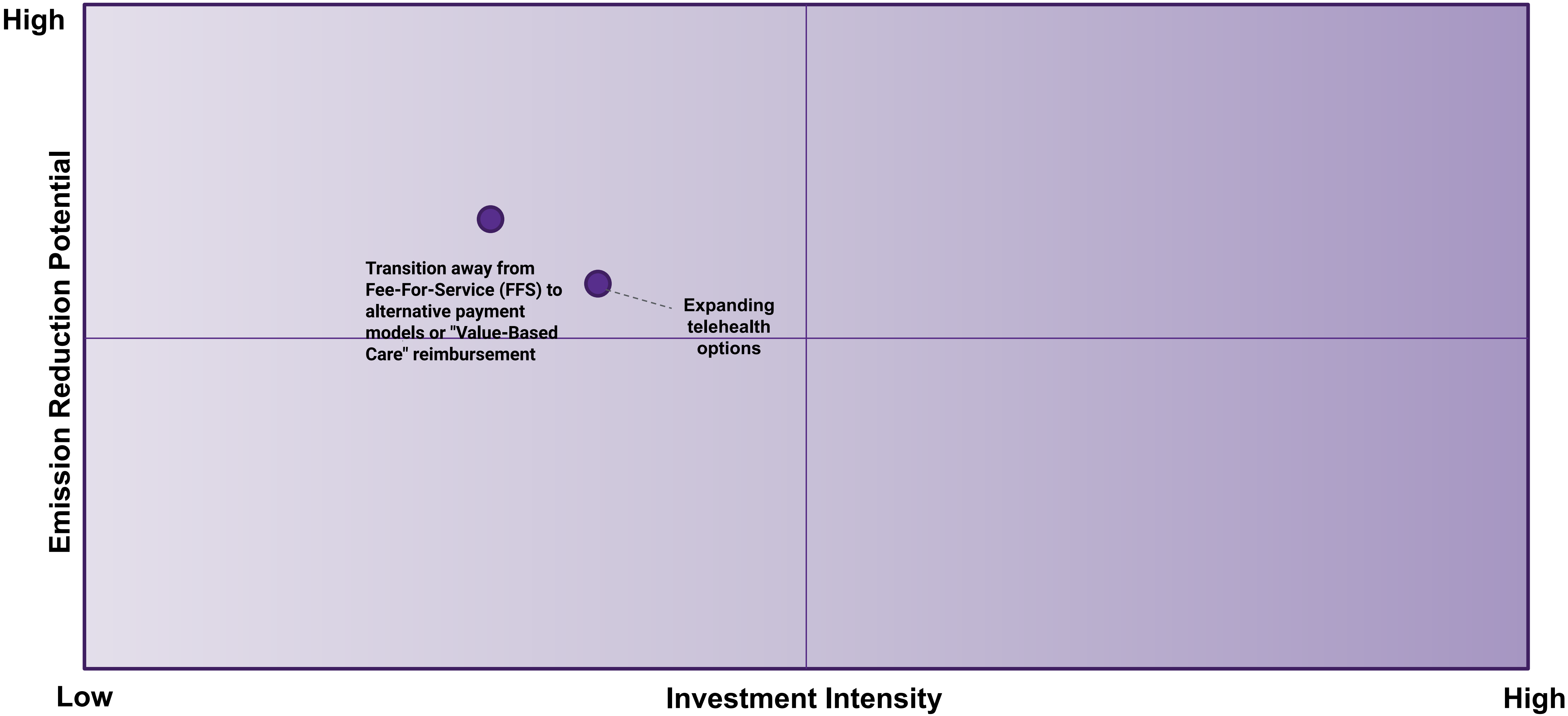
Benefits Assessment and Monetization Development

Practice: Care delivery pathways

II: Expanding telehealth options where medically appropriate

ROSI™ Mediating Factor	ROSI™ Benefits/Costs	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Risk Management	Emission reduction benefit	Calculate travel emissions for patients that are seen using telehealth to determine the avoided emissions of those visits (using patients' distance from hospital). Adjust for those patients that would not have been seen without a telehealth option	CommonSpirit health systems and University of California Davis Health System found emission savings over several years by using telehealth	• Does telemedicine reduce the carbon footprint of healthcare? A systematic review. (Purohit, Smith & Hubble, 2021)

Relative Ranking of the Identified Low emissions Clinical Care-Delivery Pathways related Sub-practices



Note: The emission reduction potential and the Investment intensity of the sub-practices is highly dependent type of healthcare delivery system, its scale of operations and its geographic location

Waste Reduction

Strategies

Energy Management	Building Design & Maintenance	Sustainable Sourcing	Food Service Optimization
Low Emissions Clinical Care	**Waste Reduction**	Responsible Investments	Reduced Transportation

Sub-practices

Produce less waste through circularity, proper sorting of waste and using waste for energy production

Practice: Waste diversion/reduction

I: Implement a waste segregation, recycling, and reuse program on the facility (including all types of waste and all types of operations)

II: Implement a system for anaerobic digestion of food waste

III: Implement a system for anaerobic digestion of medical/bio waste

IV: Donating clean, usable supplies that would otherwise be discarded due to internal practices

V: Increase document digitization where feasible or switch to 100% recycled paper content where digitization is not feasible

Benefits Assessment and Monetization Development

Practice: Waste diversion/reduction

I: Implement a waste segregation, recycling, and reuse program on the facility (including all types of waste and all types of operations)

ROSI™ Mediating Factor	ROSI™ Benefits/Costs	Potential metrics to monetize	Rationale for the benefit/cost	Relevant resources
Operational Efficiency	Reduction in costs of disposal of solid/hazardous/ non-hazardous/medical trash (such as trash haulage and disposal charges) as applicable	Compare total waste disposal costs before and after the change in process (e.g. savings due to lesser waste generation) Estimate the investment required to implement the segregation, reuse and recycling system Consider the material cost of signage, other material on the processes to be followed	Costs of waste disposal depend on the quantity of waste and the type of waste being disposed off. Regulated medical waste is costlier to dispose off than non-medical waste	• The Gold in Garbage: Implementing a Waste Segregation and Recycling Initiative (Wyssusek et al., 2016) • Waste Planning by Practice Greenhealth (Retrieved on Oct 10, 2023) • CSB ROSI Project Research

Benefits Assessment and Monetization Development

Practice: Waste diversion/reduction

I: Implement a waste segregation, recycling, and reuse program on the facility (including all types of waste and all types of operations) [cont.]

ROSI™ Mediating Factor	ROSI™ Benefits/Costs	Potential metrics to monetize	Rationale for the benefit/cost	Relevant resources
Operational Efficiency	Lower procurement costs	Compare the procurement cost of items before implementing the segregation/recycling/reuse program (eg. disposable foodware) with the costs of procurement after implementing the program	Reuse programs can lower the need for virgin material purchases, thereby lowering procurement costs	• Environmental Impact and Cost Savings of Operating Room Quality Improvement Initiatives: A Scoping Review (Sullivan et al., 2023)
Risk Management	Emission reduction	Estimate the weight of the waste that is sent to landfill pre- and post- implementing the program and multiply the difference by the related social cost of carbon/carbon offset price (as suggested by research, or used by the entity) to calculate the overall savings from reducing waste to landfill	The program will divert waste from the landfill each year avoiding greenhouse gas emissions	• Category 5: Waste Generated in Operations (Retrieved Oct 12, 2023) • EPAs GHG Emission Factors Hub (EPA, 2023) • Healthcare emissions Impact Calculator (Practice Greenhealth, 2023)

Note: Only biohazardous materials should be disposed in red bags. However, often times due to lack of clear understanding of red bag waste criteria, a lot of supplies that should be thrown in regular trash bins get discarded in red bag waste. Red bag waste has an intense disposal process, from both a cost and emission standpoint, involving autoclaves and incinerators. Intervention should involve staff education about what actually should get discarded with red bag waste.

Benefits Assessment and Monetization Development

Practice: Waste diversion

II: Implement a system for anaerobic digestion of food waste

ROSI™ Mediating Factor	ROSI™ Benefits/Costs	Potential metrics to monetize	Rationale for the benefit/cost	Relevant resources
Operational Efficiency	Reduction in costs of disposal of food waste (such as trash haulage and disposal charges) as applicable	Compare total food waste (solid) disposal costs before and after the change in process (e.g. saving due to lesser waste generation) Estimate the investment required to implement the system and ongoing costs if any	Costs of food waste disposal (haulage and disposal) depend on the quantity of waste being disposed off Consider expenses to implement the system	• Food and food-related waste management strategies in hospital food services: A systematic review (Cook et al., 2022)
Operational Efficiency	Saving in energy costs	Calculate the number of energy units that the digester can generate for the facility. Calculate the amount currently spent on the corresponding amount of energy units. Subtract the new per unit cost from the old per unit cost and multiply by the energy units	Energy generated within these digesters could be captured as biogas and used to generate different types of energy	• How Does Anaerobic Digestion Work? (EPA, 2023)
Risk Management	Emission reduction	Estimate the annual weight of the food waste pre- and post-implementing the program and multiply the difference by the associated emission factor. Multiply by the carbon offset price/carbon tax (as suggested by research, or used by the entity) to calculate the overall savings from reducing waste to landfill	The program will divert waste from the landfill each year avoiding greenhouse gas emissions	• Category 5: Waste Generated in Operations (Retrieved Oct 12, 2023)

Benefits Assessment and Monetization Development

Practice: Waste diversion

III: Implement a system for anaerobic digestion of medical/bio waste - examples are from outside of the U.S.*

