NATIONAL ACADEMY of MEDICINE

ACTION COLLABORATIVE ON DECARBONIZING THE U.S. HEALTH SECTOR

Carbon Clinic 2

Scope 3: Purchased goods & services / supply chain, capital goods, upstream and downstream transportation, use of sold products

The Carbon Clinic Series

1 2

Clinic 1: Scopes 1&2

Understanding the basics

Scope 1 and 2

Speakers

- Jon Utech, *Cleveland Clinic*
- Seema Wadhwa, *Kaiser Permanente*
- Matthew St. Claire & Seema Gandhi, *UC Health*

3

Clinic 2: Scope 3

Purchased goods & services / supply chain, capital goods, upstream and downstream transportation, use of sold products

Speakers

- Jodi Sherman, *Yale New Haven Health*
- Beth Schenk, *Providence*
- Matthew Eckelman, *Northeastern University*

3

Clinic 3: Scope 3 con't

January 26, 2023 | 11am-1pm ET

Investments, employee commuting, waste, business travel, leased assets, carbon offsets

Speakers

- Jon Utech, *Cleveland Clinic*
- Beth Schenk, *Providence*

Presenters

- Matthew Eckelman, *Northeastern University*
- Beth Schenk, *Providence*
- Jodie Sherman, *Yale New Haven Health System*

Northeastern University

Providence

Yale NewHaven Health

Agenda

- Carbon Clinic Overview
- Scope 3 Overview
- Implementation: Providence
- Implementation: Yale New Haven Health System
- Questions & Answers

NATIONAL ACADEMY OF MEDICINE

ACTION COLLABORATIVE ON DECARBONIZING THE U.S. HEALTH SECTOR

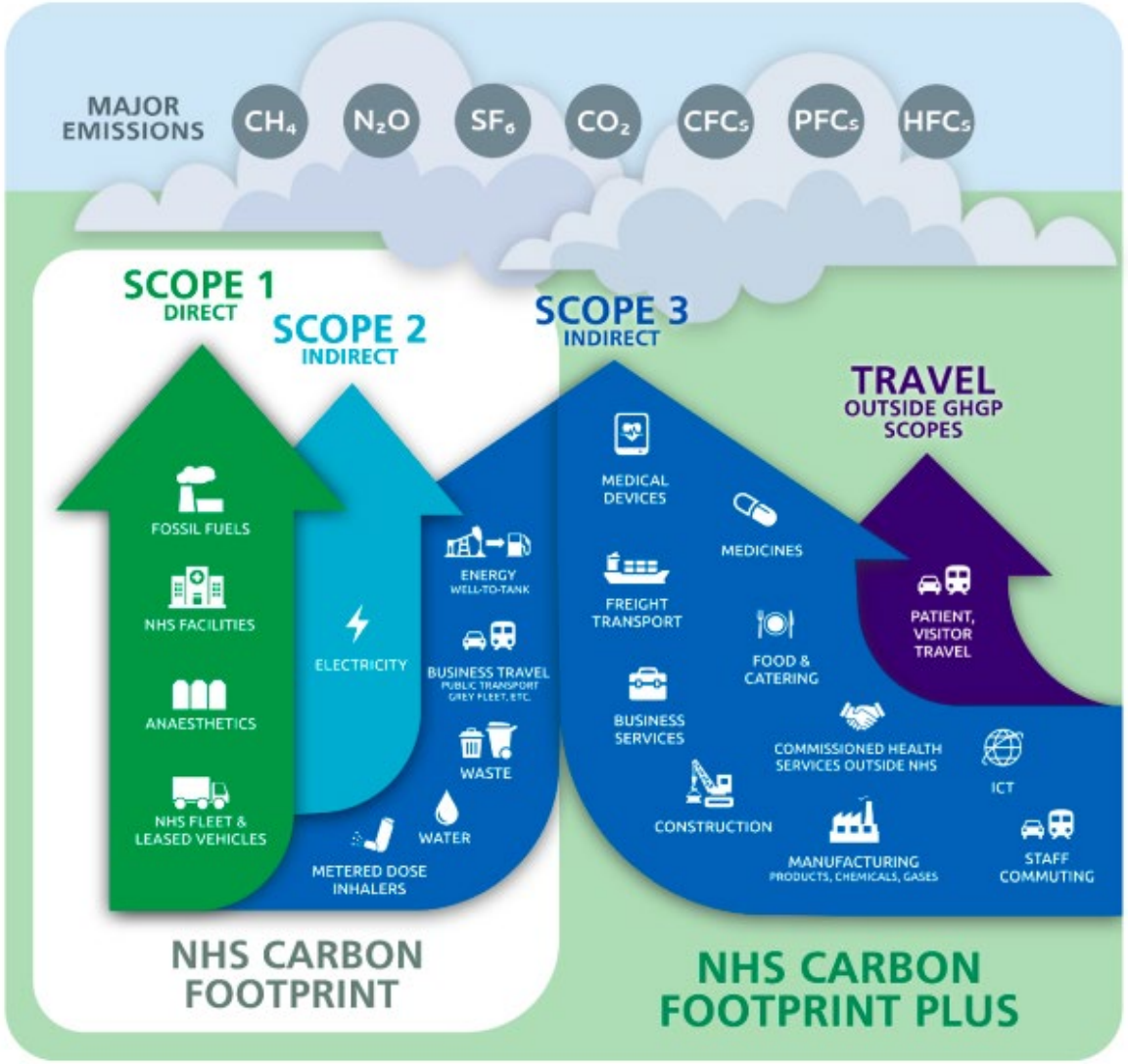
Carbon Clinic 2

Scope 3 Emissions (part 1)

Matthew Eckelman, PhD

Assoc. Prof., Civil & Environmental Engineering Northeastern University

Carbon Footprint of Health Care



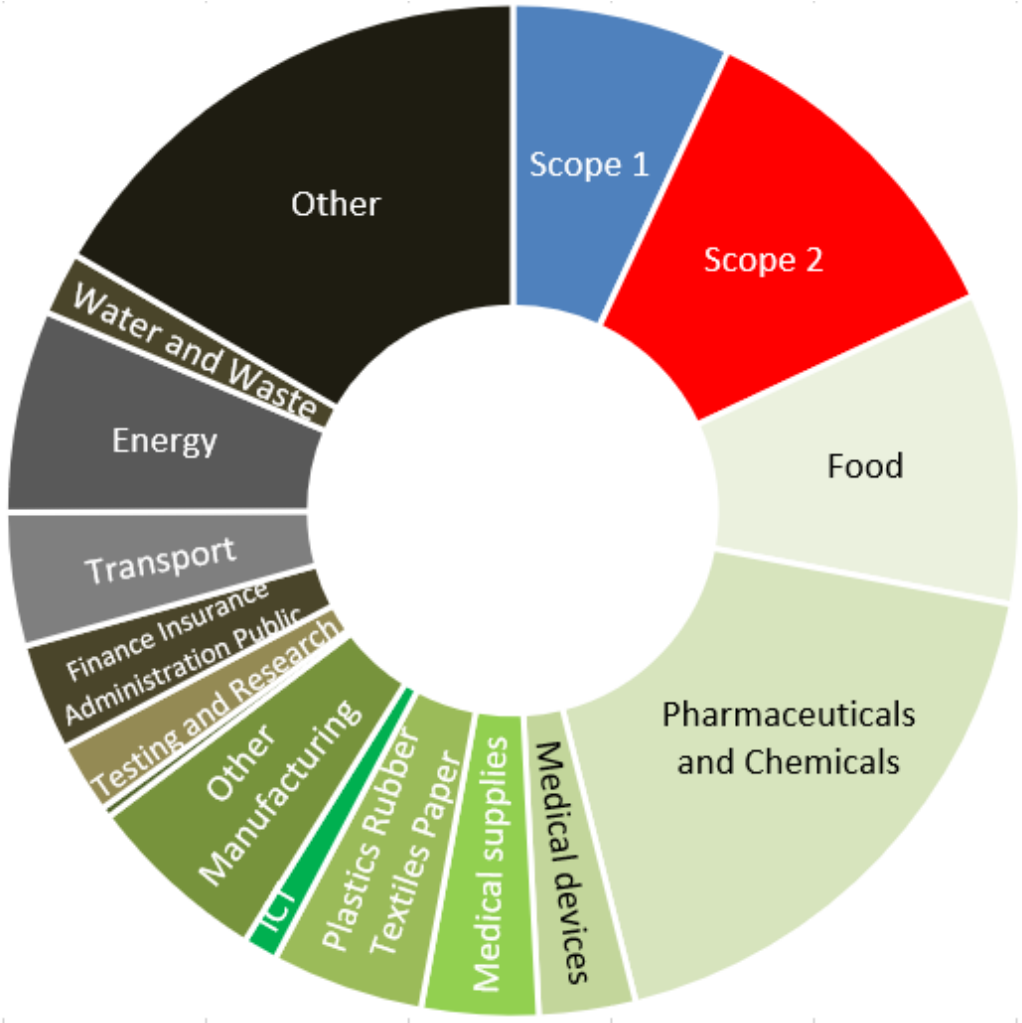
Delivering a 'Net Zero' National Health Service, NHS in England

What are Scope 3 Emissions?

“Indirect” Emissions in the Value Chain

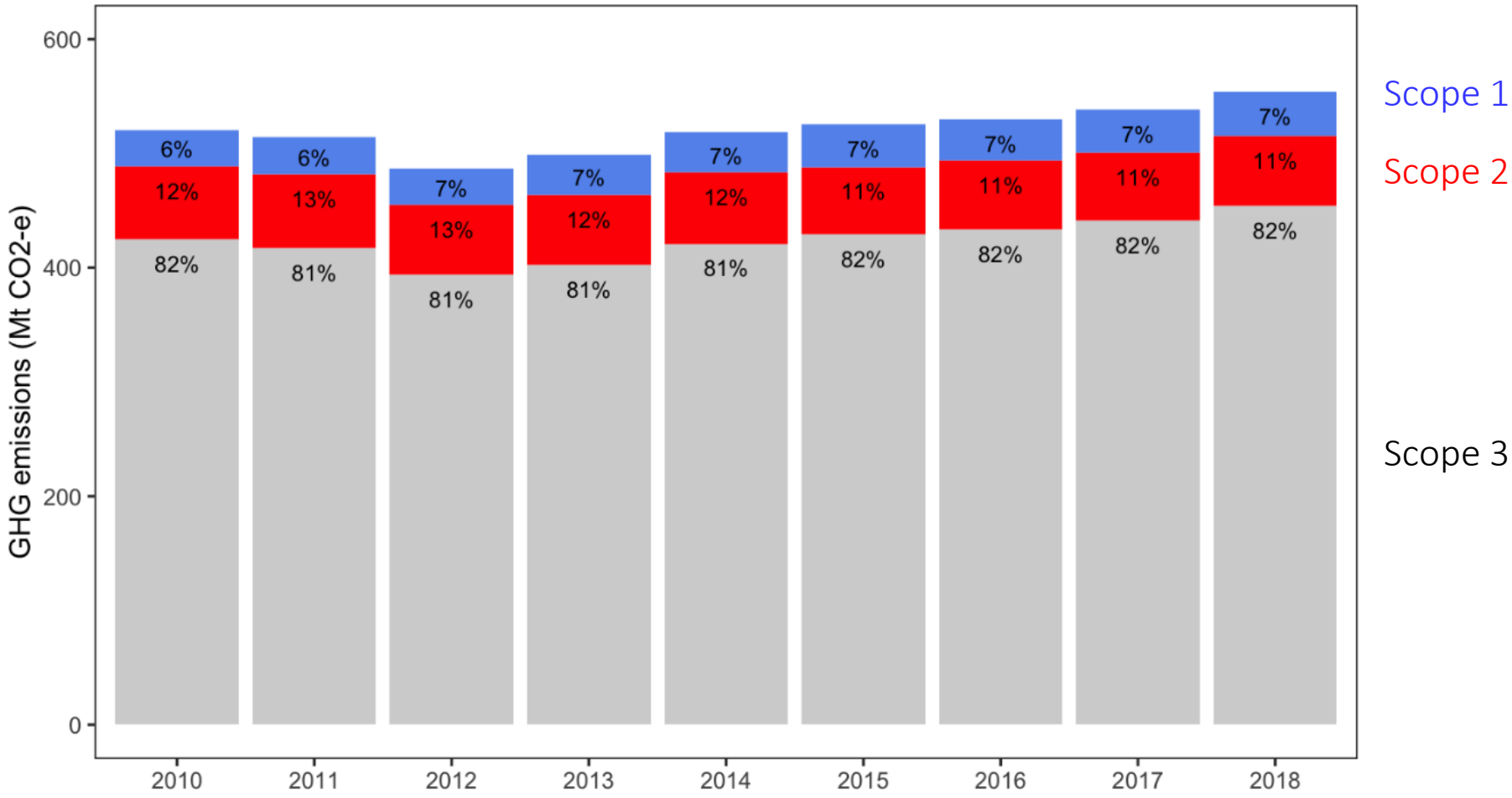
(spatially distributed, huge variety)

U.S. Health Care GHG Emission Contributions



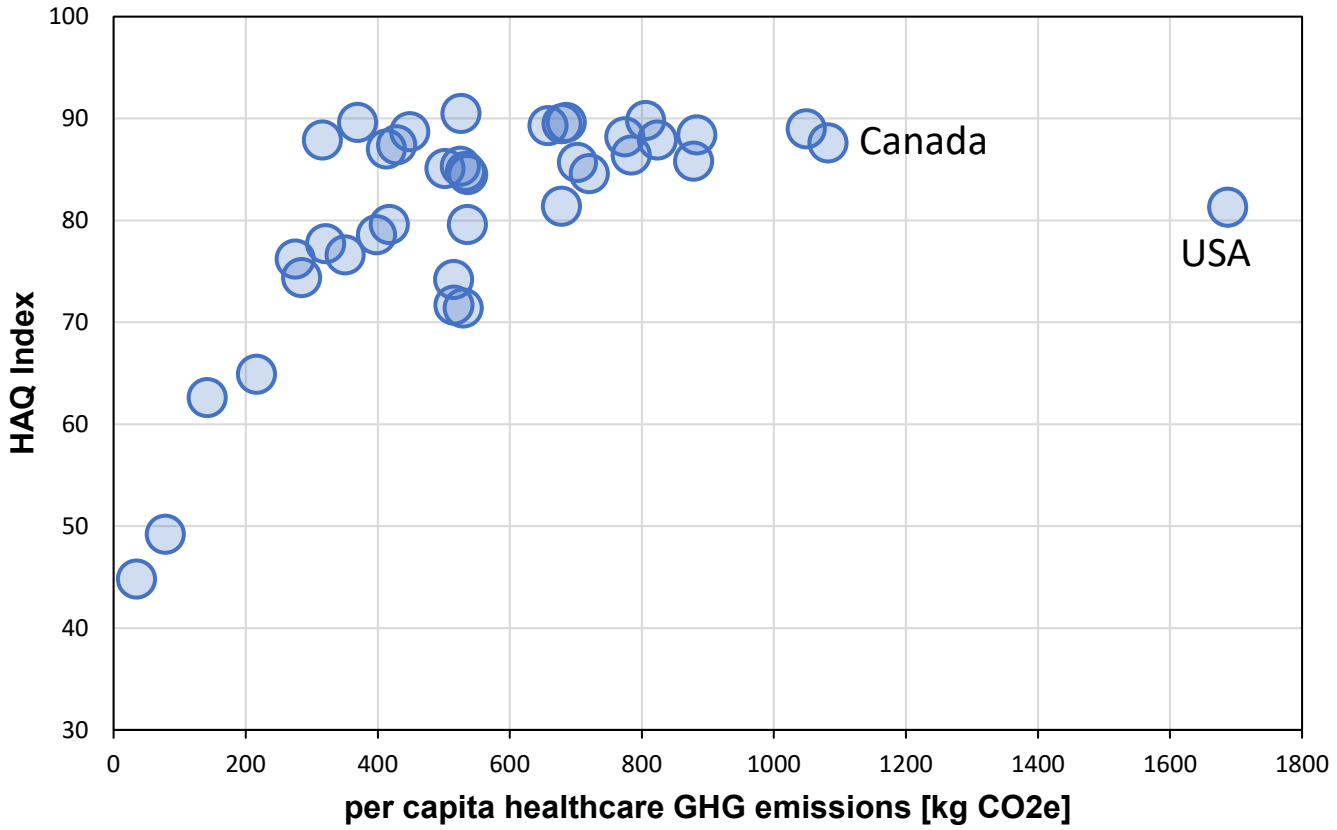
Eckelman *et al.*, *Health Affairs* 2020

