

# Collaborative Intelligence:

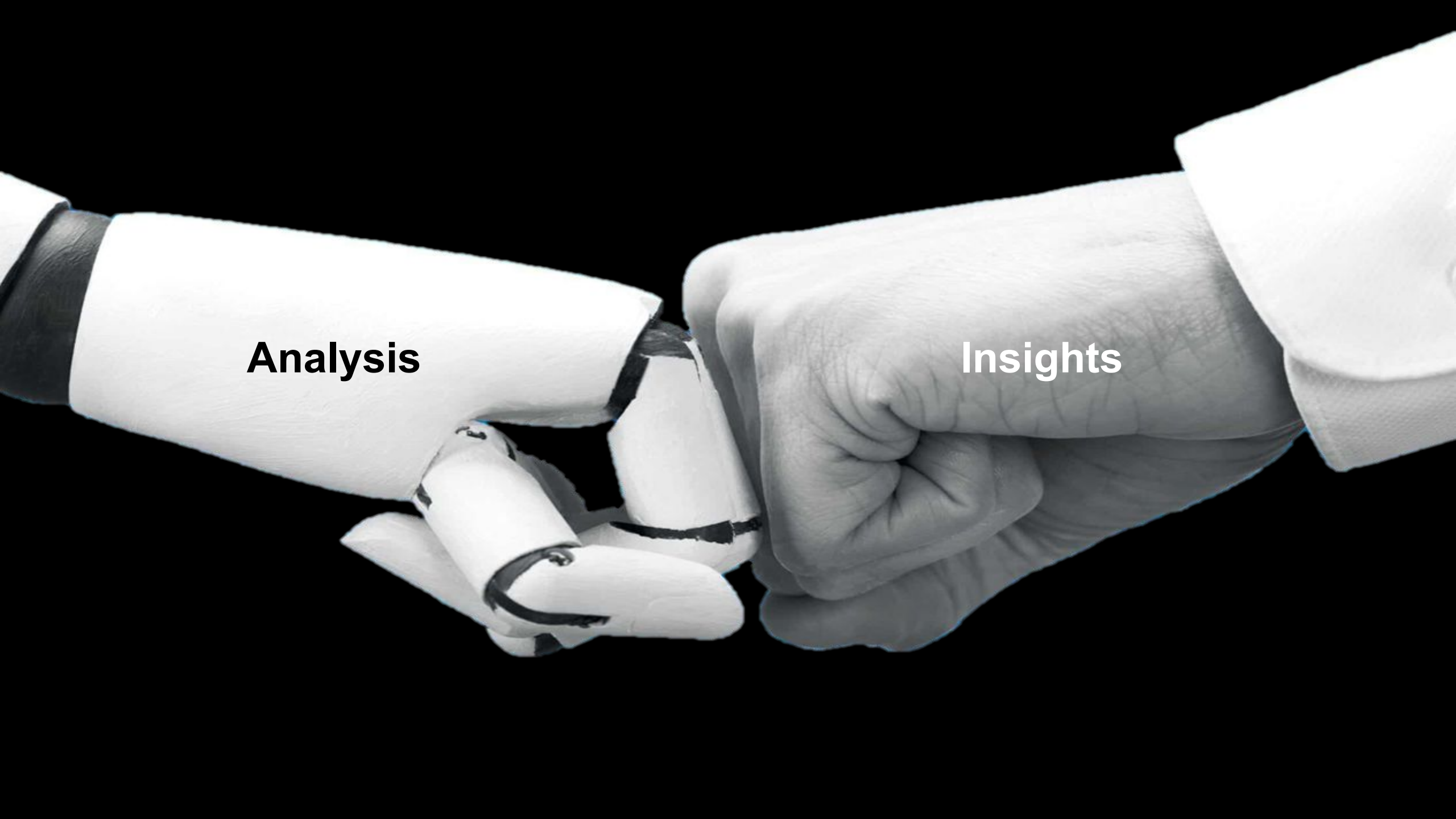
## Human + AI in Portfolio Efficiency

WITH:

SHONA O'DEA

LUKE LEUNG

SOM



**Analysis**

**Insights**

Strength and Weakness of Human and AI

# Human

- 1. Strategic Insights:** holistic, big picture, ethical - not easy to scale
- 2. “Human” Insights** - Stakeholder engagements, organization changes - time consuming, inconsistent
- 3. Tacit Insights** - experience, offline documents - lacking data support, not optimal

# AI

**1. Data Optimization Analysis** - large scale, save time - misinterpretation of data, real world judgement

**2. Scale and Speed** - real time monitor, control - not holistic on all parameters

**3. Data Dependency to Predict** - predict failure - data dependency

*Me:  
how to save energy if I have a building  
occupied 9-5 pm and HVAC system running  
24 hours?*

*AI:  
If your building is occupied from 9 AM to 5  
PM but the HVAC system runs 24/7, you're  
likely wasting a significant amount of energy  
outside of occupancy hours. Here's how to  
reduce that waste while maintaining comfort  
and safety:*



# AI

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## Building with Frequent Entry:

Building Operator:

***“Luke, do you know what is my biggest problem?”***

Me:

***“I have no idea.”***

Building Operator:

***“The people come in the building and hold the door open, it takes all day for the building to catch up and go back to the set point temperature.”***



# AI

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*Me:*

*Should I replace boilers with heat pumps?*

*AI:*

*In most cases, yes — you should consider replacing boilers with heat pumps as part of a long-term decarbonization strategy.*

*Me:*

*Can I Use Heat Pump with High Temperature Water System?*

*AI:*

*Most standard heat pumps don't supply high enough water temps (e.g., >160°F).*




# AI

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A futuristic robot with a metallic, reflective body and glowing blue internal structures is shaking hands with a man in a white shirt and tie. The man is wearing glasses and has a serious expression. They are standing behind a wooden podium with a metal railing. The background is a bright, hazy, futuristic setting with a bar chart and circular patterns.

Humans -versus- The Machine

To create a data-informed playbook that defines cost-effective, low-carbon pathways for decarbonizing building portfolios by climate zone and building typology.

# Approach Data Collection

1

## As Built

What building materials and technologies are present in the design? How do the designed efficiencies compare to current sustainable design standards?

2

## Automation

How are the building systems designed to automatically operate now that the building is constructed?

3

## Operations

What is it like for the BM/FM teams to manage building operations and maintain the building systems?

4

## Performance

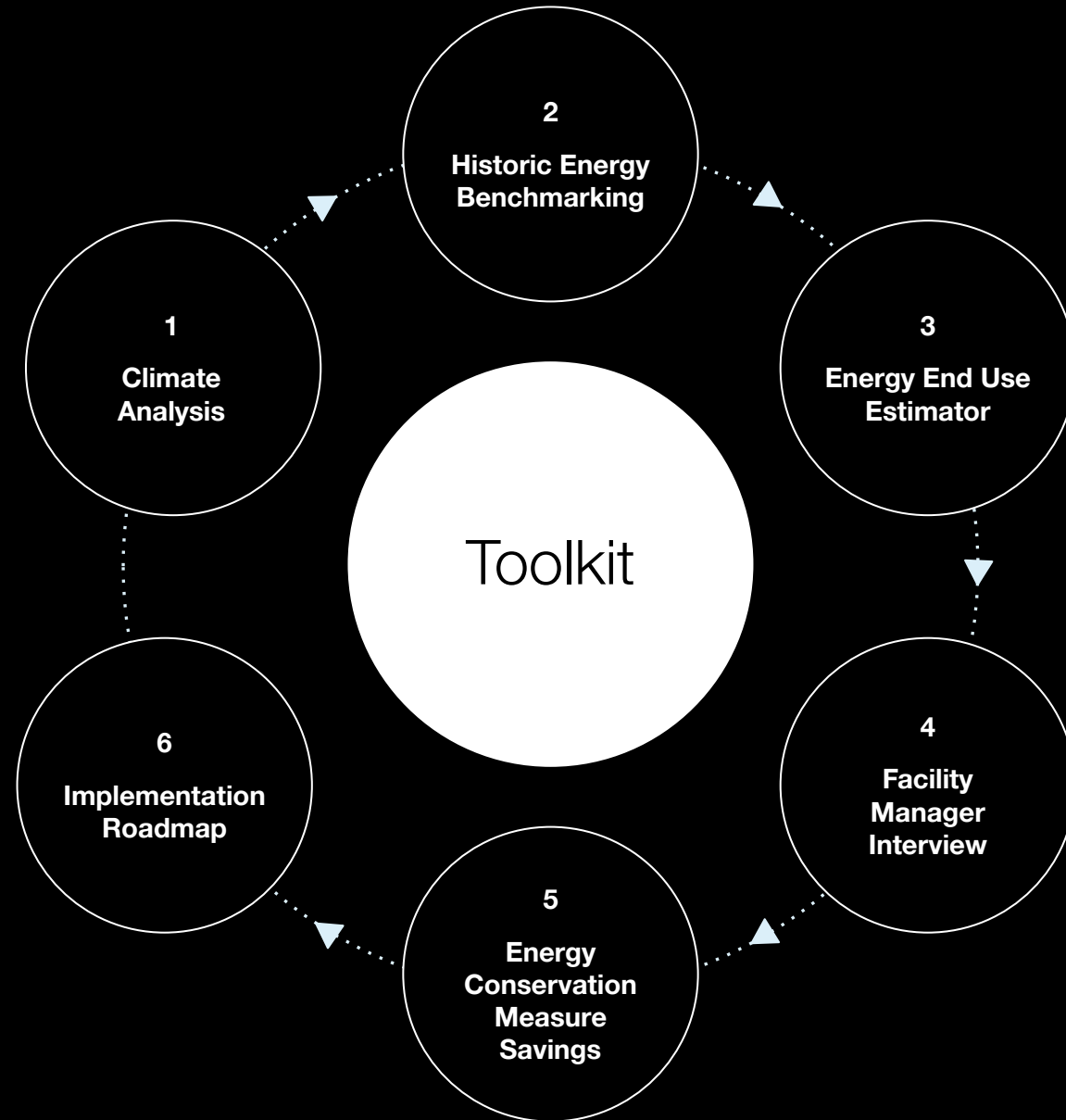
How does the building energy performance compare to expectations and industry standards?

5

## Perception

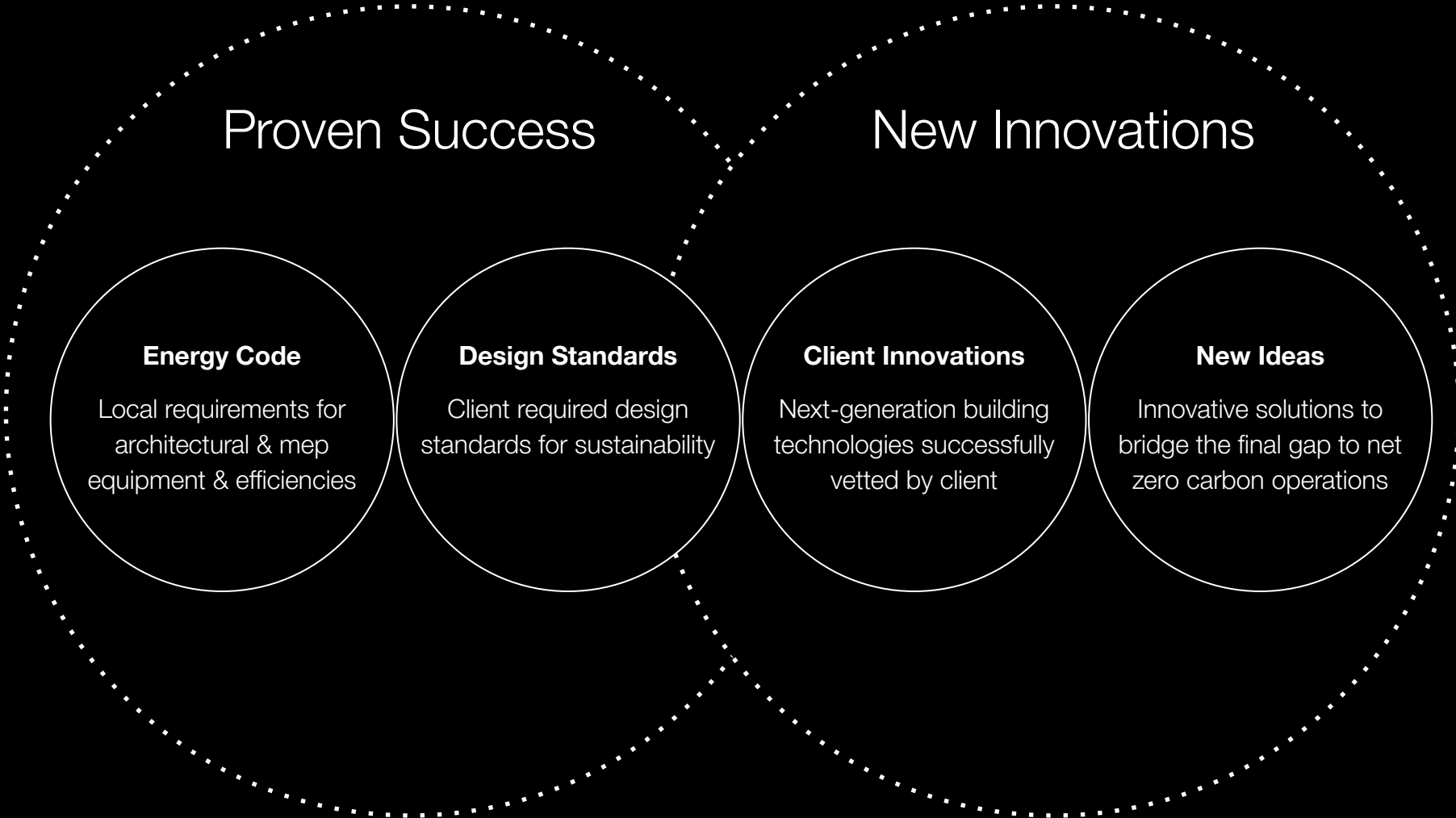
What do occupants say about their experience of the building? Are they satisfied or dissatisfied with certain parts of their indoor environment?