ROSI™ Mediating Factor	ROSI™ Benefits/Costs	Potential metrics to monetize	Rationale for the benefit/cost	Relevant resources
Innovation	Saving in energy costs	There is limited literature on whether this practice is being used within the U.S.. Reports suggest prevalence of pilots being tested in Nepal, Tanzania and Madagascar	Health Care Without Harm and the Health, Environment and Climate Action Foundation of Nepal have been working with biodigester experts to design systems – first in Nepal and then expanding to hospitals in Tanzania and Madagascar. Digesters can convert infectious organic waste into energy	• A win-win for disposing medical waste with biodigestion (Stringer, 2020) • Health Care Without Harm and the Health, Environment and Climate Action Foundation of Nepal (Retrieved Oct 12, 2023)

*While research did not uncover use of this practice in the US, it is included here as an example of innovation in waste diversion

Benefits Assessment and Monetization Development

Practice: Waste reduction

IV: Donating clean, usable supplies that would otherwise be discarded due to internal practices

ROSI™ Mediating Factor	ROSI™ Benefits/Costs	Potential metrics to monetize	Rationale for the benefit/cost	Relevant resources
Media Coverage	Earned media	By donating clean usable medical supplies, hospitals are helping divert waste to landfill and delivering aid. This can potentially earn the institution press mentions and free media coverage. Estimate the costs that would have otherwise been spent to get this kind of press coverage	Items can brought into patient areas but never opened/used. Items can be safely used but aren't due to regulations. These clean usable supplies can be donated to local non-profit organizations for example AFYA Foundation	• AFYA Foundation Donate Supplies (Retrieved on Oct 10, 2023) • Reuse, Donate or Sell (Retrieved on Oct 10, 2023
Operational Efficiency	Reduction in waste disposal costs	Calculate the weight of items donated instead of being discarded and multiply that by the average costs of waste disposal for the total cost savings	Costs of waste disposal (haulage and disposal) depend on the quantity of waste and the type of waste being disposed off	
Risk Management	Emission reduction	Estimate the weight of discarded supplies pre- and post- implementing the program and multiply the difference by the appropriate emissions factor, and then by the carbon offset price/internal carbon price of carbon (as suggested by research, or used by the entity) to calculate the overall savings from reducing waste to landfill	The program will divert waste from the landfill each year avoiding greenhouse gas emissions	• Category 5: Waste Generated in Operations (Retrieved Oct 12, 2023)

Benefits Assessment and Monetization Development

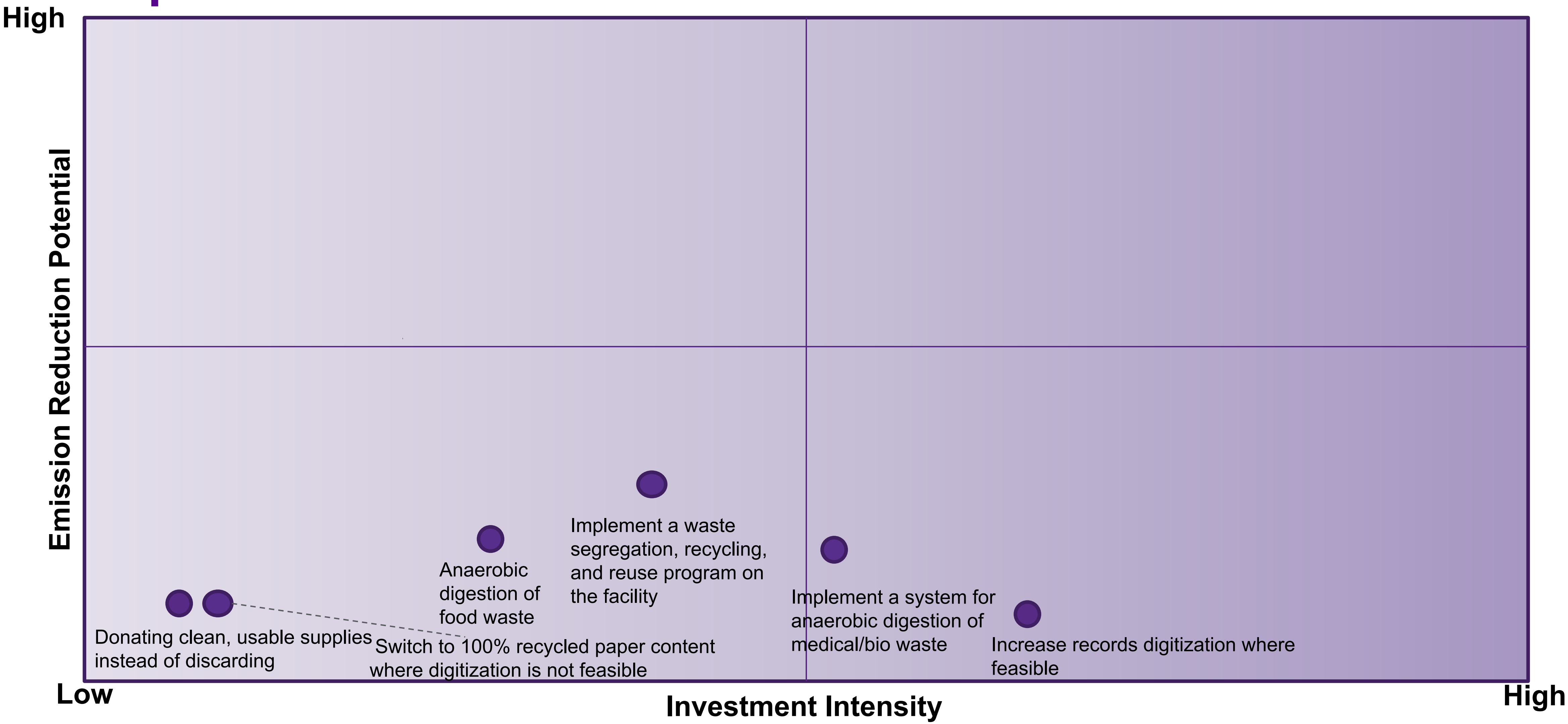
Practice: Waste reduction

V: Increase document digitization where feasible or switch to 100% recycled paper content where digitization is not feasible*

ROSI™ Mediating Factor	ROSI™ Benefits/Costs	Potential metrics to monetize	Rationale for the benefit/cost	Relevant resources
Operational Efficiency	Potential reduction in procurement costs	Compare costs of maintaining patient and other records in physical form vs, in an electronic record system. Any favorable difference is the cost saving. Consider the infrastructure costs under both scenarios, account for it	Reducing costs through decreased paperwork, improved safety, reduced duplication of testing, and improved health	• National Coordinator for Health Information Technology (Retrieved on Oct 10, 2023)
Operational Efficiency	Reduction in waste disposal costs	Calculate the reduction in the weight of documents normally discarded and multiply that by the average costs of waste disposal for the total cost savings	Recycling of paper can help bring down waste by 10%	• Recycling (Retrieved on Oct 10, 2023)
Risk Management	Emission reduction	Estimate the weight of the waste pre- and post-implementing the program and multiply the difference by the appropriate emissions factor and then by the related carbon offset price/internal price of carbon (as suggested by research, or used by the entity) to calculate the overall savings from reducing waste to landfill	The program will divert waste from the landfill each year avoiding greenhouse gas emissions	• Category 5: Waste Generated in Operations (Retrieved Oct 12, 2023)

*Decarbonization is not the main reason for implementing. There are several benefits such as better access to patient health and medical records, reduced risk of liability etc,. It may have the potential to reduce emissions

Relative Ranking of the Identified Waste Reduction related Sub-practices



Note: The emission reduction potential and the Investment intensity of the strategies is highly dependent type of healthcare delivery system, its scale of operations and its geographic location

Responsible Investments

Strategies

Energy Management	Building Design & Maintenance	Sustainable Sourcing	Food Service Optimization
Low Emissions Clinical Care	Waste Reduction	**Responsible Investments**	Reduced Transportation

Sub-practices

Prioritize investments focused on sustainability and with portfolios of companies showing progress towards carbon reduction goals

Practice: Realign investments portfolio

I: Measure and report Scope 3 emissions embedded within the Investments portfolio and design and execute a strategy to reduce these emissions. Consider re-aligning investments towards sustainable companies