U.S. Health Care GHG Emission Trends



Eckelman *et al.*, *Health Affairs* 2020

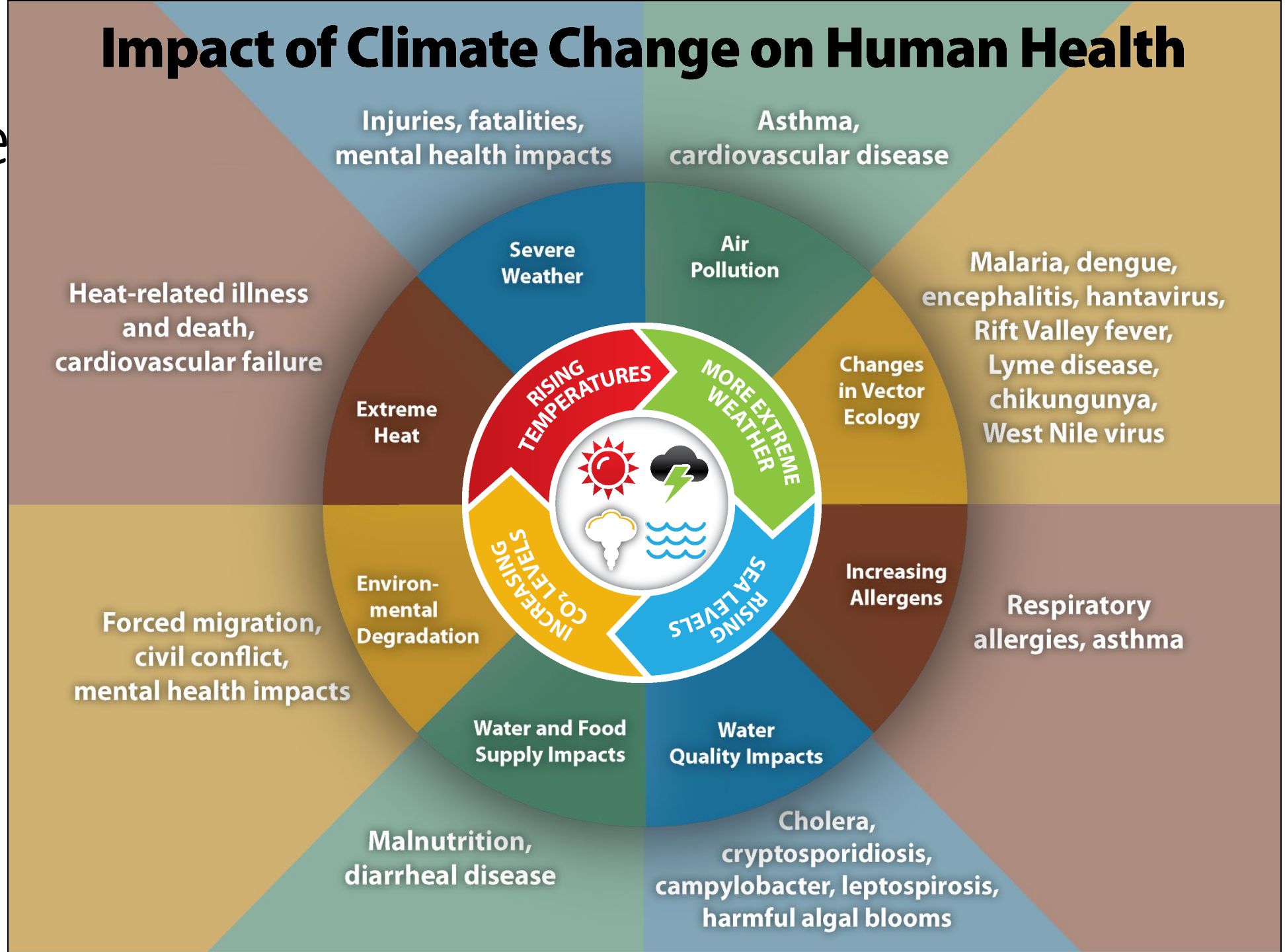
Comparing Across Health Systems



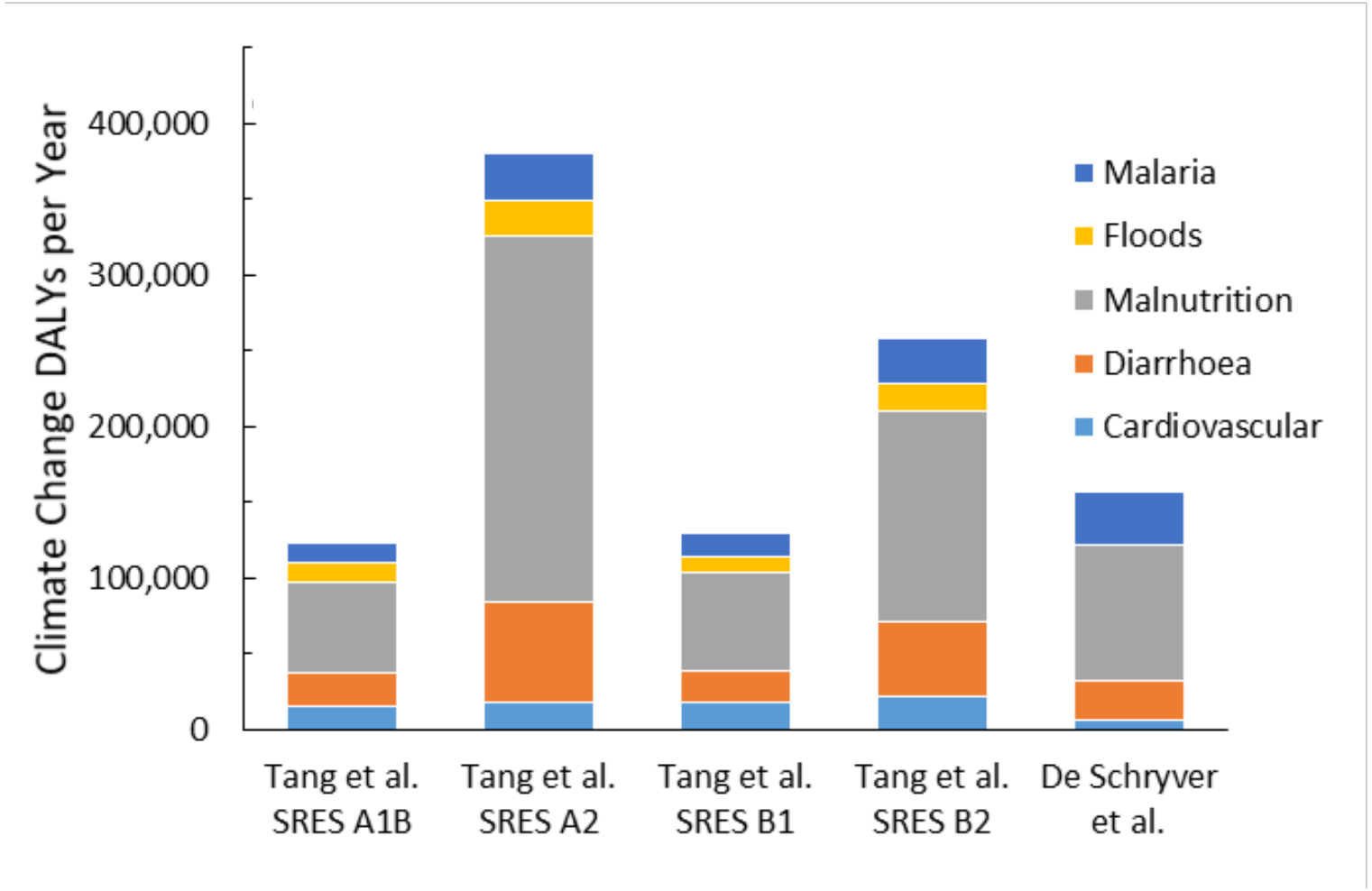
Indicator 3.6: Health Care GHG Emissions

Lancet Countdown on Health and Climate Change 2020 Report

He


Impact of Climate Change on Human Health
Injuries, fatalities, mental health impacts
Asthma, cardiovascular disease
Heat-related illness and death, cardiovascular failure
Malaria, dengue, encephalitis, hantavirus, Rift Valley fever, Lyme disease, chikungunya, West Nile virus
Forced migration, civil conflict, mental health impacts
Respiratory allergies, asthma
Malnutrition, diarrheal disease
Cholera, cryptosporidiosis, campylobacter, leptospirosis, harmful algal blooms
Severe Weather
Air Pollution
Extreme Heat
Changes in Vector Ecology
Environ-mental Degradation
Increasing Allergens
Water and Food Supply Impacts
Water Quality Impacts
RISING TEMPERATURES
MORE EXTREME WEATHER
INCREASING CO2 LEVELS
RISING SEA LEVELS

Health Effects of Health Care Emissions



Eckelman and Sherman, *AJPH* 2018

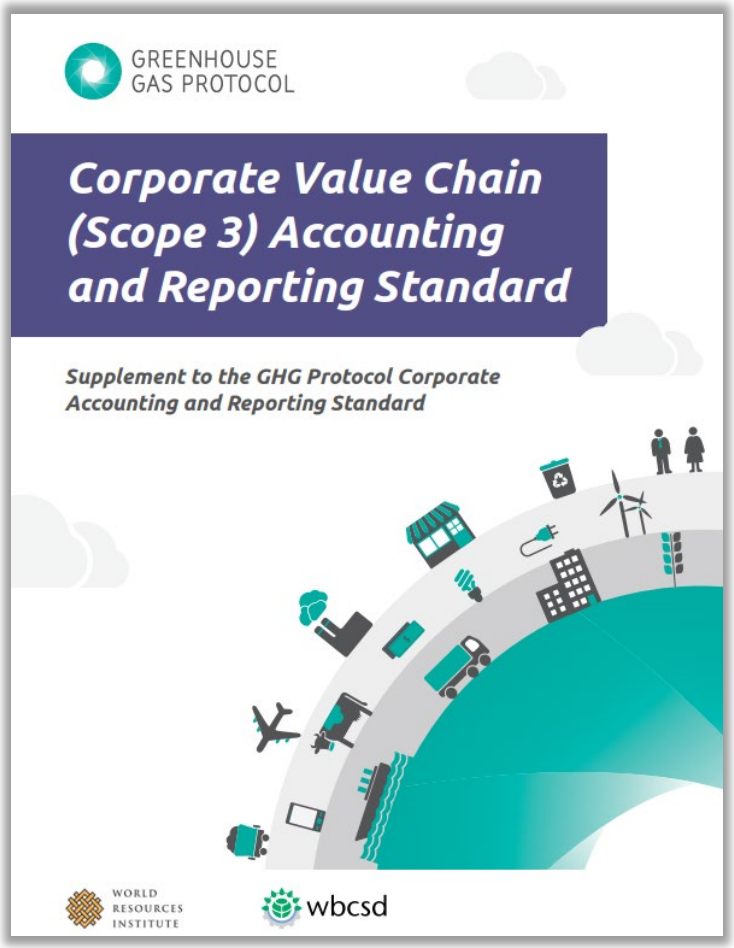
Scope 3 Categories

Upstream

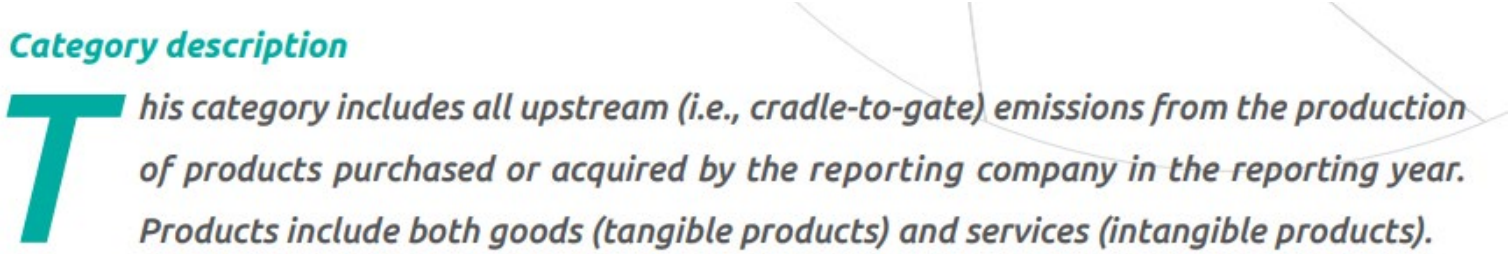
- **Purchased Goods & Services**
- **Capital Goods**
- Upstream Fuel & Energy
- **Upstream Transp. & Distribution**
- Waste
- Business Travel
- Employee Commuting
- Upstream Leased Assets

Downstream

- **Downstream Transp. & Distribution**
- **Processing of Sold Products**
- **Use of Sold Products**
- **End-of-Life of Sold Products**
- Downstream Leased Assets
- Franchises
- Investments



Scope 3: Purchased Goods & Services



- This is the largest and most complex category of Scope 3 emissions, so we will spend the most time on it
- The GHG Protocol Corporate Standard presents several carbon accounting options – you can choose

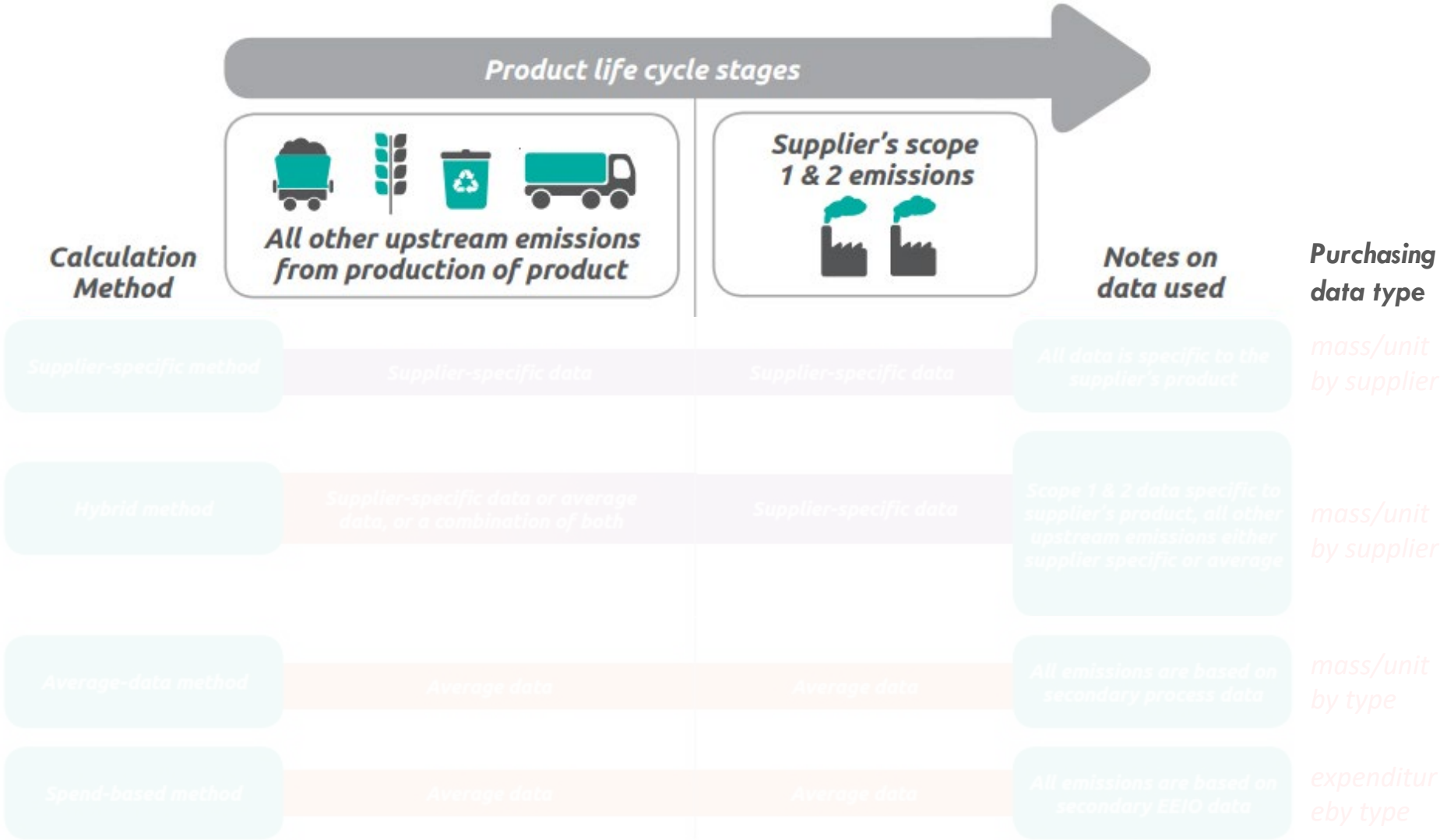
Scope 3: Purchased Goods & Services

Step 1. Collect and categorize procurement data

Vendor	Account	Item	Long Descr	Std UOM	Net Recv	Per Unit Cost	Item Cost
	910100	000000000000000424	CATHETER COUDE 14FRX5ML LATEX	EA	1.0000	$ 10.11	$ 10.11
	910100	000000000000003044	CATHETER FOLEY 14FRX5CC LATEX	EA	1.0000	$ 1.85	$ 1.85
	910100	000000000000029227	CATHETER FOLEY 5CCX14FR BALLOO	EA	1.0000	$ 3.42	$ 3.42
0000000001	910100	000000000000029275	CATHETER THORACIC 28FRX20IN STERILE STRAIGHT 6 EYE PVC CLEAR CS/10EA	EA	1.0000	$ 4.22	$ 4.22
	910100	000000000000035927	TRAY CATHETERIZATION FOLEY URI	EA	1.0000	$ 9.13	$ 9.13
	910100	000000000000438579	CATHETER VIRDEN RECTAL 17 30FR	EA	1.0000	$ 23.06	$ 23.06
	910100	000000000000003048	TRAY CATHETERIZATION FOLEY W/O	EA	2.0000	$ 1.80	$ 3.61
	910100	000000000000029228	CATHETER FOLEY 5CCX16FR BALLOO	EA	2.0000	$ 3.69	$ 7.37
	910100	000000000000082837	CATHETER URETHRAL 30CCX22FR FO	EA	2.0000	$ 2.68	$ 5.36
	910100	000000000000012097	TRAY CATHETERIZATION URETH W/	EA	2.9999	$ 1.72	$ 5.16
0000000001	910100	000000000000000423	CATHETER FOLEY 20FRX30ML LATEX BALLOON URETHRAL 2 WAY ROUND TIP LUBRICATED STERILE CS/12EA	EA	3.0000	#N/A	
	910100	000000000000048756	CATHETER SUCTION 10FR STRL W/	EA	3.0000	$ 0.24	$ 0.71
0000000001	910100	000000000000101207	CATHETER FOLEY BARDEX IC 16FR 5CC BX/12EA	BX	3.0000	$ 92.56	$ 277.68
	910100	000000000000043363	CATHETER VENTRIC 35CMX2.9X1.6M	EA	4.0000	$ 57.57	$ 230.28
	910100	000000000000044173	CATHETER VENTRIC 80CMX1.5X0.7M	EA	4.0000	$ 151.69	$ 606.75
0000000001	910100	000000000000044173	eM: CATHETER VENTRIC 80CMX1.5X0.7MM EXT LUMBR HERMETIC CLS TP	EA	4.0000	$ 151.69	$ 606.75
	910100	000000000000145094	KIT ICP MONITORING 4FR CATHETE	EA	4.0000	$ 581.79	$ 2,327.14
0000003825	910100	000000000000447226	eM: CATHETER LICOX TUNNELING KIT	EA	4.0000	#N/A	
	910100	000000000000029226	CATHETER FOLEY 5CCX12FR BALLOO	EA	5.0000	$ 3.85	$ 19.27
0000000001	910100	000000000000037418	CATHETER FOLEY 18FRX5ML LATEX BALLOON URETHRAL 3 WAY LUBRICATED RADIOPAQUE STERILE RED PK/12CS/12EA	EA	5.0000	$ 9.12	$ 45.61
0000000001	910100	000000000000470117	CATHETER SWAN-GANZ TD VIP CS/5EA	EA	5.0000	$ 38.92	$ 194.60

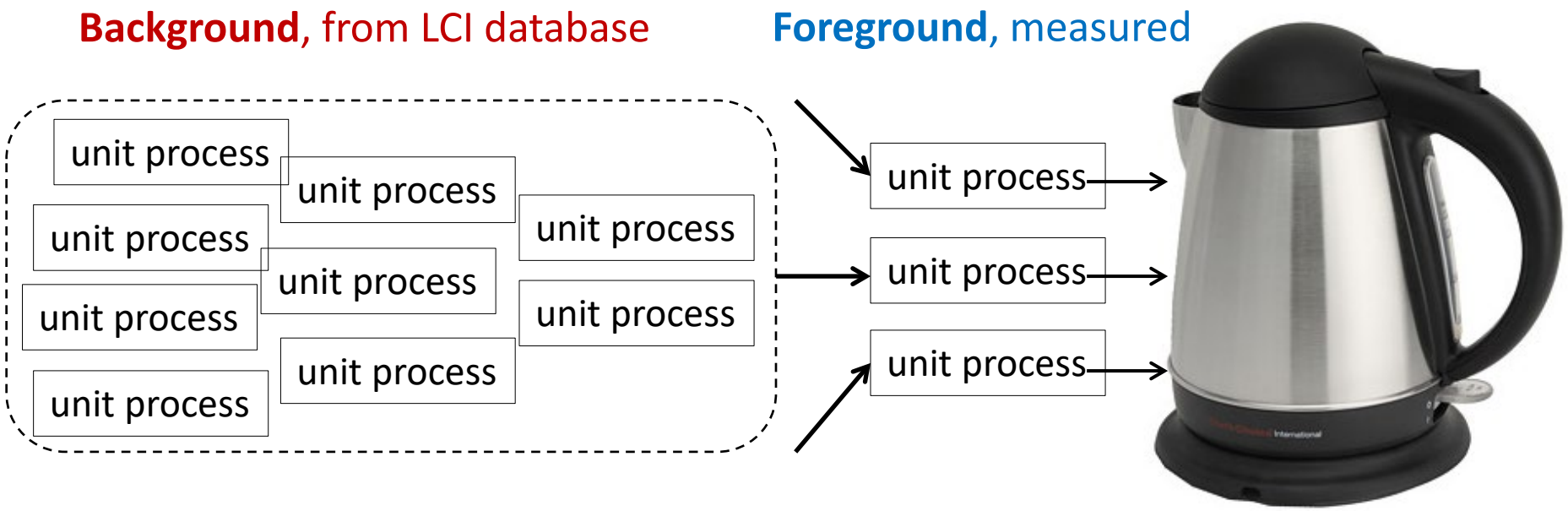
Scope 3: Purchased Goods & Services

Step 2. Decide on Accounting Method



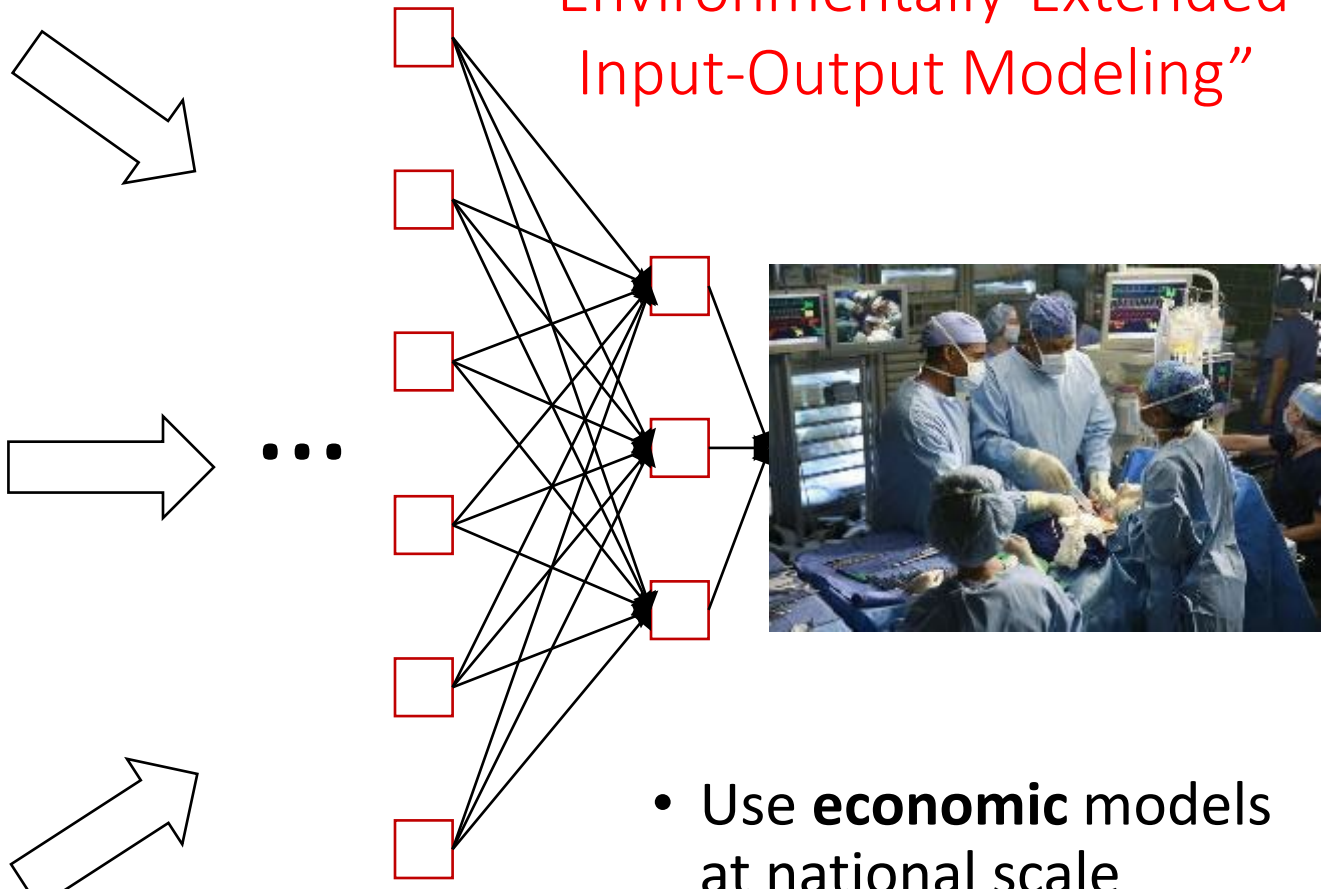
GHG Protocol Scope 3 Standard

Mass-based Process LCA Models



- Uses **engineering** models to determine emissions from each process/material in the supply chain