# Approach Analysis Calculators



# Data Collection & Analysis

## Energy Conservation Measures



Approach  
Delivery: Analysis

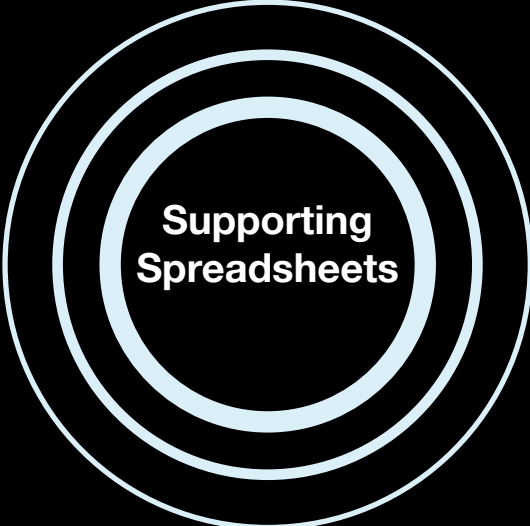
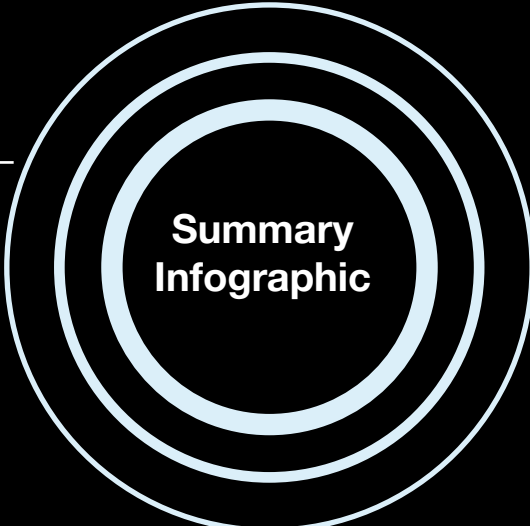
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Current Energy Use & GHG  
Proposed Strategies  
Challenges  
Technology Combinations



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Analysis Findings



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Energy  
Carbon  
Cost

**Approach**  
**Delivery: Report**

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Decarbonization Pathways &  
Decision Making Protocol

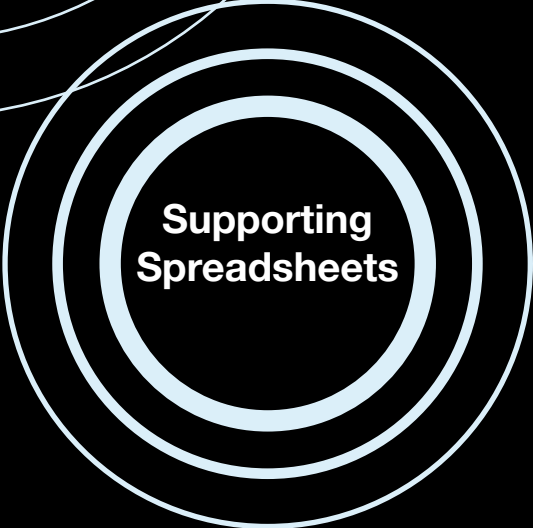
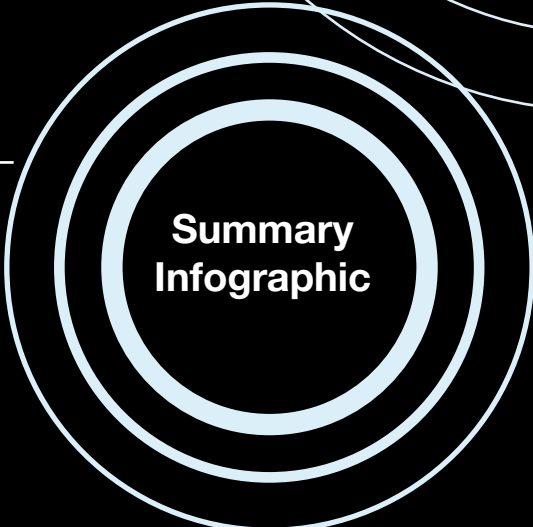
by:

Climate Zone  
Building Type



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Analysis Findings



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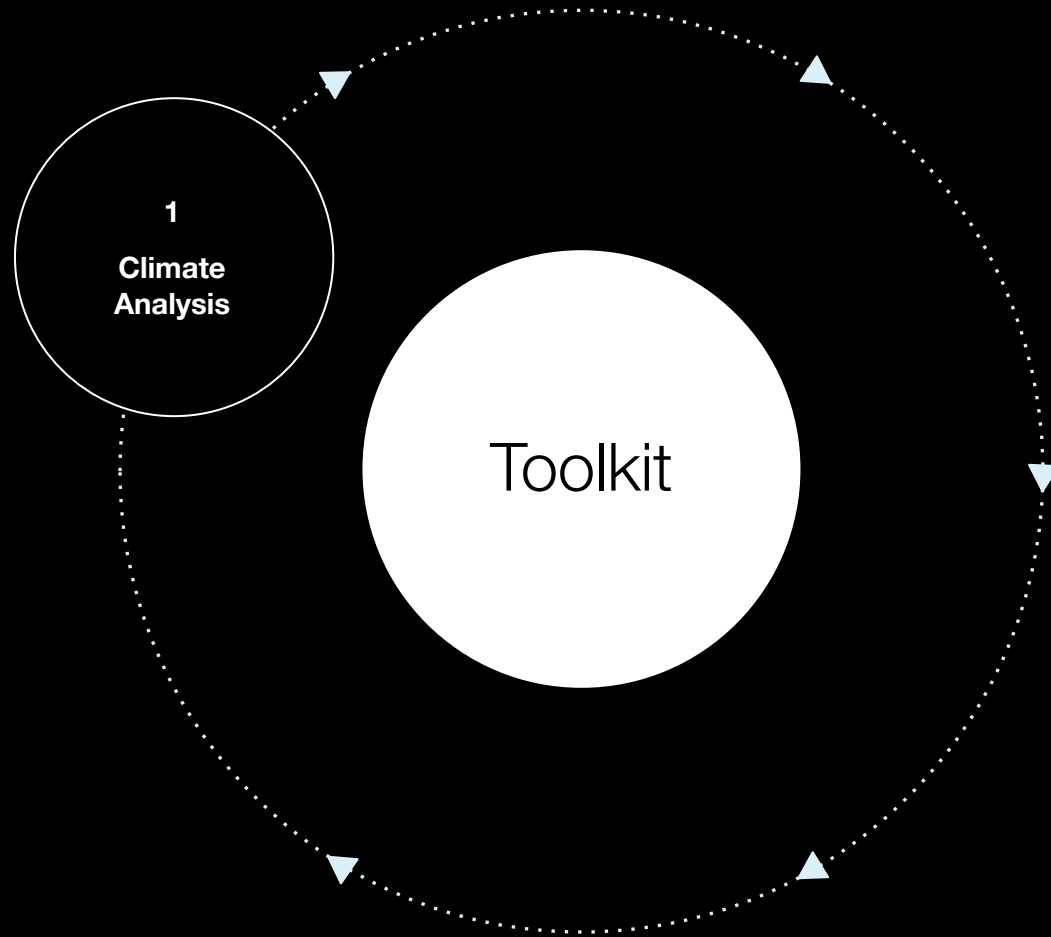
Energy  
Carbon  
Cost



