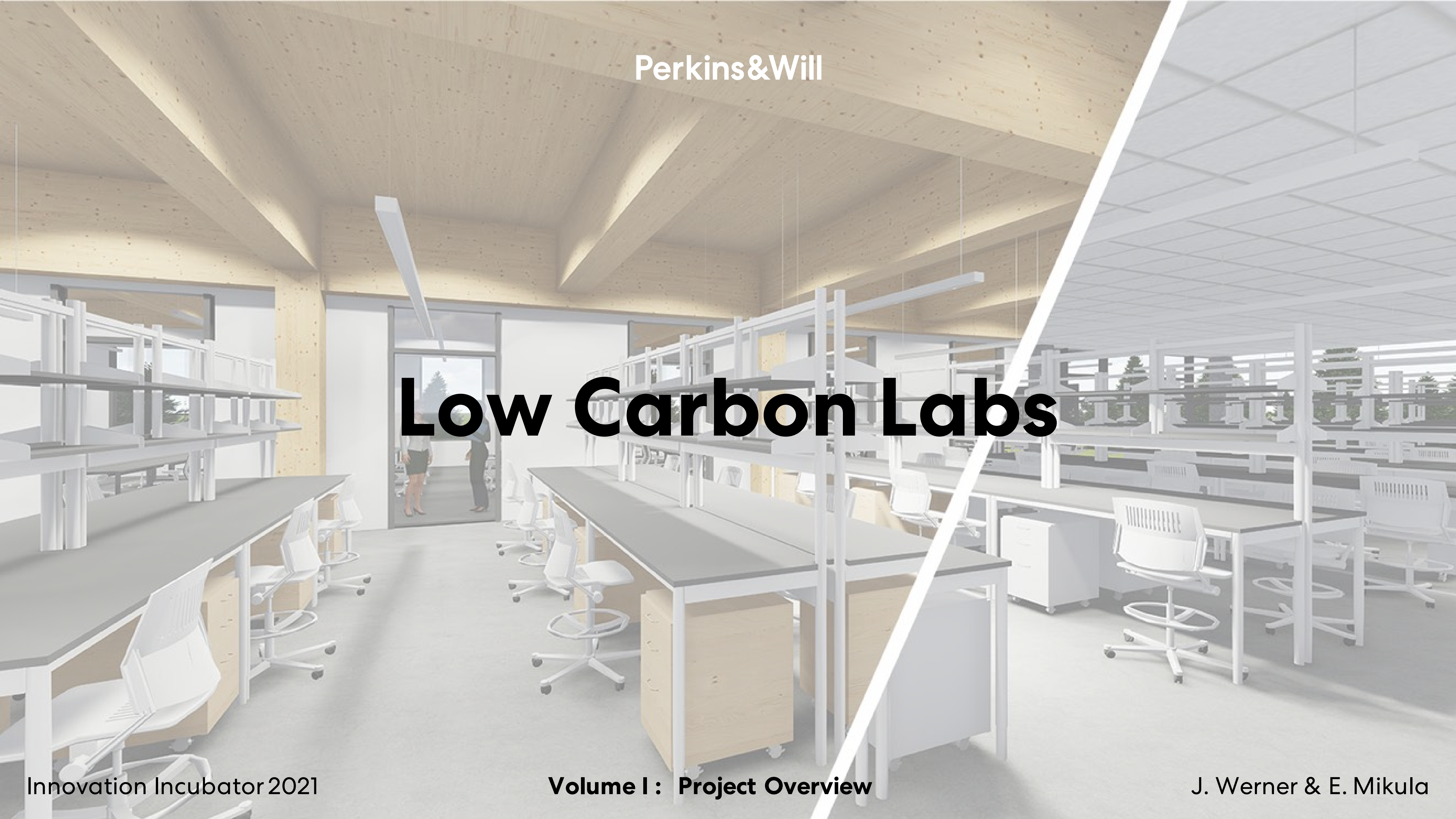
Perkins&Will



Low Carbon Labs

Innovation Incubator 2021

Volume I : Project Overview

J. Werner & E. Mikula

Low Carbon Labs - Executive Summary

Why Laboratory Embodied Carbon ?

EMBODIED CARBON - TECHNICAL BUILDINGS

LCA tools have experienced a renaissance, enabling an increasing focus on the embodied carbon impacts of structural materials in light commercial, multifamily, and residential applications. But little is known about the embodied carbon intensity of other building types and systems.

Improved design resources will enable us to make better choices at earlier design phases, leading to more beautiful design, better occupant outcomes, and less impact to our fragile climate.

WHY LABS ?

Labs are designed to support discovery and innovation. Their designs can serve as models for innovation in buildings of all types.

Lab building embodied carbon is significant, due to the intensive structure, finishes, and mechanical systems of these buildings. For example: lab building structural systems are heavier per square foot than office or residential structures, due to their vibration performance. And lab building finishes and built-in casework are significantly more robust than office equivalents.

But hard data is lacking on the embodied carbon intensity of labs and technical buildings that would allow us to quantify these differences.

LABS RE-IMAGINED

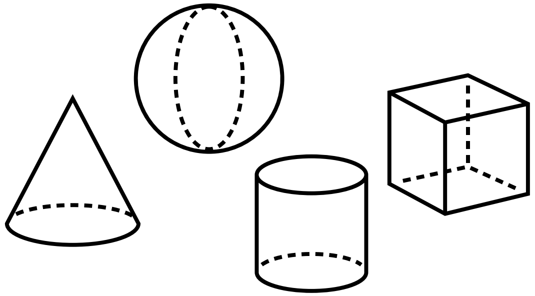
A standard kit of parts for lab planning and lab materials choices has emerged over the past 50+ years. Lab designers have become familiar with a predictable set of choices applying to many projects.

Recent projects show experimentation with a variety of design choices uncommon in laboratory buildings, such as CLT / Timber structural systems, low-carbon concrete, wood cladding, timber curtain wall, and demountable partitions. But no resource brings these experiments into a common framework for evaluating their carbon benefits.

Our goal is to daylight these strategies, quantify their benefits, and advocate for broader adoption. Our hope is this transforms how - and what - we design.

Low Carbon Labs - Executive Summary

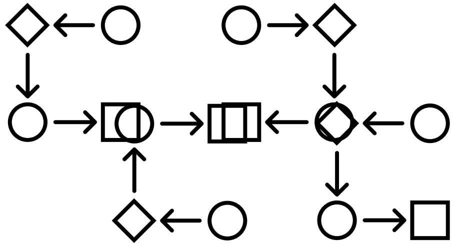
Caveats



"all models are wrong but some models are useful"

It has been said that "all models are wrong but some models are useful." In other words, any model is at best a useful fiction ... Nevertheless, enormous progress has been made by entertaining such fictions and using them as approximations. - George Box, Statistical Control: By Monitoring and Feedback Adjustment, 1997

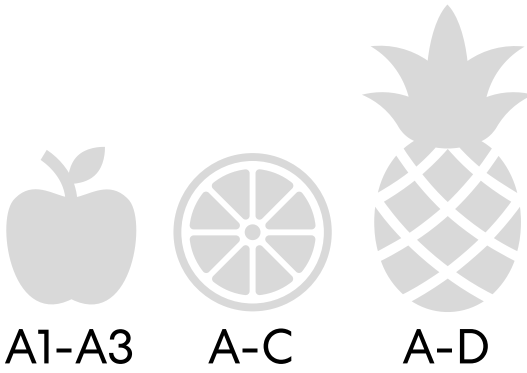
Low Carbon Labs is a simplified model of building systems. It does not include all the systems and products required to make a lab building. But it does demonstrate a method for evaluating individual design choices to improve future projects. We hope that the methods and examples help building owners and designers to contextualize the carbon impact of design choices alongside other conventional project drivers, such as scope, schedule, and cost.



Complexity

A key lesson of the study is the surprising difficulty of conducting embodied carbon analysis. There are numerous obstacles, including:

- Lack of EPD data for many products
- Wide variation in EPD scope and format
- Difficulty obtaining quantity takeoffs from design software
- Complexity of conversions between design software units and EPD reporting units
- Complexity of summarizing data across many product categories and creating holistic dashboards
- EC analysis software tools are still developing



Apples, Oranges, and Pineapples

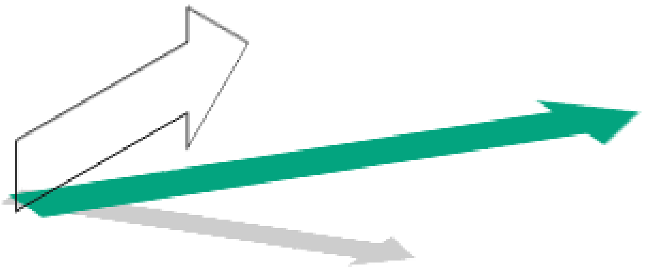
This study intentionally mixes EPD data from a variety of sources with different Product Category Rules (PCRs), modules (aka. product life cycle stages), and EPD types (ex. product specific vs. industry average).

This is out of necessity. Quality EPD data is sorely lacking for many individual products and, in some cases, for whole product categories.

To maintain "fairness" in comparisons between individual system selections, we have held the calculations within each system to consistent rules (for example, using consistent A1-A3 scope and product specific EPDs).

Low Carbon Labs - Executive Summary

Caveats

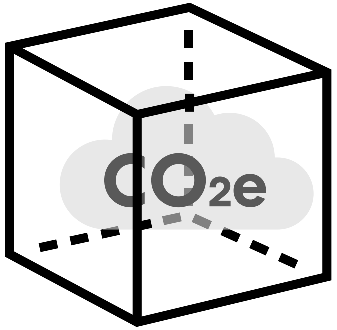


Directionality vs. Magnitude

This analysis represents a set of design choices, not a complete embodied carbon assessment of a laboratory building.

The complexity and difficulty of assessing just the products and systems included within this study belie the extraordinary difficulty of summarizing the complete Embodied Carbon picture of any building, let alone one as complex as a laboratory.

This leaves us unable to compare the total impact of various systems or design choices relative to the total Embodied Carbon impact of a whole building. For example, we are unable to say "Structure represents X% of a lab building's Embodied Carbon", because we don't know what a lab building's total embodied carbon is. Nobody does.



So what can we say about Embodied Carbon?

This study shows that many design choices have significant Embodied Carbon impact that can be easily compared to a building's Operational Carbon profile from an energy model or utility meters.

While the absolute magnitude of carbon reduction is debatable, the results clearly show that Embodied Carbon reduction options exist that are equivalent to years (or even decades) of Operational Carbon pollution.

As we have effective design choices to reduce Operational Carbon due to building energy use and building energy fuel source choices, we also have effective design choices to reduce Embodied Carbon due to building construction materials, systems, and methods.

Choose your own adventure

Is "Reimagined" right for my project?

We recognize that not all options will be possible for every laboratory project. Program differences, code / jurisdictional issues, and scope / schedule / budget drivers may place one or several system choices out of reach for a particular project.