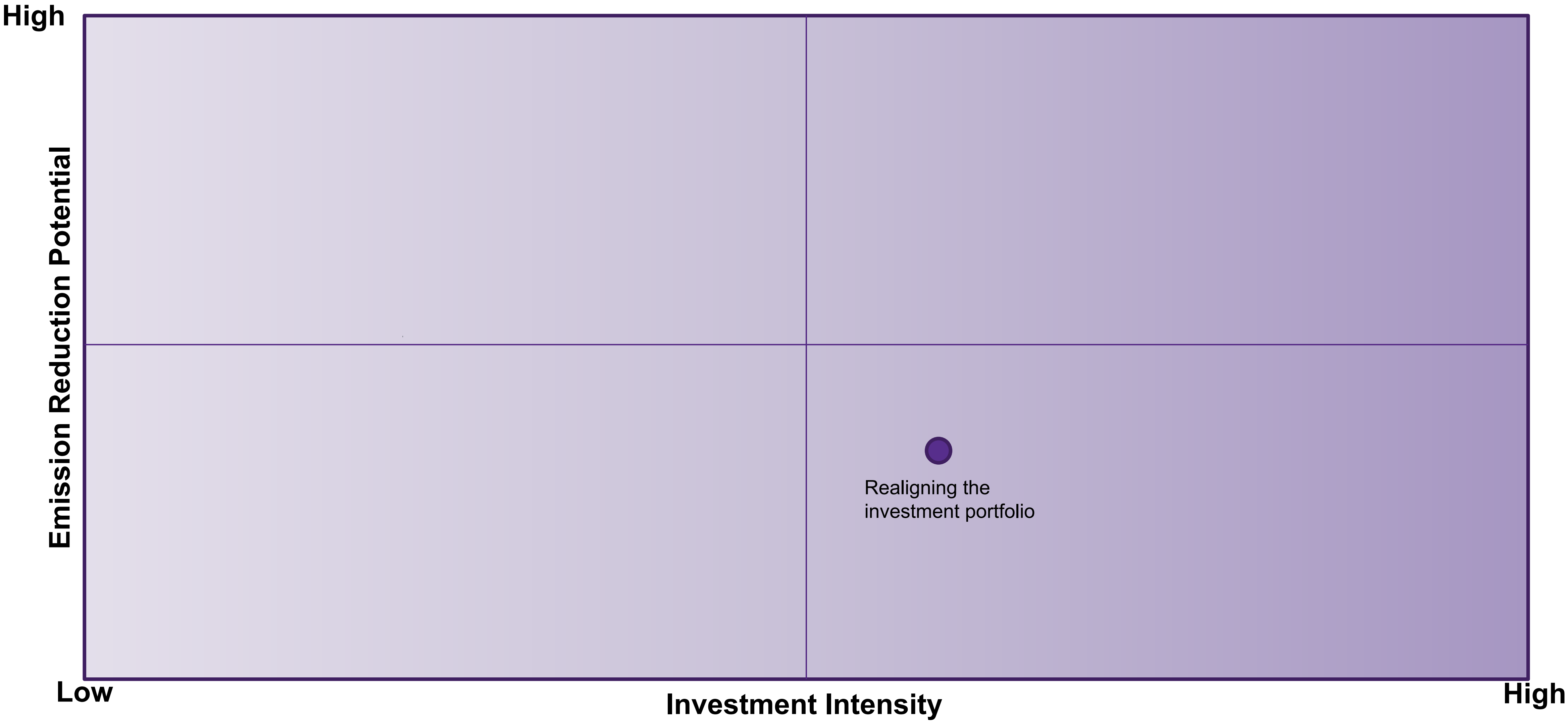
Benefits Assessment and Monetization Development

Practice: Realign investments portfolio

I: Measure and report Scope 3 emissions embedded within the Investments portfolio and design and execute a strategy to reduce these emissions. Consider re-aligning investments towards sustainable companies

ROSI™ Mediating Factor	ROSI™ Benefits to explore	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Risk Management	Reduction in Scope 3 emissions	Using established carbon accounting protocols (example the GHG protocol) create a baseline for emissions within the organization's investments/financing portfolio. Consider how these emissions can be reduced by realigning/restructuring the portfolio towards sustainable investments. After implementing the strategy, recalculate the emissions from the respective portfolio and multiply by an internal price of carbon or the price of offsets as maybe applicable. Calculate the carbon cost difference between the two portfolios to estimate the saving of carbon offset	Reducing Scope 3 emissions within investments could be possible with portfolio realignment	• Carbon Clinic 3 - Scope 3, Part 2 (National Academy of Medicine) • Category 15: Investments (Retrieved Oct 12, 2023)
Stakeholder Management	Potential to earn higher returns	Estimate the average return on investment in the historical portfolio and in the new portfolio invested in sustainability led companies. Calculate the difference between the two portfolios and apply an attribution factor to estimate the benefit from realigning investments	Investments in companies aligned with ESG policies could potentially yield higher returns	• Does Sustainability Generate Better Financial Performance? Review, Meta-analysis, and Propositions (Atz et al., 2020)

Relative Ranking of the Identified Responsible Investment related Sub-practices



Note: The emission reduction potential and the Investment intensity of the sub-practice is highly dependent on the size of Healthcare Delivery System's investment portfolio and the extent of realignment done in the portfolio

Reduced Transportation

Strategies

Energy Management	Building Design & Maintenance	Sustainable Sourcing	Food Service Optimization
Low Emissions Clinical Care	Waste Reduction	Responsible Investments	**Reduced Transportation**

Sub-practices

Implement practices that optimize and decarbonize all hospital-related transportation

Practice: Fleet conversion
I: Converting existing fleet to electric

Practice: Greener commuting
II: Encourage greener commuting

Practice: Optimizing transportation
III: Optimize last mile delivery

Benefits Assessment and Monetization Development

Practice: Fleet conversion

I: Converting existing fleet to electric (e.g. zero emission ambulances)

ROSI™ Mediating Factor	ROSI™ Benefits/Costs	Potential metrics to monetize	Rationale for the Benefit	Relevant resources
Operational Efficiency	Reduced fuel costs	Calculate the cost differential between the total fuel costs for the baseline year with the existing fleet composition vs. charging/fuel costs for a more electrified fleet	Greater efficiency of the electric vehicles, the moderate price of electricity, and the high utilization of fleet vehicles translate to a lower cost of ownership	• Charging electric-vehicle fleets: How to seize the emerging opportunity (McKinsey, 2020) • Electrified Fleets Could Save 37-44% in Energy Costs (Charged Fleet, 2021) • Fuel and Vehicle Comparison tool (Retrieved on Oct 10, 2023)
Operational Efficiency	Reduced maintenance cost	Calculate the cost differential between the total maintenance costs for the baseline year with the existing fleet composition vs. for a more electrified fleet	Estimated scheduled maintenance cost for a light-duty battery-electric vehicle (BEV) is found to be lower than a conventional internal combustion engine (ICE) vehicle	• Battery-Electric Vehicles Have Lower Scheduled Maintenance Costs than Other Light-Duty Vehicles (Vehicle Technologies Office, 2023)
Stakeholder Engagement	State and federal incentives could offset costs	Estimate the total investment required for converting the fleet. Consider the state and federal incentives available (e.g. Inflation Reduction Act, State Utility incentives and Rebate programs) that may offset the investment amount partially or in whole	Several tax credits, funding opportunities are being offered by the State and Federal agencies. **These incentives should be availed soon to maximize the benefit**	• Federal and state laws and incentives (Retrieved on Oct 10, 2023)

Benefits Assessment and Monetization Development

Practice: Fleet conversion

I: Converting existing fleet to electric (e.g. zero emission ambulances) [cont.]

ROSI™ Mediating Factor	ROSI™ Benefits/Costs	Potential metrics to monetize	Rationale for the benefit	Relevant resources
Risk Management	Emission reduction for Scope 1,3	Calculate emissions pre- and post- converting the fleet and multiply the difference with the related price of carbon offsets or an internal price of carbon (suggested by research, or used by the entity) to get the total costs of carbon emissions avoided	Lesser employee and patient travel on ICE vehicles, lower fuel usage onsite	• DocGo (Retrieved on Oct 10, 2023) • GHG Protocol's Corporate Value Chain (Scope 3) Accounting and Reporting Standard (Retrieved on Oct 10, 2023)

Benefits Assessment and Monetization Development

Practice: Greener commuting

II: Encourage greener commuting (public transit, car pooling, ride shares, idling free zones)

ROSI™ Mediating Factor	ROSI™ Benefits/Costs	Potential metrics to monetize	Rationale for the benefit	Relevant resources
Operational Efficiency	Savings from green commuting tax benefits	Calculate the cost of payroll taxes before and after implementing an employee commuter benefits program	Value of tax benefits from green commuting for organizations	• Caregiver Transportation Benefits (Cleveland Clinic, 2019) • Benefits of a Commuter program for employers in NYC (Accessed Oct 12, 2023) • IRS announces commuter benefits pre-tax limits for 2023 (Edenred, 2023) • US Department of Transportation subsidy (Biking, 2023)
Stakeholder Engagement	Reduced capital expenditure costs due to state and federal commuter incentives	Estimate investment required if any, to facilitate greener commuting such as buying bikes,creating charging stations onsite etc.,) potential netting off tax credits and incentives available from federal and state laws	Availability of state and federal incentives	
Risk Management	Reduced emissions	Scope 3 emissions pre- and post-changing and the related internal price of carbon or price of carbon offsets (suggested by research, or used by the entity)	Reduction for Scope 3 due to reduced environmental impact of employee commuting	• Green commuting: the environmental benefits of carpooling and alternative modes of transportation (DGB Group, 2022) • Category 7: Employee Commuting ((Retrieved Oct 12, 2023))

Benefits Assessment and Monetization Development

Practice: Greener commuting

II: Encourage greener commuting (public transit, car pooling, ride shares, idling free zones) [cont.]