# 1. Data Collection/Benchmarking

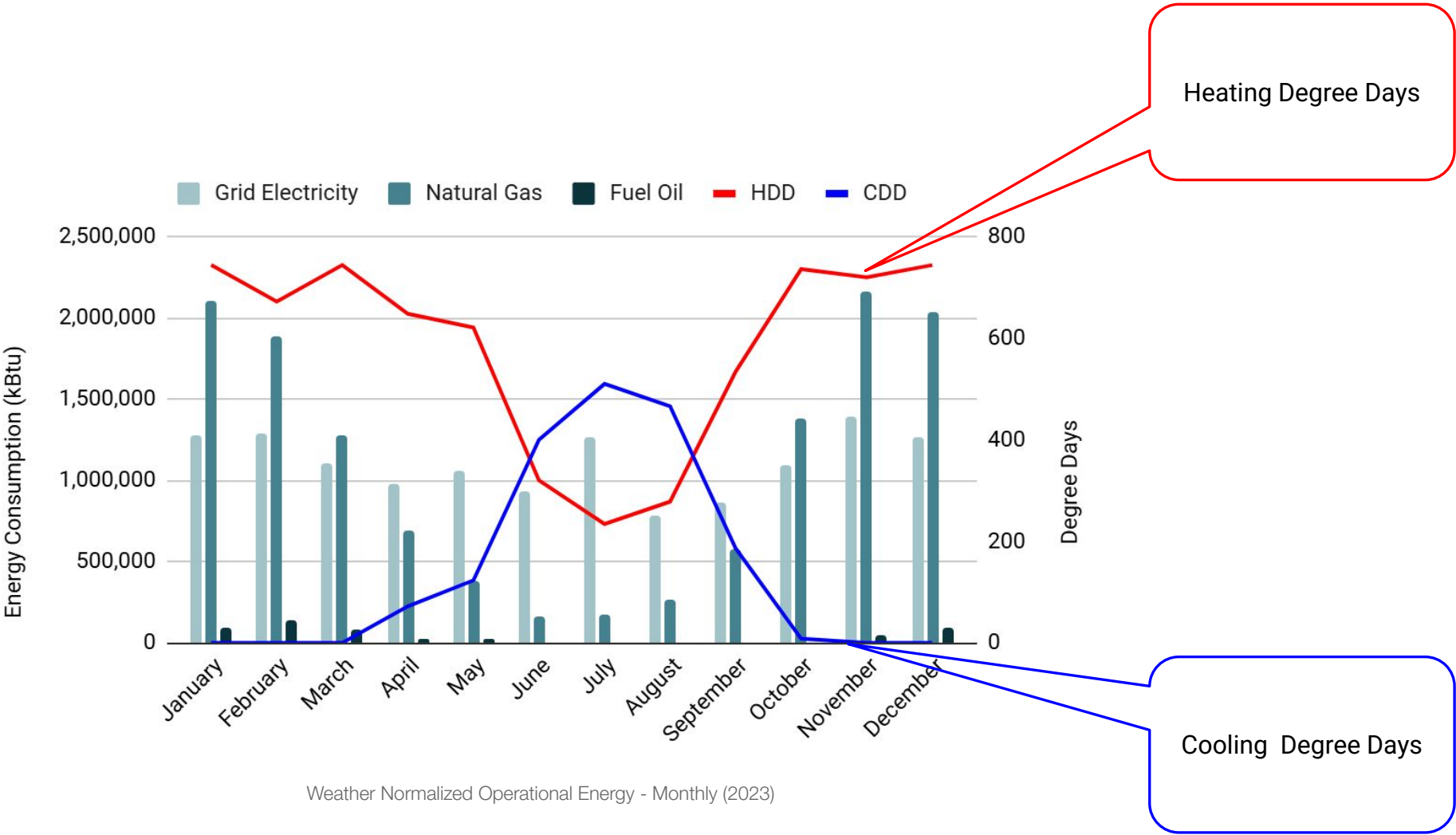
# Approach

## Analysis Calculators



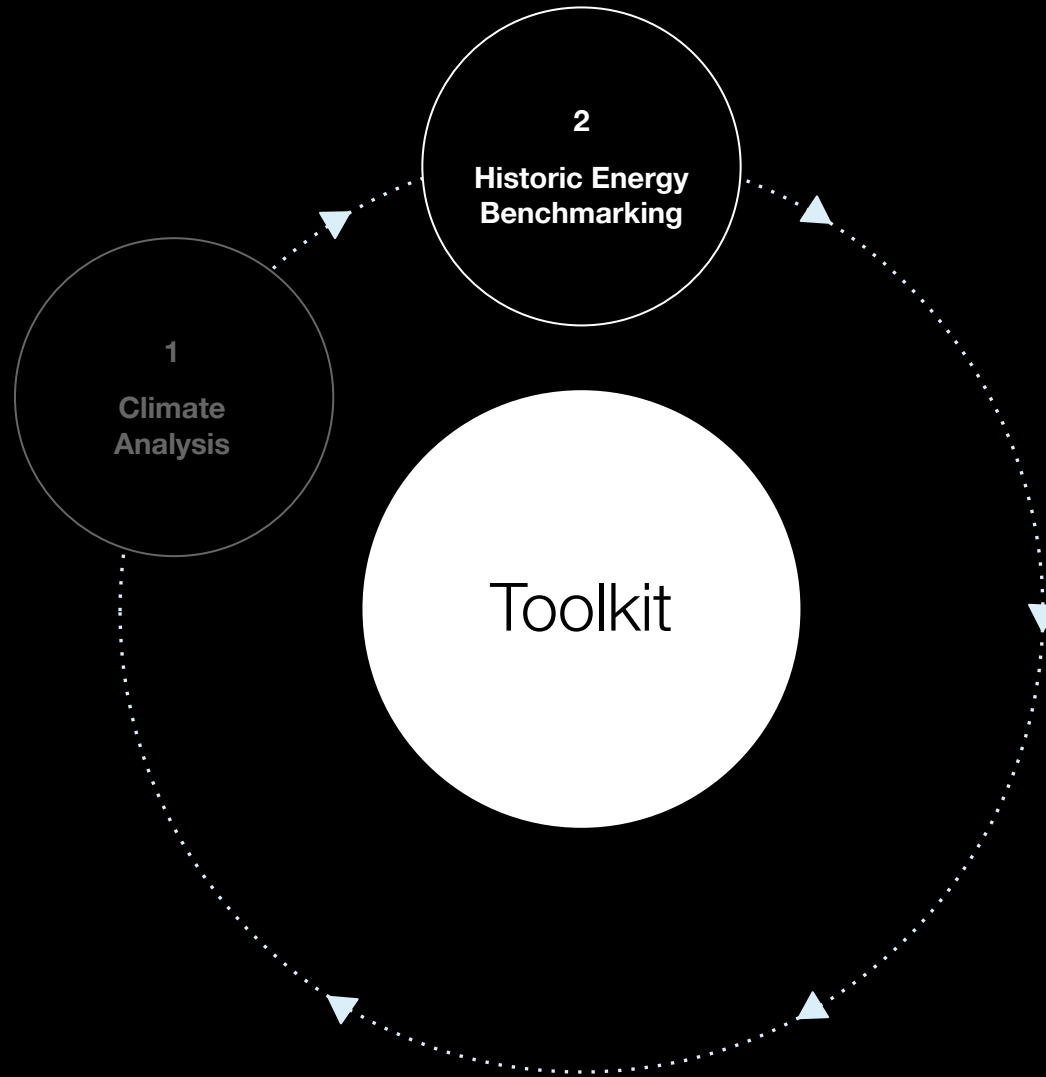
# 1. Climate Analysis

Primary: AI



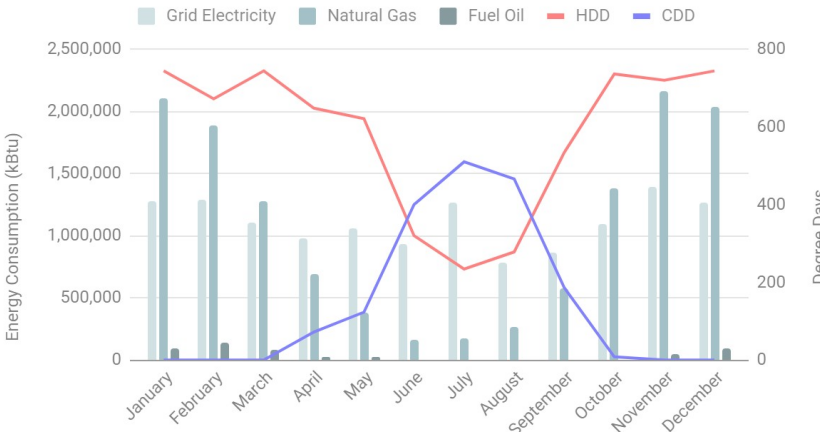
# Approach

## Analysis Calculators

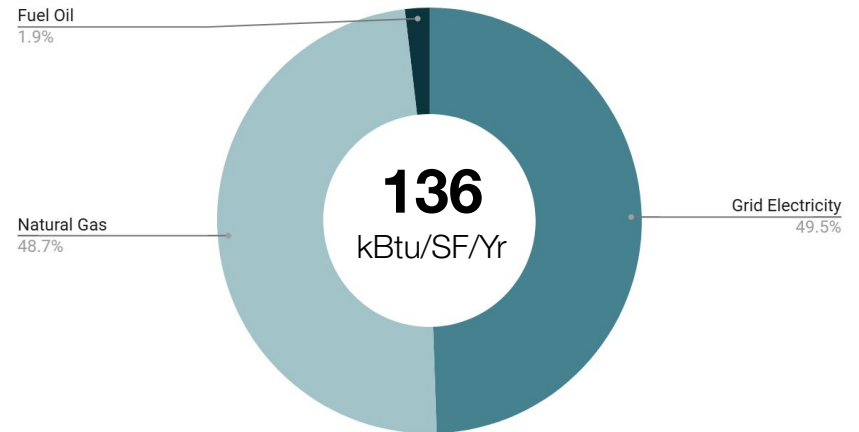


# 2. Historic Energy Benchmarking

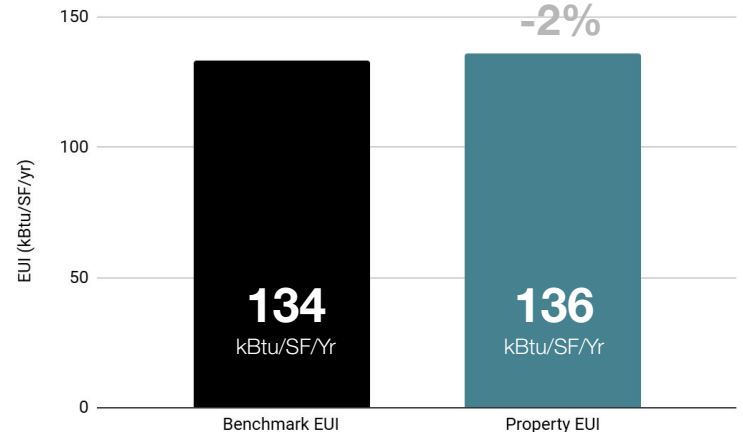
## Primary: AI



Weather Normalized Operational Energy - Monthly (2023)



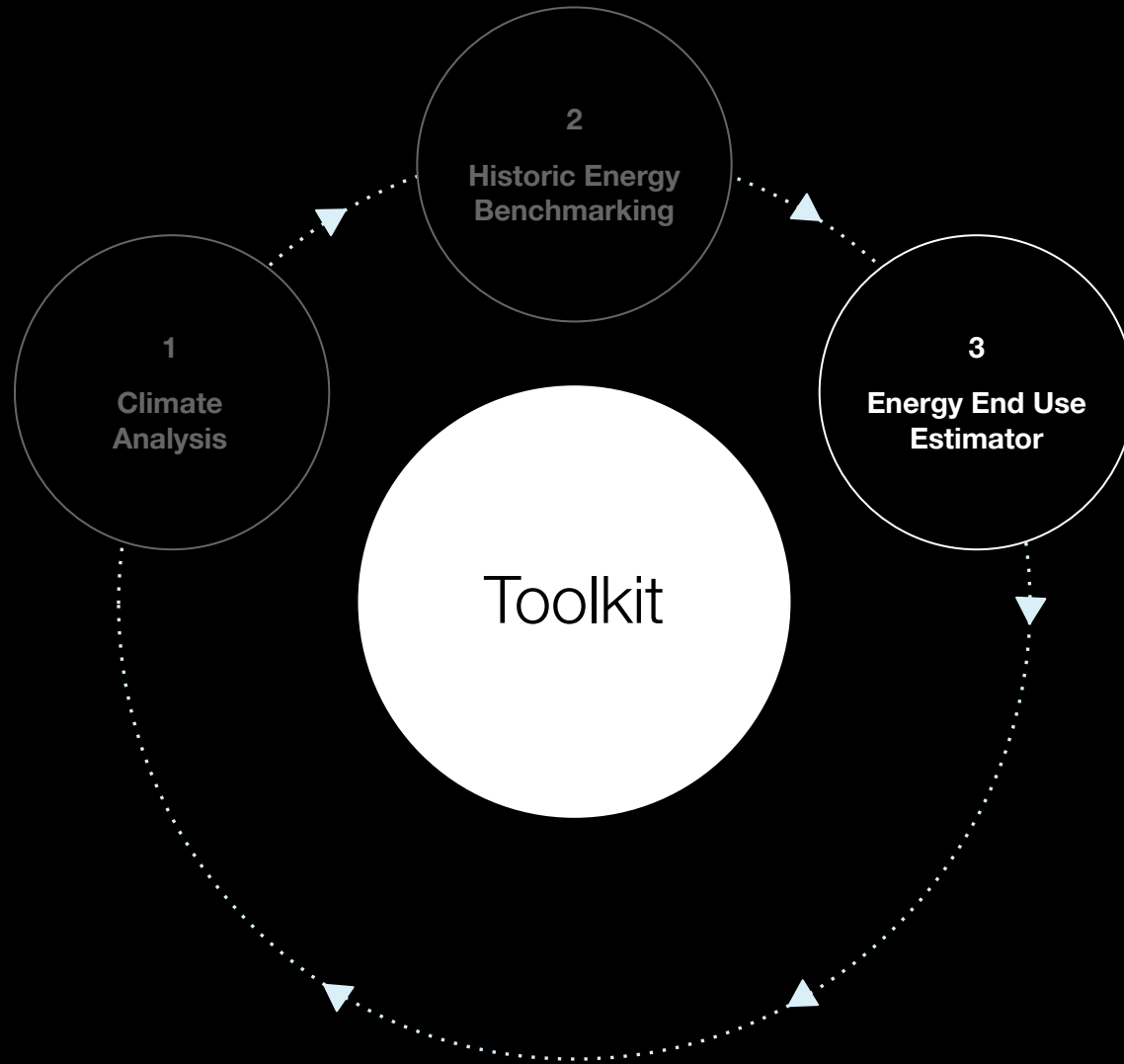
Operational Energy Source Mix (2023)



Operational Energy Benchmark (2023)