So, we have deliberately structured "Low Carbon Labs" as a "choose your own adventure" of system-by-system choices. This has two advantages:

1. Teams can pick and choose individual options as the opportunity arises to make small, medium, or large improvements on a particular project.
2. Teams can adapt the method to evaluate additional systems, options, or choices specific to their particular interests.

Low Carbon Labs - Executive Summary

Scope and Results

SCOPE AND SYSTEMS

This study uses a 22' wide x 88' long x 1 story (15' high) "module". The 22' width reflects 2x 11' wide lab aisles. The 88' depth is composed of a 33' structural bay for computing / office work, a 33' bay for wet bench ("open lab") work, and a 22' bay for laboratory support / instrument work. This module provides a cross section of typical laboratory building space types.

The study evaluates (3) choices for each of (14) different building systems: superstructure for office and lab; building envelope (wall backup, insulation, cladding, and glazing); interior partitions; doors; floor finishes for office and labs; ceilings for office and labs; lab equipment (fumehoods); chairs; systems furniture; lab casework cabinets and countertop.

For some systems (ex. flooring), we were able to find many EPDs; thus, the challenge was picking realistic system options from many choices. For other systems (ex. lab countertops), very few EPDs were available, leading to limited system options.

SCENARIOS

The 3 scenarios (Baseline, Improved, Reimagined) are summaries of individual choices within each system type, aggregated. They don't necessarily represent a specific design case. Rather, they capture the potential for savings along a continuum of design choices. Still, the scenarios are useful to explain the potential of the individual choices when combined at the scale of a building.

The **Baseline** scenario provides a point of reference, with many system choices that can be found in conventional laboratory buildings.

Improved represents realistically achievable improvements that may be found in progressive projects.

Reimagined represents the better choices that we discovered for each system within the scope of the research study.

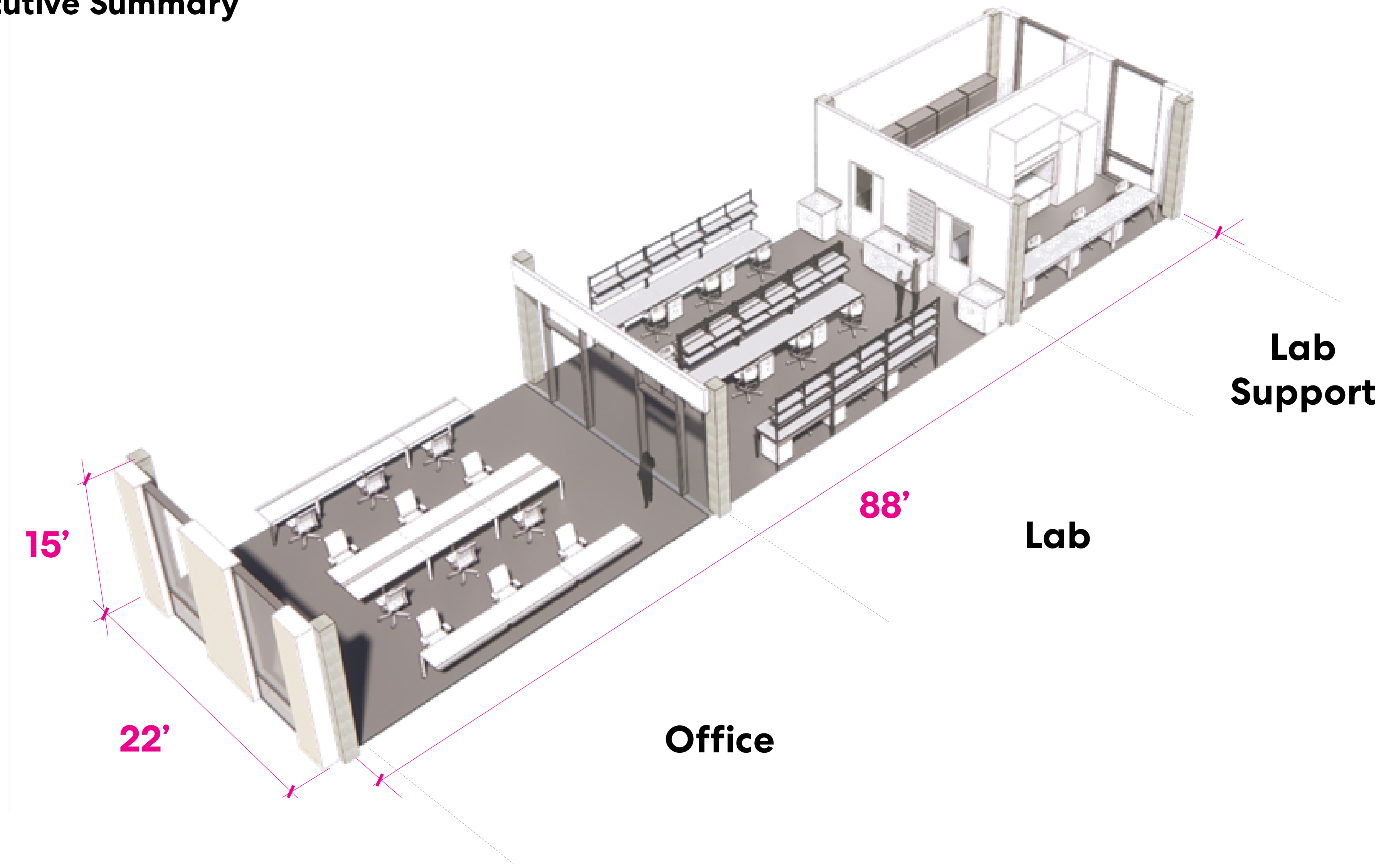
RESULTS

Baseline: The sum of the studied systems within the 22x88 module equates to ~175,000 kg CO2e/sf.

Improved: The sum of the studied systems within the 22x88 module equates to ~130,000 kg CO2e/sf, or a reduction of 26% from the baseline. The savings is equivalent to 2-7 years of operational carbon.

Reimagined: The sum of the studied systems within the 22x88 module equates to ~50,000 kg CO2e/sf, or a reduction of 73% from the baseline. The savings is equivalent to 7-20 years of operational carbon.

Scope



Systems

STRUCTURE

Special thanks to LeMessurier

ENVELOPE OPAQUE

PARTITIONS

CEILINGS

OFFICE SYSTEMS

LAB BENCHTOP

ENVELOPE GLAZING (%)