ROSI™ Mediating Factor	ROSI™ Benefits/Costs	Potential metrics to monetize	Rationale for the benefit	Relevant resources
Talent Management	Increase employee engagement & retention	Utilize surveys to measure if green commuting benefits are having a positive impact on employee engagement and retention. Use survey data to assign an attribution % to the reduction in turnover and the associated savings in hiring costs	Seattle Children Hospital's transportation programs have reduced the Single occupancy vehicle rate from 73 percent in 1995 to 38 percent in 2015, avoided the construction of a $20 million parking garage, and strengthened employee engagement	• Transportation (Practice Green Health, 2023)

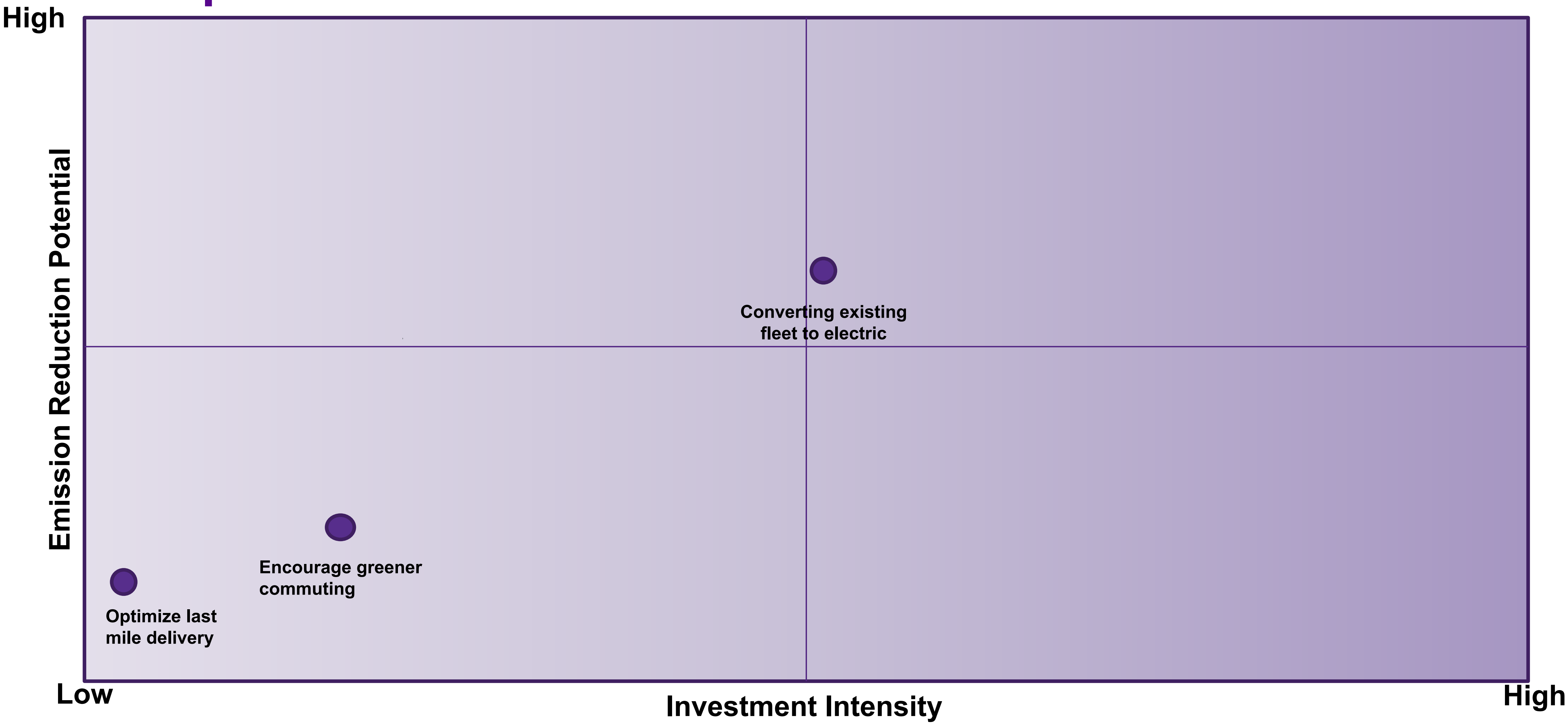
Benefits Assessment and Monetization Development

Practice: Optimizing transportation

III: Optimize last mile delivery

ROSI™ Mediating Factor	ROSI™ Benefits/Costs	Potential metrics to monetize	Rationale for the benefit	Relevant resources
Operational Efficiency	Cost reduction due to decreased delivery frequency	Calculate the cost differential between the delivered costs of supplies and/or staff allocation costs for the baseline year vs. each alternative reduced delivery scenario (e.g. reducing deliveries from 5x/week → 3x/week)	Cost reduction due to decreased delivery frequency	• 6 Strategies for Sustainable Last-Mile Delivery (Reinblatt, 2023) • CSB ROSI Project Research
Risk Management	Emission reduction for Scope 3 due to decreased delivery volume	Calculate the difference between the total emissions for the baseline year vs. each alternative reduced delivery scenario Use the projected cost of carbon offsets and/or internal cost of carbon to monetize CO2 emissions. Calculate cost differential using these proxies	Reducing frequency of transportation potentially reduces the associated emissions	• Category 9: Downstream Transportation and Distribution (Retrieved Oct 12, 2023) • EPAs GHG emission factors Hub (EPA, 2023) • Creating Carbon Credits: Is It Profitable? (Terrapass, 2023) • New study: carbon credit market expected to go through the roof (DGB Group, 2023)

Relative Ranking of the Identified Reduced Transportation related Sub-practices



Note: The emission reduction potential and the Investment intensity of the sub-practices is highly dependent type of healthcare delivery system, its scale of operations and its geographic location

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Glossary

Power Purchase Agreements (PPAs)

The US Department of Energy defines a Power Purchase Agreement (PPA) as "an arrangement in which a third-party developer installs, owns, and operates an energy system on a customer's property. The Customer then purchases the system's electricity for a predetermined period." A PPA essentially allows consumers, typically large commercial entities, to work directly with energy producers to purchase energy–usually at a steady cost. There are two types of PPAs outlined in this framework:

1. **Physical PPA -** In a physical PPA, the purchaser and the energy generation unit exist in the same physical location/grid.
2. **Virtual PPA** - In a virtual PPA, the purchaser and the energy generation unit do not necessarily need to exist in the same region. Instead, the buyer can purchase a **Registered Energy Certificate (REC)** to represent their investment in the generation of renewable energy.

Below are some resources to further explore the full range of opportunities and benefits available with PPAs:

- Power Purchase Agreement (Accessed Oct 11, 2023)
- Customer Power Purchase Agreements (EPA, 2023)
- Physical PPA (EPA, 2022)

Renewable Energy Credits (RECs)

The EPA defines a Renewable Energy Credit (REC) as “a market-based instrument that represents the property rights to the environmental, social, and other non-power attributes of renewable energy generation (2023).” RECs allow consumers that are unable to generate their own renewable electricity on-site to support renewable energy generation and make legitimate claims about renewable energy generation and use.

1 REC = **1 megawatt-hour (MWh) of electricity** that has been generated from a renewable energy resource (e.g. solar, wind) & delivered to the grid

Energy-Related GHG Emissions Factors

The EPA defines **emissions factors** as representative values that "relate the quantity of a pollutant released to the atmosphere with an activity associated with the release of that pollutant (2022)." Emissions factors typically take the form of:

weight of pollutant emitted (e.g. kg of CO_2) / activity or item emitting the pollutant

Below are some examples of resources outlining energy-related emissions factors that can be used to estimate CO_2 emissions associated with energy:

- GHG Emission Factors Hub (EPA, 2023)
- Greenhouse Gas Equivalency Calculator (Accessed Oct 11, 2023)
- Emissions Factors 2022 (IEA, 2022)

Weather Normalized Energy

Energy Star defines **weather normalized energy** as energy that "your building would have used under average conditions (also referred to as climate normals) (2020)." Weather normalized energy is able to adjust for the differences in weather conditions from year to year (e.g. a building may experience warmer or cooler weather than usual in a given year). Weather normalized energy is not yet available for new buildings because they lack experience with different weather conditions.

Below are some examples of resources that provide technical guidance on weather normalized energy:

- Climate and Weather (Energy Star, 2020)
- Simulation-Based Weather Normalization Approach To Study The Impact Of Weather On Energy Use Of Buildings In The U.S. (Makhmalbaf et al., 2013)

Food-Related GHG Emissions Factors

The EPA defines **emissions factors** as representative values that "relate the quantity of a pollutant released to the atmosphere with an activity associated with the release of that pollutant (2022)." Emissions factors typically take the form of:

weight of pollutant emitted (e.g. kg of CO_2) / activity or item emitting the pollutant

Below are some examples of resources outlining food-related emissions factors that can be used to estimate CO_2 emissions associated with food:

- Modelling the Carbon Footprint of Various Fruit and Vegetable Products Based on a Company's Internal Transport Data (Gorny et al., 2021)
- Tracking Progress Toward the Cool Food Pledge (Waite, Vennard & Pozzi, 2019)
- From Farm to Kitchen: The Environmental Impacts of U.S. Food Waste (EPA, 2021)
- Environmental Impacts of Food Production (Ritchie, Rosado & Roser, 2022)
- Interactive: What is the climate impact of eating meat and dairy? (Accessed Oct 10, 2023)
- GHG Emission Factors Hub (EPA, 2023)

Carbon Pricing Tools

Carbon Offsets/Credits

The London School of Economics (LSE) defines a **carbon offset/credit** as "a token representing the avoidance or removal of greenhouse gas (GHG) emissions, measured in tonnes of carbon dioxide equivalent (tCO_2e)." Reputable carbon offset/credit programs are typically verified by third-party organizations (e.g. American Carbon Registry, Verified Carbon Standard, Gold Standard) to ensure the accuracy of carbon accounting and that credits are retired upon purchase. Examples of types of carbon offset/credit projects include forest conservation, water filtration, and hydropower. Below are some sources explaining how pricing for carbon offsets/credits is determined and exploring long-term market trends:

- CARBON PRICING: What is a carbon credit work? (Accessed Oct 11, 2023)
- Voluntary carbon markets: how they work, how they're priced and who's involved (Favasuli & Sebastian, 2021)
- Creating Carbon Credits: Is It Profitable? (Terrapass, 2023)
- A blueprint for scaling voluntary carbon markets to meet the climate challenge (Blaufelder et al., 2021)

Carbon Pricing Tools [cont.]

Internal Price of Carbon

Organizations typically use an **internal price of carbon** to support their internal decision-making around the impacts, risks, and opportunities associated with climate change. An internal price of carbon can be determined by pulling from a variety of existing carbon pricing frameworks, such as the European Union Emissions Trading Systems (ETSs), carbon taxes, and the Social Cost of Carbon (SCC).