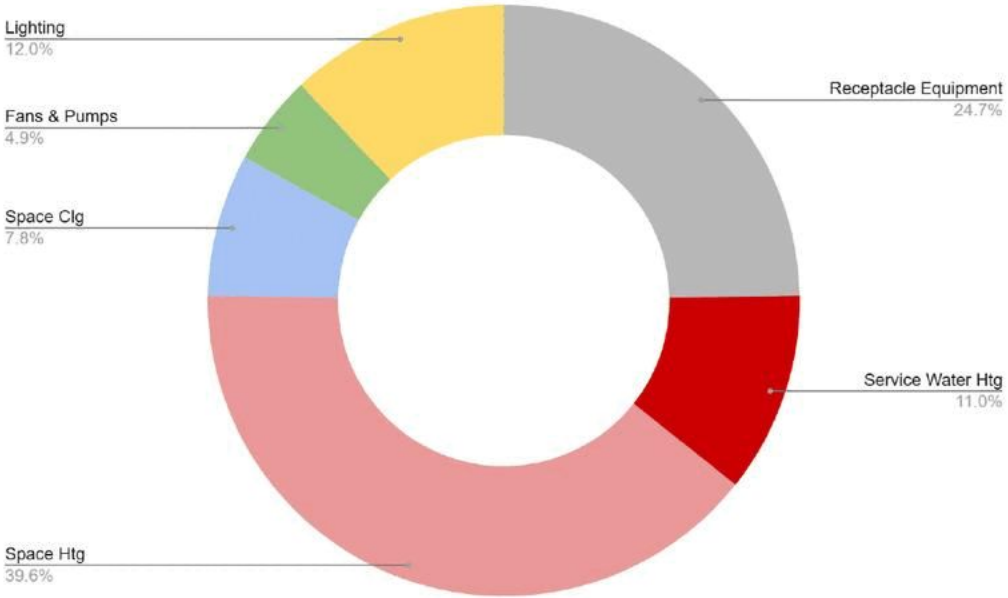
# Approach

## Analysis Calculators

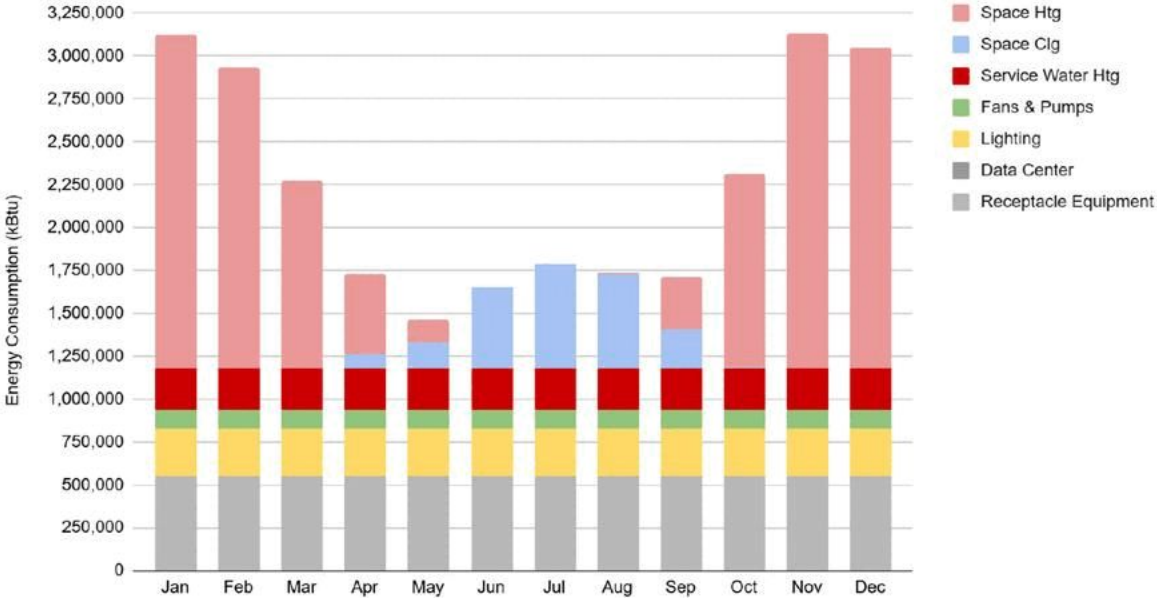


# 3. Energy End Use Estimator

## Primary: AI and Human



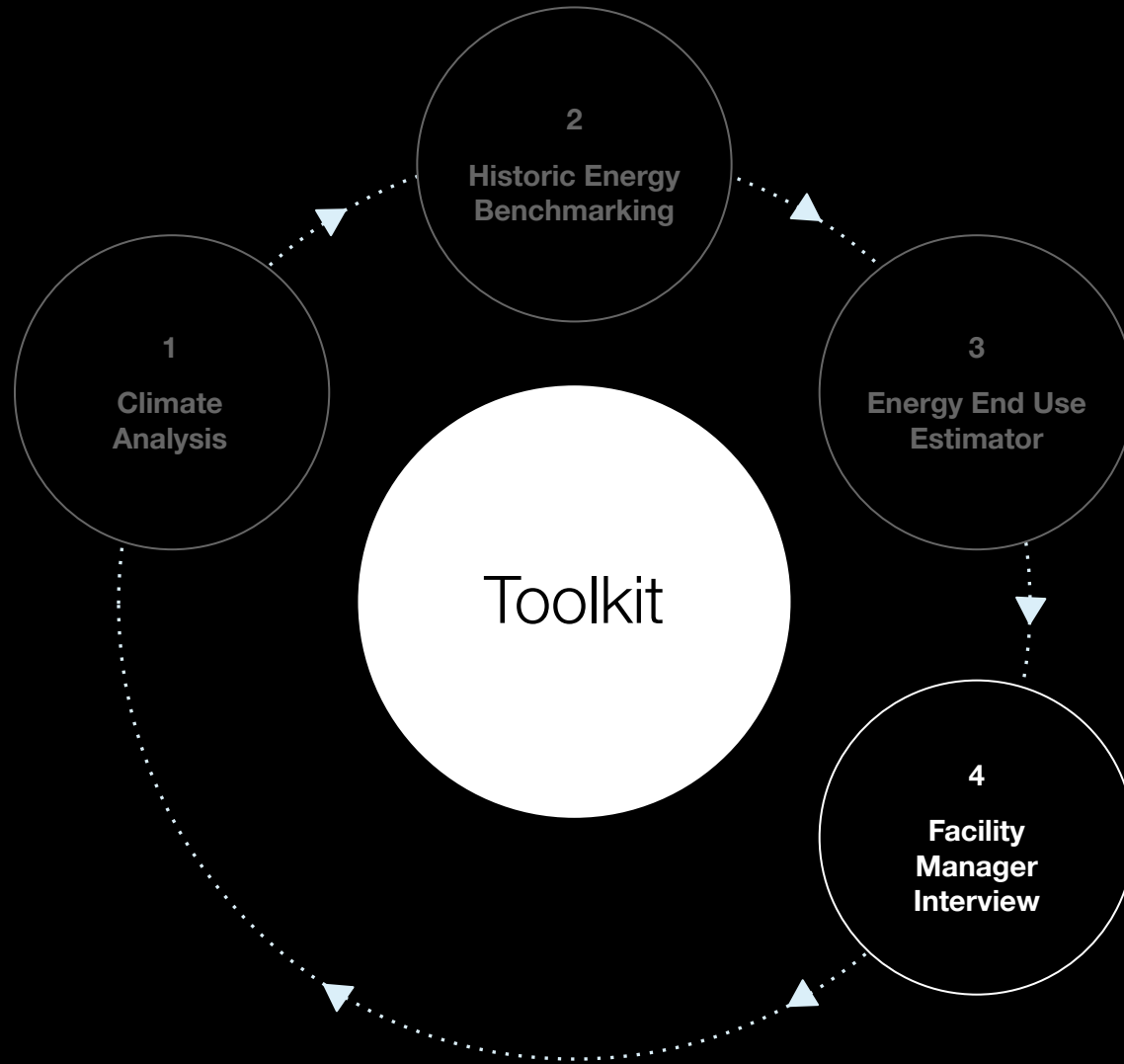
Estimated Energy End-use Breakdown



Estimated Energy End-use Breakdown Profile

# Approach

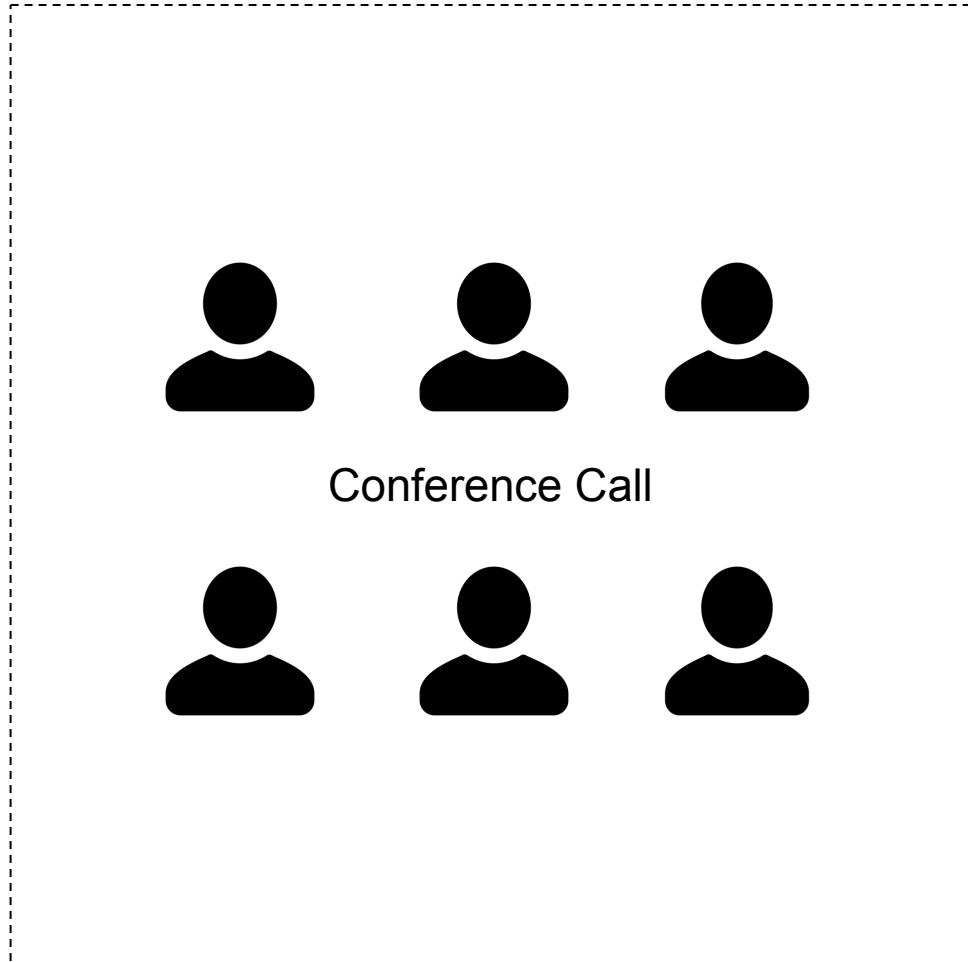
## Analysis Calculators



# 4. Facility Manager Interview - Process

Primary: Human

Input



Output

### Acute Operational Issues:

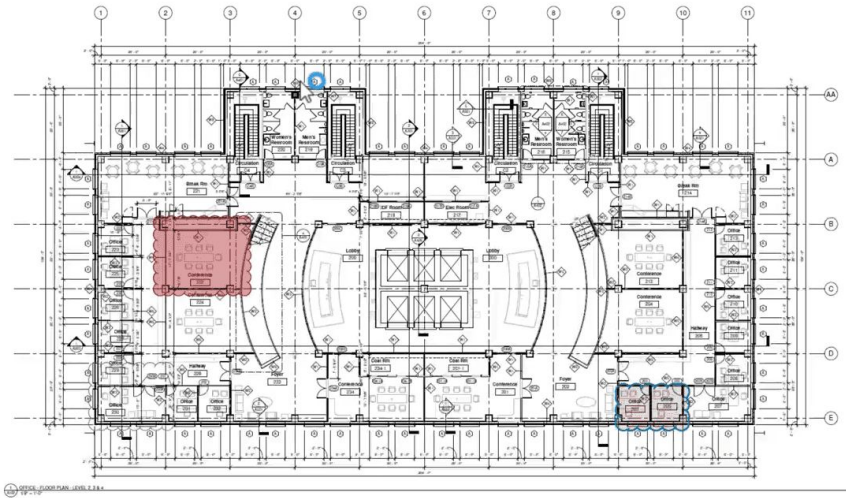
1. Facade Infiltration
2. Malfunctioning sensors (e.g. building differential pressure)
3. The Outdoor Air damper needs to be closed manually when the outdoor air quality is compromised.
4. Humidity Control
5. Lack of control of VAV through the BAS as VAV box control is still pneumatic.
6. Meeting heating setpoints - Two units have to run continuously to maintain winter setback temperature for portions of the first floor. The first floor is directly above an open parking garage with insufficient insulation.
7. Meeting cooling setpoints - During heat waves, start-up shall take longer, especially during long weekends.
8. Interior supply fans (2) are coupled to one return fan. To avoid negative pressure issues, all fans have to run in tandem, using unnecessary energy.
9. Chillers at end of life
10. Boilers at end of life

### Retrofit Wishlist:

1. Air Source Heat Pumps with Backup Boiler
2. CO2 Control
3. Replace the perimeter radiant heating
4. Replace AHU in FY 25
5. Low air velocity system
6. Lighting Control with BAS

# 4. Facility Manager Interview - Drawings and Specifications Not Online

## Primary: Human



<https://www.autodesk.com/blogs/construction/construction-drawings/>

### **SUBSTRUCTURE**

#### **SITE INVESTIGATION:**

A copy of the site investigation report will be provided to the Contractor if available.

#### **EXISTING SERVICES:**

The Contractor shall undertake to full CAT Scan of the site to verify any information provided.

#### **FOUNDATIONS:**

##### **FOUNDATIONS GENERALLY:**

- Foundations are to be as indicated on the drawings and in accordance with Building Regulations Approved Document A1/2.
- Foundations to be constructed at a minimum depth of 750-1000mm, below the influence of drains, and or surrounding trees, on level firm natural undisturbed ground of adequate ground bearing capacity to the approval of the Building Control Officer.

##### **STRIP FOUNDATIONS:**

- Strip foundations to have a minimum width of 600mm and thickness of 225mm.
- The concrete mix should be ST2 or GEN1

##### **TRENCH FILL FOUNDATIONS:**

- Trench fill foundations should have a minimum width of 450mm and a minimum 500mm thickness of concrete.
- The concrete mix should be ST2 or GEN1.

##### **ALTERNATIVE FOUNDATION DESIGNS:**

<https://houseplansdirect.co.uk/product/new-home-building-specifications-template/>

## 4. Facility Manager Interview - Acute Issues Log

Primary: Human

“Missing insulation in overhangs makes it hard to achieve thermal comfort in winter”

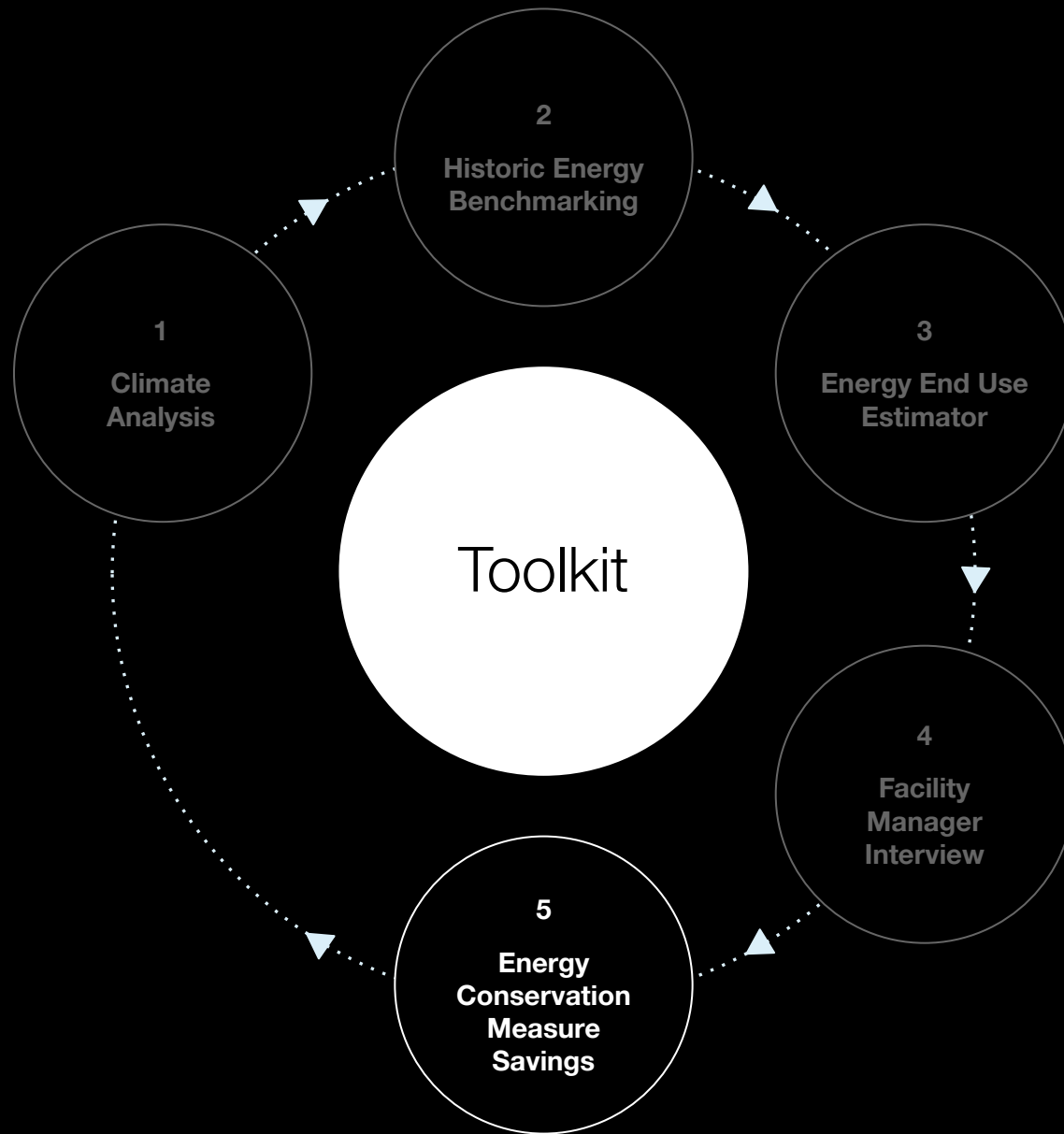
“Tenant fit outs, and space repurposing has driven up building load. HVAC cannot meet setpoint”

“I try to manually turn off lights on every floor at the end of each day”

“The main entry door is propped open all day so we lose heat to the outdoors”