DOORS

FLOORS

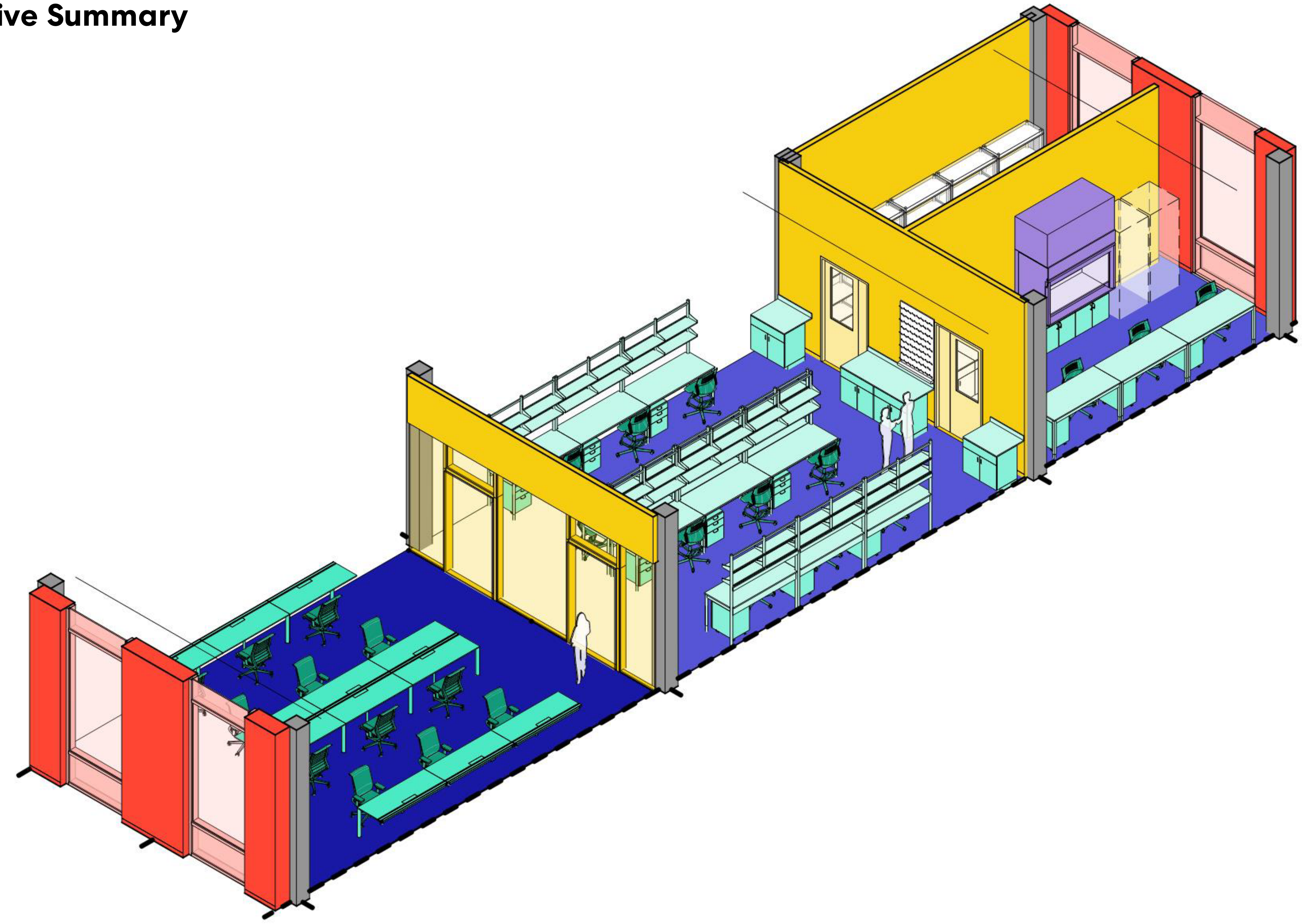
LAB CASEWORK

LAB FUMEHOODS

Special thanks to BR+A

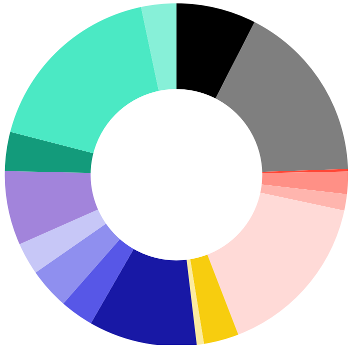
MEP SYSTEMS

Systems

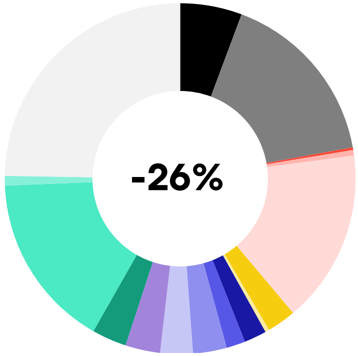


Scenarios

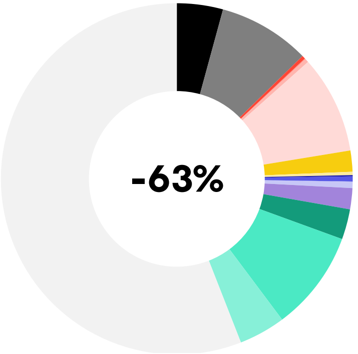
BASELINE



IMPROVED

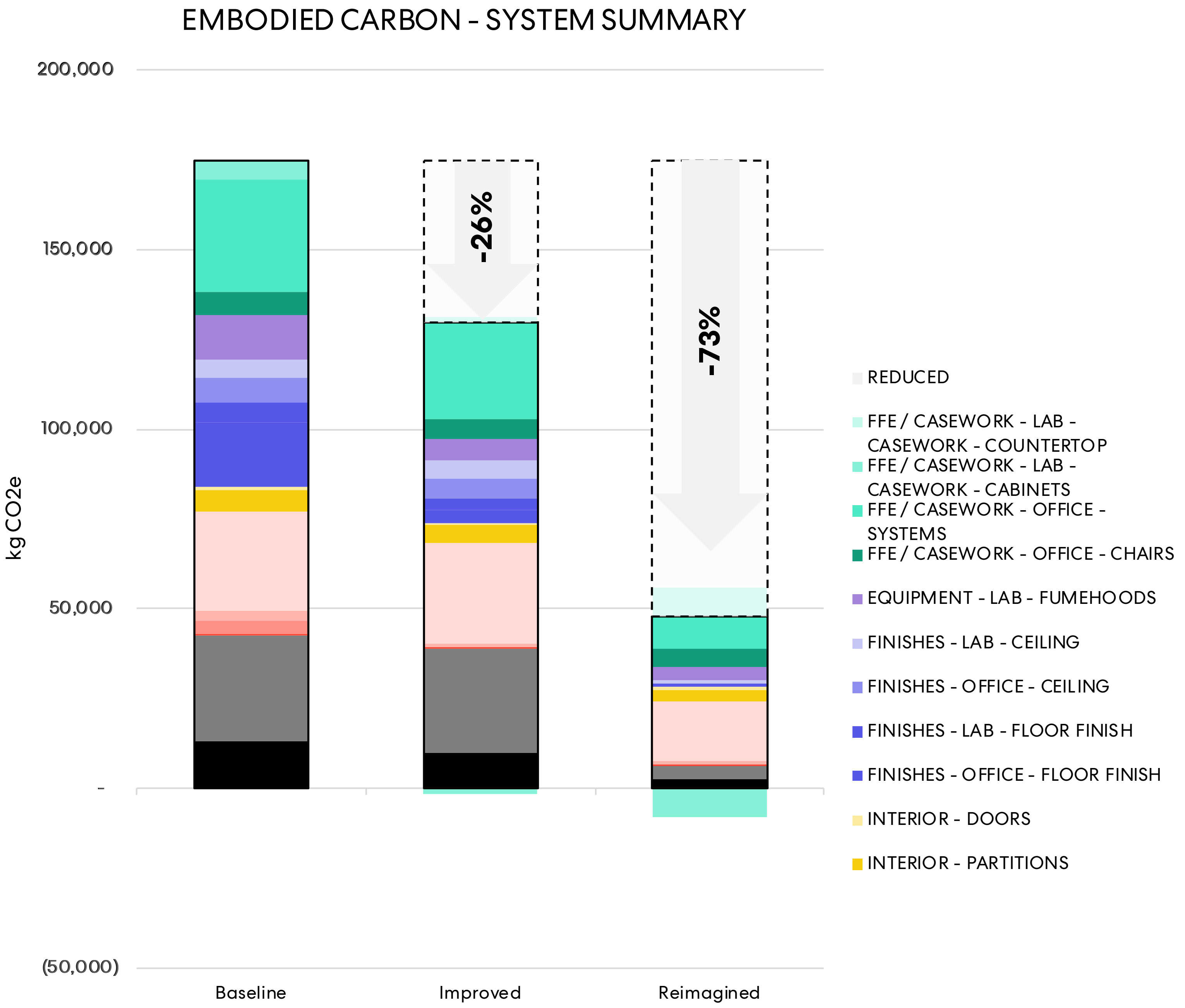


REIMAGINED



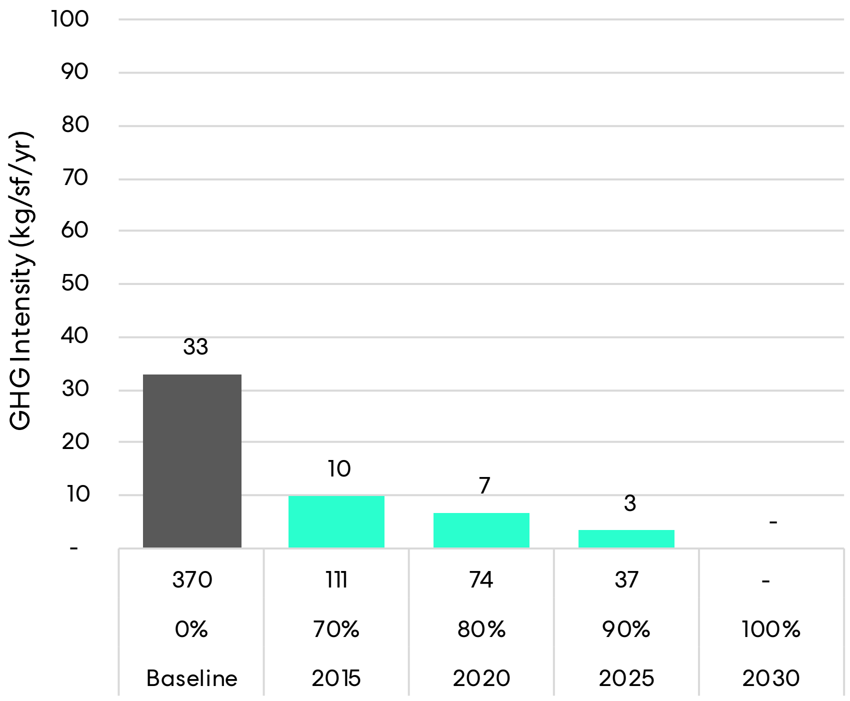
Low Carbon Labs - Executive Summary

Results



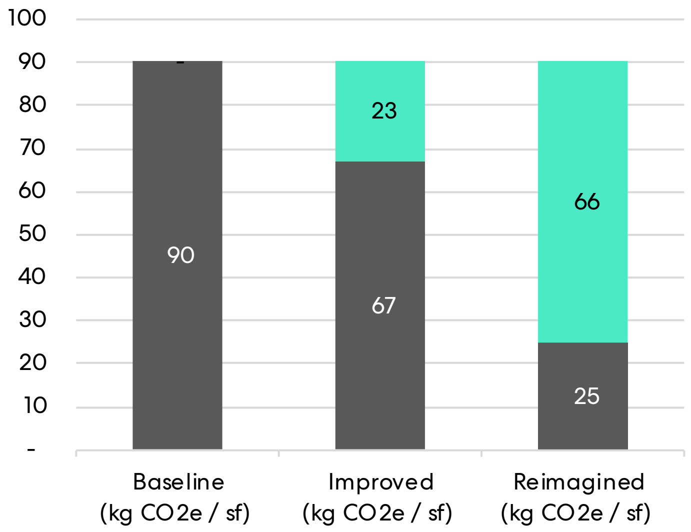
Context

Operational Carbon Intensity Labs



Site EUI (kBtu/sf/yr)
AIA 2020 % reduction
AIA 2030 Target Year

Embodied Carbon Intensity All Design Choices



Baseline	Improved	Reimagined
9-27 Years of Operation	2-7 Years of Operation Saved	7-20 Years of Operation Saved

Note: the "module" represents "net" program area of lab space. A real building would contain "gross" areas such as corridors, stairways, mechanical spaces, and storage. These may equate to 35-50% of the total building area included in the operational carbon assessments. So, the comparison of embodied carbon reduction to operational carbon may be diluted by a similar factor in practice.

Why do we care?

How We Thought We'd Do It

How We Did It

Looking Ahead

Why do we care?
(Why We Need the Data)

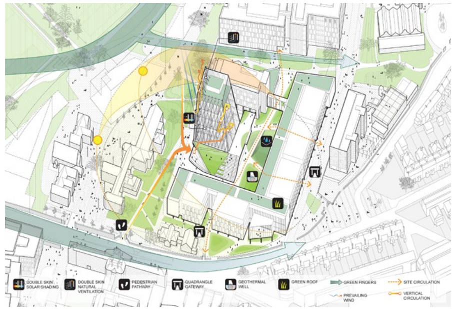
Low Carbon Labs

Who's Asking?

FOCAS

Technical University Dublin

Ireland, 2020



Competition Brief - Stage I

Strategic Objectives

It is the GDA's ambition to develop an enduring, adaptable and environmentally responsible building, which is of its place and reflective of the progressive ethos of TU Dublin, its staff, students and its research programmes.

The following objectives support that ambition:

Research
To develop a research Institute that underpins TU Dublin's research strategy and facilitates growth in research numbers at TU Dublin. FOCAS must be an open, collaborative and enriching learning environment that will support the development of interdisciplinary work.

Environmental Responsibility
To make a beautiful, useful and environmentally responsible building. The project design solutions must support reduced carbon impacts in terms of the building operation, its life cycle and also embodied carbon.

Sustainability & Climate Action

Site wide Sustainability Strategy
The GDA is committed to meeting the requirements of the Programme for Government and the Climate Action & Low Carbon Development Act.

Collective Ambition
Developing a culture of awareness of environmental responsibility around the design, delivery and occupancy of FOCAS is an important consideration.

The architect as Team Lead must be able to engender and support a culture that encourages integration and innovation of sustainable and low carbon solutions.

Embodied Carbon
This project targets an outcome of a minimum of 40% reduction in upfront embodied carbon compared to a baseline. The baseline is the current RIBA referenced M4i benchmark of 1,000kg CO2e/m2. This is considered to be a minimum target, the Design Team must work to maximise reductions and review all emerging guidance and benchmarks particularly during preliminary design (CWMF Work Stage (i)).

A range of solutions and opportunities must be considered in the reduction of embodied carbon. It is anticipated that integration of structure, facade, service strategies and fire engineering will be critical in the success of a low embodied carbon solution.

The potential for off-site, modular construction and low carbon materials such as mass timber/ mass timber hybrid both to affect whole life carbon and minimise time-on-site must be interrogated as fundamental design principles.

Life Cycle Assessment & Life Cycle Costs
Both of these targets for embodied and operational carbon sit under the concept of 'Whole Life Net Carbon' and circular design as structured in BS EN 15978. The carrying out of Life Cycle Assessments and integrating this into the design process to support and check these targets will form part of the Design Team scope.