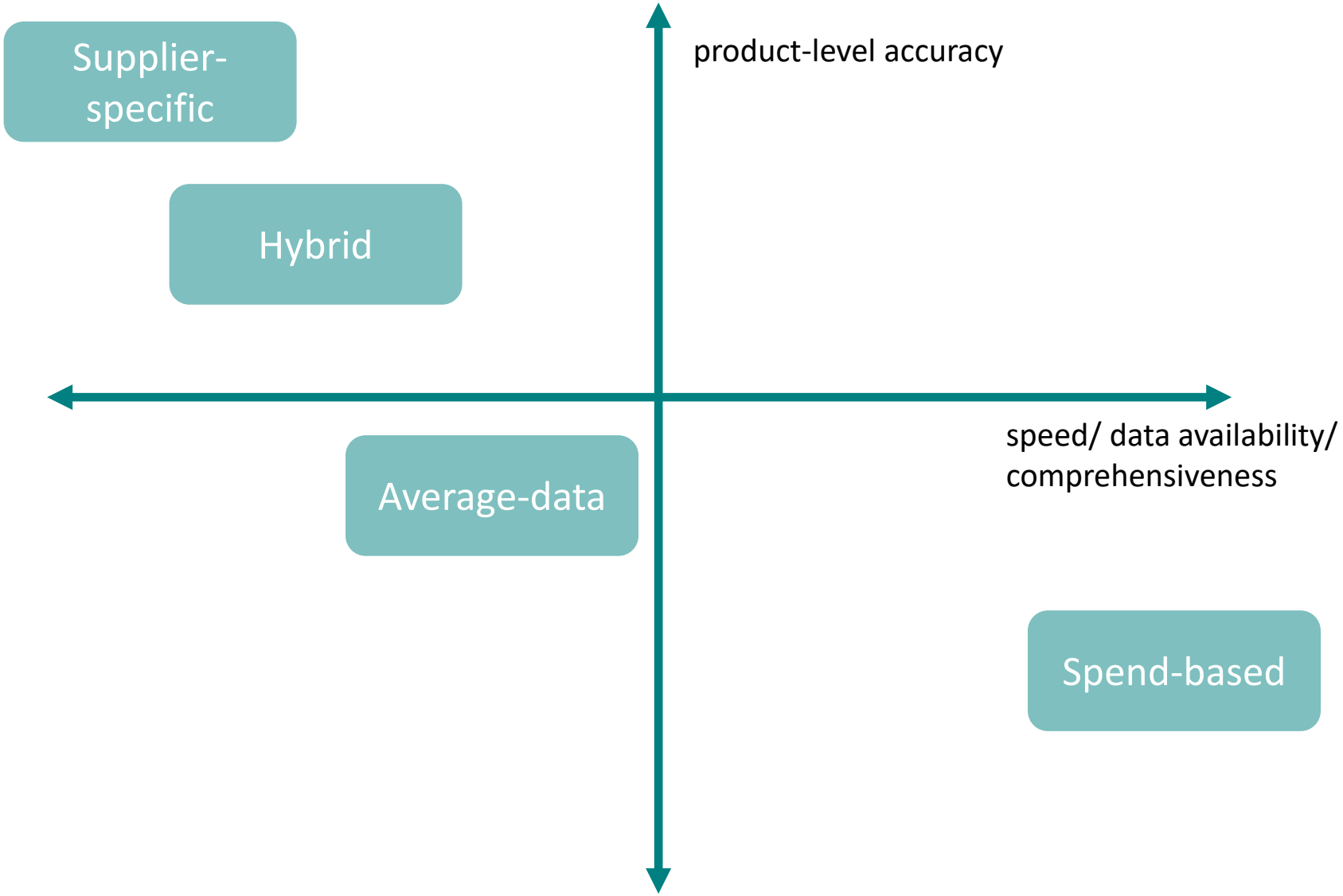
Spend-based / EEIO Modeling



- Use **economic** models at national scale

Scope 3: Purchased Goods & Services

Step 2. Decide on Accounting Method



Scope 3: Purchased Goods & Services

Step 2. Decide on Accounting Method

Typical Challenges

- it’s difficult to get procurement data
- it’s difficult to categorize procurement data
- it’s difficult to get mass quantities from procurement data
- a single supplier may provide hundreds of different items
- multiple suppliers may provide the same item
- suppliers change over time
- suppliers have limited / no information to provide
- suppliers only track their own Scopes 1-2 emissions, not supply chain
- services don’t have mass…
- spend-based methods don’t reflect a supplier’s green initiatives

Spend-based Aggregation Disadvantages

- Using EEIO modeling, these things are the same:

$1000 at IKEA

$1000 at Aspen Fine Furniture

Spend-based Quality/Price Disadvantages

- Using [illegible] mea[illegible]

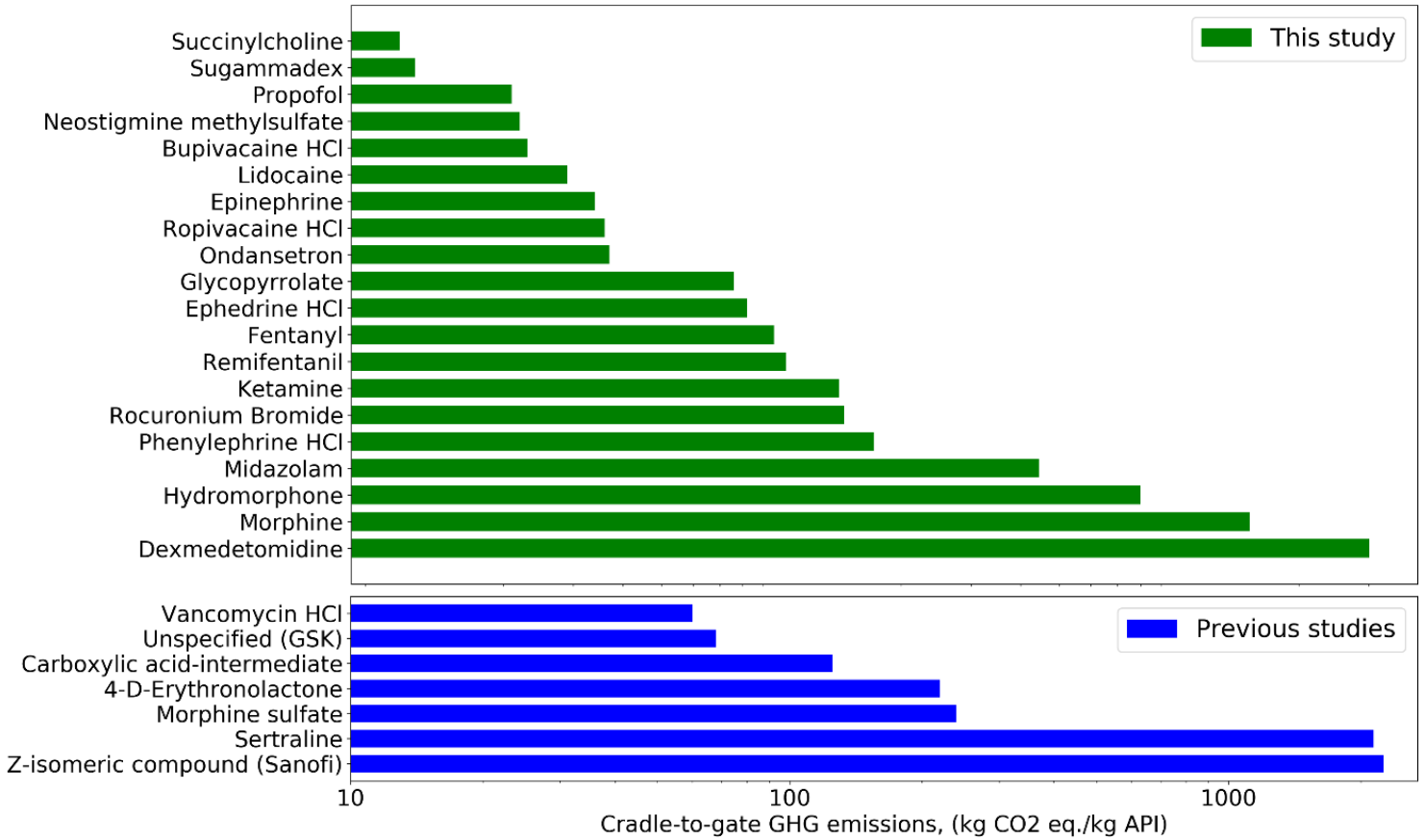
Shipped from Netherlands to Supermarket: $1.99/lb.

Farmer's Market: $6/lb.

Spend-based Averaging Disadvantages

Cradle-to-Gate Greenhouse Gas Emissions for Twenty Anesthetic Active Pharmaceutical Ingredients Based on Process Scale-Up and Process Design Calculations

Abhijeet G. Parvatker,[†] Huseyin Tunceroglu,[‡] Jodi D. Sherman,[‡] Philip Coish,[§] Paul Anastas,[§,∥] Julie B. Zimmerman,[§,∥,⊥] and Matthew J. Eckelman*[,#]

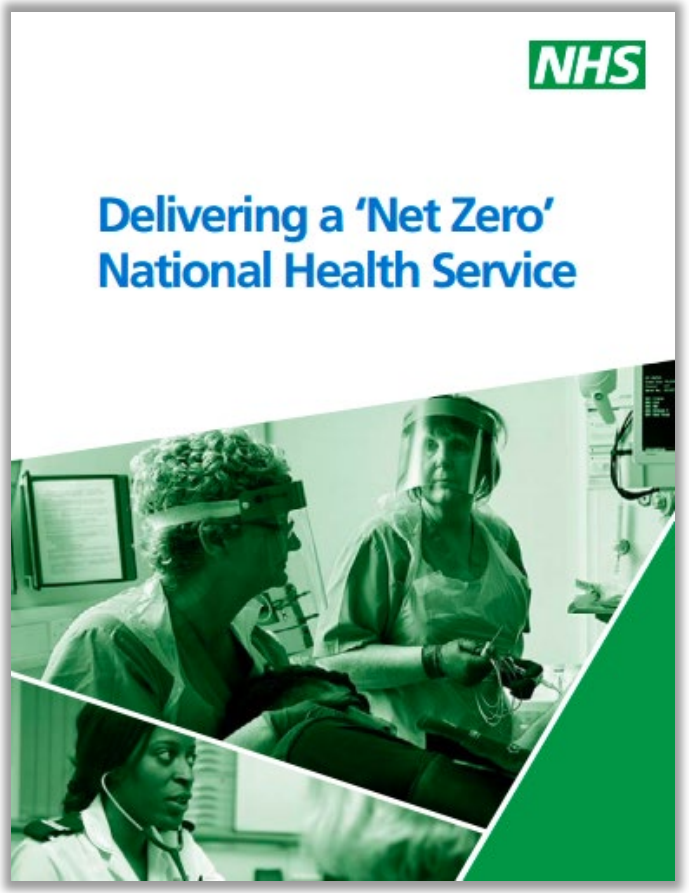


What Modeling Approach is Best?

- Both are needed!

- Spend-based methods are critical for reporting and identifying hotspots – needs to be comprehensive
  ~ REPORTING and STRATEGY

- Process-LCA is critical for making improvements or choosing among options
  ~IMPLEMENTATION



Scope 3: Purchased Goods & Services

Step 2. Decide on Accounting Method

My Recommendation:

- Use ***spend-based*** method to count everything
- Use ***average-data*** method to count large-volume, homogenous items (like paper)
- Once you have this baseline, reach out to preferred suppliers to get information on specific items of interest using ***hybrid*** method

Scope 3: Purchased Goods & Services

Step 3. Get Embodied Carbon Factors

Example: Supplier Specific Environmental Product Declaration (EPD)

Summary of
Environmental Product Declaration

Central Concrete

Mix 340PG9Q1

San Jose Service Area

EF V2 Gen Use P4000 3" Line 50% SCM

Performance Metrics

28-day compressive strength	4,000 psi
Slump	4.0 in

Environmental Impacts

Impact name	Unit	Impact per m3	Impact per cyd
Total primary energy consumption	MJ	2,491	1,906
Concrete water use (batch)	m3	6.66E-2	5.10E-2
Concrete water use (wash)	m3	8.56E-3	6.55E-3
Global warming potential	kg CO2-eq	271	207
Ozone depletion	kg CFC-11-eq	5.40E-6	4.14E-6
Acidification	kg SO2-eq	2.26	1.73
Eutrophication	kg N-eq	1.31E-1	1.00E-1
Photochemical ozone creation	kg O3-eq	46.6	35.7

A sample EPD for a concrete mix design by Central Concrete Supply Co.

Credit: Central Concrete Supply

Scope 3: Purchased Goods & Services

Step 3. Get Embodied Carbon Factors

Example: Average-data Tools

- Industry product calculators

- Aggregated embodied carbon factors (careful about where these come from)

- Life cycle inventory databases

- Published studies

Scope 3: Purchased Goods & Services

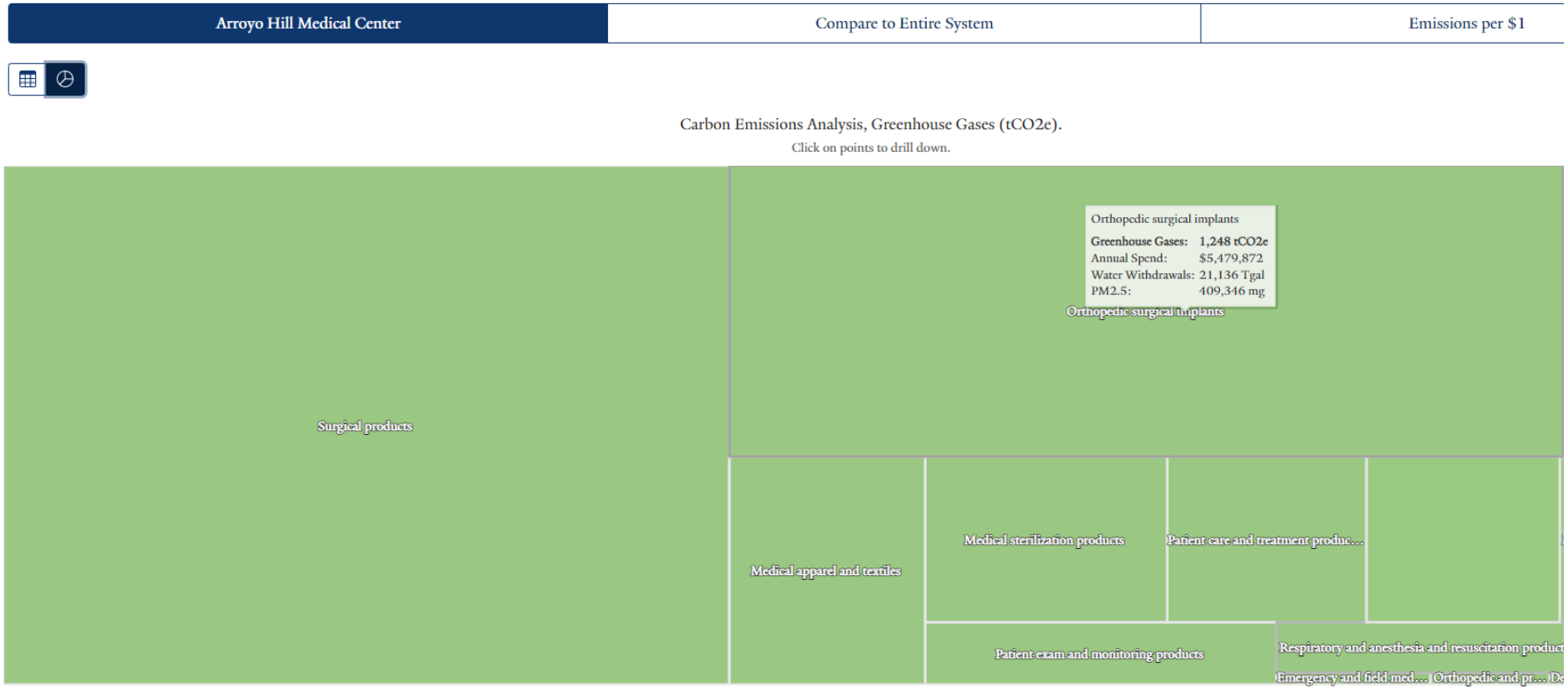
Step 3. Get Embodied Carbon Factors

Example: Spend-based tools

- Specific to the healthcare sector
  - Health Care Supply Chain Emissions Carbon Calculator: https://healthcareghg.org/
  - HCWH/Practice Greenhealth: https://practicegreenhealth.org/tools-and-resources/scope-3-ghg-emissions-accounting-tool
- Not-specific to healthcare
  - GHG Protocol/Quantis Scope 3 Evaluator: https://quantis-suite.com/Scope-3-Evaluator/
  - Many consulting company offerings…
  - USEEIO model: https://www.epa.gov/land-research/us-environmentally-extended-input-output-useeio-technical-content