## 2. Asset Prioritization

# Approach Analysis Calculators



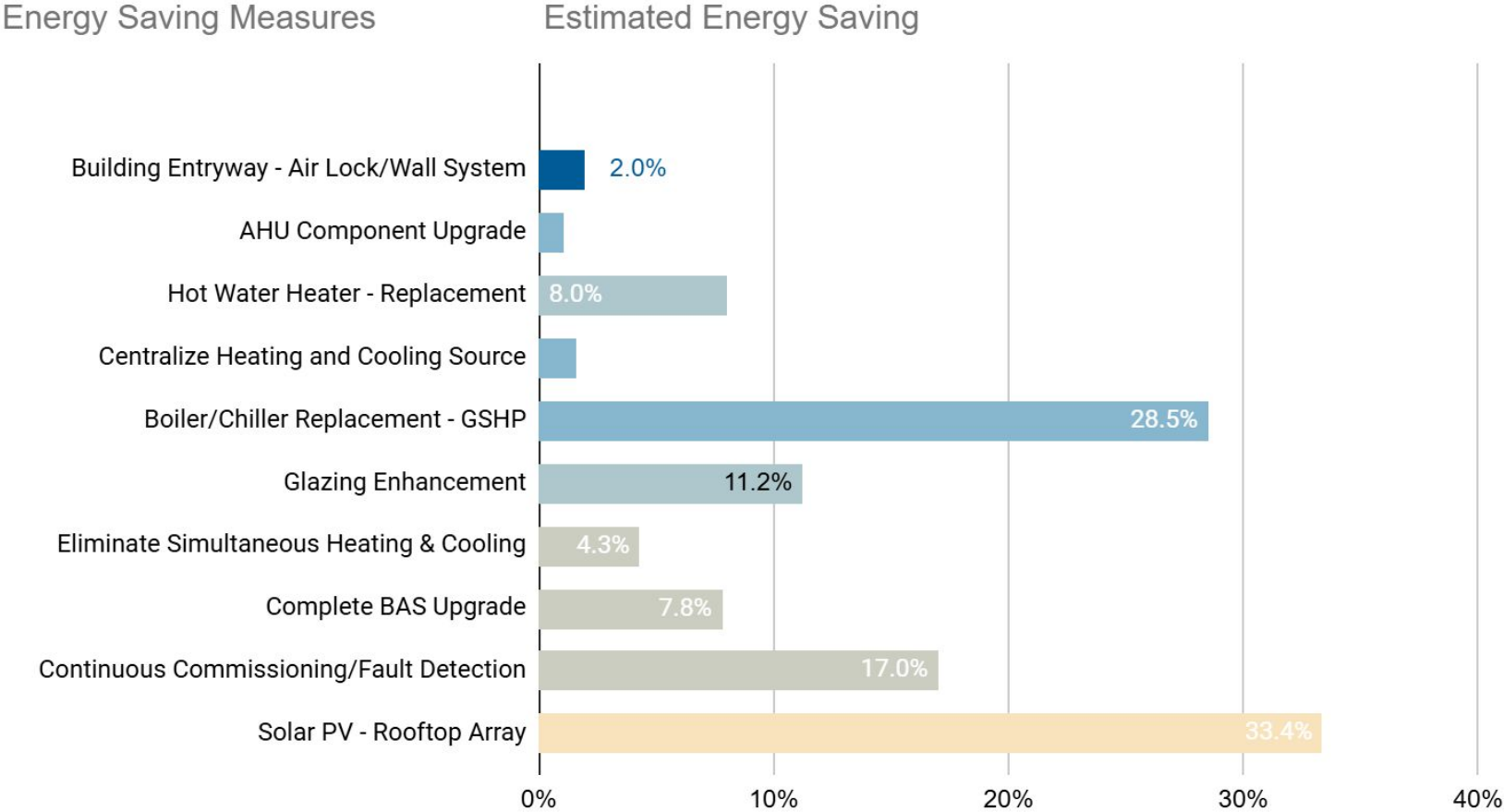
# 5. Energy Conservation Measures: ECM Ratings

Primary: AI and Human

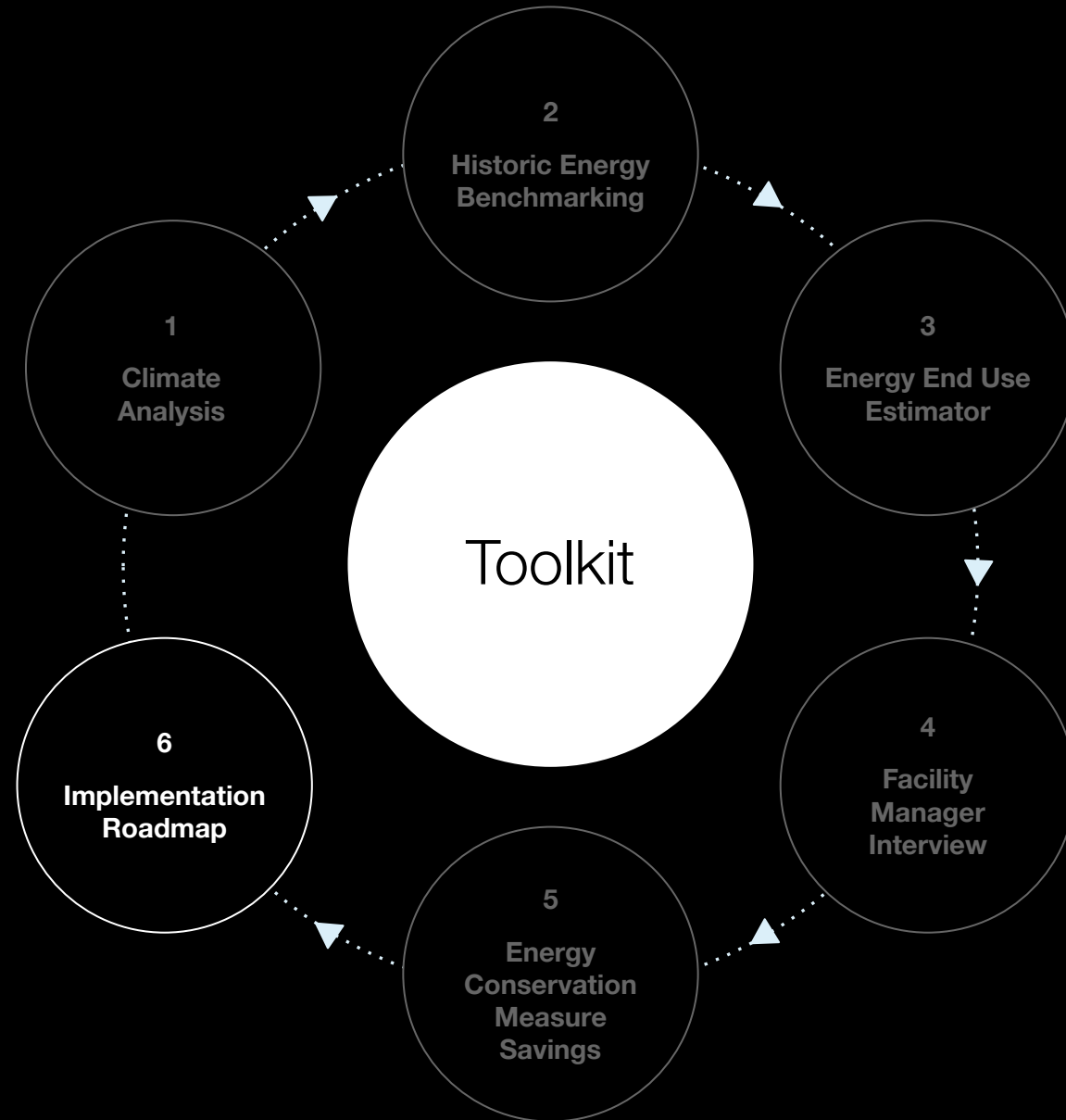
Category	Intervention	Facilities	Acute	End of Life	Impact Rating (1: Low - 5: High)				Selection
					Energy	Carbon	Energy Cost	Implementation	
Controls	Complete BAS Upgrade	N	Y	Y	5	5	5	5	3.0
HVAC	Boiler/Chiller Replacement - GSHP	N	N	N	5	5	2	5	2.7
HVAC	Boiler Replacement - ASHP	Y	N	N	5	5	1	5	2.6
HVAC	Future-ready Hydronic Heat Transfer Loop	N	N	N	5	5	1	5	2.6
Controls	Eliminate Simultaneous Heating & Cooling	N	N	N	4	4	4	1	4.0
Envelope	Building Entryway - Air Lock/Wall System	N	Y	N	4	4	4	1	4.0
Controls	Continuous Commissioning/Fault Detection	N	N	N	3	3	3	2	2.3
Envelope	Glazing Enhancement	N	Y	N	3	3	3	3	2.0
HVAC	Centralize Heating and Cooling Source	Y	N	N	3	3	3	3	2.0
Renewables	Solar PV - Parking Canopy	N	N	N	3	3	3	3	2.0
Renewables	Solar PV - Rooftop Array	N	N	N	3	3	3	3	2.0
Renewables	PV for EV Charging	N	N	N	3	3	3	4	1.9
Domestic Hot Water	Hot Water Heater - Replacement	N	N	Y	3	3	1	3	1.7
HVAC	AHU Component Upgrade	N	N	Y	3	3	3	2	2.3
Energy Storage	Energy Storage - Battery	N	N	N	3	3	3	5	1.8
Controls	Demand Controlled - Ventilation	N	N	N	2	2	2	2	1.5
Lighting	Exterior Lighting Replacement	N	N	N	2	2	2	2	1.5
Controls	Building Level Submetering	Y	N	N	2	2	2	3	1.3
Controls	Lighting Control Upgrade	Y	Y	N	2	2	2	3	1.3
HVAC	Air Side Energy Recovery	N	N	N	2	2	2	3	1.3
Controls	BAS Integration: AHU Control	N	Y	N	2	2	2	4	1.3
Controls	Energy Metering by End-use	Y	N	N	2	2	2	4	1.3
Envelope	Roof Insulation	N	N	N	2	2	2	4	1.3
Envelope	Wall Insulation	N	Y	N	2	2	2	4	1.3
Renewables	Solar - Hot Water	N	N	N	2	2	2	4	1.3
Energy Storage	Thermal Energy Storage	N	N	N	2	2	2	5	1.2
HVAC	Chiller Replacement	Y	N	Y	2	2	2	5	1.2
Renewables	Alternative Fleet Energy Use	N	N	N	1	3	1	4	1.1
HVAC	Earth/Ground Tube Preheating	N	N	N	2	2	2	4	1.3

# 5. Energy Conservation Measures: Estimated Energy Savings

Primary: AI

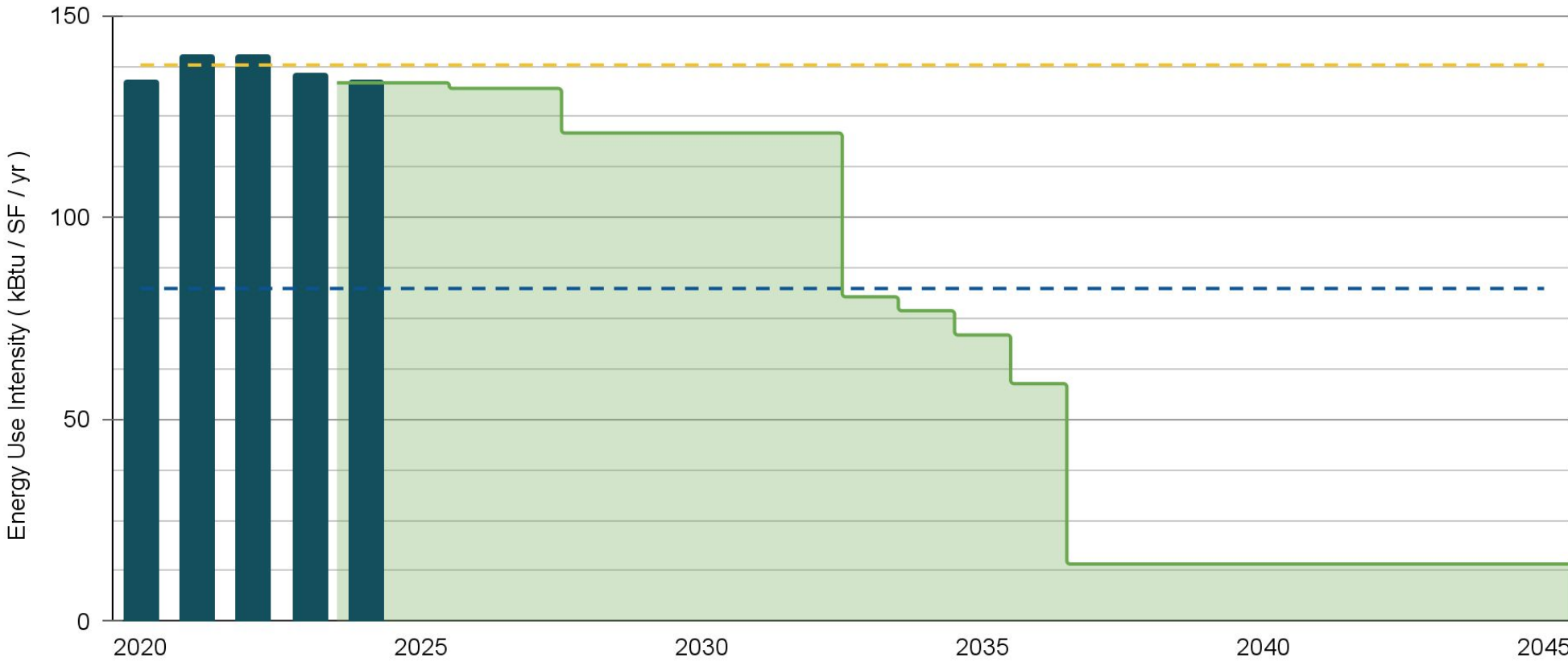
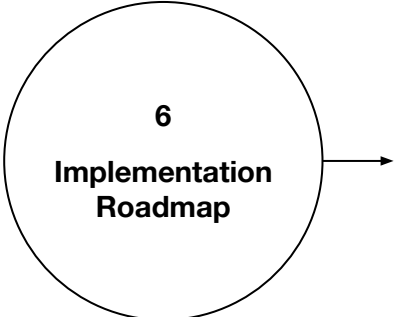