Developing a Preliminary Design

FOCAS is an innovative and distinctive Institute and it is expected that this way of thinking and working be reflected in an approach to pedagogy.

The Design Team will develop strategies for carbon reduction and environmental responsibility, defining further targets and metrics appropriate to the project. This will be done in collaboration with the GDA and TU Dublin. It will be critical to the ongoing success of the project in meeting all targets that are set that strategies are developed with a full understanding of value and measured against agreed benchmarks. Upfront and life cycle costs must be understood, measured and demonstrated.

Competition Regulations

Competition Brief

This Competition relates to TU Dublin's FOCAS Research Institute (FOCAS), originally the Facility for Optical Characterisation and Spectroscopy. TU Dublin is Ireland's first Technological University, its City Campus at Grangegorman is being developed by the GDA.

FOCAS is an existing TU Dublin research institute which will be relocated to the Grangegorman City Campus. The Competition Brief and supporting information for FOCAS are available from the GDA website. Entrants will be provided with a full access following successful registration to participate in the Competition.

The aspirations and guiding principles of the project are underpinned by project objectives. These are set out in the Competition Brief and include:

Research
To develop a research Institute that underpins TU Dublin's Research strategy and facilitates growth in research numbers at TU Dublin. FOCAS must be an open, collaborative and enriching learning environment that will support the development of interdisciplinary work.

Environmental Responsibility
To make a beautiful, useful and environmentally responsible building. The project design solutions must support reduced carbon impacts in terms of the building operation, its life cycle and also embodied carbon.

Design Approach - Response Requirements

Stage II is an opportunity for Entrants to develop their Stage I submission. Entrants must further demonstrate their understanding of the needs and requirements set out in the Project Brief.

Entrants are particularly asked to illustrate an approach to the following:

Atmosphere – The making of an open, collaborative and enriching learning environment that will support the development of interdisciplinary research;

Adaptability – Spatial adaptability considering evolution of use and research activities as well as enduring 'loose fit' design solutions; and

Construction – Investigate the potential of mass-timber and composite technology, low-carbon materials and off site fabricating with reduced on-site assembly. Solutions should address opportunities of modularity and sequencing of the construction works to minimise time-on-site and maximise the potential for disassembly and re-use.

Submissions will be evaluated based on their response to the above with reference to an understanding of the Brief and project requirements.

Design Statement - Response Requirements

In the Design Statement, Entrants must address three topics. The response to this section must be aligned to the Entrants' Design Approach.

a. Design

Entrants must describe their design strategy to realise the project brief - in particular Whole Life Carbon objectives.

This strategy should be succinct in describing proposed methods for working with and leading design solutions with the Design Team - in particular addressing the collaboration across competencies beyond the Team Lead's expertise.

The strategy must specifically reflect the requirement to work with the GDA and TU Dublin in developing a Definitive Project Brief as part of Work Stage (i).

How We Thought We'd Do It

Tally

Tally, a tool originally developed by Kieran Timberlake, “allows Revit users to imbue their BIM with the complete information about the building materials and architectural products their structures will ultimately contain. Tally quantifies a building or material's embodied environmental impacts to land, air, and water systems...Tally gives its users the power to conduct whole building LCAs during design and to use LCA data to run comparative analyses of various design options that show their differing environmental impacts. ”

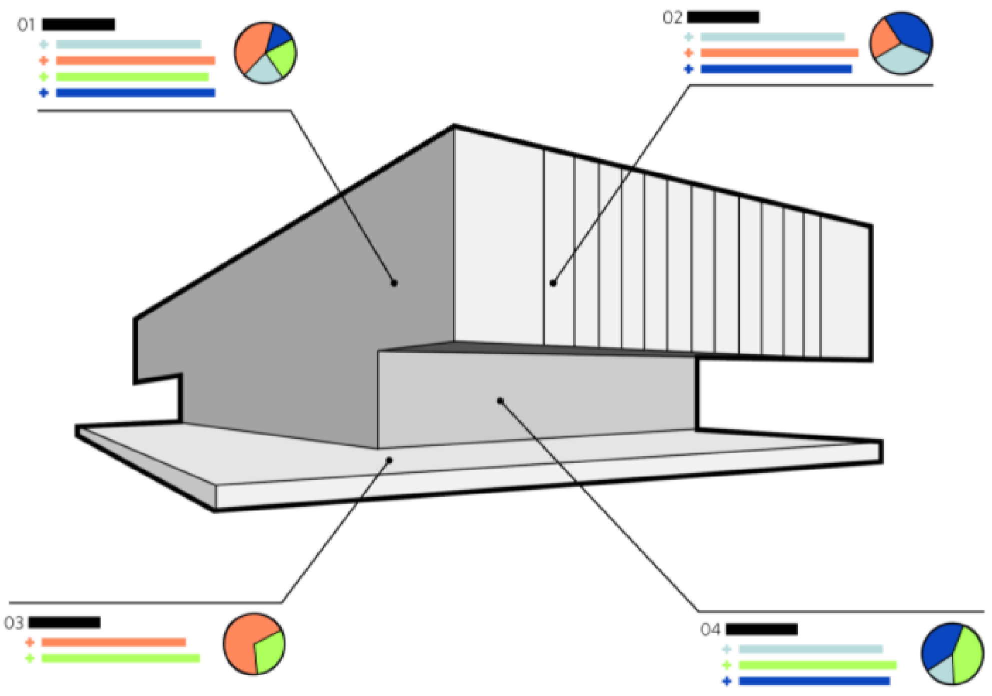
- https://kierantimberlake.com/page/tally

tally®

About▾ Learn▾

WEBINARS

To learn more about LCA and Tally watch the recorded webinars below. Topics range from LCA for designers to interpreting data and achieving the LEED v4 Whole Building Life-Cycle Impact Reduction credit.



Re-framing Steel: How to Optimize Your Steel Structure to Reduce Embodied Impacts

https://choosetally.com/webinars/

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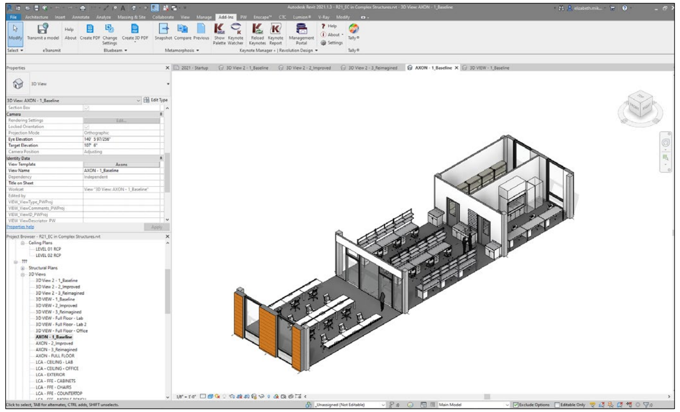
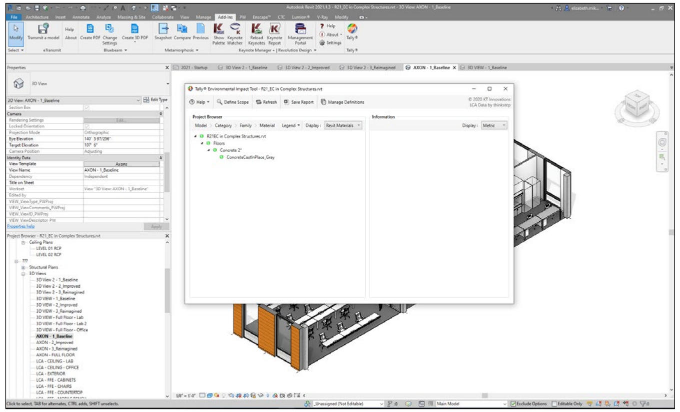




Model in Revit

Model lab module in Revit, utilizing design options to include Baseline, Improved and Reimagined scenarios

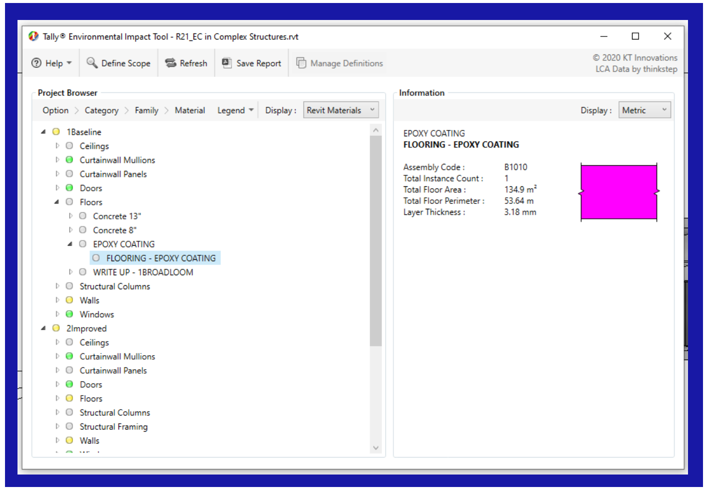
Use Tally to Assign Materials

Utilizing Tally Revit Plug-in, assign materials aligned with materials specified in Laboratory projects

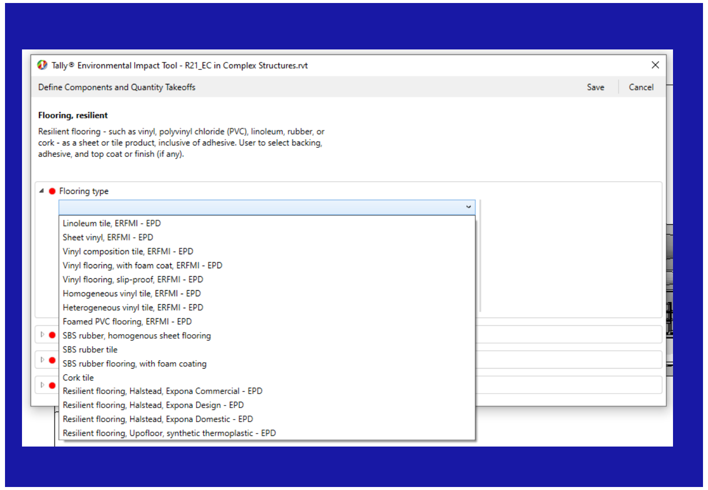
Report produced by Tally for Material Assessment

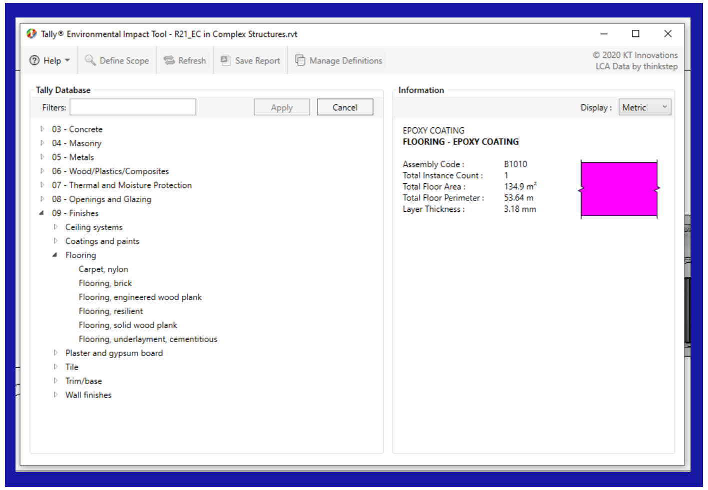
Tally

Low Carbon Labs



Material Categories currently available in Tally cover some, but not all categories relevant to an embodied carbon in laboratories analysis.