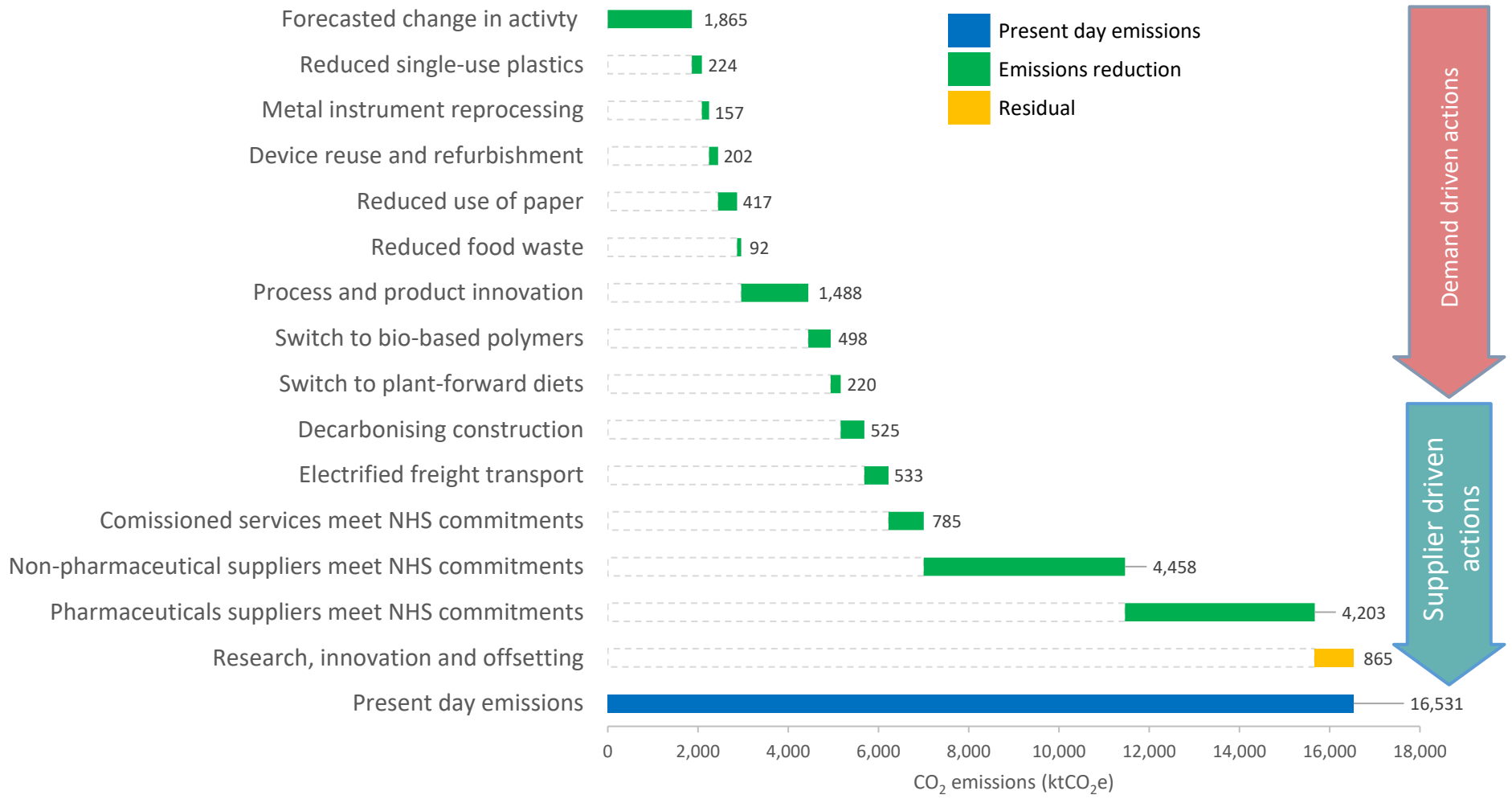
Scope 3: Purchased Goods & Services

Step 4. Multiply mass/value by EF for each category



demo data from: https://healthcareghg.org/

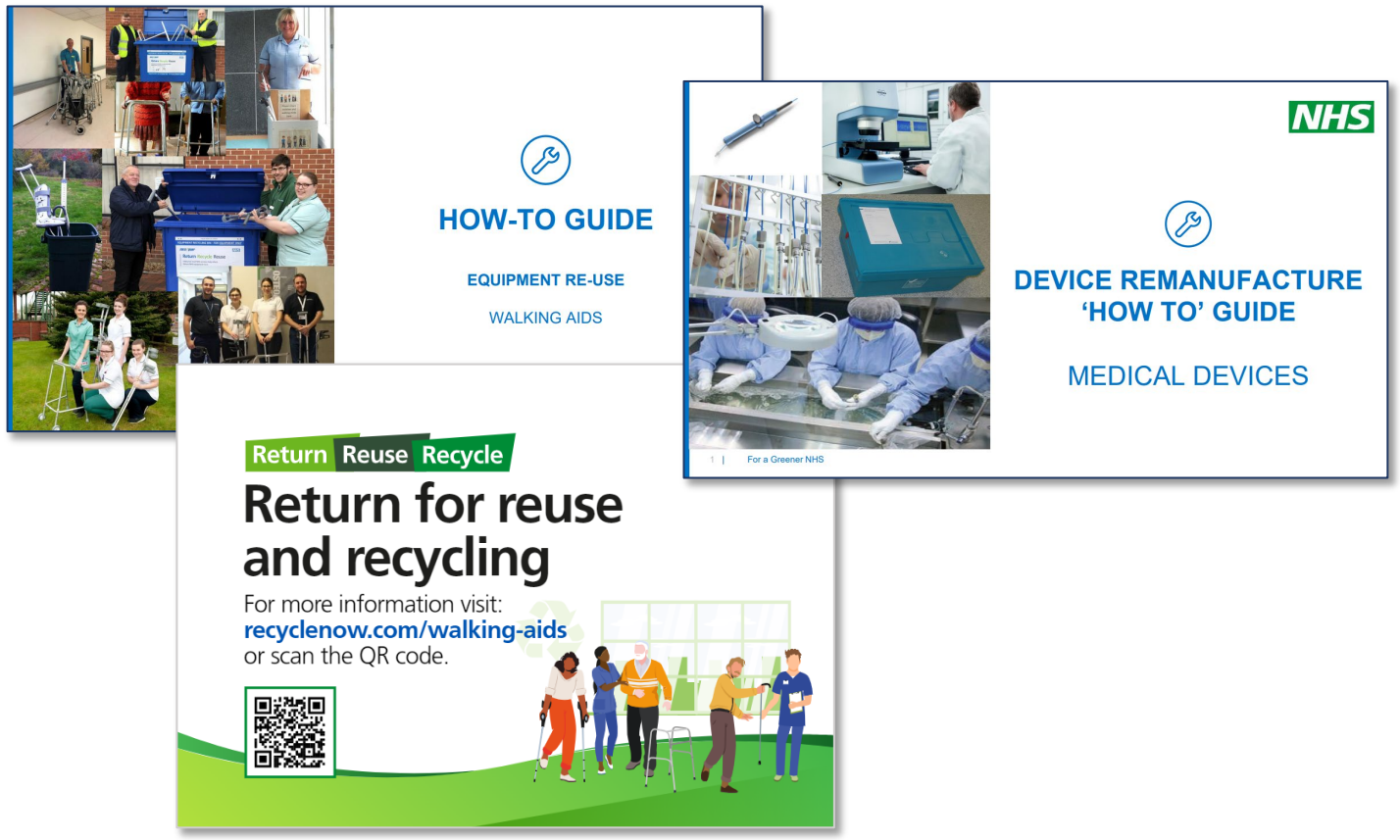
From Reporting to Implementation

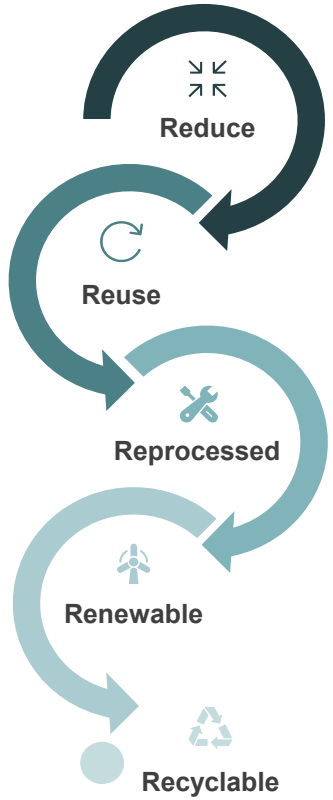


(slide courtesy of NHS)

From Reporting to Implementation

- NHS identified supply chain measures that they could influence
- Education and training are key to demand-side interventions





(slide courtesy of NHS)

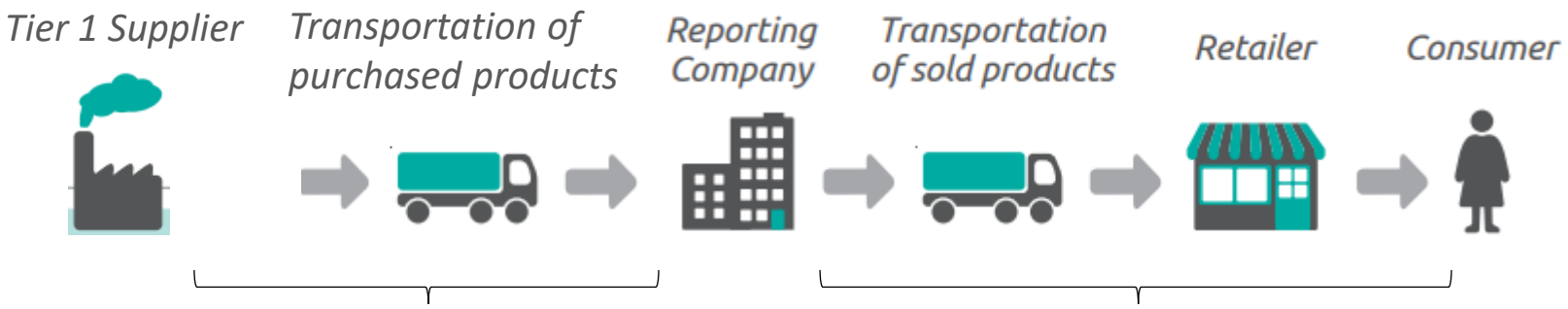
Scope 3: Capital Goods

Category description

This category includes all upstream (i.e., cradle-to-gate) emissions from the production of capital goods purchased or acquired by the reporting company in the reporting year. Emissions from the use of capital goods by the reporting company are accounted for in either scope 1 (e.g., for fuel use) or scope 2 (e.g., for electricity use), rather than in scope 3.

- Easy, go through the same steps as for Purchased Goods & Services
- DO NOT DEPRECIATE OR AMORTIZE assign all emissions to purchasing year
- DO NOT COUNT EMISSIONS DURING USE

Scope 3: Up/Downstream Transp. & Distrbn.



If an HCO contracts for transportation, whether upstream or downstream, it is included in ***Category 4***

Scope 3- Up/Downstream Transp. & Distrbn.

Step 1. Decide on method and collect/estimate data

- *Fuel-based*. If you know how much physical fuel is being used
- *Distance-based*. If you don't know the fuel use but you do know how far items are being shipped, and how
- *Spend-based*. If you only know how much you are spending (such as for contracted transportation)

Step 2. Collect emissions factors

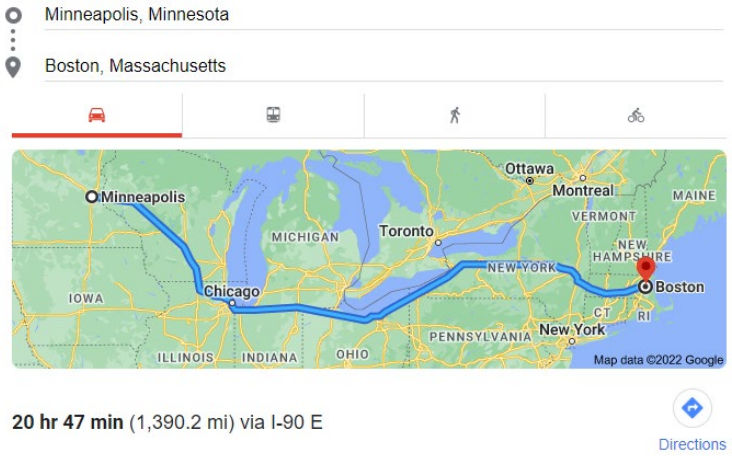
- In the US, recommend USEPA Emissions Factors https://www.epa.gov/climateleadership/ghg-emission-factors-hub
- Outside US, see GHG Protocol Category 4 Guidance https://ghgprotocol.org/sites/default/files/standards_supporting/Chapter4.pdf

Step 3. Multiply!

Scope 3- Up/Downstream Transp. & Distrbn.

Example. My Boston-area hospital takes delivery of 20 tons of medical supplies from major manufacturer in Minnesota.

Step 1. I don't know how much fuel is combusted, choose distance-based method



Step 2. Use USEPA emissions factor:

Vehicle Type	CO_2 Factor (kg / unit)	CH_4 Factor (g / unit)	N_2O Factor (g / unit)	Units
Medium- and Heavy-Duty Truck	1.450	0.013	0.034	vehicle-mile
Passenger Car [A]	0.332	0.007	0.007	vehicle-mile
Light-Duty Truck [B]	0.454	0.012	0.009	vehicle-mile
Medium- and Heavy-Duty Truck	0.211	0.0020	0.0049	ton-mile
Rail	0.022	0.0017	0.0006	ton-mile
Waterborne Craft	0.041	0.0183	0.0008	ton-mile
Aircraft [C]	1.165	-	0.0359	ton-mile

Step 3. Multiply:

(1390.2 miles)*(20 tons)*[0.21+(0.002)(25)/1000+(0.0049)(298)/1000]=5.88 tons CO_2e

Scope 3: Processing/Use of Sold Products

- Emissions associated with downstream processing or use of **sold** health care devices or products
  - Cold chain medicines → electricity use and refrigerants
  - Metered dose inhalers → propellant
  - Home dialysis machine → electricity use
  - (in practice, rarely accounted for)

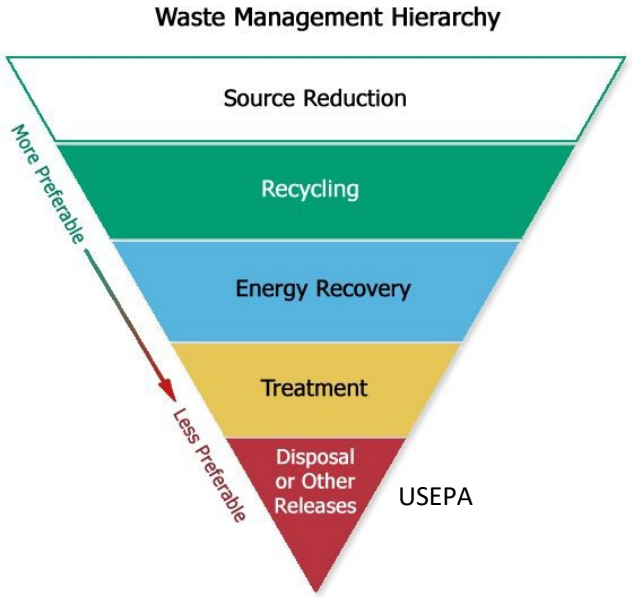
- Collect information on sales of each relevant item

- Follow Scopes 1 and 2 guidance for each, but attribute to Scope 3 ***Categories 10+11***

Scope 3: End-of-Life of Sold Products

- Emissions from waste management of sold items described in ***Categories 10+11***
- (follow same directions as for Waste Mgmt. ***Category 5***)

- Estimate material quantities/types
- Determine prevalent treatment/disposal method
- Use USEPA emissions factors: https://www.epa.gov/climateleadership/ghg-emission-factors-hub



Scope 3: Supply Chain
Providence's Approach to Carbon Accounting

Beth Schenk, PhD, RN, FAAN

Executive Director of Environmental Stewardship

120k CAREGIVERS

36k NURSES

25k PHYSICIANS

$1.9b COMMUNITY BENEFIT

52 HOSPITALS

950 CLINICS

28.1m TOTAL PATIENT VISITS

1.9m COVERED LIVES

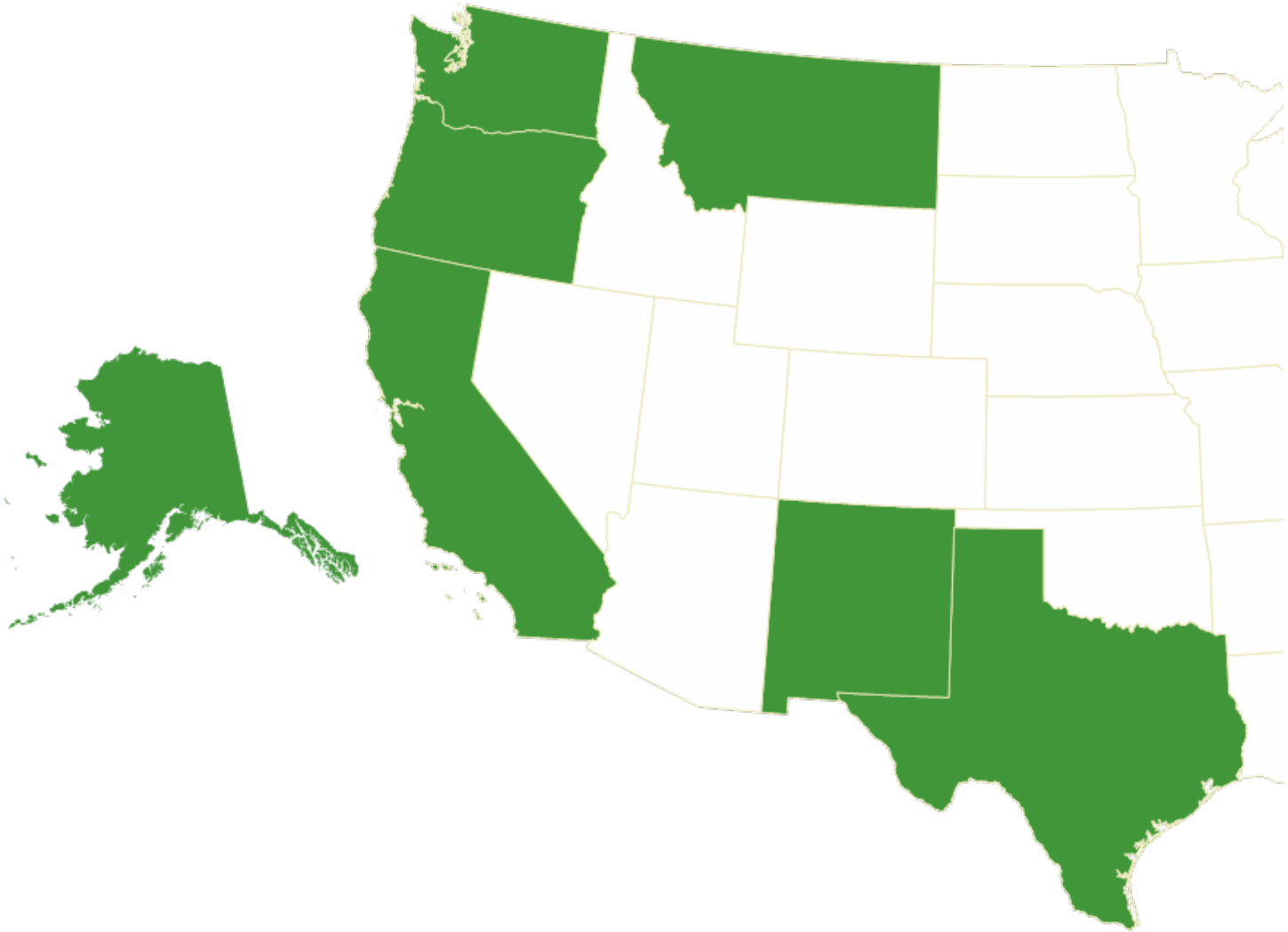
1700+ PUBLISHED RESEARCH STUDIES

1 HEALTH PLAN

17 SUPPORTIVE HOUSING FACILITIES

HIGH SCHOOL NURSING SCHOOLS & UNIVERSITY

Providence



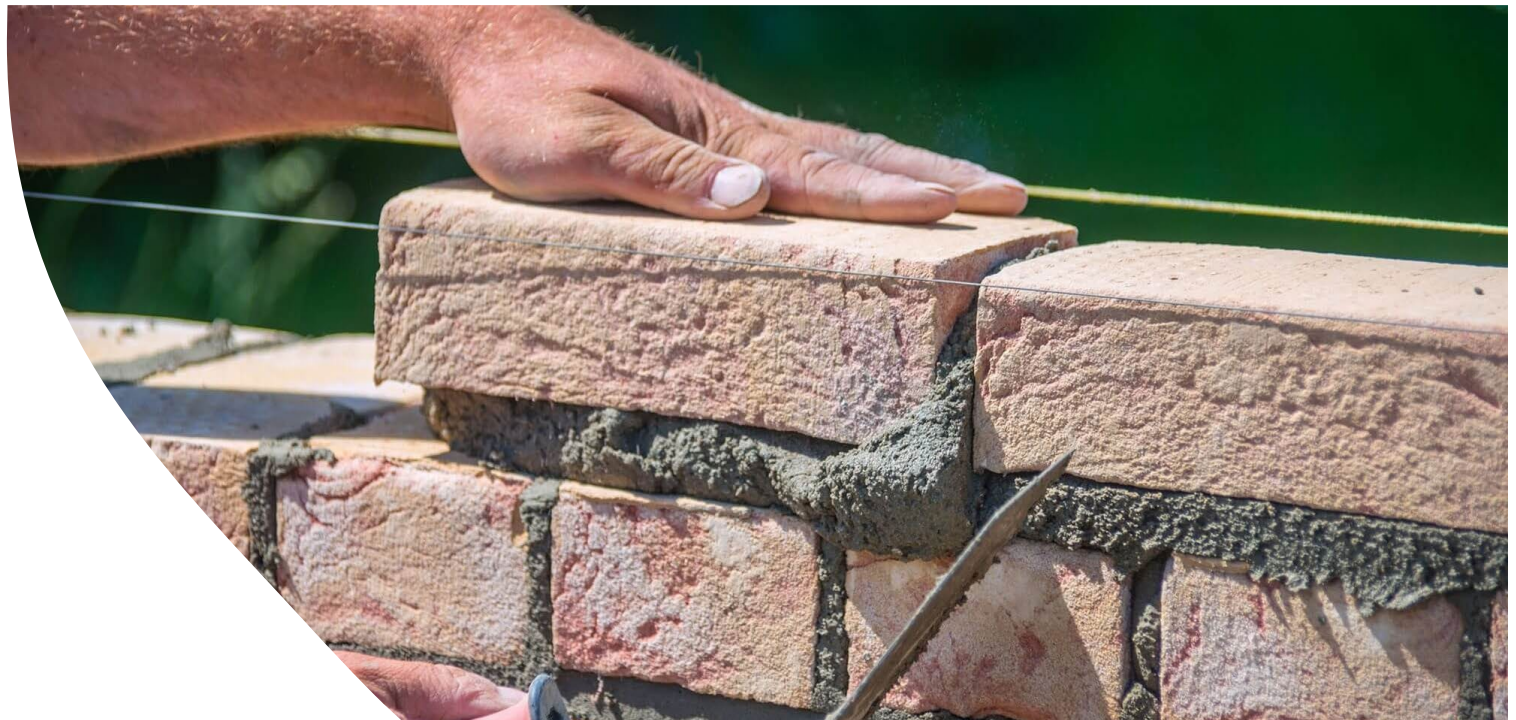
Providence

Moonshot Goal: Carbon Negative by 2030

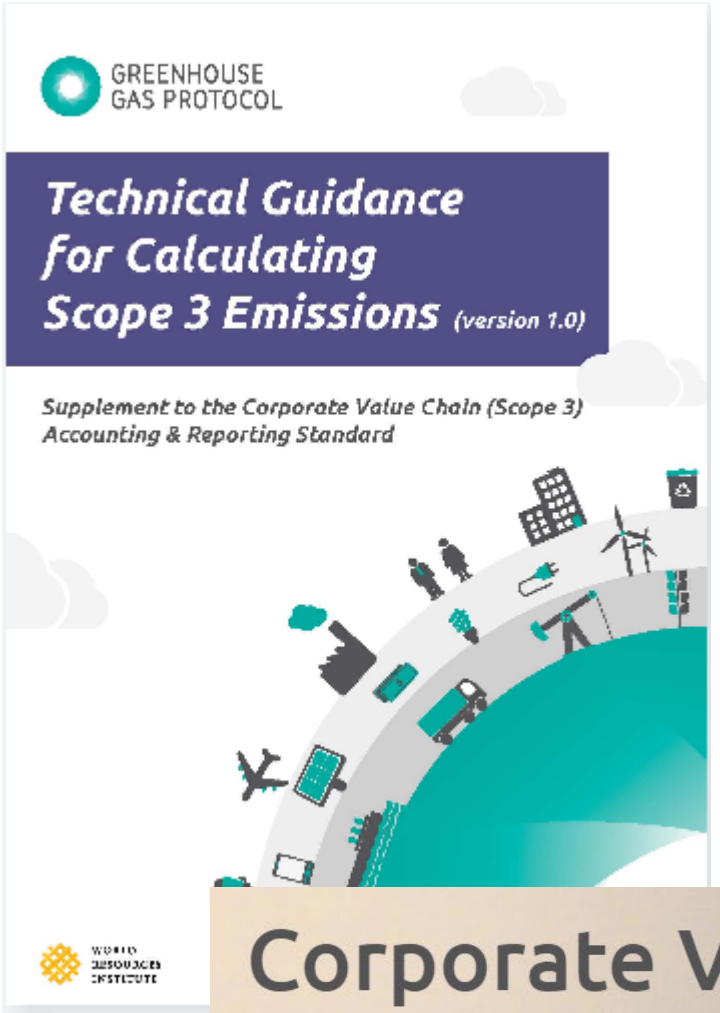
Do all we can this decade to reduce emissions and transform health care to be ***planet-safe***