# Approach Analysis Calculators



# 6. Implementation Roadmap

Primary: Human

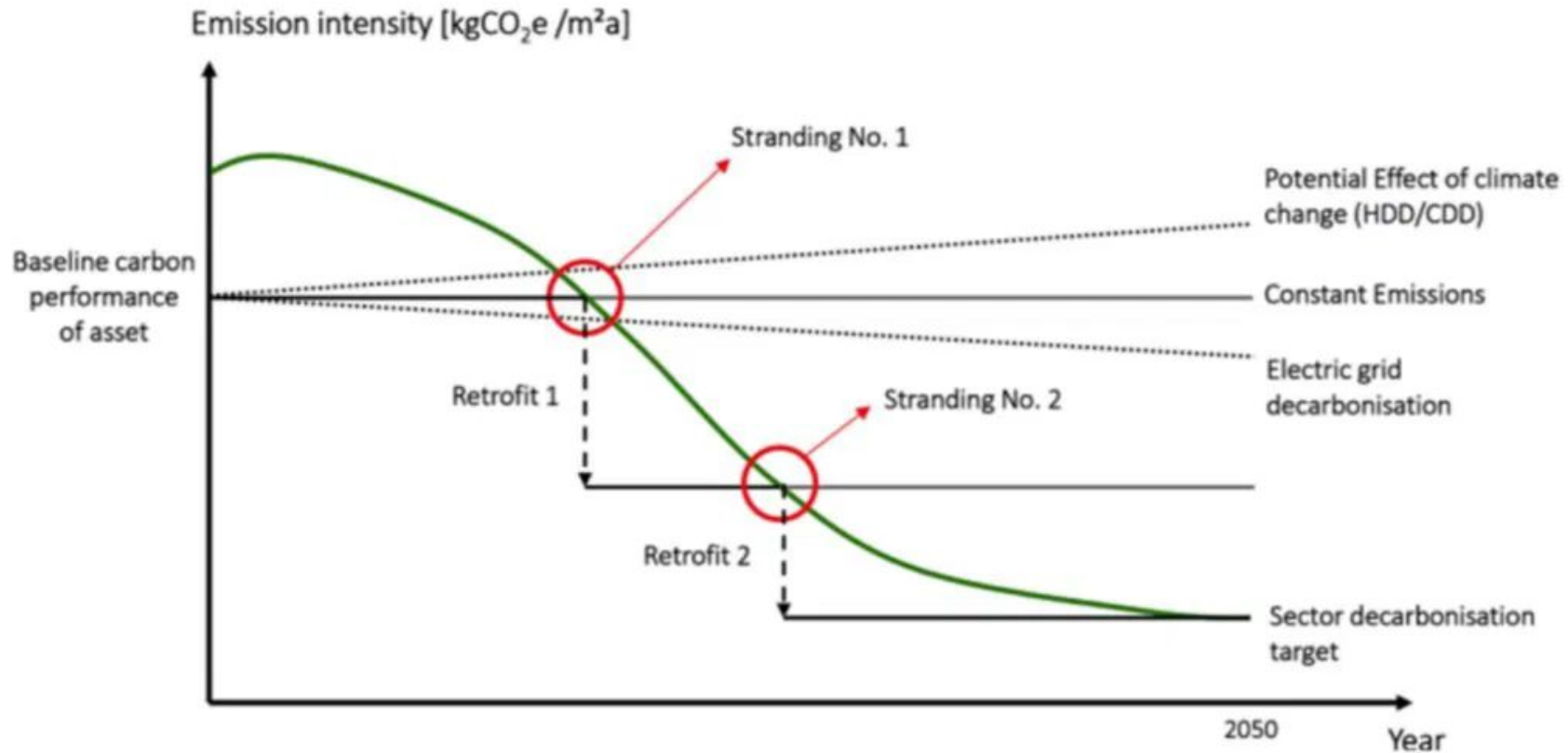


■ Measured EUI   ■ Predicted EUI w/ the proposed ECMs   - - - Predicted EUI w/o the proposed ECMs

**Output**

# 6. Implementation Roadmap

Primary: Human



# 3. Develop Decarbonization Strategies

# Develop Decarbonization Strategies Building Heating

Primary: Human

**Heating is 1.7 Times of Cooling:**

Current COP Heating: 0.9

100 unit output =

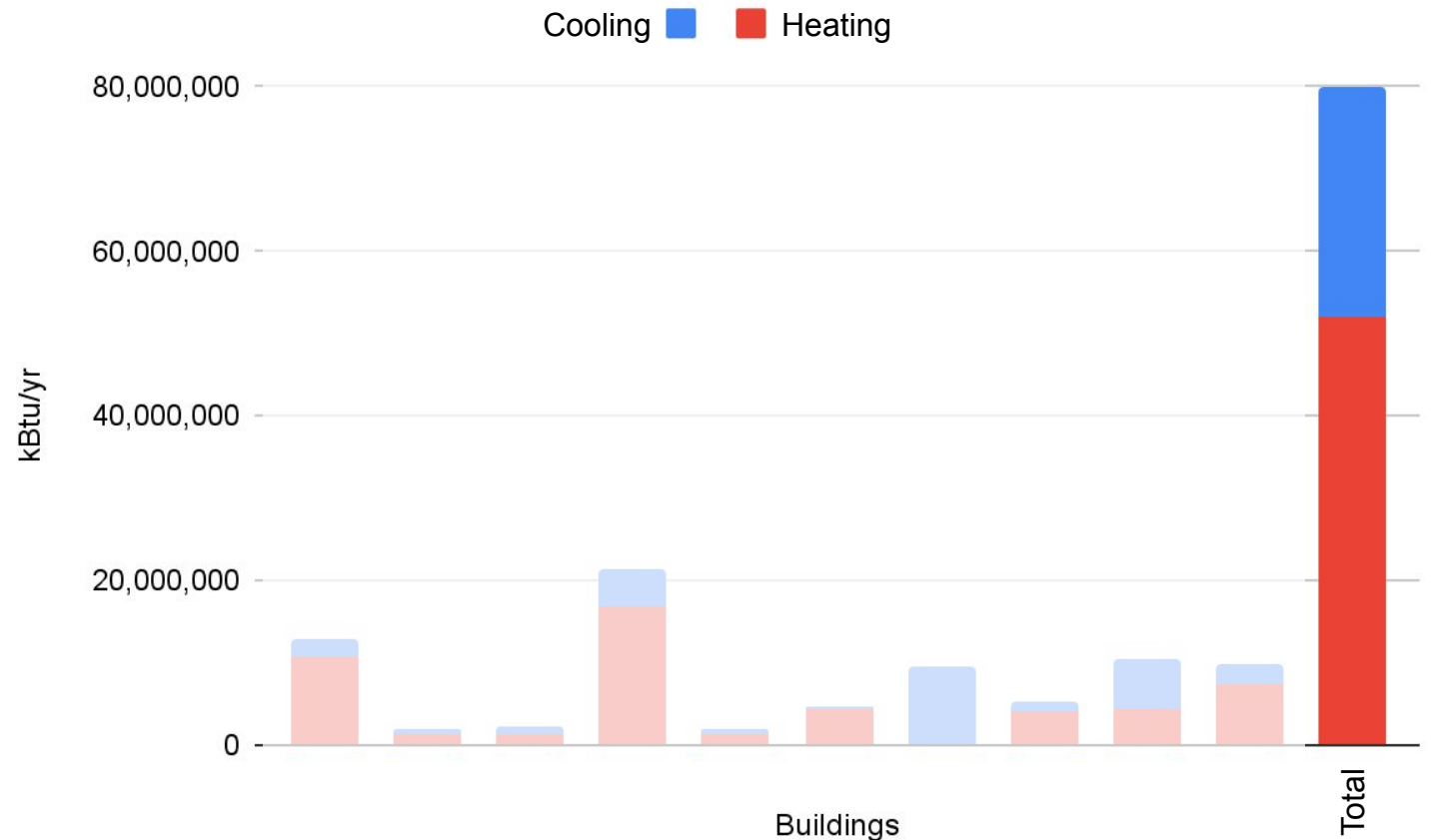
**111 unit input, boiler**

**40 unit input, heat pump**

Current COP Cooling: 6 - 9

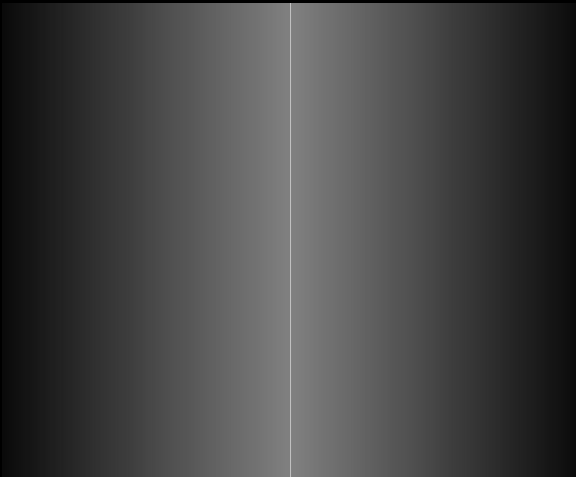
100 unit output

= 13.3 unit input



# Develop Decarbonization Strategies Building Age

Primary: Human



1930

1972

1985

1995

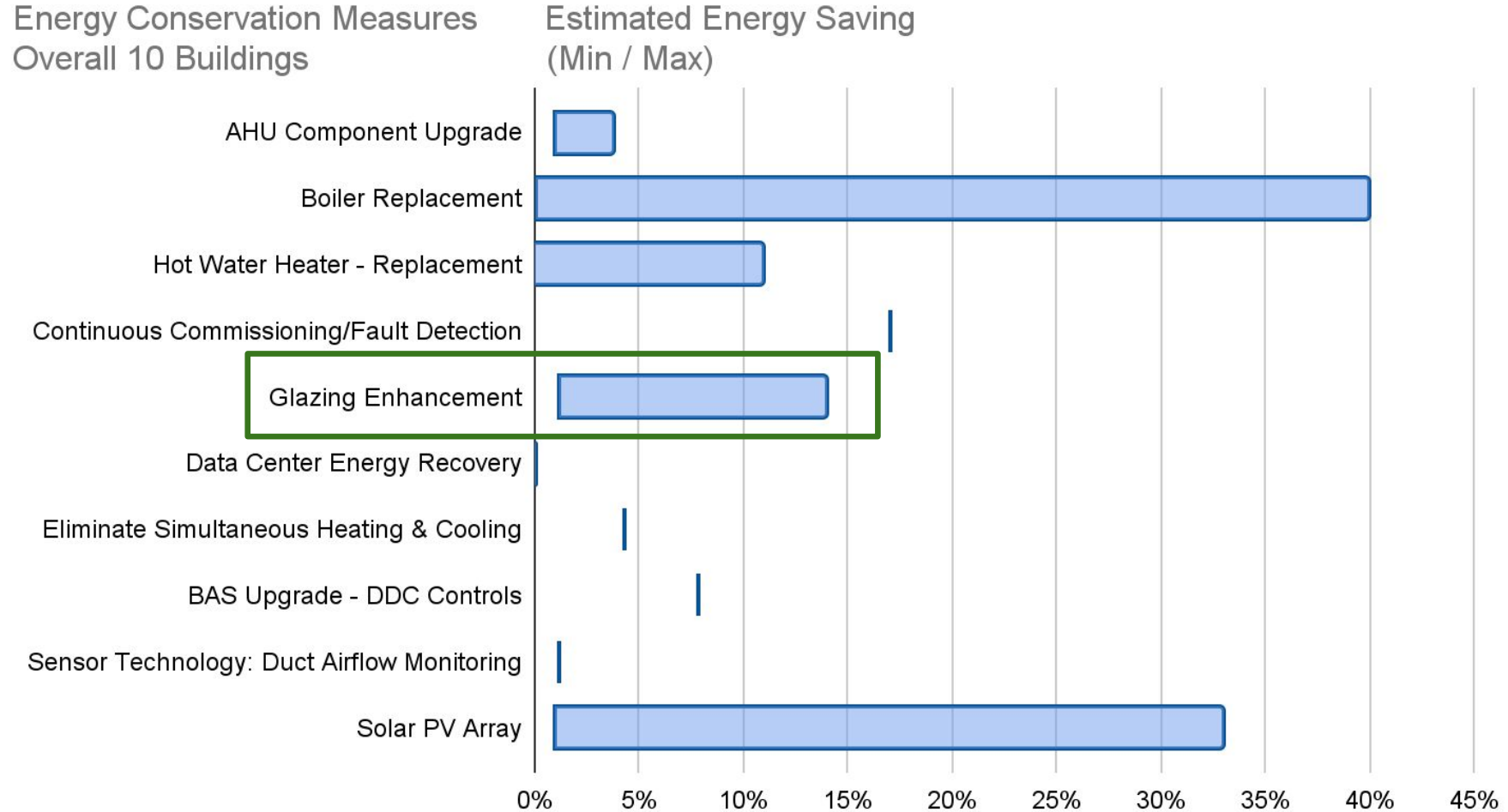
2000

2007



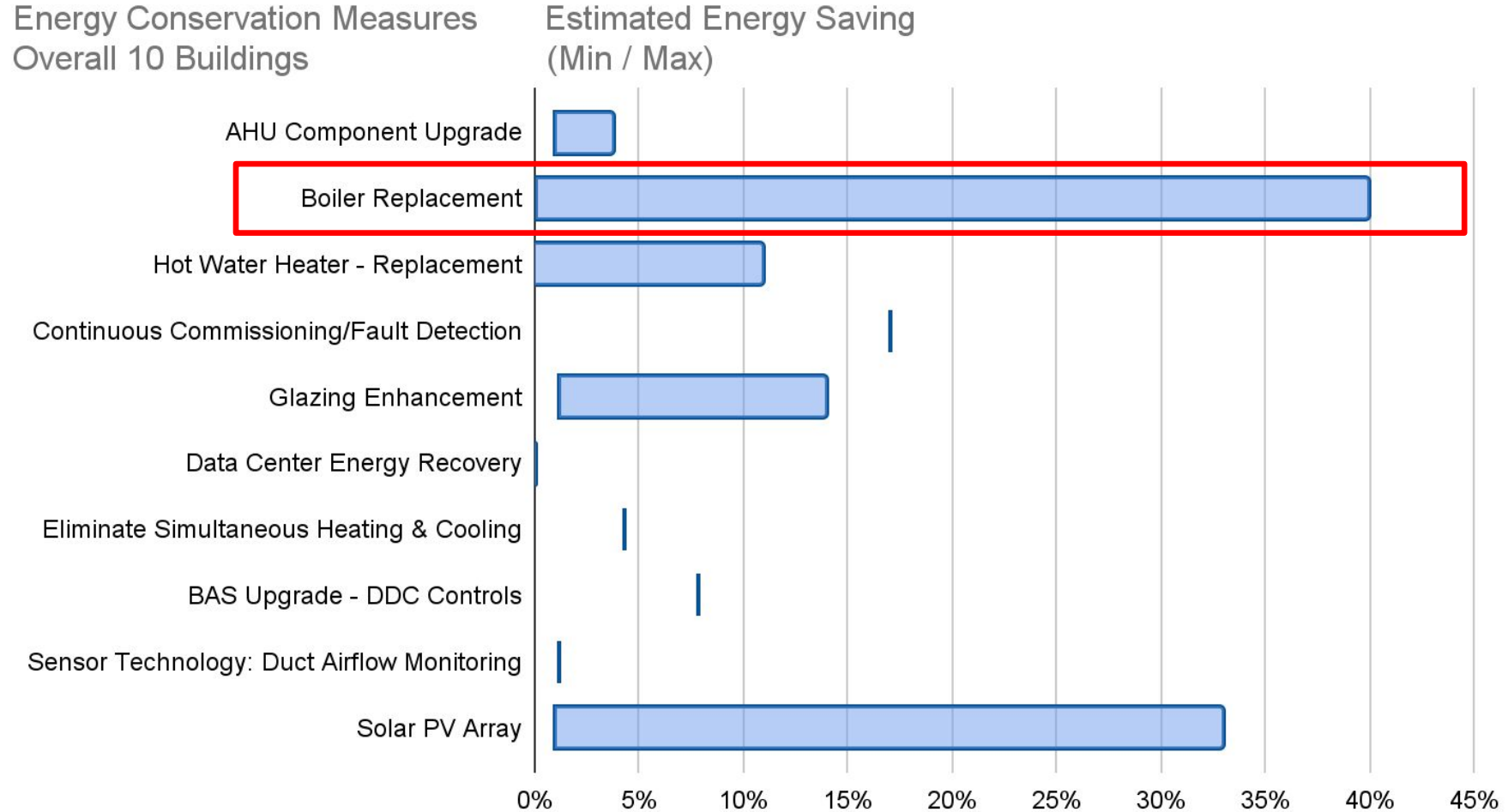
# Develop Decarbonization Strategies Building Envelope