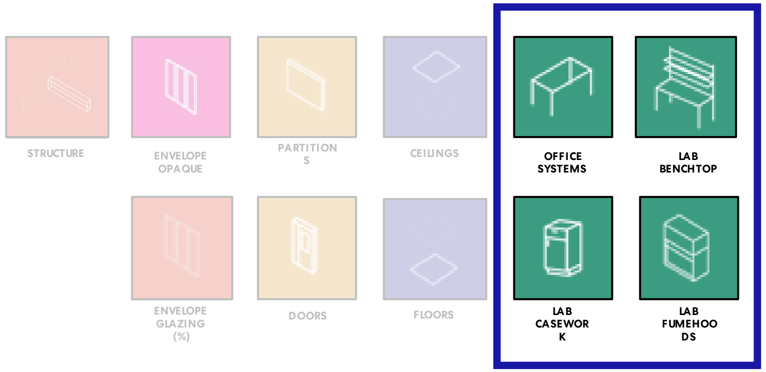


For available categories, material options currently available in Tally do not yet include the laboratory finishes typically specified.

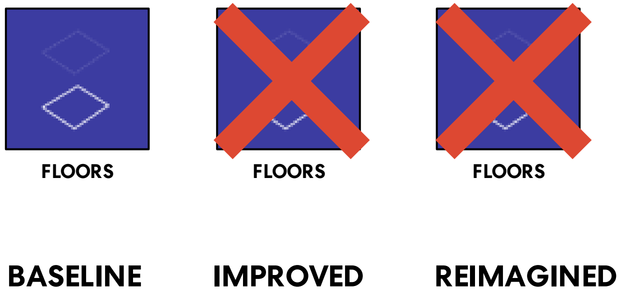
Tally

Low Carbon Labs

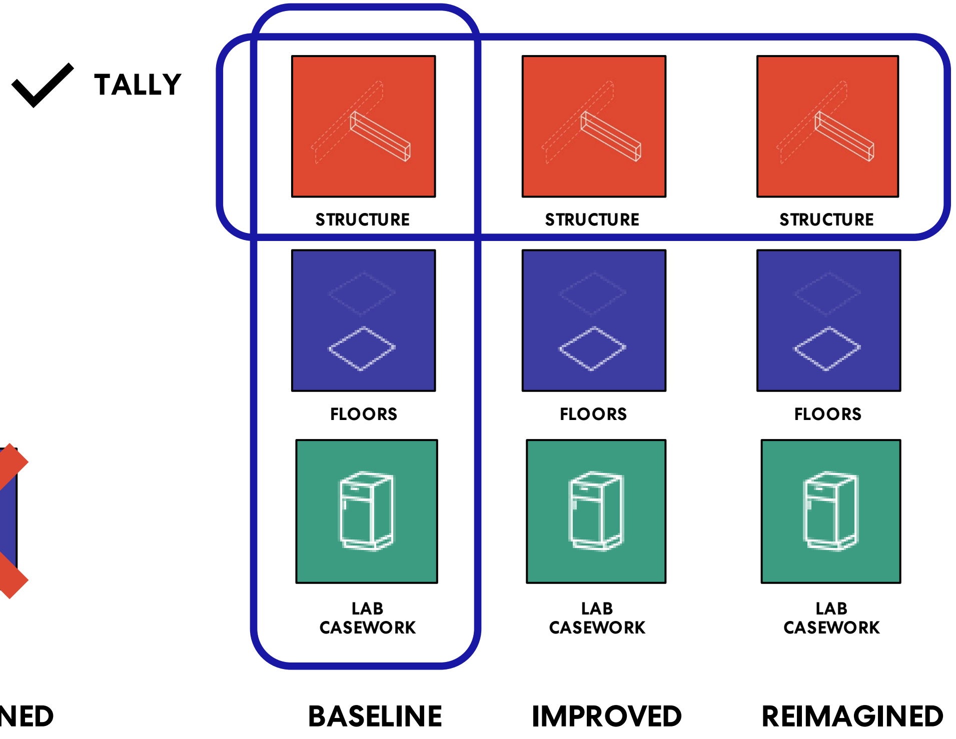
Tally



Whole systems not available in Tally –lab casework, equipment, office/writeup furniture systems.



When the system is available, the products we specify aren't available – flooring is available to analyze, but not the flooring we are looking to analyze.



Tally assessment is geared towards whole-building LCA – could not review system by system, to understand individual impact of specific material choice.

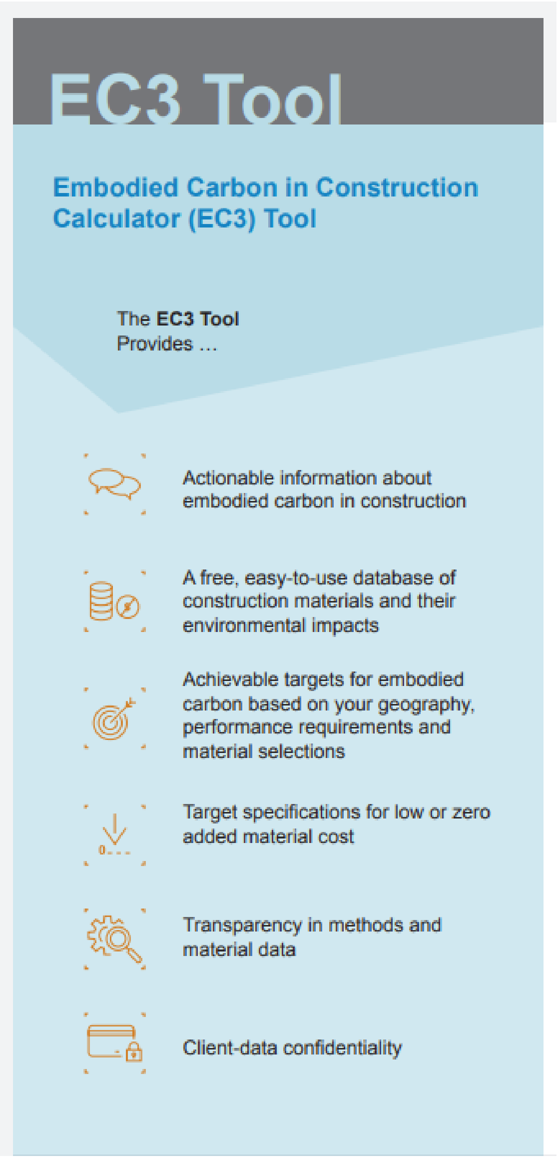
EC3

"**The Embodied Carbon in Construction Calculator (EC3) tool**, is a …tool that allows benchmarking, assessment and reductions in embodied carbon, …The EC3 tool …utilizes building material quantities from construction estimates and/or BIM models and a robust database of digital, third-party verified Environmental Product Declarations (EPDs).

The tool and its subsequent effect on the industry is driving demand for low-carbon solutions and incentivizing construction materials manufacturers and suppliers to invest in disclosure, transparency and material innovations that reduce the carbon emissions of their products."

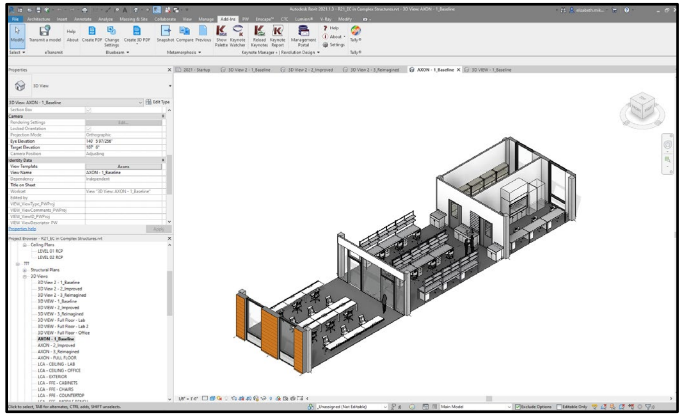
- https://carbonleadershipforum.org/what-we-do/initiatives/ec3/

EC3

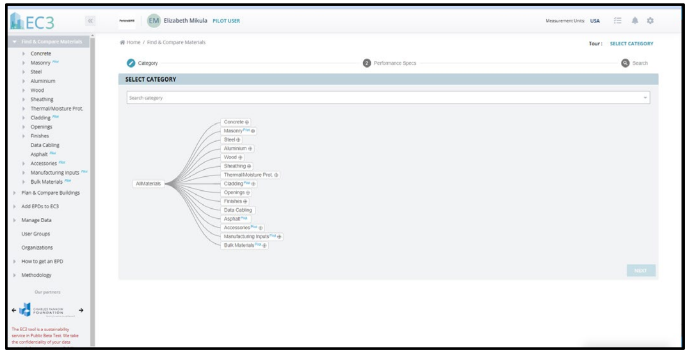


https://buildingtransparency-live-87c7ea3ad4714-809eeaa.divio-media.com/filer_public/61/f3/61f3b402-7627-402b-82ee-3619eb91525e/ec3_product_brief_pdf.pdf