Measurement using the WE ACT Scorecard –

Usage, cost, and carbon data	Each site	Monthly	Automated, transparent, accurate



GREENHOUSE GAS PROTOCOL



Corporate Value Chain (Scope 3) Standard Online Course

Category 1: Purchased Good and Services
Category 2: Capital Goods

- **Supplier-specific method** – collects product-level cradle-to-gate GHG inventory data from goods or services suppliers.
- **Hybrid method** – uses a combination of supplier-specific activity data (where available) and secondary data to fill the gaps. This method involves:
  - collecting allocated scope 1 and scope 2 emission data directly from suppliers
  - using secondary data to calculate upstream emissions wherever supplier-specific data is not available.
- **Average-data method** – estimates emissions for goods and services by collecting data on the mass (e.g., kilograms or pounds), or other relevant units of goods or services purchased and multiplying by the relevant secondary (e.g., industry average) emission factors (e.g., average emissions per unit of good or service).
- **Spend-based method** – estimates emissions for goods and services by collecting data on the economic value of goods and services purchased and multiplying it by relevant secondary (e.g., industry average) emission factors (e.g., average emissions per monetary value of goods).

Providence

- Spend based method for 2019 baseline
  - Supported by consultant
  - EEIO data (Environmentally Extended Input-Output). EPA 2016
- Hybrid method with major suppliers
  - Collecting Scope 1 and 2 emissions
  - Prorating the emissions we claim based on the percentage of their products we purchase

How did it go?

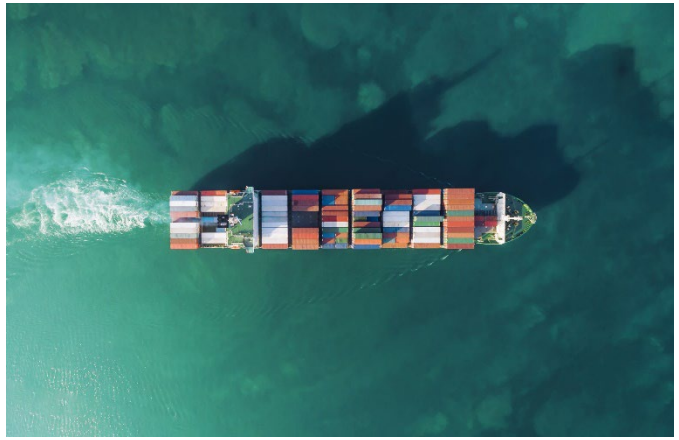
- Spend based not difficult but may not be accurate or meaningful. Approximately 40% of total.
- Hybrid method – linked to known quantity of emissions, but information very difficult to get
- Use Mass

Category 4: Upstream Transportation and Distribution
Category 9: Downstream Transportation and Distribution

- **Fuel-based method**, which involves determining the amount of *fuel consumed* (i.e., scope 1 and scope 2 emissions of transport providers) and applying the appropriate emission factor for that fuel
- **Distance-based method,** which involves determining the *mass, distance, and mode* of each shipment, then applying the appropriate mass-distance emission factor for the vehicle used
- **Spend-based method**, which involves determining the amount of *money spent* on each mode of business travel transport and applying secondary (EEIO) emission factors.

Providence

- Upstream:
  - Working to understand emissions of primary distributor
  - Spend based method for 2019 baseline
    - % added to categories 1 and 2
- Downstream: Not relevant



Category 10: Processing of Sold Products
Category 11: Use of Sold Products
Category 12: End of Life Treatment of Sold Products

For Providence: Not relevant

Accuracy:

- Depends on emission factors
- Depends on boundaries
- Depends on interpretation of GHGP

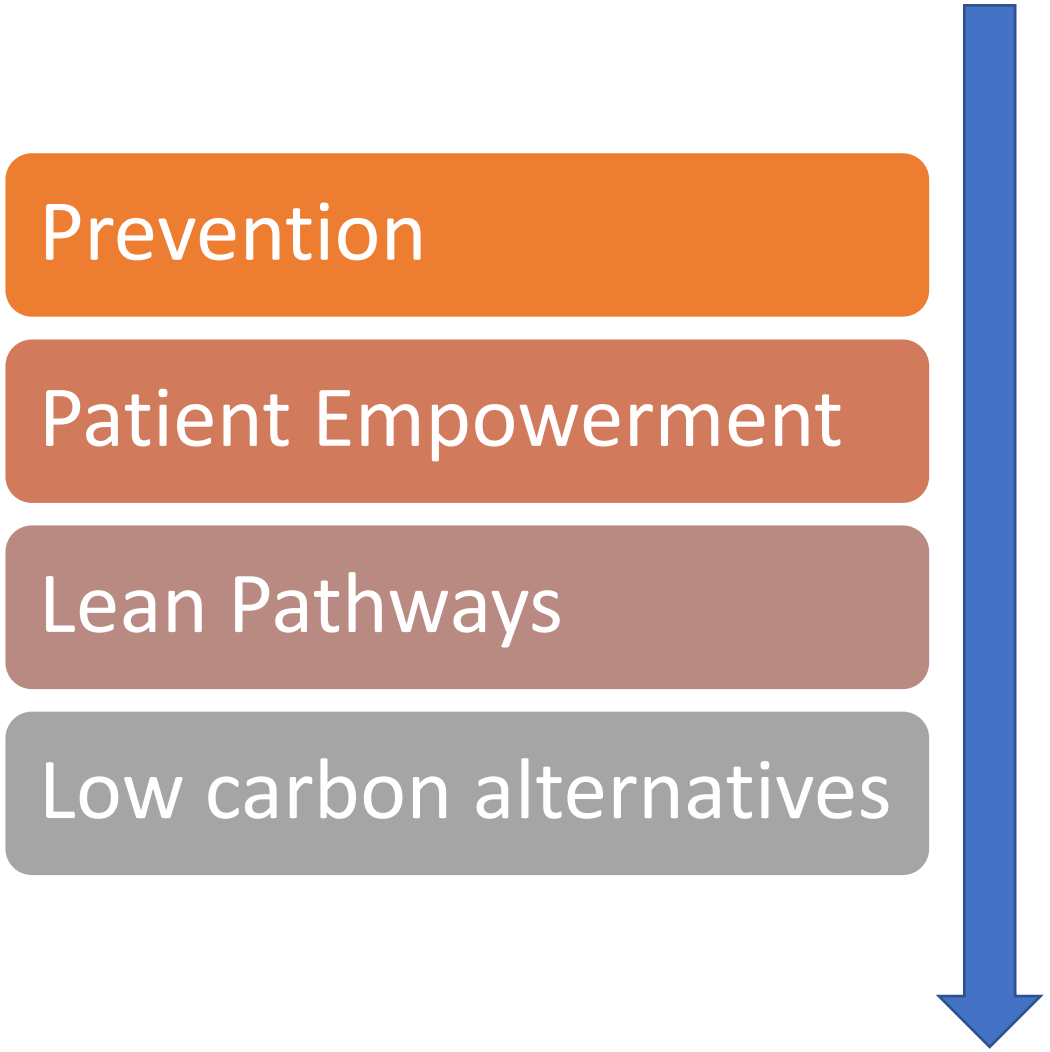
Accountability:

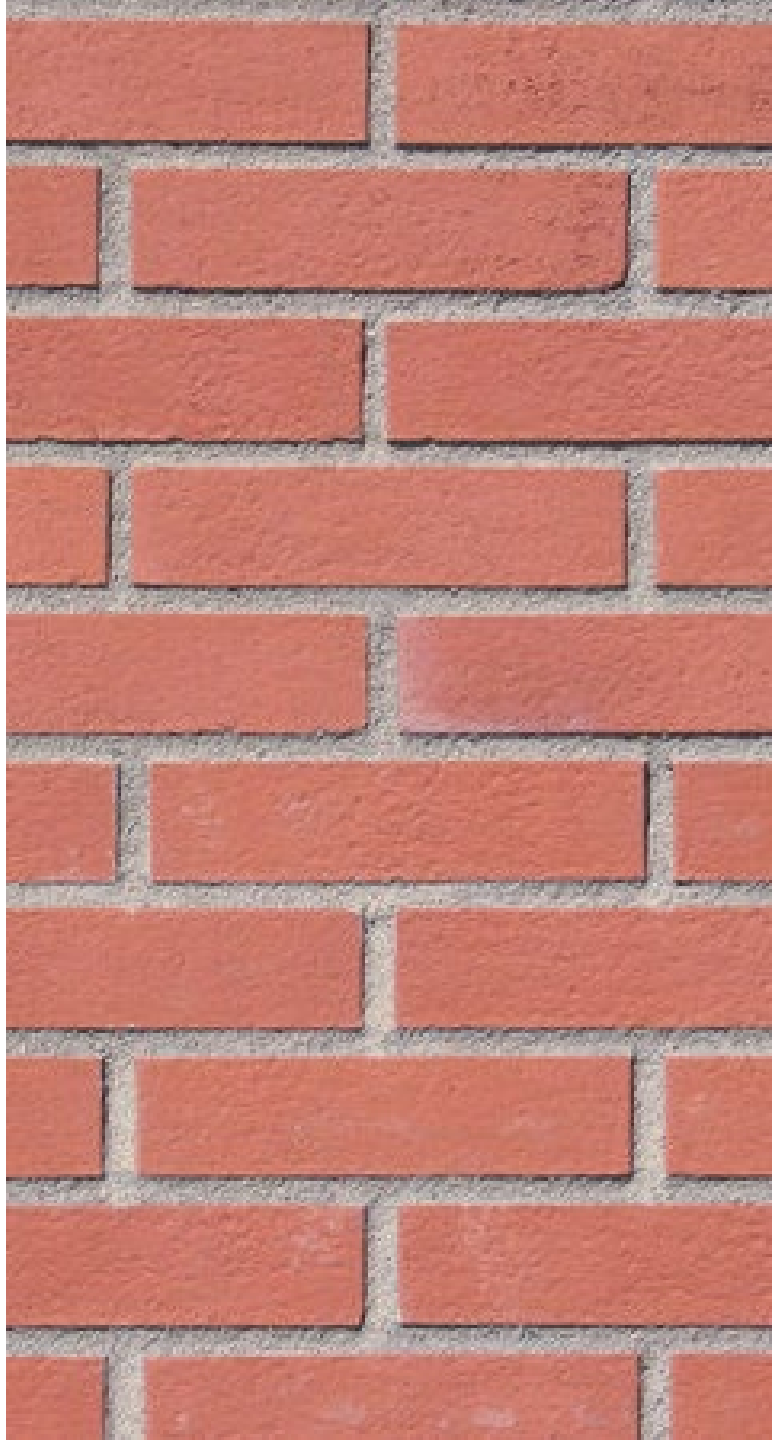
- All steps along the supply chain (for example: raw materials, transportation, manufacturing, packaging, distribution, use, end-of-life treatment) count the same emissions.

Activation:

- Complexity of accounting may stymie action
- Lack of clear accountability may hinder action
- Excess accountability may slow action

What do we do with this information?


Prevention
Patient Empowerment
Lean Pathways
Low carbon alternatives



Brick by Brick…
Emissions Analysis and Reduction Projects

- Linen Analysis
- Inhaled medications
- Carbon intensity of meals
- Blue wrap analysis
- Embodied carbon – construction
- Leased Vehicles
- Computer Power Management
- Reprocessed products
- Surgical Supply Optimization

Clinical Supply Optimization

- Dave Wilson, Six Sigma Black Belt, Process Improvement, Oregon

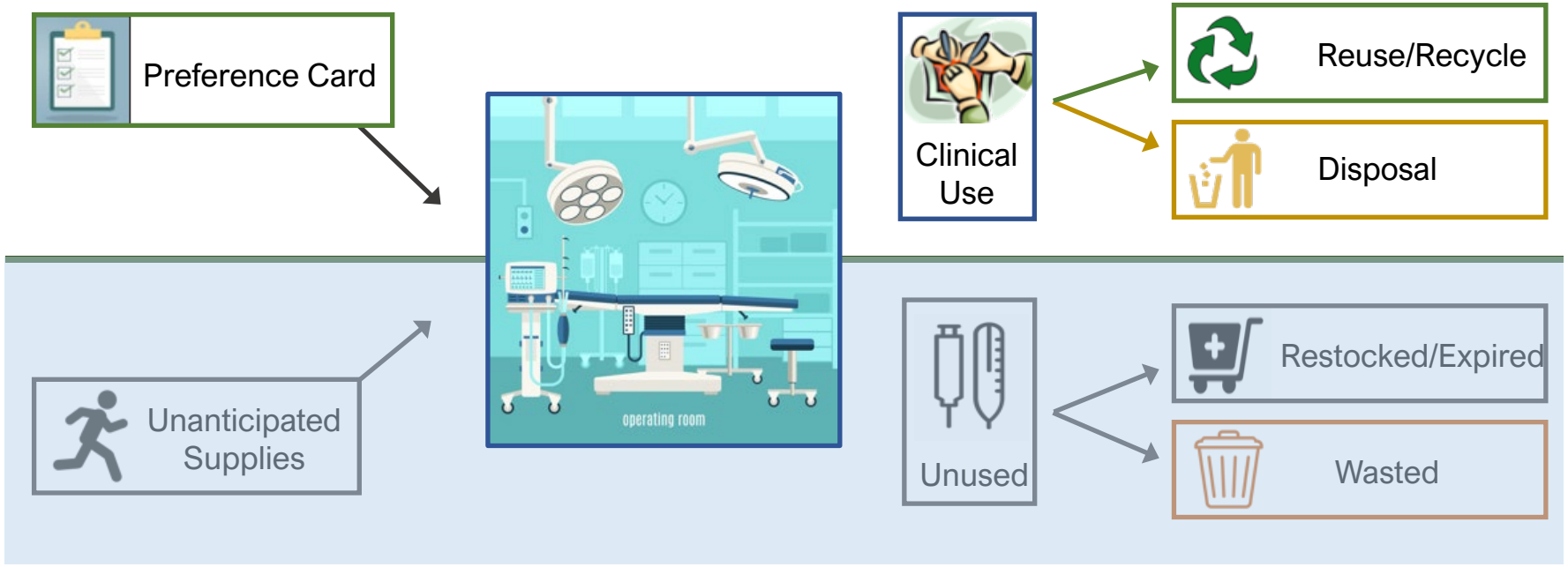
- Brian Chesebro, MD, Medical Director, Environmental Stewardship, Oregon

Background

- Surgical care is resource intensive – and prone to inefficiency and waste
- Surgical preference cards are common – to determine what products are used (or opened and not used)
- Inefficiency leads to
  - Discard of new items
  - Excessive sterilization costs
  - Labor costs
  - Environmental impacts – emissions, energy, water, waste

Process Engineering & Decision Support Tools

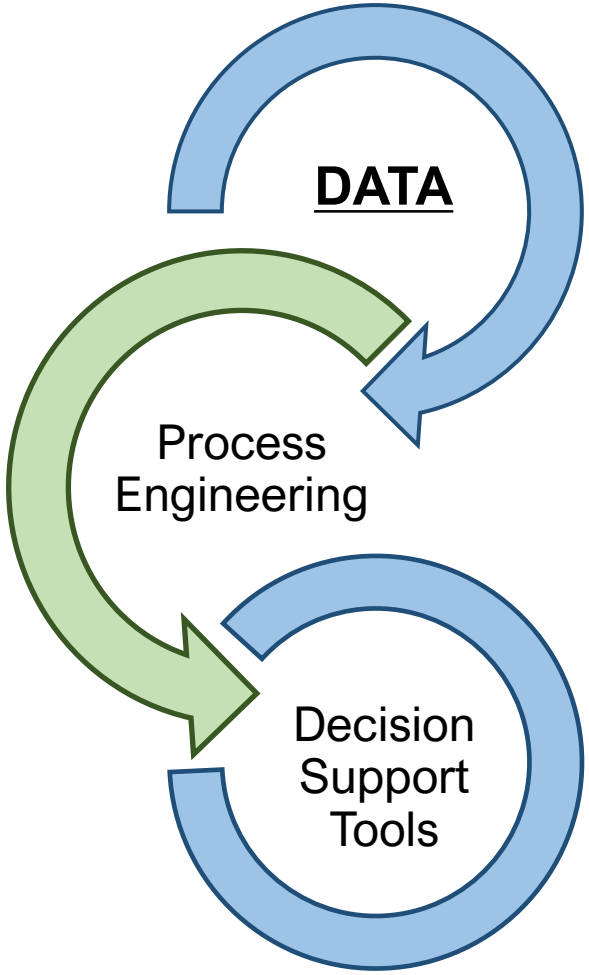
Surgical Supply Optimization



Process Engineering & Decision Support Tools

Surgical Supply Optimization

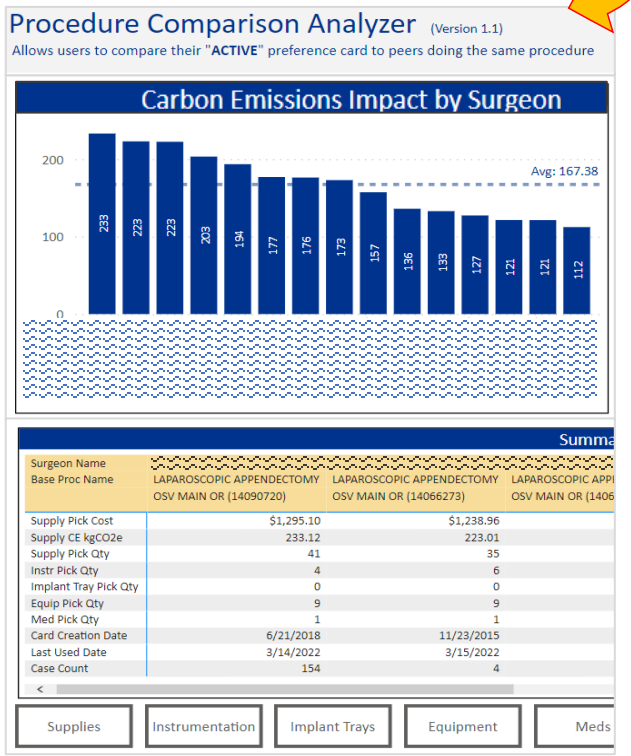
Operationalize data.
Relieve clinicians of tasks.