Primary: Human



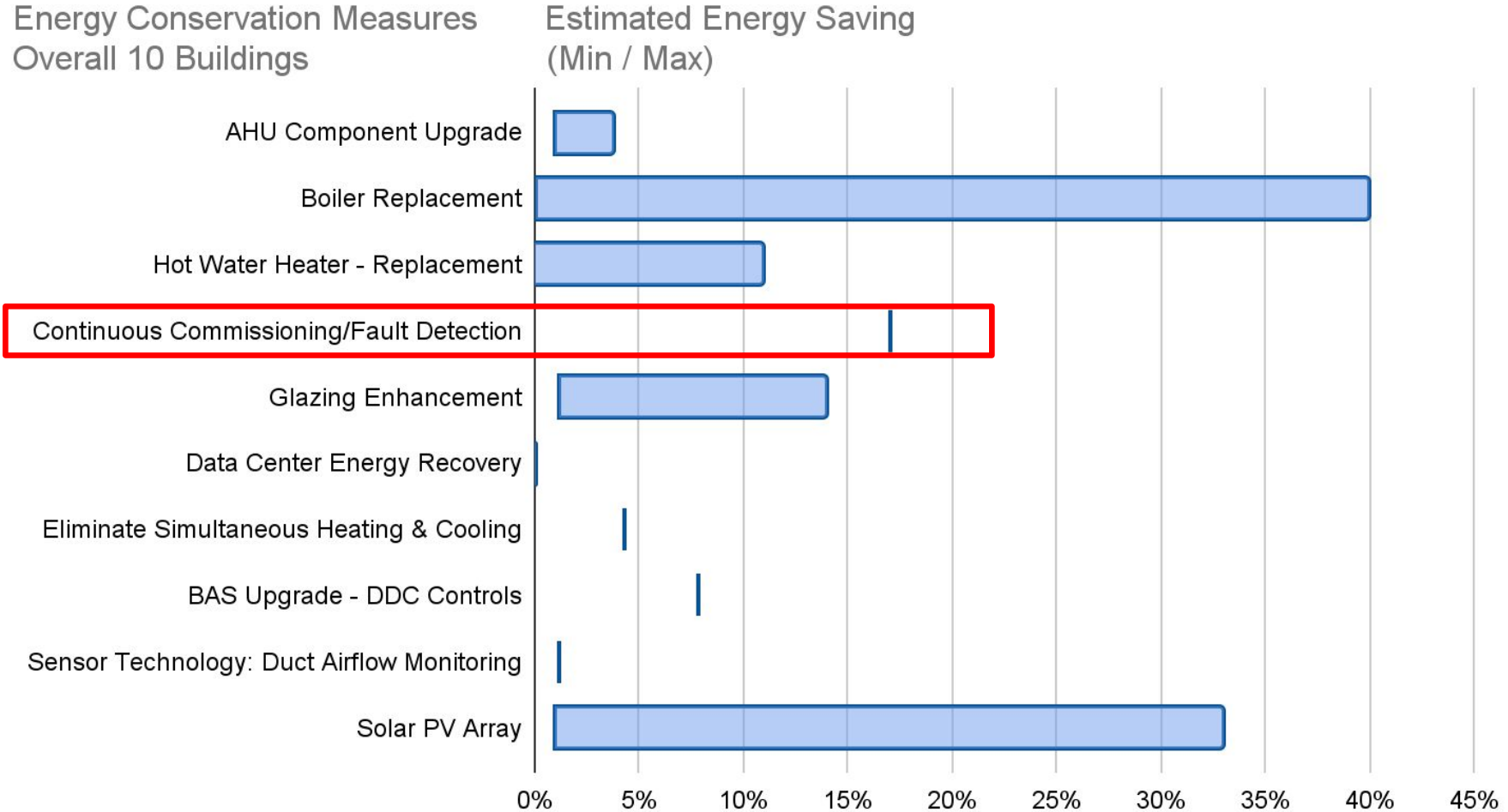
# Develop Decarbonization Strategies HVAC

Primary: Human



# Develop Decarbonization Strategies BAS

Primary: Human



# Develop Decarbonization Strategies Data Center

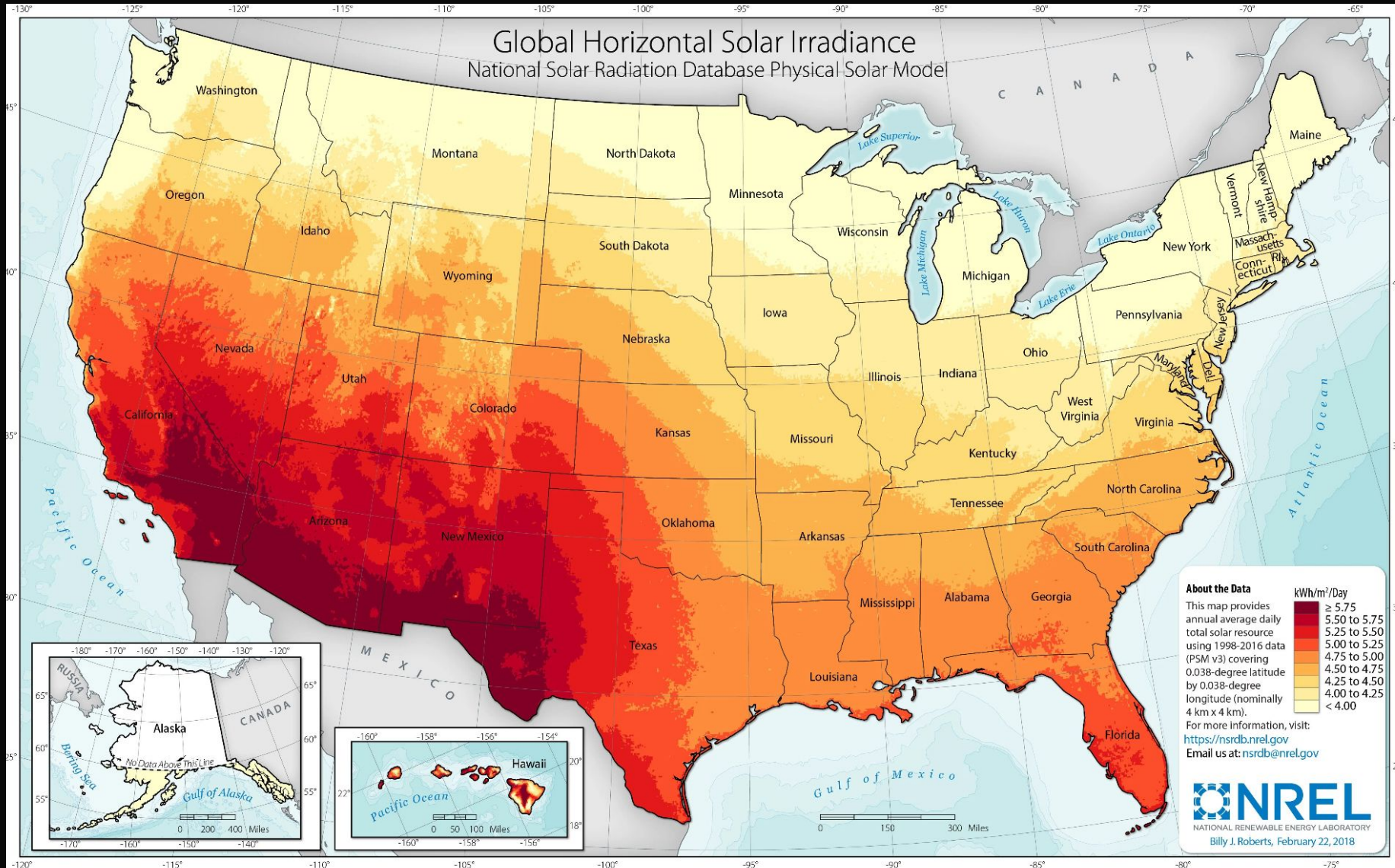
Primary: Human

**60% of the buildings have computer center**

<b>% of GSF</b>	<b>Overall EUI Impacts (kbtu/sf/yr)</b>	<b>Current EUI of Building</b>	<b>% of Current EUI</b>
<b>4.0%</b>	40.1	77	<b>52.1%</b>
<b>1.2%</b>	12.2	68	<b>17.9%</b>
<b>0.9%</b>	9.2	53	<b>17.3%</b>
<b>4.4%</b>	43.7	146	<b>29.9%</b>
<b>0.3%</b>	3.2	65	<b>4.9%</b>
<b>0.04%</b>	0.4	70	<b>0.6%</b>

# Develop Decarbonization Strategies Renewable

Primary: Human



# Energy Conservation Measure: Want Vs. Impact

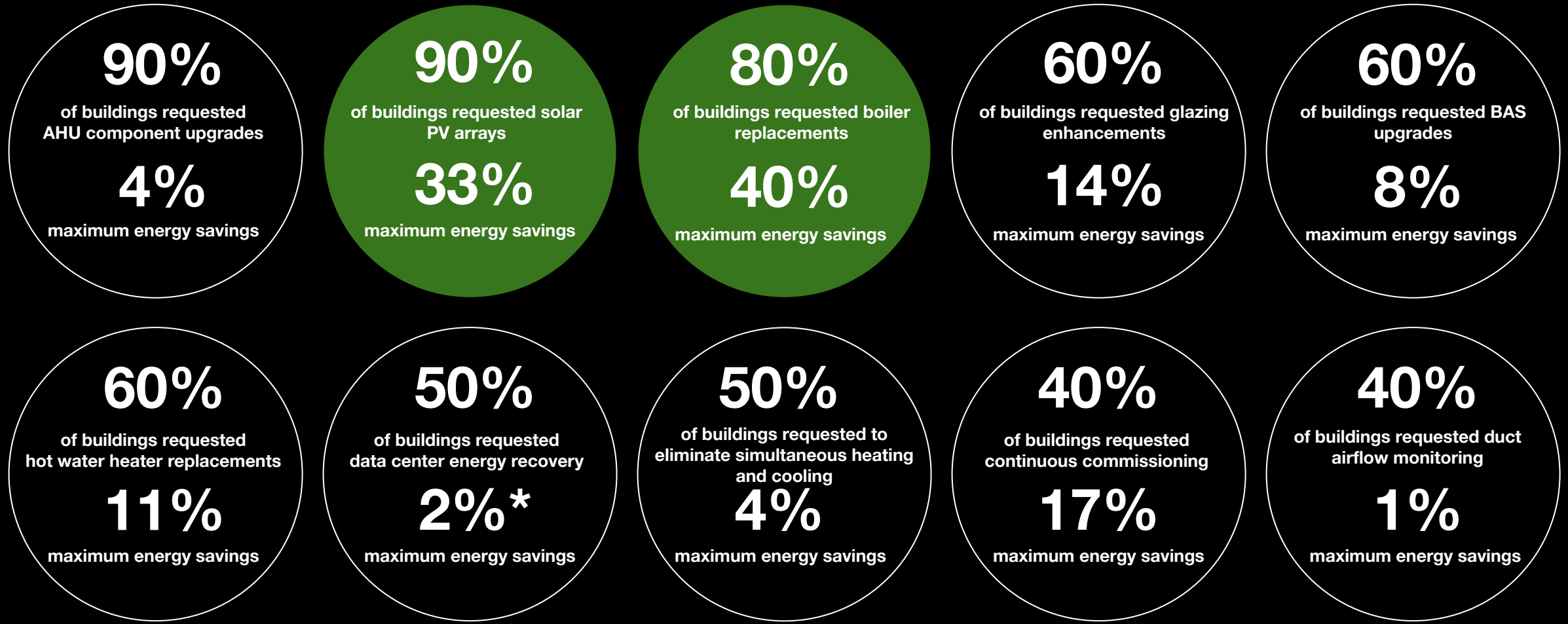
Primary: Human



\*Estimate based on Energy End Use Breakdown Estimator and Data Center Energy Recovery Calculator