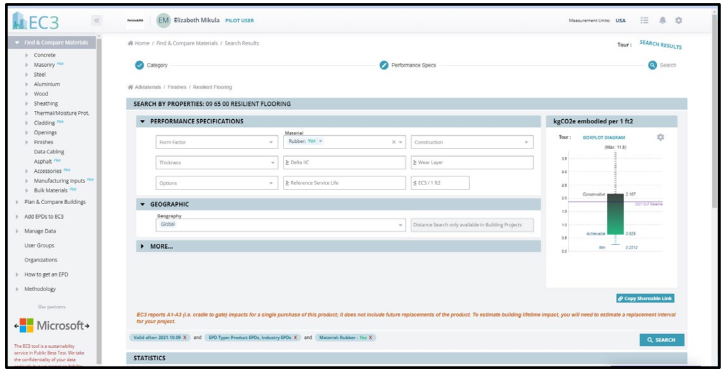
Low Carbon Labs



Model in Revit

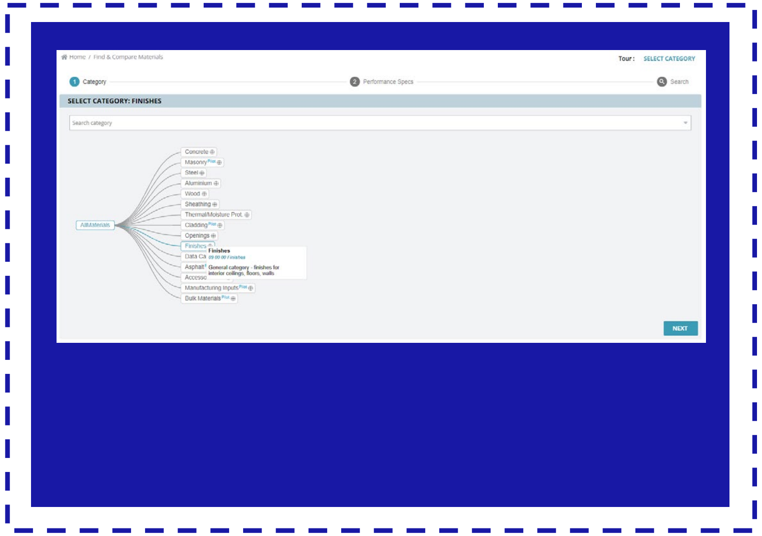


Import to EC3 from BIM360

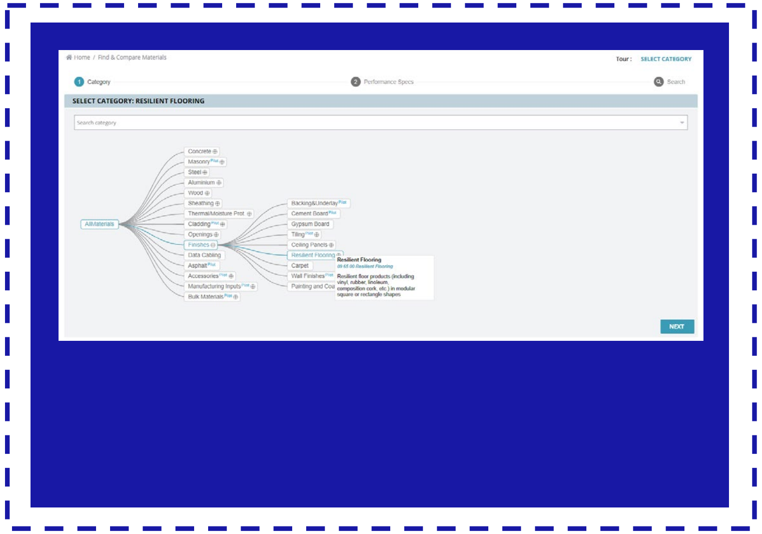


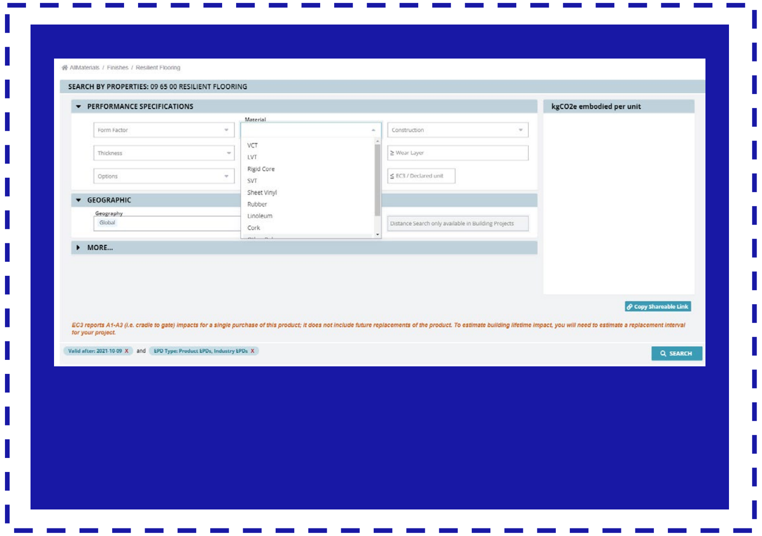
Assign Materials and Compare Options in EC3

Low Carbon Labs



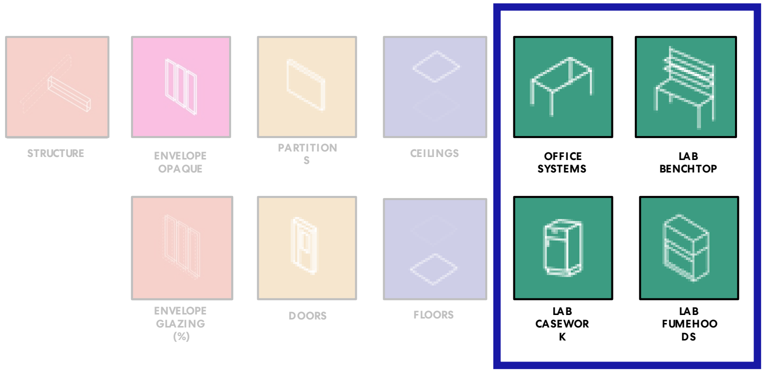
Material Categories currently available in EC3 cover some, but not all categories relevant to an embodied carbon in laboratories analysis. (even with Pilot program access)

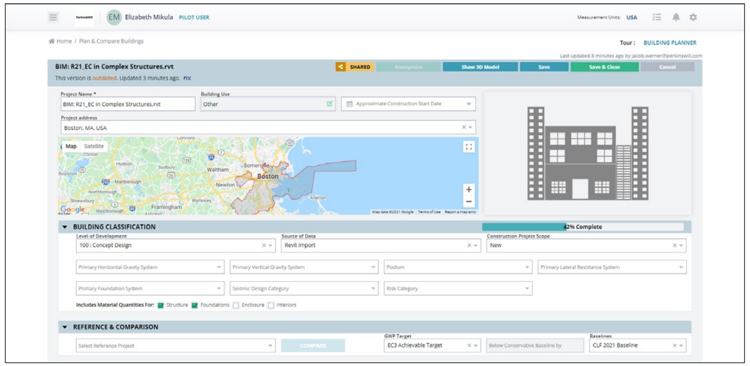


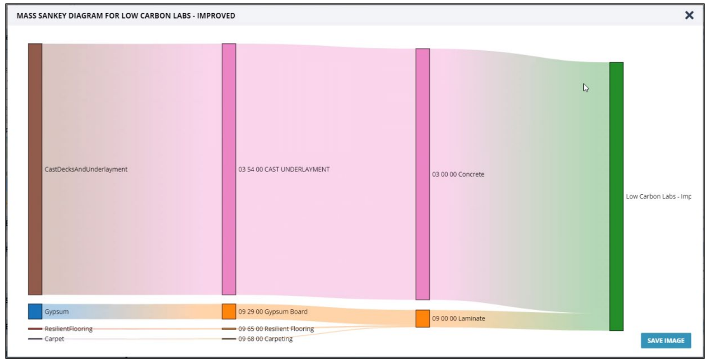


For available categories, material options currently available in EC3 do not yet include the laboratory finishes typically specified.

EC3







Similar to Tally, challenges with lack of systems and lack of options within systems.

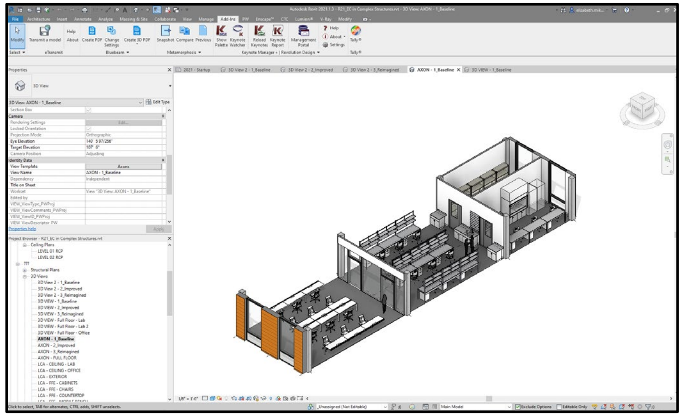
EC3 tool is aimed for use during a specific phase of the construction process; the level of information required for input is often not available early in design phases.

Formatting information for option comparison is difficult.

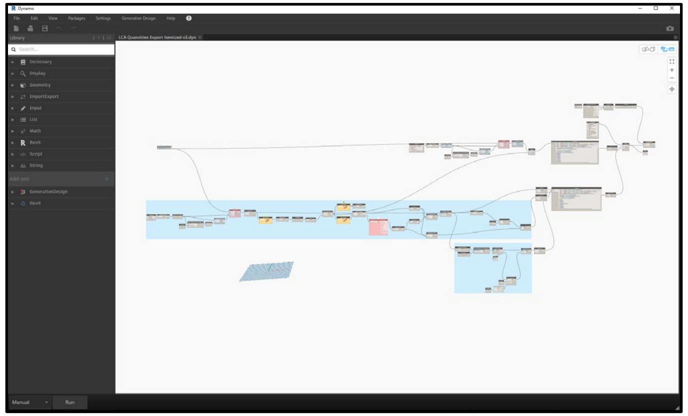
How We Did It

Method

Low Carbon Labs

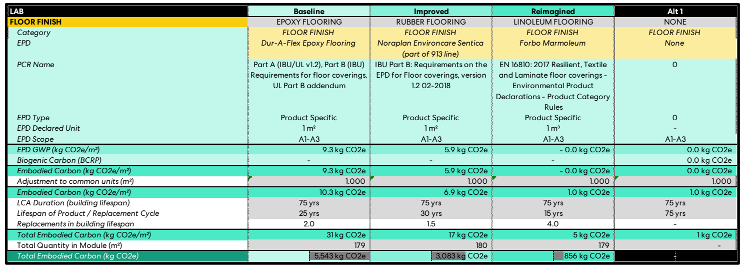


Model in Revit

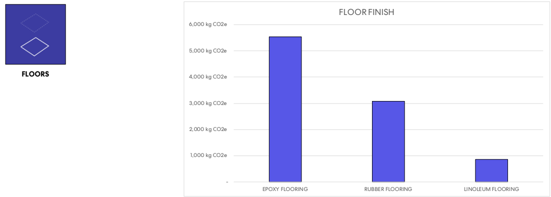


Use Dynamo to Extract Information

Utilize Dynamo script to extract material quantity data



LAB	Baseline	Improved	Reimagined	Alt 1
FLOOR FINISH	EPOXY FLOORING	RUBBER FLOORING	LINOLEUM FLOORING	NONE
Category	FLOOR FINISH	FLOOR FINISH	FLOOR FINISH	FLOOR FINISH
EPD	Dur-A-Flex Epoxy Flooring	Noraplan Environcare Sentica (part of 913 line)	Forbo Marmoleum	None
PCR Name	Part A (IBU/UL v1.2), Part B (IBU) Requirements for floor coverings. UL Part B addendum	IBU Part B: Requirements on the EPD for Floor coverings, version 1.2 02-2018	EN 16810: 2017 Resilient, Textile and Laminate floor coverings - Environmental Product Declarations - Product Category Rules	0
EPD Type	Product Specific	Product Specific	Product Specific	0
EPD Declared Unit	1 m²	1 m²	1 m³	-
EPD Scope	A1-A3	A1-A3	A1-A3	A1-A3
EPD GWP (kg CO2e/m²)	9.3 kg CO2e	5.9 kg CO2e	- 0.0 kg CO2e	0.0 kg CO2e
Biogenic Carbon (BCRP)	-	-	-	0.0 kg CO2e
Embodied Carbon (kg CO2e/m²)	9.3 kg CO2e	5.9 kg CO2e	- 0.0 kg CO2e	0.0 kg CO2e
Adjustment to common units (m²)	1.000	1.000	1.000	1.000
Embodied Carbon (kg CO2e/m²)	10.3 kg CO2e	6.9 kg CO2e	1.0 kg CO2e	1.0 kg CO2e
LCA Duration (building lifespan)	75 yrs	75 yrs	75 yrs	75 yrs
Lifespan of Product / Replacement Cycle	25 yrs	30 yrs	15 yrs	75 yrs
Replacements in building lifespan	2.0	1.5	4.0	-
Total Embodied Carbon (kg CO2e/m²)	31 kg CO2e	17 kg CO2e	5 kg CO2e	1 kg CO2e
Total Quantity in Module (m²)	179	180	179	-
Total Embodied Carbon (kg CO2e)	5,543 kg CO2e	3,083 kg CO2e	856 kg CO2e	-