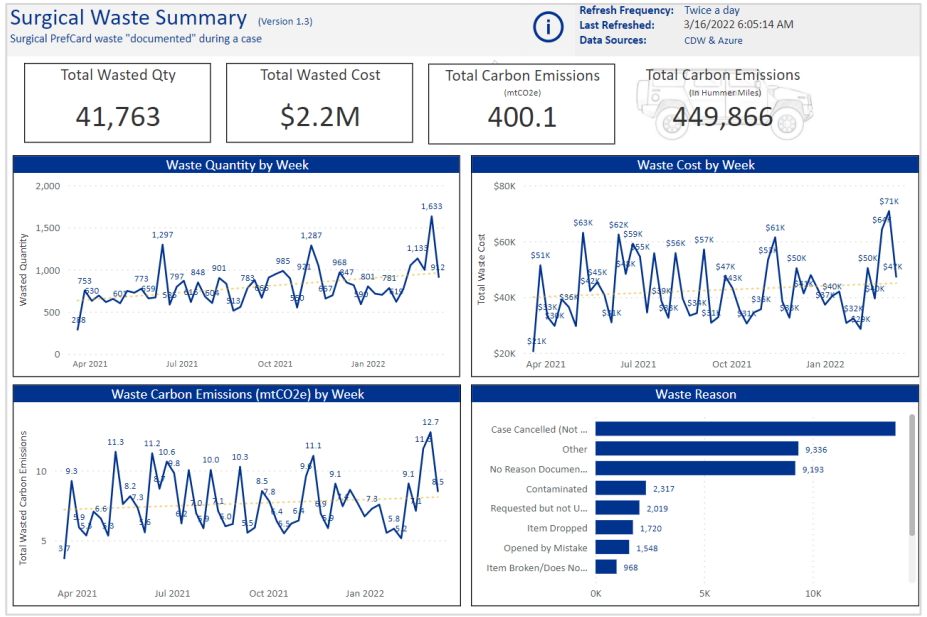


what enters?
what is used?
what is wasted?
what expires?

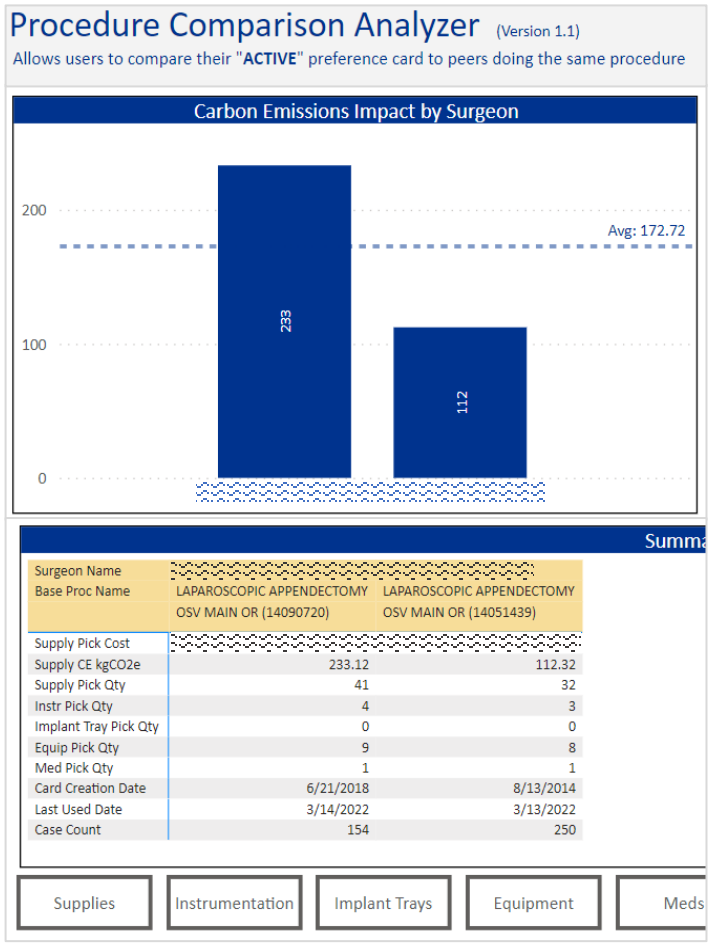
Engage clinicians with relevant information to inform decisions.

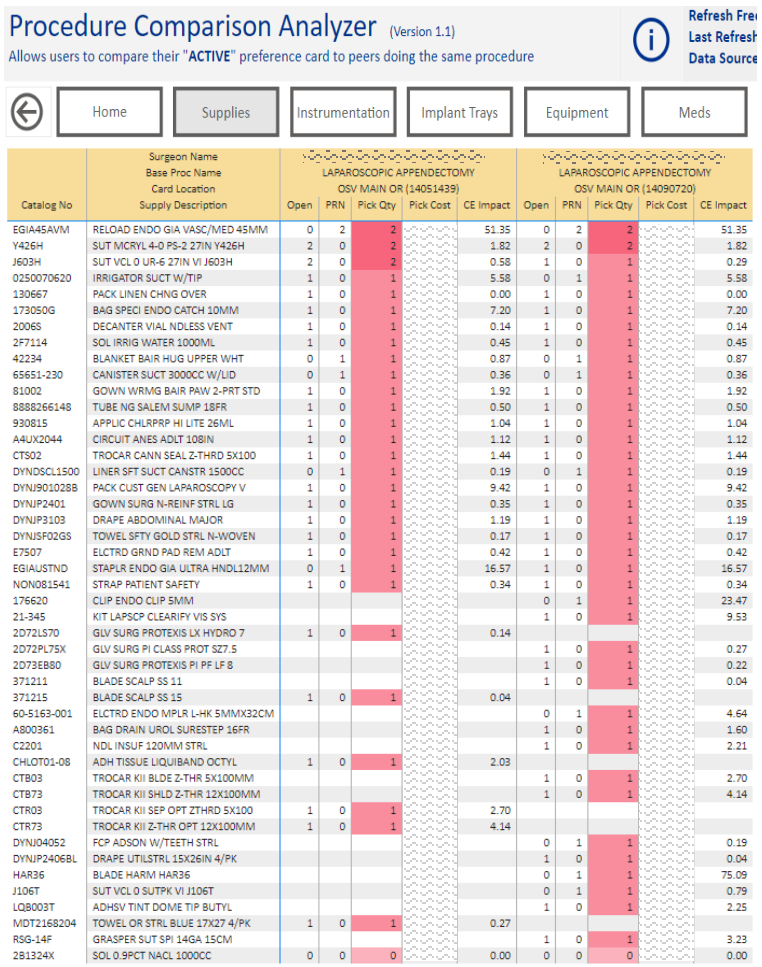
Process Engineering & Decision Support Tools





Process Engineering & Decision Support Tools





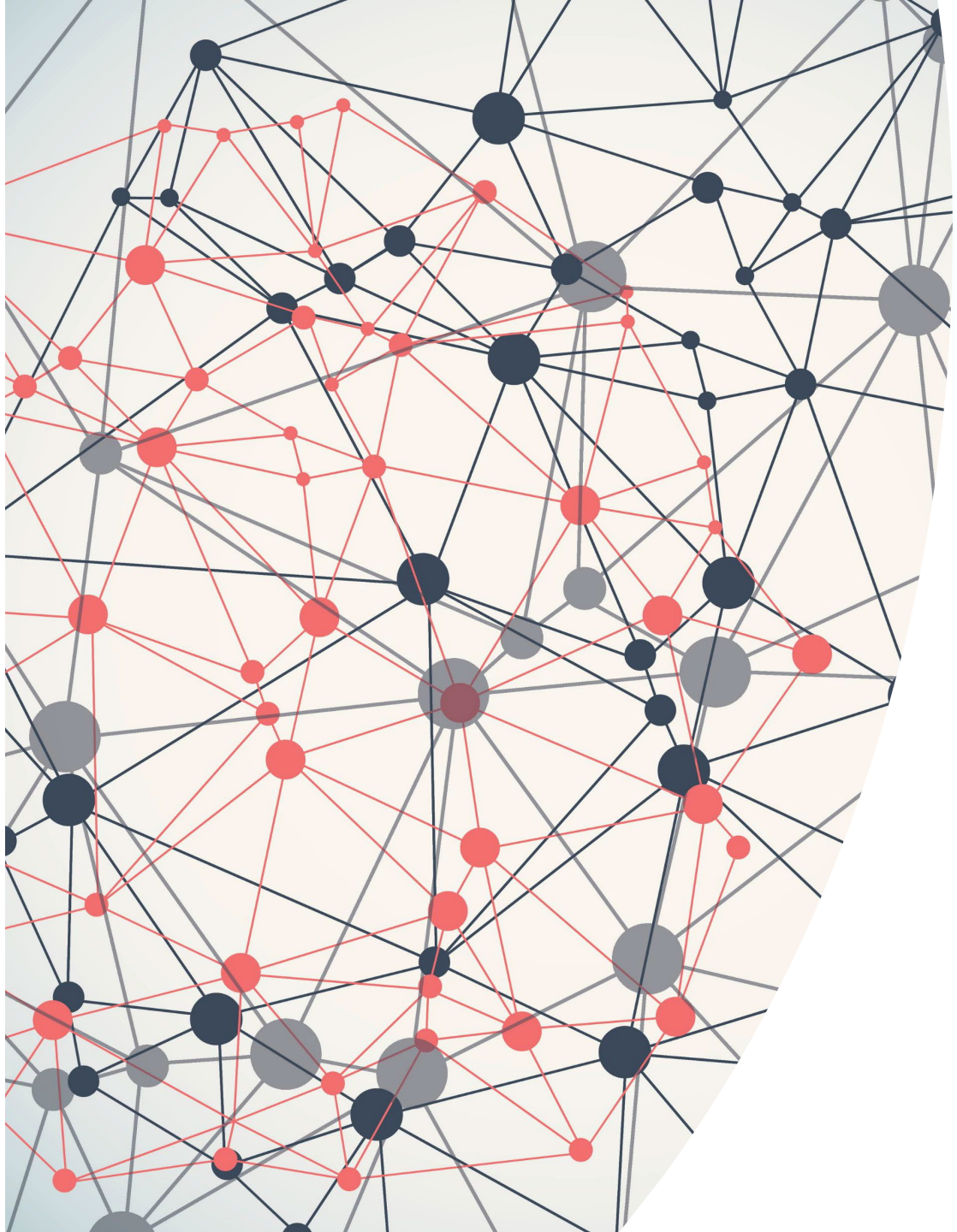
Process Engineering & Decision Support Tools

Pilot Hospital- 24 operating rooms

GHG reduction ($mtCO_2e$)	Energy saved (kWh)	Water saved (gallons)	$ saved	Waste reduced (tons)
834	450,000	820,000	$ 1.77 M	~10

Progressive Scalability- automation, expansion

- Involve end-users in all stages of development
- Avoid interference with direct patient care (alert fatigue)
- Feed data as close to decision-point as possible
- Provide comparisons
- Consolidate data



"We are surrounded by data but starved for insights."

Jay Baer

Providence

Health for a Better World

Thank You

NAM Carbon Clinic – Scope 3 Goods and Services

Yale New Haven Health System

Jodi Sherman, MD
YNHHS Medical Director of Sustainability
December 15, 2022

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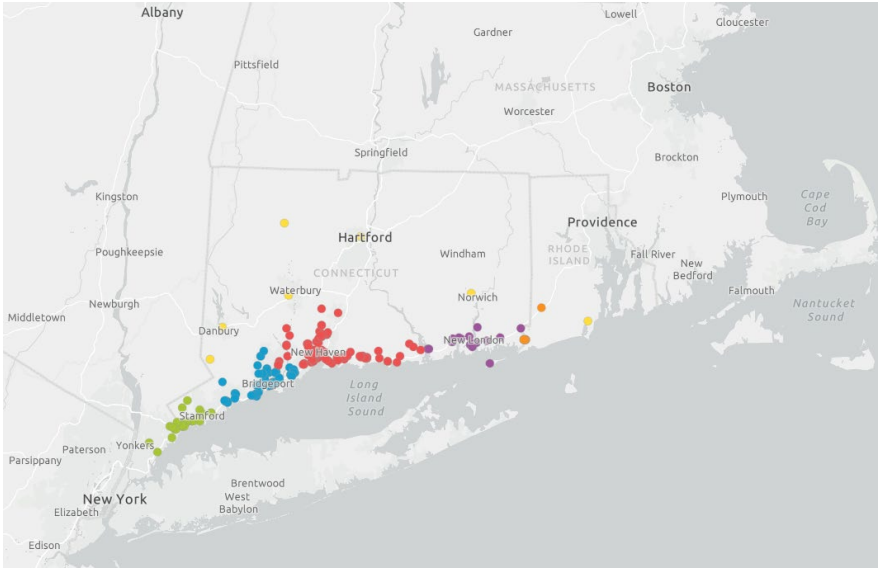
Center on Climate Change and Health

YaleNewHavenHealth



5+ hospitals throughout CT, RI, NY
(Flagship hospital, 1590 beds)
200+ clinics

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Agenda: YNHHS Goods and Services Accounting

- total goods and services CO_{2e}
- metered dose inhaler (MDI)
- intravenous drugs
- pulse oximeter

Disclosures:
Canadian Institutes for Health Research
Commonwealth Fund
Institute for Healthcare Improvement

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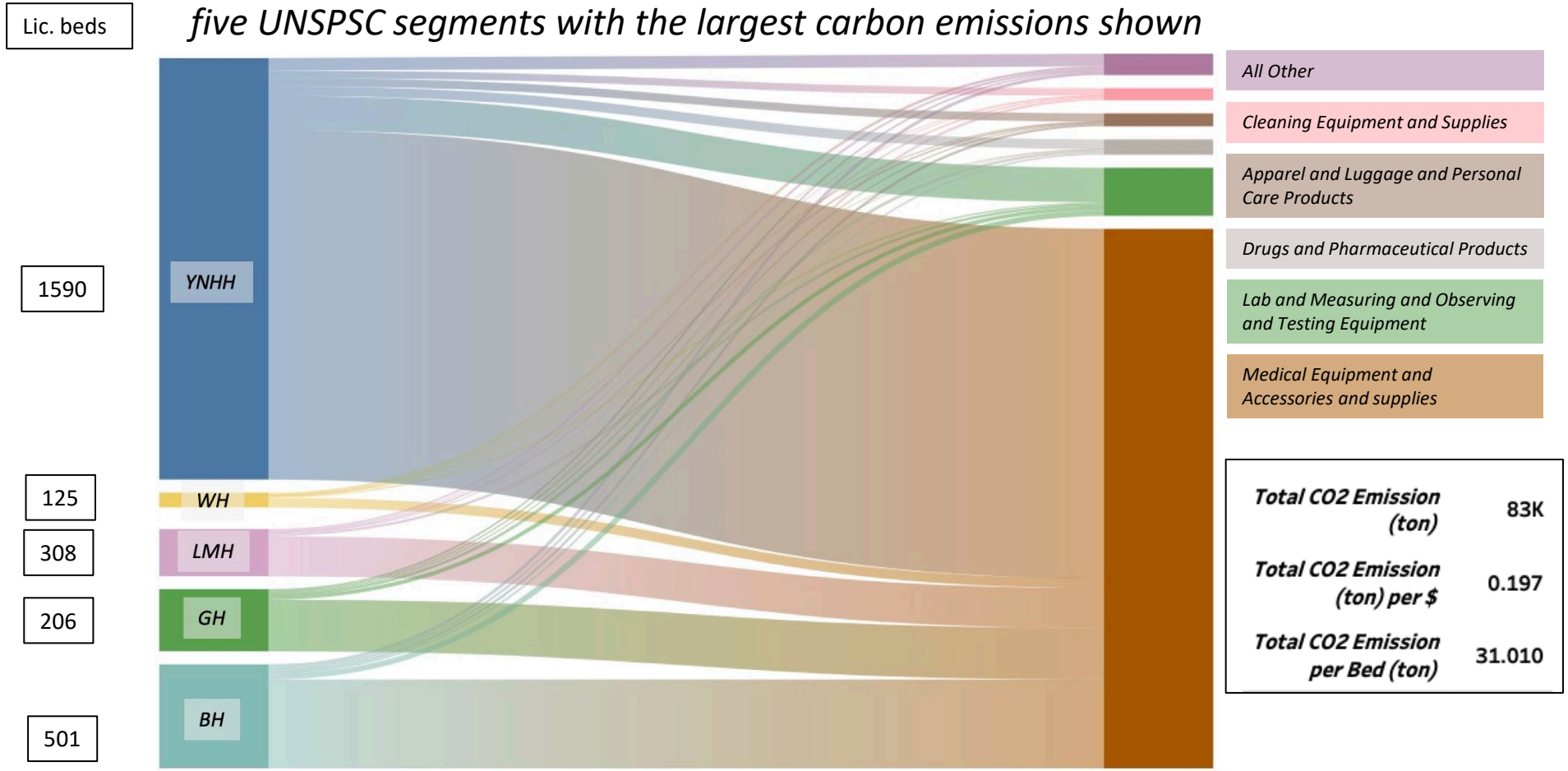
YNHHS Scope 3: Purchased Goods FY2021



Source: YNHHS Supply Chain, YNHHS Center for Sustainable Healthcare and www.healthcareghg.org.

Abbreviations: BH: Bridgeport Hospital, GH: Greenwich Hospital, LMH: Lawrence + Memorial Hospital, WH: Westerly Hospital, YNHH: Yale New Haven Hospital

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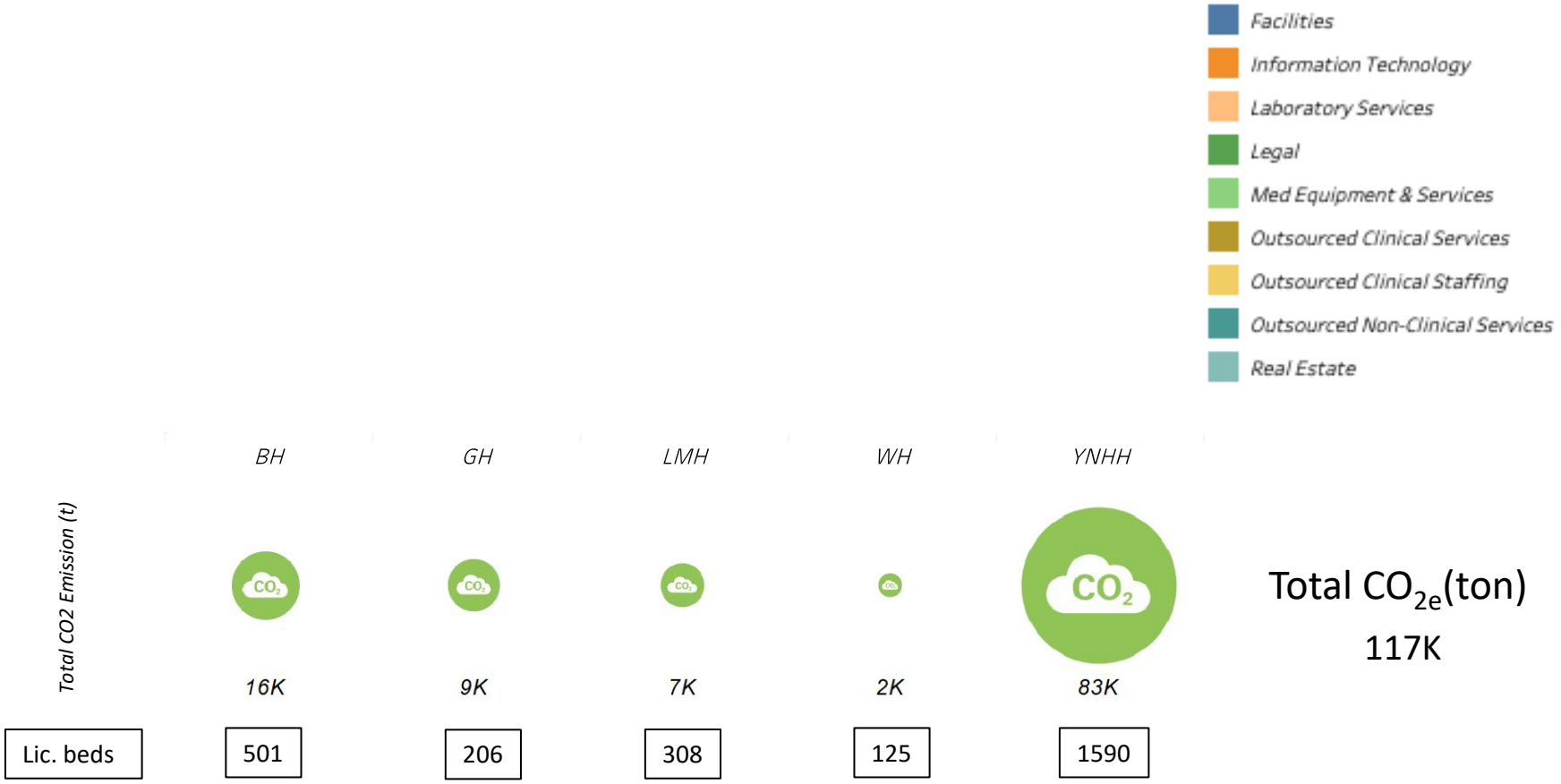
YNHHS Scope 3: Purchased Services FY2021