# Energy Conservation Measure: Want Vs. Impact

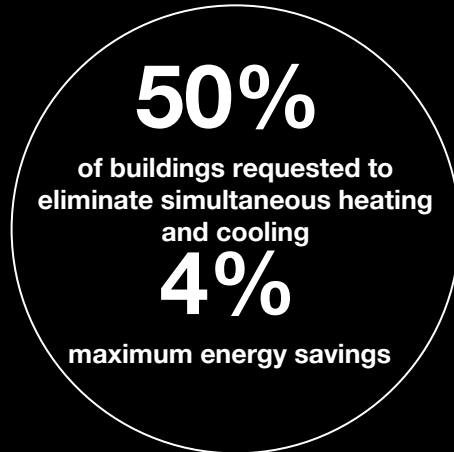
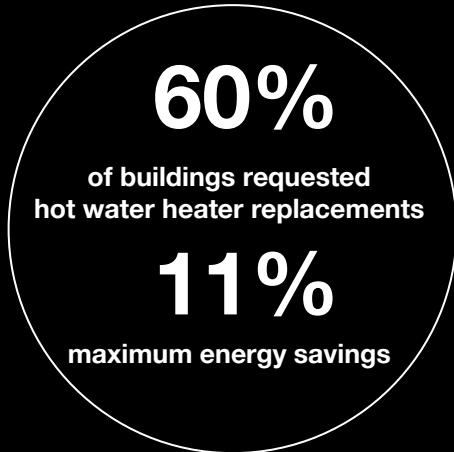
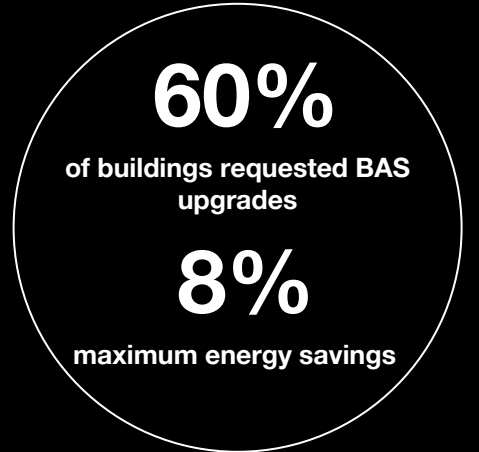
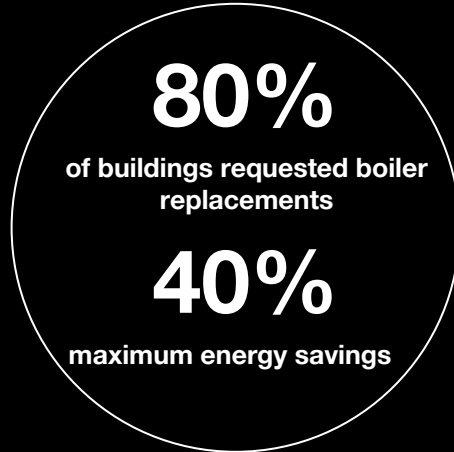
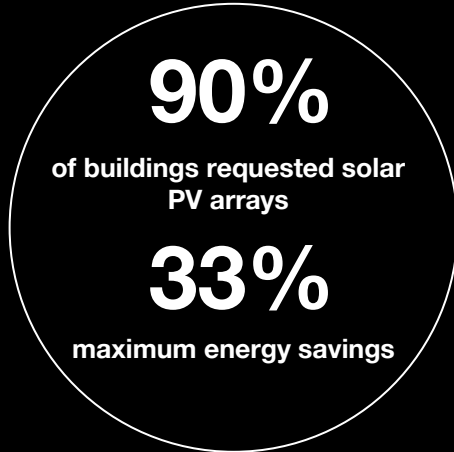
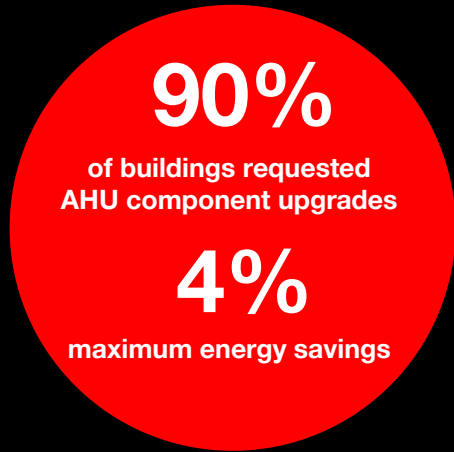
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# Energy Conservation Measure: Want Vs. Impact

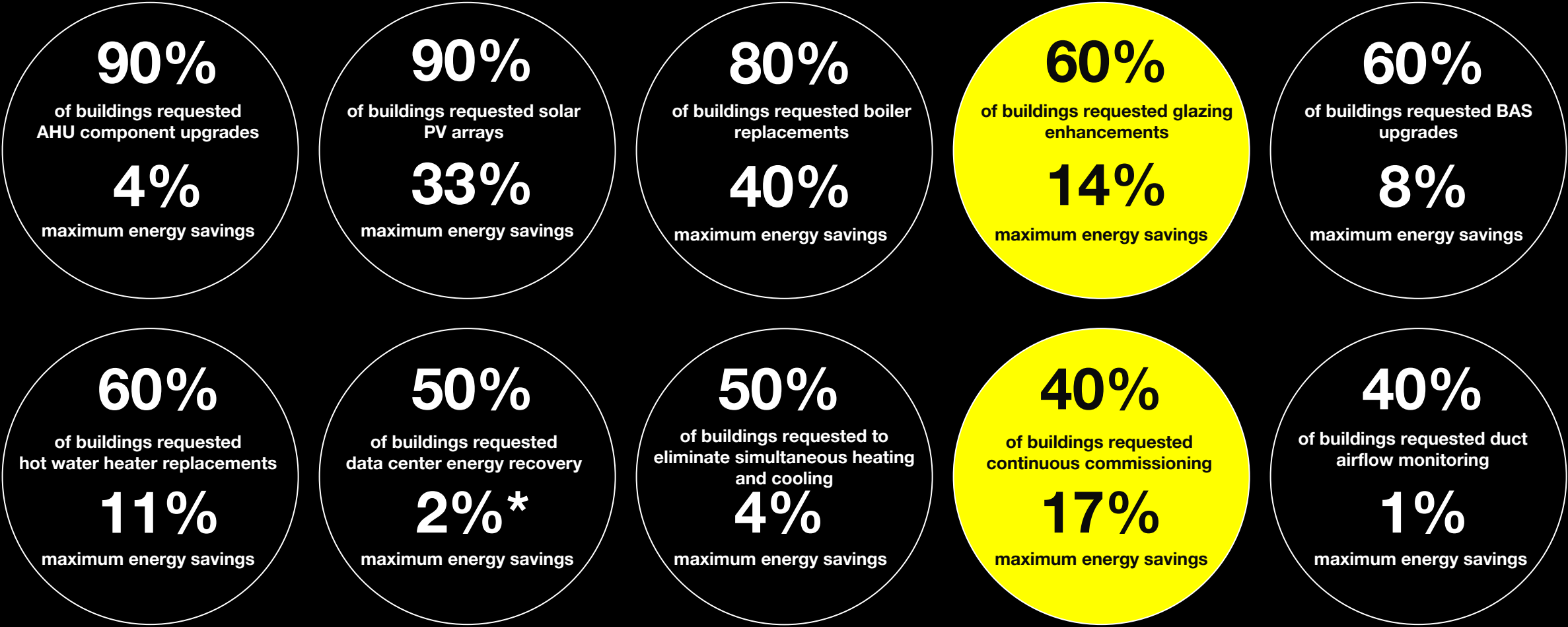
Primary: Human



\*Estimate based on Energy End Use Breakdown Estimator and Data Center Energy Recovery Calculator

# Energy Conservation Measure: Want Vs. Impact

Primary: Human



\*Estimate based on Energy End Use Breakdown Estimator and Data Center Energy Recovery Calculator

Future Ready

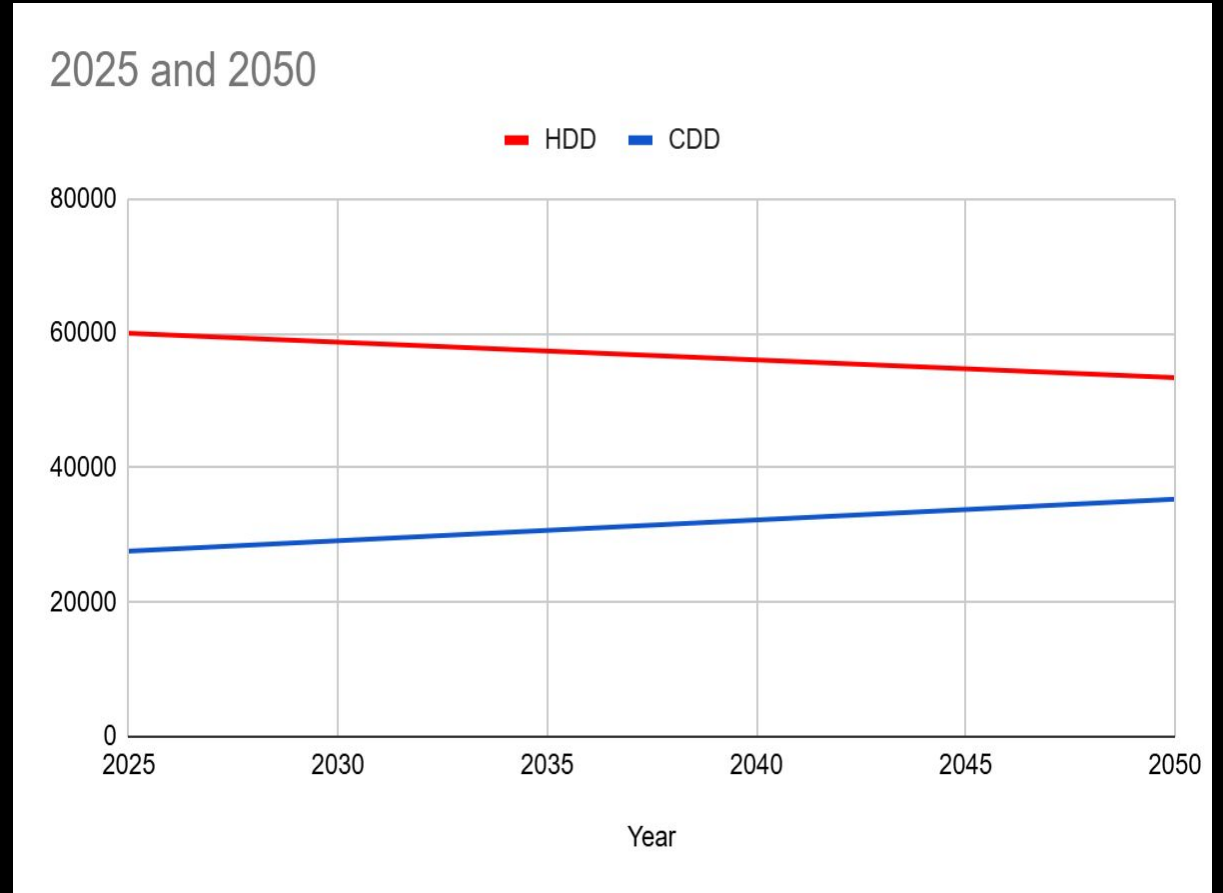
# Future Ready - Energy Resilience

Primary: AI and Human

Year	2025	2050
<b>HDD</b>	<b>60,004</b>	<b>53,404</b>
<b>CDD</b>	<b>27,596</b>	<b>35,323</b>

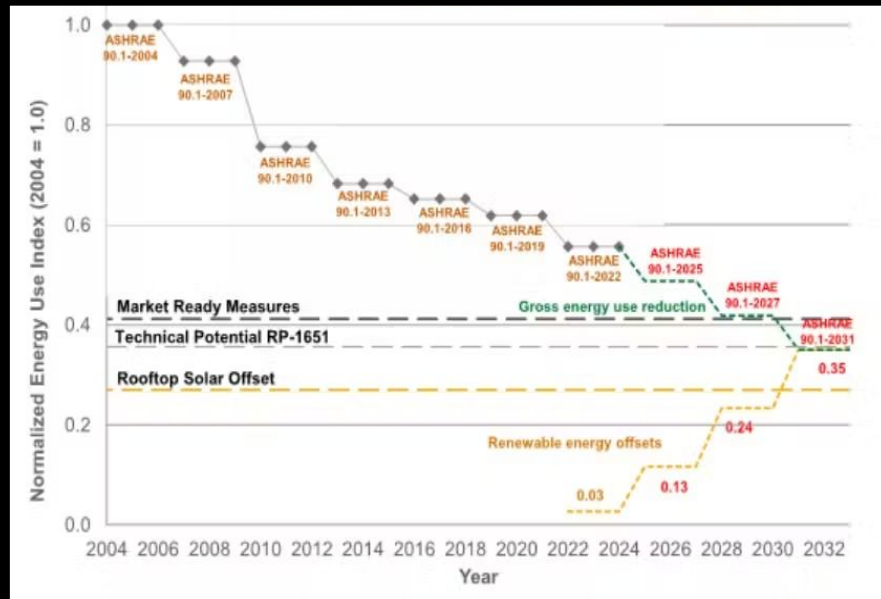
Per US EIA, trend to 2050

**11%** ↓  
**28%** ↑

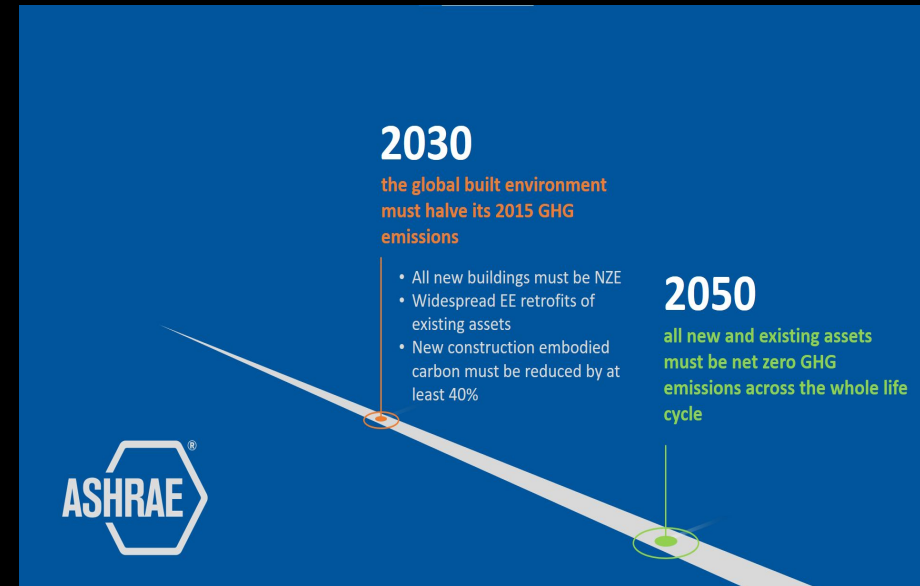


# Future Ready - Codes and Standards

## Primary: AI and Human



ASHRAE 90.1



ASHRAE 2050



# Hybrid Collaborative Teams

# Collaboration Intelligence:

Human + AI in Portfolio Efficiency

SOM