Pivot Data collected from Revit with Data collected from EPDs

Utilize database created with specific laboratory materials to manually analyze with material quantity data pulled from Revit model

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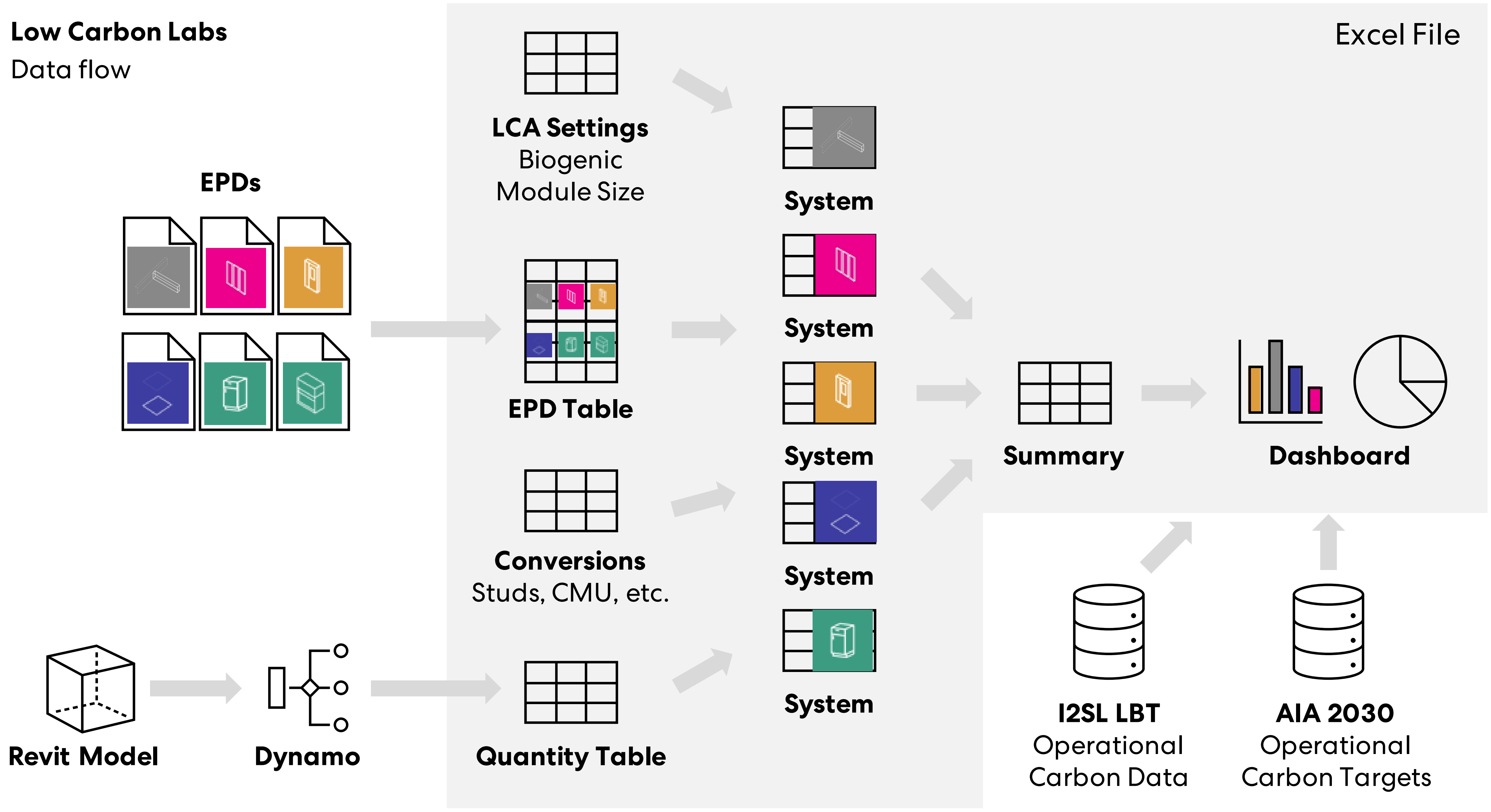
Data flow



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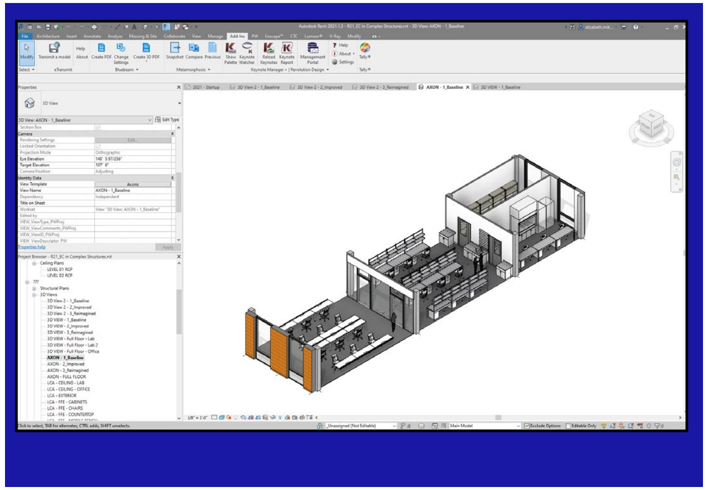
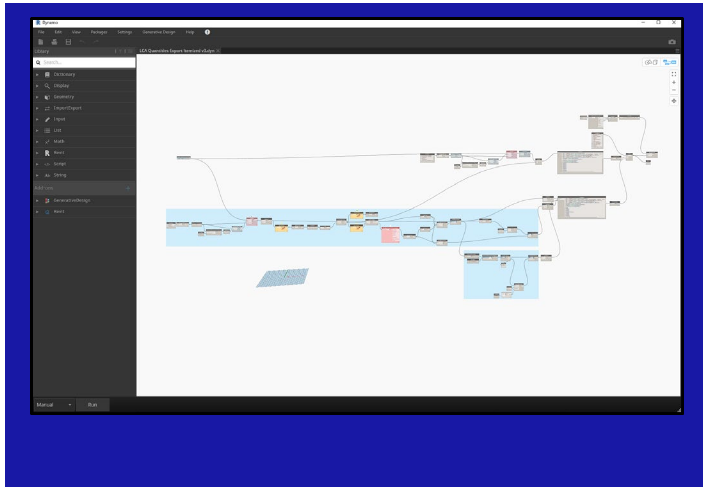
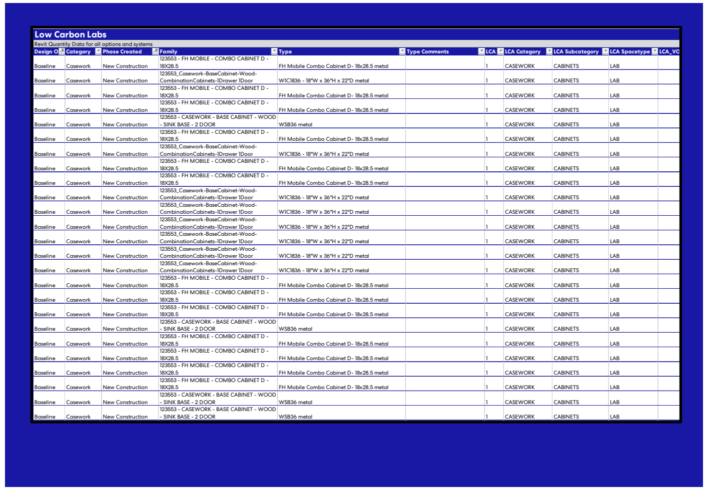


Use module modeled in Revit, to pull relevant material quantity data via Dynamo script.





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Revit Quantity Data for all options and systems