Total CO_{2e}(ton)

117K

Source: YNHHS Supply Chain, YNHHS Center for Sustainable Healthcare, and www.healthcareghg.org

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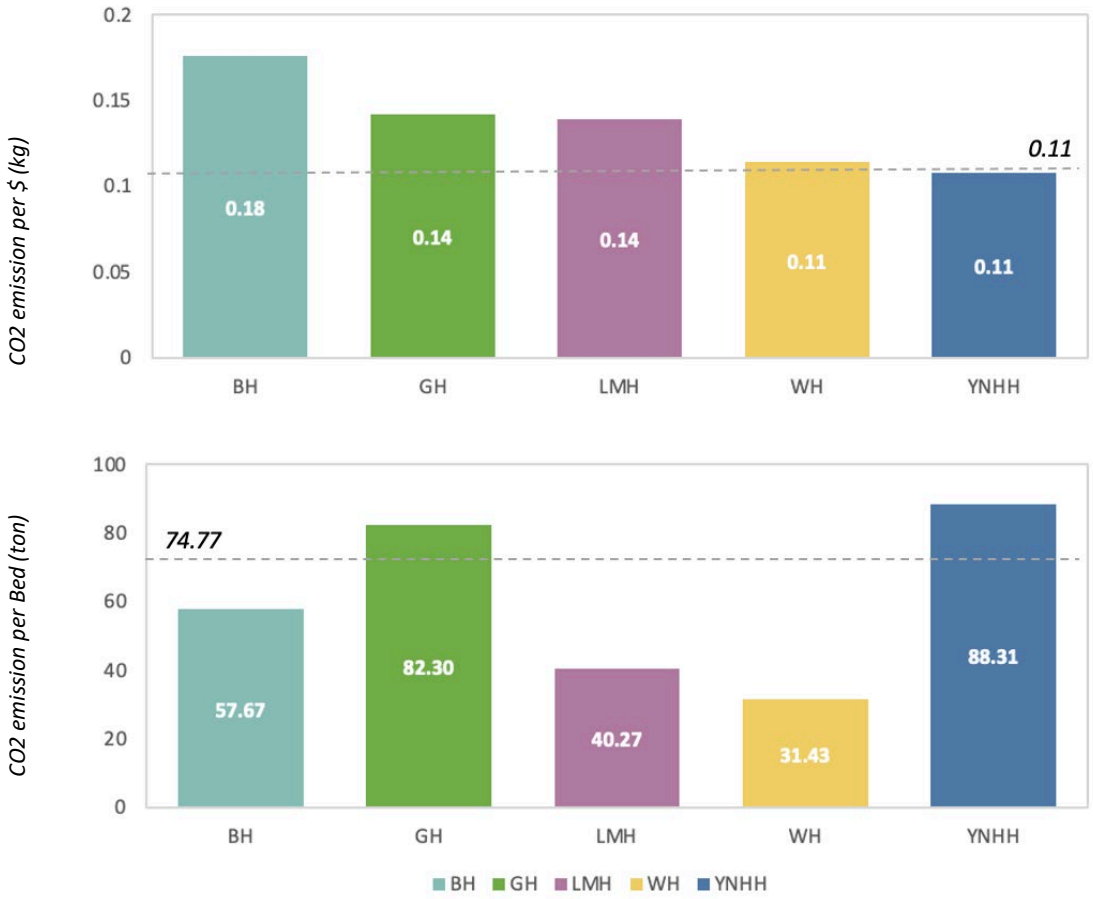
YNHHS Scope 3: Purchased Goods & Services FY2021



What is good performance?

How do these hospitals differ?

Source: YNHHS Supply Chain, YNHHS Center for Sustainable Healthcare, and www.healthcareghg.org

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Inhalers for reactive lung disease

The New York Times

The Cruel Irony of Inhalers That Make Climate Change Worse

July 23, 2022

- Hydrofluroalkane (HFA) propellants in metered dose inhalers (MDIs) potent GHGs
  - One albuterol inhaler has similar carbon output as driving mid-size car ~200 miles
- 55 million MDIs dispensed in US in 2019
- 3% of National Health Service (NHS) total emissions from MDIs
- Multiple alternatives: dry power inhaler (DPI), softmist inhaler (SMIs), nebulizers
- Sweden now 88% DPIs, and other nations and health systems following suit

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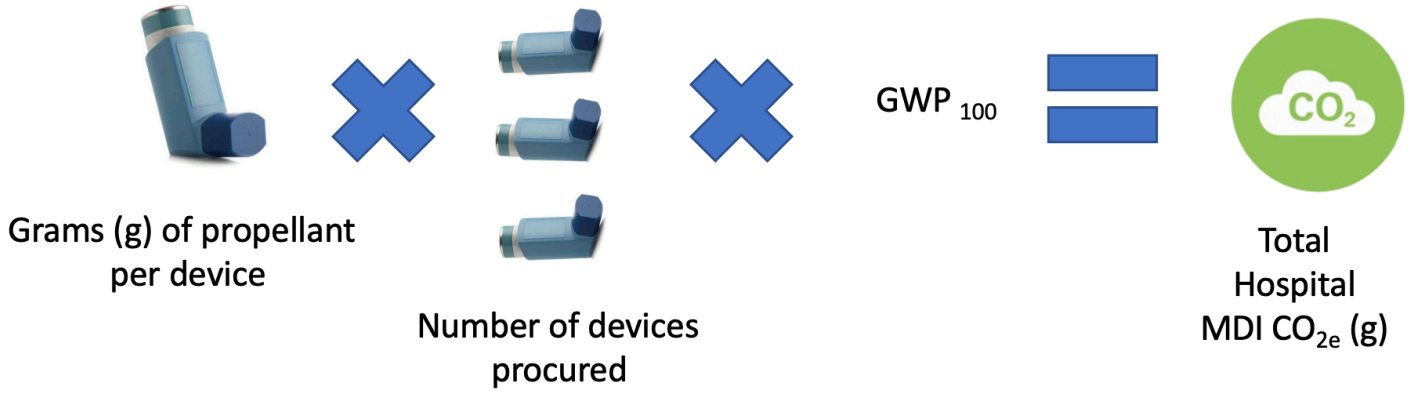
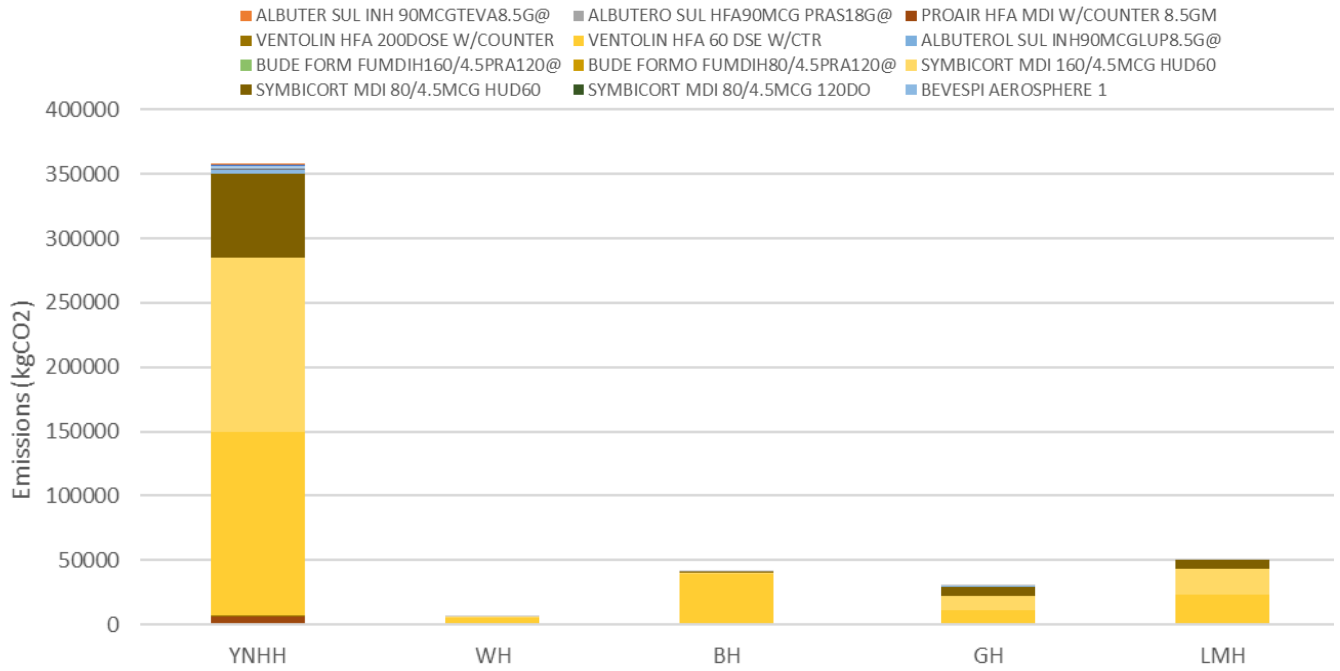
US EPA 2021
Market Characterization of the U.S. Metered Dose Inhaler Industry, ICF 2021
Tennison et al, *Lancet Planetary Health* 2020
Janson et al, *Thorax* 2019

Top-down v Bottom-up: Metered Dose Inhaler (MDI) emissions

- Propellant Global Warming Potential (GWP_{100})
  - HFA-134a = 1,430
  - HFA-227ea = 3,220
- Total hospital MDI CO_{2e} emissions
- Top-down: 0.223 x $$
- Bottom-up:



YNHHS Inhaled MDI Emissions 2019



Lic. beds	1590	125	501	206	308

Source: YNHHS Supply Chain, YNHHS Care Signature, and YNHHS Center for Sustainable Healthcare

Abbreviations: BH: Bridgeport Hospital, GH: Greenwich Hospital, LMH: Lawrence + Memorial Hospital, WH: Westerly Hospital, YNHH: Yale New Haven Hospital

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Are MDIs Scope 1 or Scope 3?

Scope 1

- In-patient use: propellent released directly from the hospital
- Propellant emissions are known, very high, dwarf those of rest materials, and dwarf cost-based emissions calculations
- Similar story as inhaled anesthetics accounting

Scope 3

- Out-patient use: propellent released indirectly, outside of the health syst, down stream
- #/type of prescriptions from health system known
- Distribution/utilization of the devices unknown to health system (unless they own the pharmacy)
- What about ALL outpatient prescriptions? If a health system accounts for MDI prescriptions, then they should count all prescriptions

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Strategic Management: Inhaler emissions mitigation

- Reduce unnecessary treatments
- Choose less carbon-intensive treatments
- Reduce waste
- Take-back programs for proper waste treatment (high-temperature incineration)

To view all inhaler videos, go to:
Canadian Lung Association: How to use your inhaler
https://www.lung.ca/lung-health/get-help/how-use-your-inhaler

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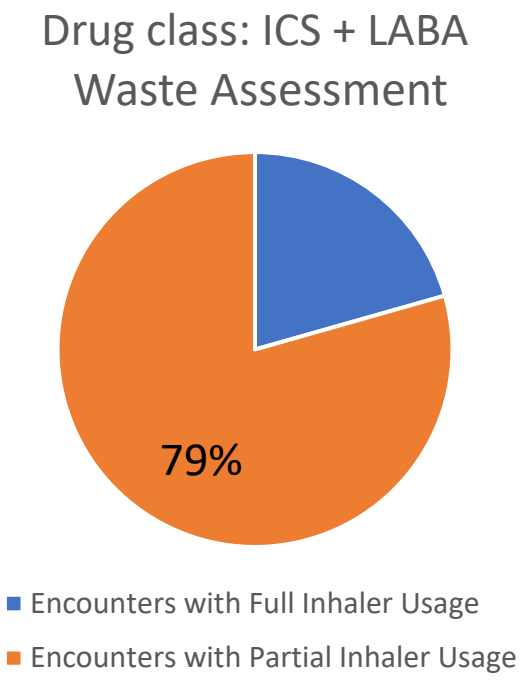
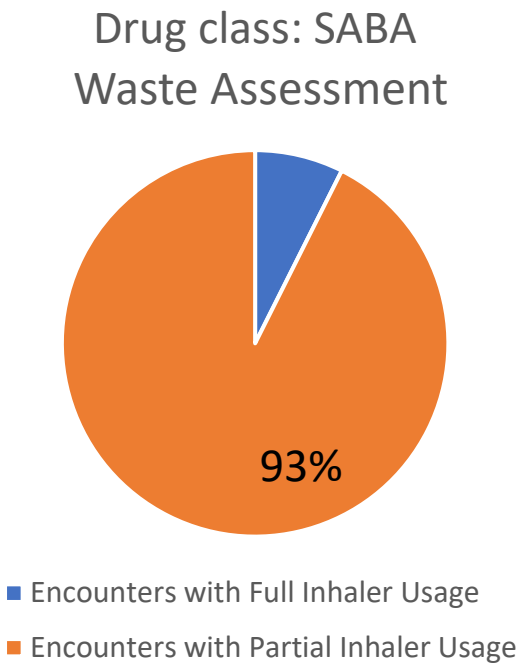
CASCADES
Climate Action Healthcare + Action climatique soins de santé

This project was undertaken with the financial support of the Government of Canada. Ce projet a été réalisé avec l'appui financier du gouvernement du Canada.

YNHH encounters with MDI waste





Encounters with associated inhaler waste:

- Patients moved between wards and dispensed new device
- Patients not allowed to take MDI home

Source: YNHHS Pharmacy, YNHHS Care Signature, and YNHHS Center for Sustainable Healthcare

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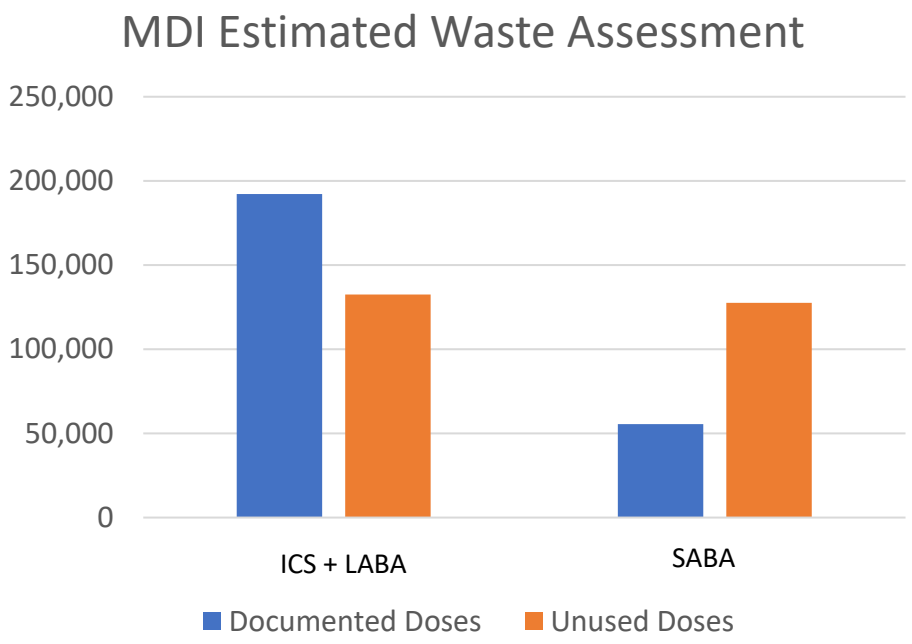
YNHH wasted MDI doses



- Utilization (doses given):
  - ICS + LABA: $226,913
  - SABA: $61,160
- Wasted (unused doses):
  - ICS + LABA: $93,034 (41%)
  - SABA: $42,812 (70%)

Source: YNHHS Pharmacy, YNHHS Care Signature, and YNHHS Center for Sustainable Healthcare

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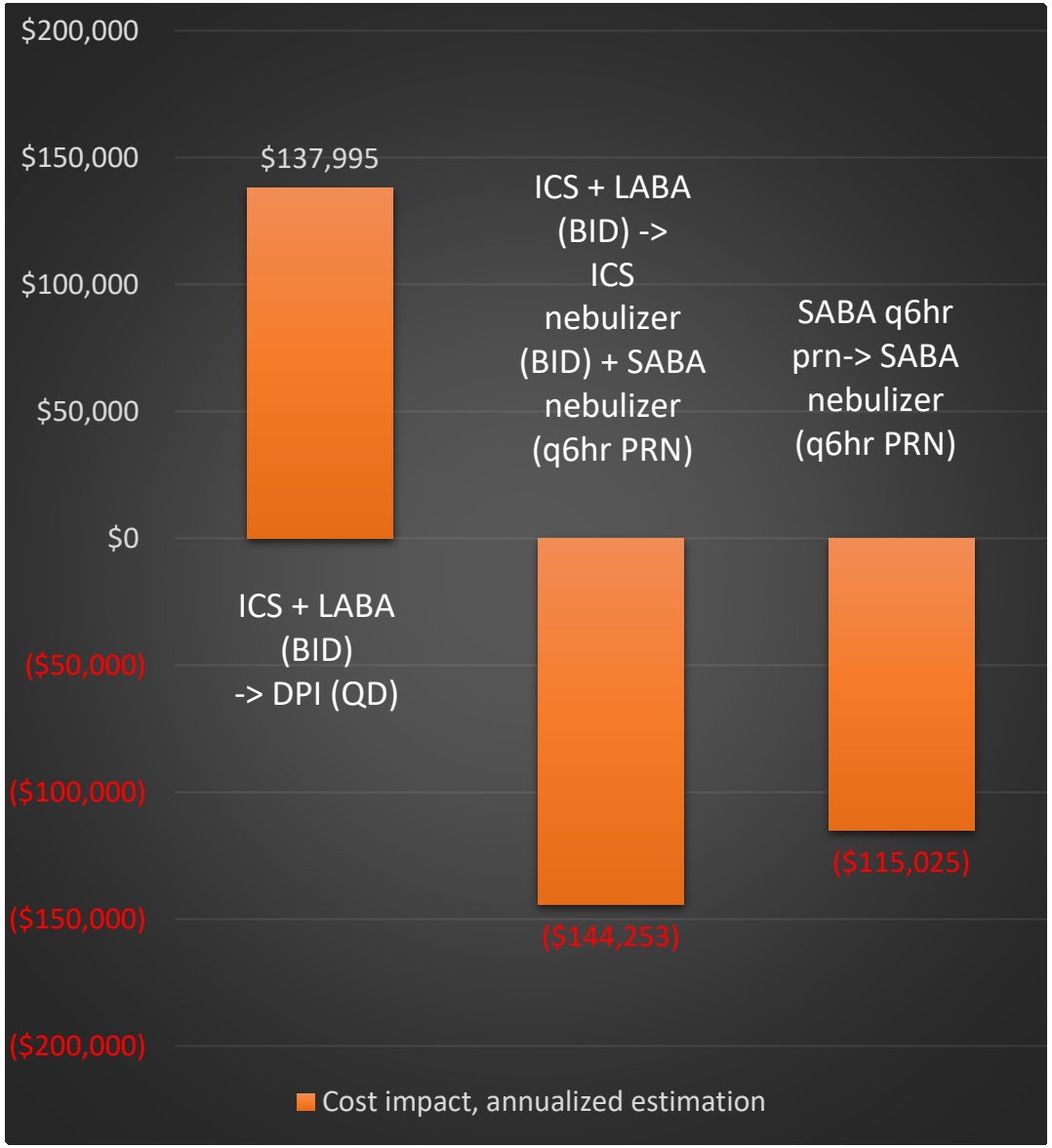

Source: YNHHS Pharmacy, Care Signature, and YNHHS Center for Sustainable Healthcare