- The Brookings Institution defines the **Social Cost of Carbon** as "an estimate of the cost, in dollars, of the damage done by each additional ton of carbon emissions (2023)." SCC can also be used to approximate "the benefit of any action taken to reduce a ton of carbon emissions (Asdourian & Wessel, 2023)."

Below are some examples of resources that can be used to calculate internal price of carbon:

- Putting a price on carbon: The state of internal carbon pricing by corporates globally (CDP, 2021)
- What is Carbon Pricing? (Accessed Oct 11, 2023)
- Report on the Social Cost of Greenhouse Gases: Estimates Incorporating Recent Scientific Advances (EPA, 2022)

Appendix

Other Decarbonization Resources for Hospitals

Resource	Summary
Practice Greenhealth (Accessed Oct 11, 2023)	Practice Greenhealth is a critical resource to help hospitals and health systems in the United States and Canada navigate sustainability and environmental stewardship. The organization provides various opportunities for partnerships directly with hospitals and health systems as well as other NGOs, non-profits, government partners, academic partners, and other members of the healthcare value chain.
NAM's Key Actions on Decarbonization (NAM, 2023)	This document from the National Academy of Medicine's (NAM) Climate Collaborative offers a short list of critical actions that hospitals and health systems can take to decarbonize.
Reducing Healthcare Carbon Emissions (AHRQ, 2022)	This document from the Agency for Healthcare Research and Quality (AHRQ) serves as a primer on various actions that healthcare organizations can take to mitigate climate change. The document was created to empower healthcare organizations to begin taking action to reduce their greenhouse gas emissions by offering measures to decarbonize and monitor progress.
Sustainability Roadmap For Health Care (Accessed Oct 11, 2023)	This guide from the American Hospital Association lists further insights and resources to help hospitals and health systems incorporate sustainability across their operations, procurement, purchasing, maintenance, and care models.
Delivering a net zero NHS (Accessed Oct 11, 2023)	This web page leads to the UK's National Health Service (NHS) net zero roadmap reports. The NHS has been an early actor in the health space in progressing towards net zero through their Health and Care Act of 2022.

References

2021 CoolFood Pledge Data - CoolFood. (2022, October 7). Coolfood. https://coolfood.org/news-and-updates/pledgeupdate2021/

A win-win for disposing medical waste with biodigestion | Green Policy Platform. (2020, May 21). https://www.greenpolicyplatform.org/blog/win-win-disposing-medical-waste-biodigestion

About us | Practice Greenhealth. (n.d.). https://practicegreenhealth.org/about/about-us

Agency for Healthcare Research and Quality [AHRQ]. (2022). Reducing Healthcare Carbon Emissions: A Primer on Measures and Actions for Healthcare Organizations to Mitigate Climate Change. In *Agency for Healthcare Research and Quality.*

Alternative Fuels Data Center: Alternative fuels and advanced vehicles. (n.d.). https://afdc.energy.gov/fuels/

Alternative Fuels Data Center: federal and state laws and incentives. (n.d.). https://afdc.energy.gov/laws

American Hospital Association. (n.d.). *Sustainability for Health Care - Achieving your sustainability goals | AHA*. American Hospital Association. https://www.aha.org/sustainability

Asdourian, E. & Wessel, D. (2023). What is the social cost of carbon?. In *Brookings. https://www.brookings.edu/articles/what-is-the- social-cost-of-carbon/*

Assessing the costs of disposable and reusable supplies wasted during surgeries. *International Journal of Surgery*, *53*, 18–23. https://doi.org/10.1016/j.ijsu.2018.02.004

Association of Medical Device Reprocessors [AMDR]. (2019). Reprocessing By the Numbers: 2019 Reprocessing Annual Survey from AMRDR. In *AMDR.*

Atz, U., Liu, Z. Z., Bruno, C. C., & Van Holt, T. (2020). Do corporate sustainability and sustainable finance generate Better financial Performance? A review and meta-analysis. *Social Science Research Network*. https://doi.org/10.2139/ssrn.3708495

Baker, N., Bromley-Dulfano, R., Chan, J., Gupta, A., Herman, L., Jain, N., Taylor, A. L., Lu, J., Pannu, J., Patel, L., & Prunicki, M. (2020). COVID-19 solutions are climate solutions: Lessons from reusable gowns. *Frontiers in Public Health*, *8*. https://doi.org/10.3389/fpubh.2020.590275

Bartley, J., Olmsted, R. N., & Haas, J. P. (2010). Current views of health care design and construction: Practical implications for safer, cleaner environments. *American Journal of Infection Control*, *38*(5), S1–S12. https://doi.org/10.1016/j.ajic.2010.04.195

Behnam, M., Foster, T., Gambell, T., & Karunakaran, S. (2020). The resilience imperative for medtech supply chains. *McKinsey & Company*. https://www.mckinsey.com/capabilities/operations/our-insights/the-resilience-imperative-for-medtech-supply-chains

Better Buildings Initiative. (n.d.). *Green Bonds | Better Buildings Initiative*. https://betterbuildingssolutioncenter.energy.gov/financing-navigator/option/green-bonds

Better Buildings Initiative. (n.d.). *Power Purchase Agreement | Better Buildings Initiative*. https://betterbuildingssolutioncenter.energy.gov/financing-navigator/option/power-purchase-agreement

Bland, R., Gao, W., Noffsinger, J., & Siccardo, G. (2020). Charging electric-vehicle fleets: How to seize the emerging opportunity. *McKinsey & Company*. https://www.mckinsey.com/capabilities/sustainability/our-insights/charging-electric-vehicle-fleets-how-to-seize-the-emerging-opportunity

Blaufelder, C., Levy, C., Mannion, P., & Pinner, D. (2021). A blueprint for scaling voluntary carbon markets to meet the climate challenge. In *McKinsey & Company*. https://www.mckinsey.com/capabilities/sustainability/our-insights/a-blueprint-for-scaling-voluntary-carbon-markets-to-meet-the-climate-challenge

Braish, T., Tinel, L., Depelchin, L., Gaudion, V., Andrès, Y., Caudron, C., Antczak, E., Brachelet, F., & Locoge, N. (2023). Evaluation of the seasonal variation of VOC surface emissions and indoor air concentrations in a public building with bio-based insulation. *Building and Environment*, *238*, 110312. https://doi.org/10.1016/j.buildenv.2023.110312

Buckley, S., Sparks, R., Cowdery, E., Stirling, F., Marsching, J., & Phillips, N. (2022). Enhancing crop growth in rooftop farms by repurposing CO2 from human respiration inside buildings. *Frontiers in Sustainable Food Systems*, *6*. https://doi.org/10.3389/fsufs.2022.918027

Building and Environment, *45*(3), 559–565. https://doi.org/10.1016/j.buildenv.2009.07.011

C. L., Young, S. B., Lagasse, R. S., & Sherman, J. D. (2020). Transforming The Medical Device Industry: Road Map To A Circular Economy. *Health Affairs*, *39*(12), 2088–2097. https://doi.org/10.1377/hlthaff.2020.01118

Caldwell, W. (2020, September 8). How Telehealth Improves Revenue, Cost, and Quality. *Health Catalyst*. https://www.healthcatalyst.com/insights/telehealth-solutions-advance-revenue-cost-and-quality

Carbon Accounting 101 - National Academy of Medicine. (2023, August 28). National Academy of Medicine. https://nam.edu/programs/climate-change-and-human-health/action-collaborative-on-decarbonizing-the-u-s-health-sector/ carbon- accounting-101/

CARBON PRICING: What is a carbon credit worth? | The Gold Standard. (n.d.). https://www.goldstandard.org/blog-item/carbon-pricing-what-carbon-credit-worth

Carlisle FoodService Products. (n.d.). *How to implement a successful room service program: improving patient satisfaction & reducing waste | Carlisle FoodService Products*. https://www.carlislefsp.com/healthcare/article/room-service

Cesari, S., Valdiserri, P., Coccagna, M., & Mazzacane, S. (2020). The Energy Saving Potential of Wide Windows in Hospital Patient Rooms, Optimizing the Type of Glazing and Lighting Control Strategy under Different Climatic Conditions. *Energies*, *13*(8), 2116. https://doi.org/10.3390/en13082116

Characterisation of volatile organic compounds in hospital indoor air and the potential impact on healthcare worker health.

Charged Fleet. (2021). Electrified fleets could save 37-44% in energy costs. *© 2023 Charged Fleet, Bobit. All Rights Reserved*. https://www.chargedfleet.com/10148713/electrified-fleets-could-save-37-43-in-energy-costs

Charlebois, S., Hill, A., Morrison, T. G., Vézeau, J., Music, J., & Mayhew, K. (2022). Is buying local less expensive? Debunking a Myth—Assessing the price competitiveness of local food products in Canada. *Foods*, *11*(14), 2059. https://doi.org/10.3390/foods11142059

Chasseigne, V., Leguelinel-Blache, G., Nguyen, T., De Tayrac, R., Prud'homme, M., Kinowski, J., & Da Silva Costa, P. (2018).

Cleveland Clinic. (2019). Caregiver Transportation Benefits. In *Ugo University Circle.*

Commuter-benefits-FAQs. (n.d.). https://www.nyc.gov/site/dca/about/commuter-benefits-FAQs.page

Compliance - sustainable buildings. (n.d.). https://www.nyc.gov/site/sustainablebuildings/requirements/compliance.page

Cook, N., Goodwin, D., Porter, J., & Collins, J. (2022). Food and food-related waste management strategies in hospital food services: A systematic review. *Nutrition & Dietetics*, *80*(2), 116–142. https://doi.org/10.1111/1747-0080.12768

Cool roofs. (n.d.). Energy.gov. https://www.energy.gov/energysaver/cool-roofs

David, E., & Niculescu, V. (2021). Volatile Organic compounds (VOCs) as environmental pollutants: Occurrence and mitigation using nanomaterials. *International Journal of Environmental Research and Public Health*, *18*(24), 13147. https://doi.org/10.3390/ijerph182413147

Devlin-Hegedus, J., McGain, F., Harris, R., & Sherman, J. D. (2022). Action guidance for addressing pollution from inhalational anaesthetics. *Anaesthesia*, *77*(9), 1023–1029. https://doi.org/10.1111/anae.15785

DGB Group. (2023, April 27). New study: carbon credit market expected to go through the roof. *DGB Group*. https://www.green.earth/news/new-study-carbon-credit-market-expected-to-go-through-the-

Eckelman, M. J., Huang, K., Lagasse, R. S., Senay, E., Dubrow, R., & Sherman, J. D. (2020). Health Care Pollution And Public Health Damage In The United States: An Update. *Health Affairs*, *39*(12), 2071–2079. https://doi.org/10.1377/hlthaff.2020.01247

Emissions Factors 2022 - Data product - IEA. (n.d.). IEA. https://www.iea.org/data-and-statistics/data-product/emissions-factors- 2022

Energy efficient commercial buildings deduction | Internal Revenue Service. (2023, October 6). https://www.irs.gov/credits-deductions/energy-efficient-commercial-buildings-deduction

Energy Star. (2020). *Climate and Weather*.

ENERGY STAR. (n.d.). The Simple Choice for Energy Efficiency. https://www.energystar.gov/
Environmental Health Perspectives, *2022*(1). https://doi.org/10.1289/isee.2022.p-0110

Environmental stewardship - Providence Environmental Stewardship Report. (n.d.). https://blog.providence.org/i/1465085-providence-environmental-stewardship-report/11?

EPA. (2022). Supplementary Material for the Regulatory Impact Analysis for the Supplemental Proposed Rulemaking, "Standards of

Performance for New, Reconstructed, and Modified Sources and Emissions Guidelines for Existing Sources: Oil and Natural Gas Sector Climate Review”. In *United States Environmental Protection Agency.*

Evidence-Based Project: Cost savings and reduction in environmental release with Low-Flow Anesthesia. (2021). *AANA Journal*. http://www.onlinedigeditions.com/publication/?i=691174&article_id=3865755&view=articleBrowser

Farrelly, J. S., Clemons, C., Witkins, S., Hall, W., Christison-Lagay, E. R., Ozgediz, D., Cowles, R. A., Stitelman, D. H., & Caty, M. G. (2017). Surgical tray optimization as a simple means to decrease perioperative costs. *Journal of Surgical Research*, *220*, 320–326. https://doi.org/10.1016/j.jss.2017.06.029

Favasuli, S., & Sebastian, V. (2021, June 10). S&P Global Commodity Insights. *S&P Global*. https://www.spglobal.com/commodityinsights/en/market-insights/blogs/energy-transition/061021-voluntary-carbon-markets-pricing-participants-trading-corsia-credits

FOTW #1190, June 14, 2021: Battery-Electric Vehicles Have Lower Scheduled Maintenance Costs than Other Light-Duty Vehicles. (n.d.). Energy.gov. https://www.energy.gov/eere/vehicles/articles/fotw-1190-june-14-2021-battery-electric-vehicles-have- lower-scheduled

“Greening” the operating room and your budget by reducing desflurane use. (2022, May 1). ASRA. https://www.asra.com/news-publications/asra-updates/blog-landing/asra-news/2022/05/01/greening-the-operating-room-and-your-budget-by-reducing- desflurane-use

GHG Emission Factors Hub | US EPA. (2023, April 3). US EPA. https://www.epa.gov/climateleadership/ghg-emission-factors-hub

GHG Emission Factors Hub | US EPA. (2023, April 3). US EPA. https://www.epa.gov/climateleadership/ghg-emission-factors-hub

Customer Power Purchase Agreements | US EPA. (2023, April 26). US EPA. https://www.epa.gov/statelocalenergy/customer-power-

GHG Protocol. (n.d.). Category 1: Purchased Goods and Services. In *Greenhouse Gas Protocol.*

GHG Protocol. (n.d.). Category 12: End-of-Life Treatment of Sold Products. In *Greenhouse Gas Protocol.*

GHG Protocol. (n.d.). Category 15: Investments. In *Greenhouse Gas Protocol.*

GHG Protocol. (n.d.). Category 5: Waste Generated in Operations. In *Greenhouse Gas Protocol.*

GHG Protocol. (n.d.). Category 7: Employee Commuting. In *Greenhouse Gas Protocol.*

GHG Protocol. (n.d.). Category 9: Downstream Transportation and Distribution. In *Greenhouse Gas Protocol.*

GHG Protocol. (n.d.). Corporate Value Chain (Scope 3) Accounting and Reporting Standard. In *Greenhouse Gas Protocol.*

GHG Reduction Programs & Strategies | US EPA. (2023, March 19). US EPA. https://www.epa.gov/climateleadership/ghg-reduction-programs-strategies#Energy_Efficiency

Goodman, D. D. T. P. a. J. (n.d.). *Interactive: What is the climate impact of eating meat and dairy?* Carbon Brief. https://interactive.carbonbrief.org/what-is-the-climate-impact-of-eating-meat-and-dairy/

Górny, K., Idaszewska, N., Sydow, Z., & Bieńczak, K. (2021). Modelling the carbon footprint of various fruit and vegetable products based on a company's internal transport data. *Sustainability*, *13*(14), 7579. https://doi.org/10.3390/su13147579

Green bonds. (n.d.). [Video]. Unpacked Explainer Series | J.P. Morgan. https://www.jpmorgan.com/solutions/cib/insights/investment-banking-explained-video/unpacked-green-bonds

Green roofs. (n.d.). GSA. https://www.gsa.gov/governmentwide-initiatives/federal-highperformance-green-buildings/resource-library/integrative-strategies/green-roofs

Greener, T. (2022, February 11). *Intermountain Utah Valley Hospital Bike Accessibility Project completed: Benefiting patients, employees, and the community*.http://www.bikeprovo.org/intermountain-utah-valley-hospital-bike-accessibility-project-completed-benefiting-patients-employees-and-the-community/

Greenhouse Gas Equivalencies Calculator | *US EPA*. (2023, July 21). US EPA. https://www.epa.gov/energy/greenhouse-gas- equivalencies-calculator

Greenhouse Gases Equivalencies Calculator - Calculations and References | *US EPA*. (2023, May 30). US EPA. https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references

Grid systems. (n.d.). Energy.gov. https://www.energy.gov/oe/grid-systems

Gruenewald, F., Haag, J., Hornyai, F., Lingqvist, O., & Nordigården, D. (2023). The potential impact of reusable packaging. *McKinsey & Company*. https://www.mckinsey.com/industries/packaging-and-paper/our-insights/the-potential-impact-of- reusable-packaging

Harvey, L., Smith, K., & Curlin, H. (2017). Physician engagement in improving operative supply chain efficiency through review of surgeon preference cards. *Journal of Minimally Invasive Gynecology*, *24*(7), 1116–1120. https://doi.org/10.1016/j.jmig.2017.06.018

Health Care Without Harm & Arup. (2019). HEALTH CARE'S CLIMATE FOOTPRINT. In *Health Care Without Harm*. Health Care Without Harm.

Health care without harm. (n.d.). Health Care Without Harm. https://noharm-uscanada.org/issues/us-canada/green-chemistry

How does anaerobic digestion work? | *US EPA*. (2023, February 9). US EPA. https://www.epa.gov/agstar/how-does-anaerobic- digestion-work

How we're improving our chemical and anesthetic use. (n.d.). How We're Improving Our Chemical and Anesthetic Use. https://blog.providence.org/blog/how-we-re-improving-our-chemical-and-anesthetic-use

Hyttinen, M., Rautiainen, P., Ruokolainen, J., Sorvari, J., & Pasanen, P. (2021). VOCs concentrations and emission rates in hospital environment and the impact of sampling locations. *Science and Technology for the Built Environment*, *27*(7), 986–994. https://doi.org/10.1080/23744731.2021.1926322

Identifying greener cleaning products | US EPA. (2023, May 15). US EPA. https://www.epa.gov/greenerproducts/identifying-greener- cleaning-products

Implementation of a rooftop farm integrated with a teaching kitchen and preventive food pantry in a hospital setting. *American Journal of Public Health*, *109*(8), 1119–1121. https://doi.org/10.2105/ajph.2019.305116

Edenred. (2022, November 02). IRS announces commuter benefits pre-tax limits for 2023 - Edenred Benefits. *Edenred Benefits - Innovative employee benefits*. https://edenredbenefits.com/irs-announces-commuter-benefits-pre-tax-limits-for-2023/ Kampmeier, T., Rehberg,

S., Alsaleh, A. J. O., Schraag, S., Pham, J., & Westphal, M. (2021). Cost-Effectiveness of propofol (Diprivan) versus inhalational anesthetics to maintain general anesthesia in noncardiac surgery in the United States. *Value in Health*, *24*(7), 939–947. https://doi.org/10.1016/j.jval.2021.01.008

Karimi, M., Lee, E.C., Couture, S.J., Gonzales, A., Gigorescu, V., Smith, S.R., De Lew, N.,Sommers, B.D. (2022). National Survey Trends in Telehealth Use in 2021: Disparities in Utilization and Audio vs. Video Services. *Assistant Secretary for Planning andEvaluation (ASPE).*