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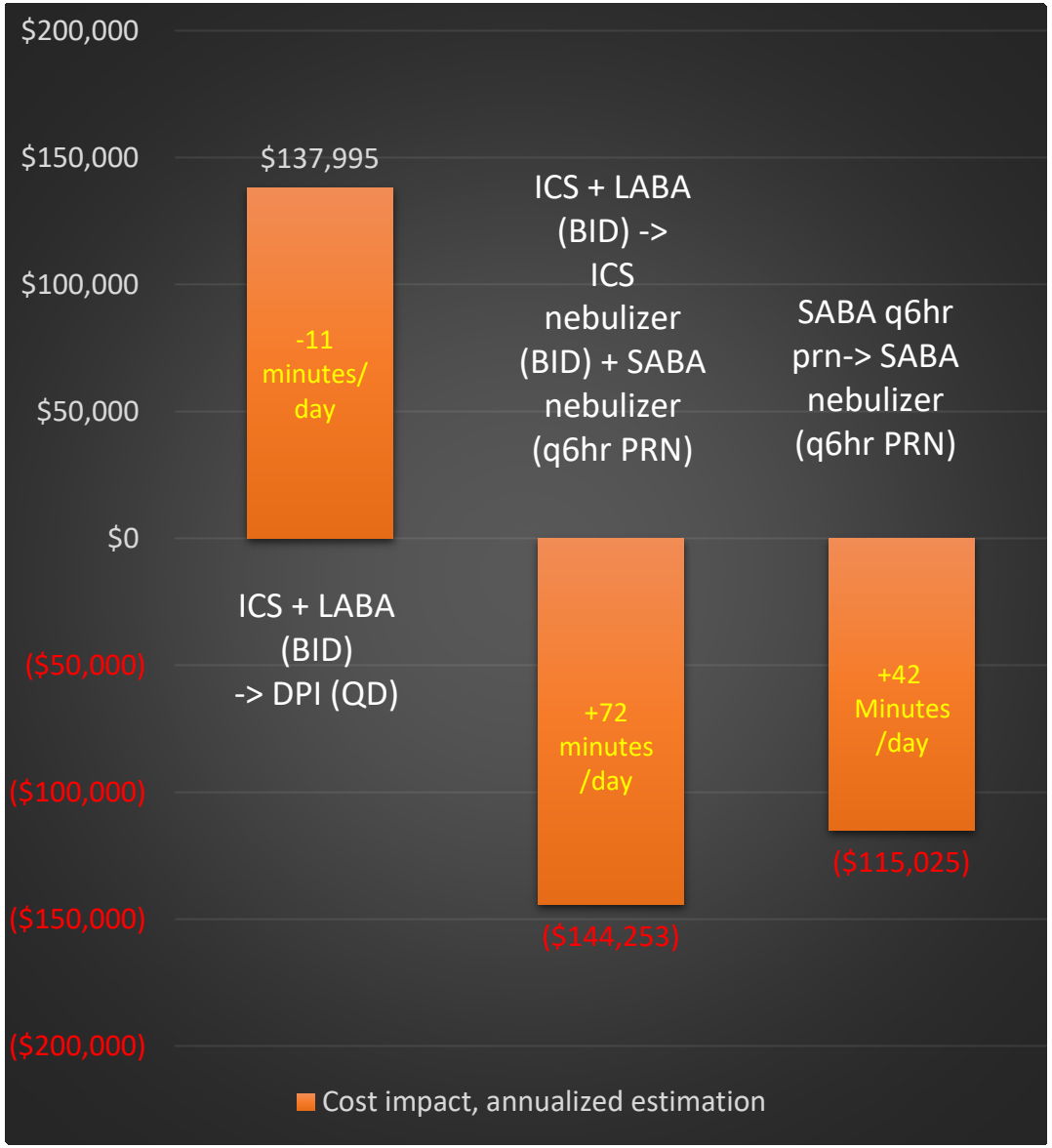
Nebulizer treatment: 15.84 minutes
MDI treatment: 11.52 minutes



Source: YNHHS Pharmacy, Care Signature, and YNHHS Center for Sustainable Healthcare

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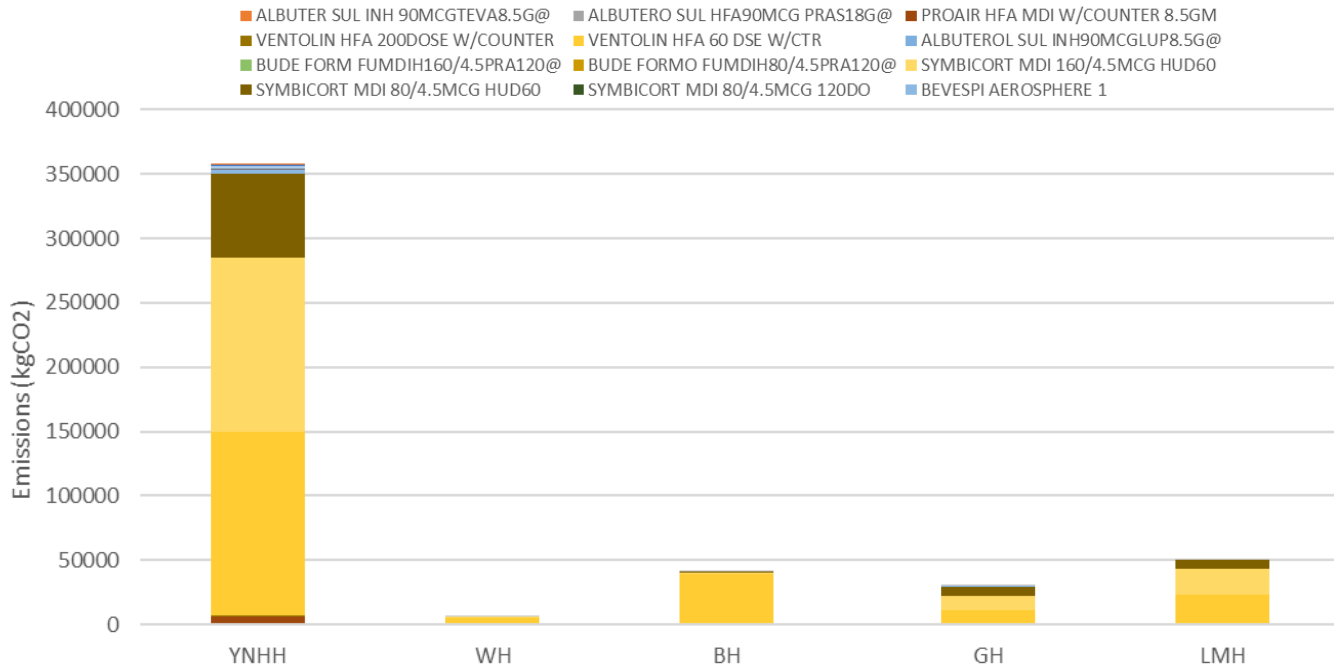
YNHHS Inhaled MDI Emissions 2019



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Top-down v Bottom-up: intravenous (IV) drugs

Drug	Total ML Opened	Total ML Used	Total ML Wasted	% Wasted
Propofol	9900	7198.2	2701.8	27.29%
Neostigmine	2190	830	1360	62.10%
Ketamine	660	122	538	81.52%
Rocuronium	2425	1943.1	481.9	19.87%
Dexamethasone	800	322.25	477.75	59.72%
Zofran	790	786.5	3.5	0.44%
Fentanyl	2195	1455.1	739.9	33.71%
Glycopyrrolate	1235	880	355	28.74%
Midazolam	558	537	21	3.76%
Midazolam	185	78	107	57.84%
Succinylcholine	850	392.5	457.5	53.82%
Toradol	57	51.9	5.1	8.95%
Lidocaine	1785	1368.9	416.1	23.31%
Ephedrine (diluted)	1200	347.4	852.6	71.05%
Labetalol	1380	303	1077	78.04%
Hydromorphone (diluted)	2420	945	1475	60.95%
Phenylephrine (diluted)	14400	523.3	13876.7	96.37%
SUM			**24945.85**	

- Multiple studies, overall volume of ***anesthesiology-prepared*** drug waste ranges from 30-80%
- Problems/solutions apply to all IV drugs and care locations

Source: YNHHS Pharmacy and YNHHS Center for Sustainable Healthcare

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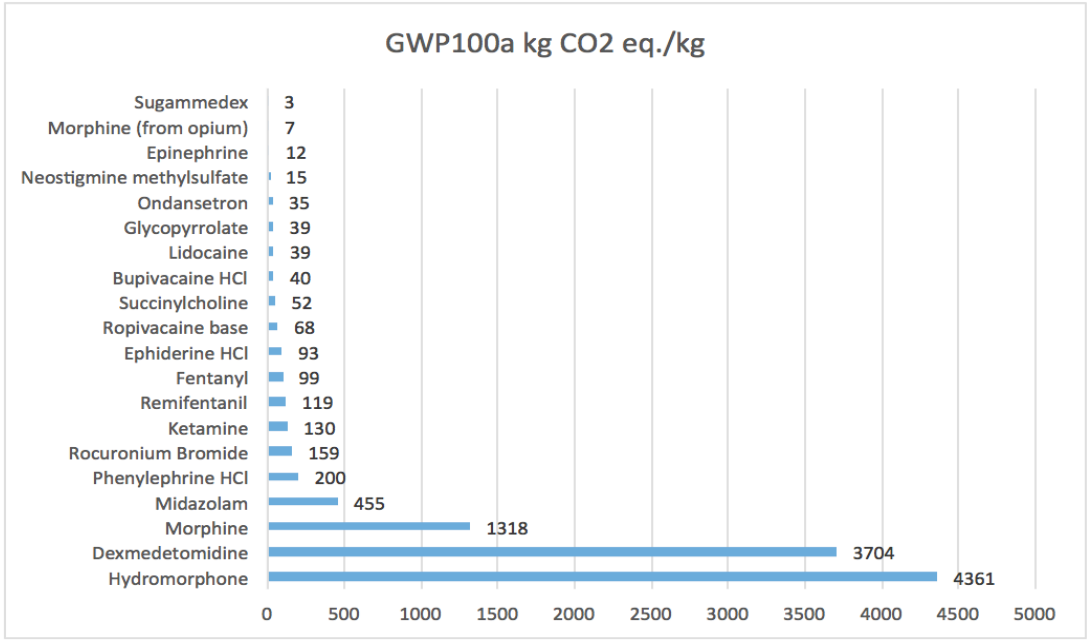
Top-down v. Bottom-up: Intravenous Drugs

Pharmaceutical Drugs	GWP100a kg CO2 eq./kg
Hydromorphone	4361
Dexmedetomidine	3704
Morphine	1318
Midazolam	455
Phenylephrine HCl	200
Rocuronium Bromide	159
Ketamine	130
Remifentanil	119
Fentanyl	99
Ephiderine HCl	93
Ropivacaine base	68
Succinylcholine	52
Bupivacaine HCl	40
Lidocaine	39
Glycopyrrolate	39
Ondansetron	35
Neostigmine methylsulfate	15
Epinephrine	12
Morphine (from opium)	7
Sugammedex	3



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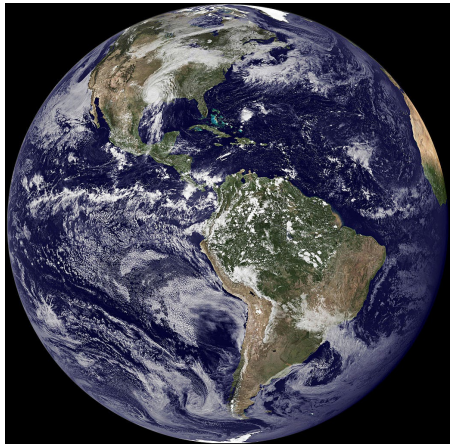
Parvatker, et al, ACS Sust. Chem Eng. 2019

Operating Room intravenous drug waste

- 20 common OR drugs, one hospital
- $1.2 million wasted annually
- 22,514 kg CO_{2e}
- Similar to driving 54,778 miles in standard passenger vehicle



Tunceroglu, et at

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Why so much drug waste?

- Over-sized vials
- Regulation
- Contamination
- Over-preparation
- Expiration

We routinely waste 99% of insulin in the OR

Reduce waste: “pre-filled” syringes and bags

Original manufacturer “emergency drugs”

$$$

Longest shelf life

Third-party vendor splits vials

$$

Medium shelf life

In-house pharmacy splits vials

$

Shorter shelf life

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Do pre-filled syringes reduce waste?

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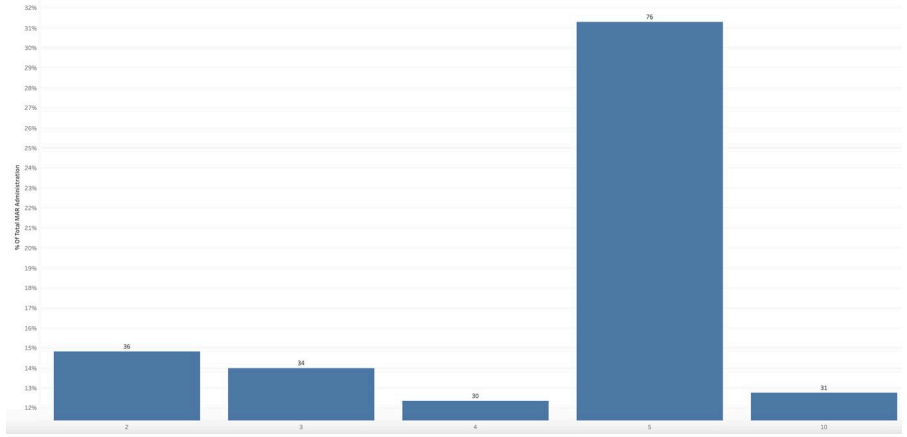
Center on Climate Change and Health

Courtesy H. Hopf

Data-driven solutions for waste reduction: insulin intra-op doses



- Electronic Health Record: utilization
- Integration with procurement data management system
- Strategic guidance for pharmacy splitting for greatest efficiency

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Optimizing drug package size and concentration for waste reduction and improved safety

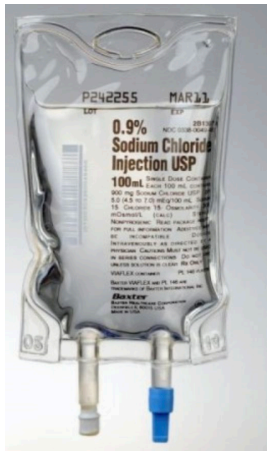
Reduce vial size

1000 units/ml

10,000 units

3,000 units

1 unit/ml



100 units

1 unit/ml

5 units

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Provider performance reports: behavior change

Medication Waste by Provider

Provider Name: SHERMAN, JODI D | Surgery Date Range: Last 12 months | Service: (All)

% Waste | % Waste (Service Avg)

Provider: SHERMAN, JODI D **Apr 1, 2018 to Jan 10, 2019** **Service: (All)**

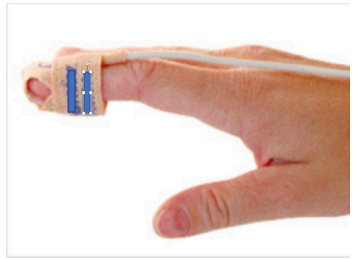
Medication Name	Surgical Cases	Packages Opened	% Waste	% Waste	Expense Wasted
PHENYLEPHRINE 10 MG/ML INJECTION SOLUTION	45	46	99.9%		$162
DIPHENHYDRAMINE 50 MG/ML INJECTION SOLUTION	8	8	98.3%		$5
EPINEPHRINE 1 MG/ML INJECTION SOLUTION	1	1	98.0%		$496
DEXMEDETOMIDINE 100 MCG/ML INTRAVENOUS SOLUTION	22	24	97.7%		$165
EPHEDRINE SULFATE 50 MG/ML INTRAVENOUS SOLUTION	35	35	97.0%		$969
ATROPINE 1 MG/ML INJECTION SOLUTION	1	1	96.8%		
KETOROLAC 30 MG/ML (1 ML) INJECTION SOLUTION	95	95	96.0%		$215
FUROSEMIDE 10 MG/ML INJECTION SOLUTION	1	1	96.0%		$1
METRONIDAZOLE 500 MG/100 ML-SODIUM CHLORIDE(ISO) INTRAVE..	1	1	96.0%		$1
MIDAZOLAM (PF) 5 MG/ML INJECTION SOLUTION	1	1	96.0%		$1
CIPROFLOXACIN 400 MG/200 ML IN 5 % DEXTROSE INTRAVENOUS PI	4	4	95.8%		$10
Service					
(All)	400	6,816	33.8%		$9,095
TOTAL (All Services)	400	6,816	33.8%		$9,095

Integrate CO_{2e}

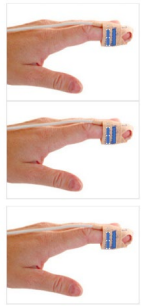
Analogous to inhaled anesthetics

Pulse Oximeter Probes

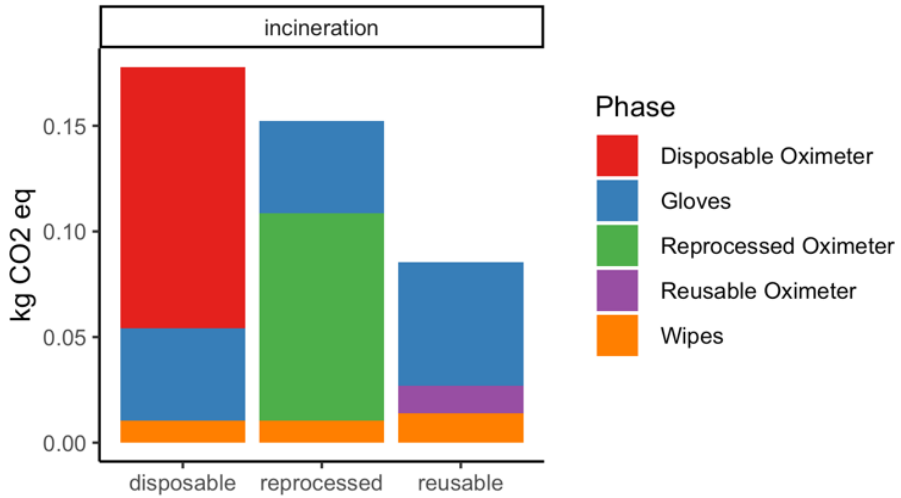
disposable



Reprocessed disposable



reusable



Global Warming Potential (kg CO_2 eq) of Disposable, Reprocessed, and Reusable Pulse Oximeters (5 days)

Mueller, Ishi, et al.

YNHHS: Disposable -> Reusable

- 123,432 kg CO_{2e}
- $4.4 million per year

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Supply Chain carbon accounting of the future

Supports external accounting and internal strategic management

- Manufacturer:
  - product-level life cycle emissions labeling
- Distributer: procurement data
  - product-level emissions
  - Purchased, used, expired, returned
- Electronic Health Records: utilization data
  - Patient-specific data (co-morbidities and treatments)
  - Provider-specific data

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Acknowledgements

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- **Jessica Bootle, PharmD**
- Diana LeMieux, PharmD
- Molly Leber
- Teresa Papstein
- Amber Zaniewski, PharmD
- Michael Nay, MBA
- Nancy Kim, MD, PhD
- **William Fowler, MD**
- **YNHHS Care Signature Team**
- **Zoe Zhang, MS, MPH**
- Brian Chesebro, MD
- Bibek Shrestha
- Hussein Tunceroglu, MD
- Elena Bukanova, MS, MD
- Tobias Mueller, MS
- Momoko Ishi, MS, MPH
- **Abhijeet Parvatker, PhD**
- **Matthew Eckelman PhD**
- **Kim Walker, Pharm D**

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Appendix

Supplementary Table

Carbon Emission from Purchased Services Details and Ranking

Vendor Sub-Category	Vendor Category	*BH*		*GH*		*LMH*		*WH*		*YNHH*		*Grand Total*	
		Rank of Spend	Rank of t CO2e	Rank of Spend	Rank of t CO2e	Rank of Spend	Rank of t CO2e	Rank of Spend	Rank of t CO2e	Rank of Spend	Rank of t CO2e	Rank of Spend	Rank of t CO2e

The table is sorted on total CO2 emission of the entire system in descending order, including hospitals only, including all Vendor Sub-categories available for analysis.
Due to page limit, only the 20 highest CO2 emissions categories are shown on this slide.

Source: YNHHS Supply Chain Analytics.
Data includes purchased services from Oct 2020 through Sep 2021, including all Yale New Haven Health System hospitals and non-acute clinics outside of hospital main campuses (grouped with the hospital main campus which they are most adjacent to). Health Service Corporation, and Northeastern Medical Group are not shown in the table. Vendors ($100k-$500k Vendors) that have not been categorized at YNHHS are excluded from analysis.

Supplementary Table

Carbon Emission from Purchased Goods Details and Ranking

UNSPSC Family Description	Segment Description	*BH*		*GH*		*LMH*		*WH*		*YNHH*		*Total*	
		Rank of Spend	Rank of t CO2e	Rank of Spend	Rank of t CO2e	Rank of Spend	Rank of t CO2e	Rank of Spend	Rank of t CO2e	Rank of Spend	Rank of t CO2e	Rank of Spend	Rank of t CO2e

The table is sorted on total CO2 emission of the entire system in descending order, including hospitals only. Due to page limit, only the 20 highest CO2 emissions categories are shown on this slide.

Source: YNHHS Supply Chain Analytics.
Data includes purchased goods from Oct 2020 through Sep 2021, including all Yale New Haven Health System hospitals and non-acute clinics outside of hospital main campuses (grouped with the hospital main campus which they are most adjacent to). Health Service Corporation, and Northeastern Medical Group are not shown in the table.