Keil, M., Viere, T., Helms, K., & Rogowski, W. (2022). The impact of switching from single-use to reusable healthcare products: a transparency checklist and systematic review of life-cycle assessments. *European Journal of Public Health*, *33*(1), 56–63. https://doi.org/10.1093/eurpub/ckac174

Key actions to reduce greenhouse gas emissions by U.S. hospitals and health Systems - National Academy of Medicine. (2023, August 29). National Academy of Medicine. https://nam.edu/wp-content/uploads/2023/05/NAM-Climate-Collaborative_Key-Actions-to-Reduce-Greenhouse-Gas-Emissions-by-U.S.-Hospitals-and-Health-Systems-one-page-5.17.23.pdf

Kreuder, A. D., House-Knight, T., Whitford, J., Ponnusamy, E., Miller, P., Jesse, N., Rodenborn, R., Sayag, S., Gebel, M., Aped, I., Sharfstein, I., Manaster, E., Ergaz, I., Harris, A., & Grice, L. N. (2017). A Method for Assessing Greener Alternatives between Chemical Products Following the 12 Principles of Green Chemistry. *ACS Sustainable Chemistry & Engineering*, *5*(4), 2927– 2935. https://doi.org/10.1021/acssuschemeng.6b02399

Kuronuma, T., Watanabe, H., Ishihara, T., Daitoku, K., Kazunari, T., Ando, M., & Shindo, S. (2018). CO2 Payoff of Extensive Green Roofs with Different Vegetation Species. *Sustainability*, *10*(7), 2256. https://doi.org/10.3390/su10072256

Kuvadia, M., Cummis, C., Liguori, G. A., & Wu, C. L. (2020). “Green-gional” anesthesia: the non-polluting benefits of regional anesthesia to decrease greenhouse gases and attenuate climate change. *Regional Anesthesia and Pain Medicine*, *45*(9), 744–745. https://doi.org/10.1136/rapm-2020-101452

Lahvic N & Liu M. (2023). Waste Gas Scavenging System. *StatPearls*.

LEED rating system | U.S. Green Building Council. (n.d.). https://www.usgbc.org/leed

Lewis, C., Horstman, C., Blumenthal, D., Abrams, M.K. (2023). Value-Based Care: What It Is, and Why It’s Needed. *The*

Commonwealth Fund.

Li, M., Jia, N., Lenzen, M., Malik, A., Wei, L., Jin, Y., & Raubenheimer, D. (2022). Global food-miles account for nearly 20% of total food-systems emissions. *Nature Food*, *3*(6), 445–453. https://doi.org/10.1038/s43016-022-00531-w

Lichtnegger, S., Meissner, M. H., Paolini, F., Silas, U., Hafermann, J., & Saunders, R. S. (2023). MT7 Hospital Waste and Cost Prevention Potential of reprocessing medical devices. *Value in Health*, *26*(6), S298. https://doi.org/10.1016/j.jval.2023.03.1654

Lineburger, E. B., Módolo, N. S. P., Braz, L. G., & Nascimento, P. D. (2023). Minimal fresh gas flow sevoflurane anesthesia and postoperative acute kidney injury in on-pump cardiac surgery: a randomized comparative trial. *Brazilian Journal of Anesthesiology (English Edition)*, *73*(1), 46–53. https://doi.org/10.1016/j.bjane.2021.11.004

Liou, T. (2023, August 21). *Addressing the insurance Crisis through Property Resilience | GlobeSt*. GlobeSt. https://www.globest.com/2023/08/21/addressing-the-insurance-crisis-through-property-resilience/?slreturn=20230912112530

MacNeill, A., Hopf, H. W., Khanuja, A., Alizamir, S., Bilec, M. M., Eckelman, M. J., Hernandez, L. V., McGain, F., Simonsen, K., Thiel, Makhmalbaf, A.,

Srivastava, V., & Wang, N. (2013). Simulation-based Weather Normalization Approach To Study The Impact Of Weather On Energy Use Of Buildings In The U.s. *Building Simulation Conference Proceedings*. https://doi.org/10.26868/25222708.2013.2453

McCray, S., Maunder, K., Krikowa, R., & MacKenzie-Shalders, K. (2018). Room service improves nutritional intake and increases patient satisfaction while decreasing food waste and cost. *Journal of the Academy of Nutrition and Dietetics*, *118*(2), 284–293. https://doi.org/10.1016/j.jand.2017.05.014

Methodology for Estimated Energy Savings from Cost-Effective Air. (n.d.). https://www.energystar.gov/saveathome/seal_insulate/methodology

Morris, M. T., Morris, J., Wallace, C., Cho, W., Sharan, A., Abouelrigal, M., & Joseph, V. A. (2018). An Analysis of the Cost- Effectiveness of Spinal versus General Anesthesia for lumbar spine surgery in various hospital settings. *Global Spine Journal*, *9*(4), 368–374. https://doi.org/10.1177/2192568218795867

Municipal bonds and green bonds | US EPA. (2023, April 26). US EPA. https://www.epa.gov/statelocalenergy/municipal-bonds-and- green-bonds

Musicus, A. A., Vercammen, K. A., Fulay, A., Moran, A. J., Burg, T., Allen, L., Maffeo, D., Berger, A., & Rimm, E. B. (2019).

National Academy of Medicine. (n.d.). *Carbon Clinic 3* [Slide show]. Action Collaborative On Decarbonizing the U.S. Health Sector. https://nam.edu/wp-content/uploads/2023/06/Carbon-Clinic-3-Slides.pdf

NHS England. (n.d.). *Greener NHS » Delivering a net zero NHS*. https://www.england.nhs.uk/greenernhs/a-net-zero-nhs/

NHS England. (n.d.). Technology Enabled Care Services (TECS) Evidence Database. In *NHS England.*

NYSERDA. (2017). Benefit-Cost Analysis of Potential Food Waste Diversion Legislation. In *NYSERDA.*

O'Hara, A. C., Miller, A. C., Spinks, H., Seifert, A., Mills, T., & Tuininga, A. R. (2022). The Sustainable Prescription: Benefits of green roof implementation for urban hospitals. *Frontiers in Sustainable Cities*, *4*. https://doi.org/10.3389/frsc.2022.798012

ONC | Office of the National Coordinator for Health Information Technology. (2023, July 1). https://www.healthit.gov/ Openanesthesia. (2023, May 10). *Environmental impact of nitrous oxide - OpenAnesthesia*. OpenAnesthesia. https://www.openanesthesia.org/keywords/environmental-impact-of-nitrous-oxide/

OUR VISION - DocGo. (n.d.). https://docgo.com/our-vision/#social-impact

Pesigan, P., Chen, H., Bajaj, A. A., & Gill, H. (2021). Cost savings in urology operating rooms by editing surgeon preference cards.

Physical PPA | US EPA. (2022, November 21). US EPA. https://www.epa.gov/green-power-markets/physical-ppa

Practice Greenhealth. (n.d.). Anesthetic gas how-to guide: A guide to climate-smart anesthesia care. In *Practice Greenhealth.* purchase-agreements

Purohit, A., Smith, J., & Hibble, A. (2021). Does telemedicine reduce the carbon footprint of healthcare? A systematic review. *Future Healthcare Journal*, *8*(1), e85–e91. https://doi.org/10.7861/fhj.2020-0080

Putting a price on carbon - CDP. (n.d.). https://www.cdp.net/en/research/global-reports/putting-a-price-on-carbon

Qian, H., Li, Y., Seto, W. H., Ching, P., Ching, W., & Sun, H. (2010). Natural ventilation for reducing airborne infection in hospitals. *Quality Management in Health Care*, *30*(2), 135–137. https://doi.org/10.1097/qmh.0000000000000311

Reinblatt, H. (2023). 6 Strategies for Sustainable Last-Mile Delivery. *getcircuit.com*. https://getcircuit.com/teams/blog/sustainable- last-mile-delivery

Reusable Food Container and Dishware program for companies and businesses | Re:DISH. (n.d.). Re:Dish. https://www.redish.com/companies

Reuse, donate, or sell | Practice Greenhealth. (n.d.). https://practicegreenhealth.org/topics/waste/reuse-donate-or-sell

Riveron, T. P., Wilde, M., Ibrahim, W., Monks, P. S., Greening, N., Brightling, C., Siddiqui, S., Hansell, A., & Cordell, R. (2022). Ritchie, H, Rosado, P. & Roser, M. (2022, December 2). *Environmental impacts of food production*. Our World in Data. https://ourworldindata.org/environmental-impacts-of-food?insight=food-emissions-local#key-insights-on-the-environmental-impacts-of-food

Rooftop Farm | Boston Medical Center. (n.d.). Boston Medical Center. https://www.bmc.org/nourishing-our-community/rooftop-farm Rowntree, J. E., Stanley, P., Maciel, I. C. F., Thorbecke, M., Rosenzweig, S. T., Hancock, D. W., Guzman, A., & Raven, M. R. (2020). Ecosystem impacts and productive capacity of a Multi-Species pastured livestock system. *Frontiers in Sustainable*

Food Systems, *4*. https://doi.org/10.3389/fsufs.2020.544984

Roulo, C. (2011, November 22). Hospital conserves energy by 27% with heat recovery chiller system. *Contractor*. https://www.contractormag.com/home/article/20872742/hospital-conserves-energy-by-27-with-heat-recovery-chiller-system

Safe haven in the storm: Protecting lives and margins with. (2018, May 18). Health Care Without Harm. https://noharm-uscanada.org/documents/safe-haven-storm-protecting-lives-and-margins-climate-smart-health-care

Scarborough, P., Clark, M., Cobiac, L. J., Papier, K., Knüppel, A., Lynch, J., Harrington, R., Key, T. J., & Springmann, M. (2023).

Schraag, S., Pradelli, L., Alsaleh, A. J. O., Bellone, M., Ghetti, G., Chung, T. L., Westphal, M., & Rehberg, S. (2018). Propofol vs. inhalational agents to maintain general anaesthesia in ambulatory and in-patient surgery: a systematic review and meta- analysis. *BMC Anesthesiology*, *18*(1). https://doi.org/10.1186/s12871-018-0632-3

Scope 2 Guidance | GHG Protocol. (2021, April 19). https://ghgprotocol.org/scope-2-guidance

Seattle Children's Hospital: Employee commuting | Practice Greenhealth. (n.d.). https://practicegreenhealth.org/tools-and-resources/seattle-childrens-hospital-employee-commuting

Seglenieks, R., Wong, A., Pearson, F., & McGain, F. (2022). Discrepancy between procurement and clinical use of nitrous oxide: waste not, want not. *British Journal of Anaesthesia*, *128*(1), e32–e34. https://doi.org/10.1016/j.bja.2021.10.021

Shafique, M., Xue, X., & Luo, X. (2020). An overview of carbon sequestration of green roofs in urban areas. *Urban Forestry & Urban Greening*, *47*, 126515. https://doi.org/10.1016/j.ufug.2019.126515

Solar thermal water heating | Envision. (n.d.). Gundersen Health System. https://www.gundersenenvision.org/envision/resources/photos/solar-thermal-water-heating

Springmann, M., Clark, M., Rayner, M., Scarborough, P., & Webb, P. (2021). The global and regional costs of healthy and sustainable dietary patterns: a modelling study. *The Lancet Planetary Health*, *5*(11), e797–e807. https://doi.org/10.1016/s2542-5196(21)00251-5

Sullivan, G. A., Petit, H. J., Reiter, A. J., Westrick, J., Hu, A., Dunn, J. B., Gulack, B. C., Shah, A. N., Dsida, R. M., & Raval, M. V. (2022). Environmental impact and cost savings of operating room Quality Improvement Initiatives: A scoping review. *Journal of the American College of Surgeons*, *236*(2), 411–423. https://doi.org/10.1097/xcs.0000000000000478

Summary of Inflation Reduction Act provisions related to renewable energy | US EPA. (2023, June 1). US EPA. https://www.epa.gov/green-power-markets/summary-inflation-reduction-act-provisions-related-renewable-energy

Sustainable procurement guide | Practice Greenhealth. (n.d.). https://practicegreenhealth.org/sustainableprocurementguide/toolkit

The Scottish Government. (2023). Making the NHS more environmentally friendly. *The Scottish Government*. https://www.gov.scot/news/making-the-nhs-more-environmentally-friendly/

The Coolfood Pledge - Coolfood. (2023, October 12). Coolfood. https://coolfood.org/pledge/

Thiel, C. L., Park, S. W., Musicus, A. A., Agins, J., Gan, J., Held, J., Horrocks, A., & Bragg, M. A. (2021). Waste generation and carbon emissions of a hospital kitchen in the US: Potential for waste diversion and carbon reductions. *PLOS ONE*, *16*(3), e0247616. https://doi.org/10.1371/journal.pone.0247616

Toor, J., Bhangu, A., Wolfstadt, J., Bassi, G., Chung, S., Rampersaud, R., Mitchell, W., Milner, J., & Koyle, M. A. (2022). Optimizing the surgical instrument tray to immediately increase efficiency and lower costs in the operating room. *Canadian Journal of Surgery*, *65*(2), E275–E281. https://doi.org/10.1503/cjs.022720

TRANServe Active Bicycle Commuting Subsidy. (n.d.). US Department of Transportation. https://www.transportation.gov/transerve/active-bicycle-commuting-subsidy

Transportation | Practice GreenHealth. (n.d.). https://practicegreenhealth.org/topics/transportation/transportation

U.S. Department of Energy. (n.d.). The State of Virtual Healthcare. In *U.S. Department of Energy Better Buildings®*.

U.S. Department of the Treasury. (n.d.). FACT SHEET: four Ways the Inflation Reduction Act's Tax Incentives Will Support Building an Equitable Clean Energy Economy. In *U.S. Department of The Treasury*.

U.S. Environmental Protection Agency. (2021). From Farm to Kitchen: The Environmental Impacts of U.S. Food Waste. In *U.S. Environmental Protection Agency.*

U.S. Securities and Exchange Commission [SEC]. (n.d.). Enhancement and Standardization of Climate-Related Disclosures. In *U.S. Securities And Exchange Commission*.

Unger, S., & Landis, A. E. (2016). Assessing the environmental, human health, and economic impacts of reprocessed medical devices in a Phoenix hospital's supply chain. *Journal of Cleaner Production*, *112*, 1995–2003. https://doi.org/10.1016/j.jclepro.2015.07.144

United States Environmental Protection Agency [EPA]. (2009). Food Waste Management Cost Calculator. In *United States Environmental Protection Agency.*

United States Government Accountability Office [GAO]. (2008). Reprocessed Single-Use Medical Devices: FDA Oversight Has Increased, and Available Information Does Not Indicate That Use Presents an Elevated Risk. In *U.S. Government Accountability Office.*

Using cool roofs to reduce heat islands | US EPA. (2023, August 15). US EPA. https://www.epa.gov/heatislands/using-cool-roofs- reduce-heat-islands

Using green roofs to reduce heat islands | US EPA. (2023, June 28). US EPA. https://www.epa.gov/heatislands/using-green-roofs- reduce-heat-islands

Vegans, vegetarians, fish-eaters and meat-eaters in the UK show discrepant environmental impacts. *Nature Food*, *4*(7), 565–574.

https://doi.org/10.1038/s43016-023-00795-w

Waite, R, Vennard, D. & Pozzi, G. (2019, September 24). *Tracking progress toward the Cool Food Pledge*. World Resources Institute. https://www.wri.org/research/tracking-progress-toward-cool-food-pledge

Wang, A., Ahsan, T., Kosarchuk, J., Liu, P., Riesenburger, R. I., & Kryzanski, J. (2022). Assessing the Environmental Carbon Footprint of Spinal versus General Anesthesia in Single-Level Transforaminal Lumbar Interbody Fusions. *World Neurosurgery*, *163*, e199–e206. https://doi.org/10.1016/j.wneu.2022.03.095

Waste | Practice GreenHealth. (n.d.). https://practicegreenhealth.org/topics/waste/waste-0

Weiskopf, R. B., & Eger, E. I. (1993). Comparing the costs of inhaled anesthetics. *Anesthesiology*, *79*(6), 1413–1418. https://doi.org/10.1097/00000542-199312000-00033

What are carbon offsets? - Grantham Research Institute on climate change and the environment. (2022, September 23). Grantham Research Institute on Climate Change and the Environment. https://www.lse.ac.uk/granthaminstitute/explainers/what-are- carbon-offsets/

What are sustainability linked bonds and how can they support the net-zero transition? (2022, November 14). World Economic Forum. https://www.weforum.org/agenda/2022/11/cop27-sustainability-linked-bonds-net-zero-transition/

What is Carbon Pricing? | Carbon Pricing Dashboard. (n.d.). https://carbonpricingdashboard.worldbank.org/what-carbon-pricing White, S., Shelton, C., Gelb, A. W., Lawson, C., McGain, F., Muret, J., & Sherman, J. D. (2021). Principles of environmentally-sustainable anaesthesia: a global consensus statement from the World Federation of Societies of Anaesthesiologists. *Anaesthesia*, *77*(2), 201–212. https://doi.org/10.1111/anae.15598

Whittinghill, L. J., Rowe, D. B., Schutzki, R. E., & Cregg, B. M. (2014). Quantifying carbon sequestration of various green roof and ornamental landscape systems. *Landscape and Urban Planning*, *123*, 41–48. https://doi.org/10.1016/j.landurbplan.2013.11.015

Why buy greener products? | US EPA. (2023, June 2). US EPA. https://www.epa.gov/greenerproducts/why-buy-greener-products Afya Foundation. (2023, June 6). *Donate medical supplies | AFYA Foundation*. https://afyafoundation.org/donate-supplies/

Terrapass. (2023, June 9). *Creating carbon credits: Is it profitable?* Terrapass. https://terrapass.com/blog/creating-carbon-credits-is-it-profitable/

Wild, K., & Woodward, A. (2019). Why are cyclists the happiest commuters? Health, pleasure and the e-bike. *Journal of Transport & Health*, *14*, 100569. https://doi.org/10.1016/j.jth.2019.05.008

Windows key to increased energy efficiency in buildings and achieving clean energy economy. (n.d.). Energy.gov. https://www.energy.gov/eere/buildings/articles/windows-key-increased-energy-efficiency-buildings-and-achieving-clean

Winning in the marketplace and the workplace. (n.d.). The National Environmental Education Foundation (NEEF).

https://www.neefusa.org/resource/winning-marketplace-and-workplace

Woodcock, A., Janson, C., Rees, J., Frith, L., Löfdahl, M., Moore, A., Hedberg, M., & Leather, D. (2022). Effects of switching from a metered dose inhaler to a dry powder inhaler on climate emissions and asthma control: post-hoc analysis. *Thorax*, *77*(12), 1187–1192. https://doi.org/10.1136/thoraxjnl-2021-218088

Wyssusek, K., Foong, W. M., Steel, C., & Gillespie, B. M. (2016). The Gold in Garbage: Implementing a Waste Segregation and Recycling Initiative. *AORN Journal*, *103*(3), 316.e1-316.e8. https://doi.org/10.1016/j.aorn.2016.01.014