Design O	Category	Phase Created	Family	Type	Type Comments	LCA	LCA Category	LCA Subcategory	LCA Spacetype	LCA_VO
Baseline	Casework	New Construction	123553 - FH MOBILE - COMBO CABINET D - 18X28.5	FH Mobile Combo Cabinet D- 18x28.5 metal		1	CASEWORK	CABINETS	LAB	
Baseline	Casework	New Construction	123553_Casework-BaseCabinet-Wood-CombinationCabinets-1Drawer 1Door	W1C1836 - 18"W x 36"H x 22"D metal		1	CASEWORK	CABINETS	LAB	
Baseline	Casework	New Construction	123553 - FH MOBILE - COMBO CABINET D - 18X28.5	FH Mobile Combo Cabinet D- 18x28.5 metal		1	CASEWORK	CABINETS	LAB	
Baseline	Casework	New Construction	123553 - FH MOBILE - COMBO CABINET D - 18X28.5	FH Mobile Combo Cabinet D- 18x28.5 metal		1	CASEWORK	CABINETS	LAB	
Baseline	Casework	New Construction	123553 - CASEWORK - BASE CABINET - WOOD - SINK BASE - 2 DOOR	WSB36 metal		1	CASEWORK	CABINETS	LAB	
Baseline	Casework	New Construction	123553 - FH MOBILE - COMBO CABINET D - 18X28.5	FH Mobile Combo Cabinet D- 18x28.5 metal		1	CASEWORK	CABINETS	LAB	
Baseline	Casework	New Construction	123553_Casework-BaseCabinet-Wood-CombinationCabinets-1Drawer 1Door	W1C1836 - 18"W x 36"H x 22"D metal		1	CASEWORK	CABINETS	LAB	
Baseline	Casework	New Construction	123553 - FH MOBILE - COMBO CABINET D - 18X28.5	FH Mobile Combo Cabinet D- 18x28.5 metal		1	CASEWORK	CABINETS	LAB	
Baseline	Casework	New Construction	123553 - FH MOBILE - COMBO CABINET D - 18X28.5	FH Mobile Combo Cabinet D- 18x28.5 metal		1	CASEWORK	CABINETS	LAB	
Baseline	Casework	New Construction	123553_Casework-BaseCabinet-Wood-CombinationCabinets-1Drawer 1Door	W1C1836 - 18"W x 36"H x 22"D metal		1	CASEWORK	CABINETS	LAB	
Baseline	Casework	New Construction	123553_Casework-BaseCabinet-Wood-CombinationCabinets-1Drawer 1Door	W1C1836 - 18"W x 36"H x 22"D metal		1	CASEWORK	CABINETS	LAB	
Baseline	Casework	New Construction	123553_Casework-BaseCabinet-Wood-CombinationCabinets-1Drawer 1Door	W1C1836 - 18"W x 36"H x 22"D metal		1	CASEWORK	CABINETS	LAB	
Baseline	Casework	New Construction	123553_Casework-BaseCabinet-Wood-CombinationCabinets-1Drawer 1Door	W1C1836 - 18"W x 36"H x 22"D metal		1	CASEWORK	CABINETS	LAB	
Baseline	Casework	New Construction	123553_Casework-BaseCabinet-Wood-CombinationCabinets-1Drawer 1Door	W1C1836 - 18"W x 36"H x 22"D metal		1	CASEWORK	CABINETS	LAB	
Baseline	Casework	New Construction	123553_Casework-BaseCabinet-Wood-CombinationCabinets-1Drawer 1Door	W1C1836 - 18"W x 36"H x 22"D metal		1	CASEWORK	CABINETS	LAB	
Baseline	Casework	New Construction	123553 - FH MOBILE - COMBO CABINET D - 18X28.5	FH Mobile Combo Cabinet D- 18x28.5 metal		1	CASEWORK	CABINETS	LAB	
Baseline	Casework	New Construction	123553 - FH MOBILE - COMBO CABINET D - 18X28.5	FH Mobile Combo Cabinet D- 18x28.5 metal		1	CASEWORK	CABINETS	LAB	
Baseline	Casework	New Construction	123553 - FH MOBILE - COMBO CABINET D - 18X28.5	FH Mobile Combo Cabinet D- 18x28.5 metal		1	CASEWORK	CABINETS	LAB	
Baseline	Casework	New Construction	123553 - CASEWORK - BASE CABINET - WOOD - SINK BASE - 2 DOOR	WSB36 metal		1	CASEWORK	CABINETS	LAB	
Baseline	Casework	New Construction	123553 - FH MOBILE - COMBO CABINET D - 18X28.5	FH Mobile Combo Cabinet D- 18x28.5 metal		1	CASEWORK	CABINETS	LAB	
Baseline	Casework	New Construction	123553 - FH MOBILE - COMBO CABINET D - 18X28.5	FH Mobile Combo Cabinet D- 18x28.5 metal		1	CASEWORK	CABINETS	LAB	
Baseline	Casework	New Construction	123553 - FH MOBILE - COMBO CABINET D - 18X28.5	FH Mobile Combo Cabinet D- 18x28.5 metal		1	CASEWORK	CABINETS	LAB	
Baseline	Casework	New Construction	123553 - FH MOBILE - COMBO CABINET D - 18X28.5	FH Mobile Combo Cabinet D- 18x28.5 metal		1	CASEWORK	CABINETS	LAB	
Baseline	Casework	New Construction	123553 - CASEWORK - BASE CABINET - WOOD - SINK BASE - 2 DOOR	WSB36 metal		1	CASEWORK	CABINETS	LAB	
Baseline	Casework	New Construction	123553 - CASEWORK - BASE CABINET - WOOD - SINK BASE - 2 DOOR	WSB36 metal		1	CASEWORK	CABINETS	LAB	

Once pulled from Revit via Dynamo, information is available in Excel for analysis.

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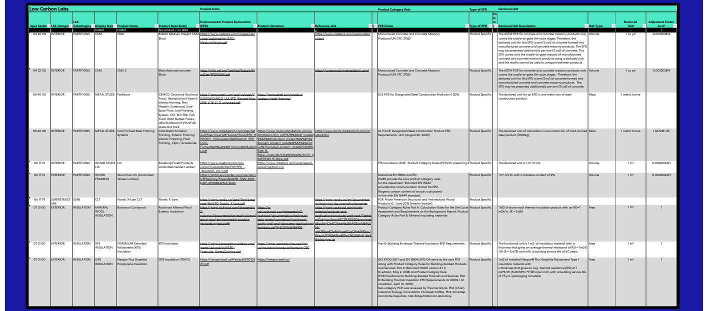
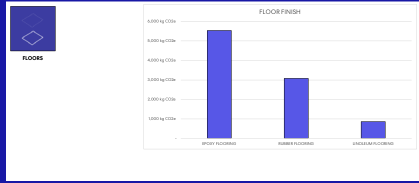


Given the specificity of laboratory material selection, a separate EPD resource was created to reference, listing products typically specified.

EMBODIED CARBON - SYSTEM SUMMARY						
LAST UPDATED:	10/10/2021	Baseline	Improved	Reimagined	Choose Your Adventure	Notes
	BUILDING STRUCTURE					
-	SUPERSTRUCTURE	.	.	.	.	
-	SUPERSTRUCTURE - OFFICE (STRENGTH)	CONCRETE (22X33)	STEEL (22X33)	TIMBER (22X22)	CONCRETE (22X33)	
		13,213 kg CO2e	10,091 kg CO2e	7,768 kg CO2e	13,213 kg CO2e	
-	SUPERSTRUCTURE - LABORATORY (VCA)	CONCRETE (22X33)	STEEL (22X33)	TIMBER (22X22)	CONCRETE (22X33)	
		29,766 kg CO2e	29,161 kg CO2e	15,488 kg CO2e	29,766 kg CO2e	
	ARCHITECTURE AND INTERIORS					
-	BUILDING ENVELOPE	.	.	.	.	Notes
-	WALL BACKUP	CMU + DRYWALL FINISH	METAL STUDS + DRYWALL FINISH	WOOD FRAMING + DRYWALL FINIS	METAL STUDS + DRYWALL FINISH	
		417 kg CO2e	399 kg CO2e	572 kg CO2e	399 kg CO2e	
07 00 00	INSULATION	XPS INSULATION	SPF INSULATION	MINERAL WOOL INSULATION	SPF INSULATION	
		3,708 kg CO2e	97 kg CO2e	140 kg CO2e	97 kg CO2e	
-	CLADDING	TERRACOTTA CLADDING	METAL PANEL CLADDING	FIBER CEMENT CLADDING	FIBER CEMENT CLADDING	
		2,712 kg CO2e	822 kg CO2e	629 kg CO2e	629 kg CO2e	Terracotta EPD contains backup framing, others do not
08 00 00	GLAZING	ALUMINUM STOREFRONT	ALUMINUM STOREFRONT	ALUMINUM STOREFRONT	ALUMINUM STOREFRONT	
		27,718 kg CO2e	28,334 kg CO2e	16,528 kg CO2e	27,718 kg CO2e	Comparison of design quantity. Limited data on glazing
-	INTERIOR	.	.	.	.	Notes
-	PARTITIONS	CMU + DRYWALL FINISH	METAL STUDS + DRYWALL FINISH	WOOD FRAMING + DRYWALL FINIS	WOOD FRAMING + DRYWALL FINISH	
		5,790 kg CO2e	4,738 kg CO2e	3,570 kg CO2e	3,570 kg CO2e	
08 00 00	DOORS	GLASS DOOR	STEEL DOOR	WOOD DOOR	WOOD DOOR	
		1,195 kg CO2e	650 kg CO2e	555 kg CO2e	555 kg CO2e	
09 00 00	FINISHES	.	.	.	.	Notes
09 00 00	OFFICE - FLOOR FINISH	CARPET BROADLOOM	CARPET TILE	CARPET TILE	CARPET TILE	
		17,905 kg CO2e	3,673 kg CO2e	210 kg CO2e	3,673 kg CO2e	divide over sf of writeup area?
09 00 00	LAB - FLOOR FINISH	EPOXY FLOORING	RUBBER FLOORING	LINOLEUM FLOORING	RUBBER FLOORING	
		5,543 kg CO2e	3,083 kg CO2e	856 kg CO2e	3,083 kg CO2e	
09 00 00	OFFICE - CEILING	DRYWALL CEILING SYSTEM	ACOUSTICAL CEILING SYSTEM	ACOUSTIC FINISH	ACOUSTICAL CEILING SYSTEM	
		6,799 kg CO2e	5,513 kg CO2e	61 kg CO2e	5,513 kg CO2e	
09 00 00	LAB - CEILING	ACOUSTICAL CEILING CLEANROOM	ACOUSTICAL CEILING SYSTEM	ACOUSTICAL CEILING	ACOUSTICAL CEILING SYSTEM	
		5,321 kg CO2e	5,321 kg CO2e	1,044 kg CO2e	5,321 kg CO2e	

LAB	Baseline	Improved	Reimagined	Alt 1
FLOOR FINISH	EPOXY FLOORING	RUBBER FLOORING	LINOLEUM FLOORING	NONE
Category	FLOOR FINISH	FLOOR FINISH	FLOOR FINISH	FLOOR FINISH
EPD	Dur-A-Flex Epoxy Flooring	Noraplan Environcare Sentica (part of 913 line)	Forbo Marmoleum	None
PCR Name	Part A (IBU/UL v1.2), Part B (IBU) Requirements for floor coverings. UL Part B addendum	IBU Part B: Requirements on the EPD for Floor coverings, version 1.2 02-2018	EN 16810: 2017 Resilient, Textile and Laminate floor coverings - Environmental Product Declarations - Product Category Rules	0
EPD Type	Product Specific	Product Specific	Product Specific	0
EPD Declared Unit	1 m²	1 m²	1 m³	-
EPD Scope	A1-A3	A1-A3	A1-A3	A1-A3
EPD GWP (kg CO2e/m²)	9.3 kg CO2e	5.9 kg CO2e	- 0.0 kg CO2e	0.0 kg CO2e
Biogenic Carbon (BCRP)	-	-	-	0.0 kg CO2e
Embodied Carbon (kg CO2e/m²)	9.3 kg CO2e	5.9 kg CO2e	- 0.0 kg CO2e	0.0 kg CO2e
Adjustment to common units (m²)	1.000	1.000	1.000	1.000
Embodied Carbon (kg CO2e/m²)	10.3 kg CO2e	6.9 kg CO2e	1.0 kg CO2e	1.0 kg CO2e
LCA Duration (building lifespan)	75 yrs	75 yrs	75 yrs	75 yrs
Lifespan of Product / Replacement Cycle	25 yrs	30 yrs	15 yrs	75 yrs
Replacements in building lifespan	2.0	1.5	4.0	-
Total Embodied Carbon (kg CO2e/m²)	31 kg CO2e	17 kg CO2e	5 kg CO2e	1 kg CO2e
Total Quantity in Module (m²)	179	180	179	-
Total Embodied Carbon (kg CO2e)	5,543 kg CO2e	3,083 kg CO2e	856 kg CO2e	-



Collecting EPDs, and cataloging their data, enabled manual creation of Baseline, Improved and Reimagined Scenarios,

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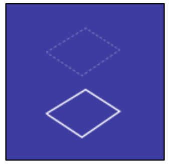
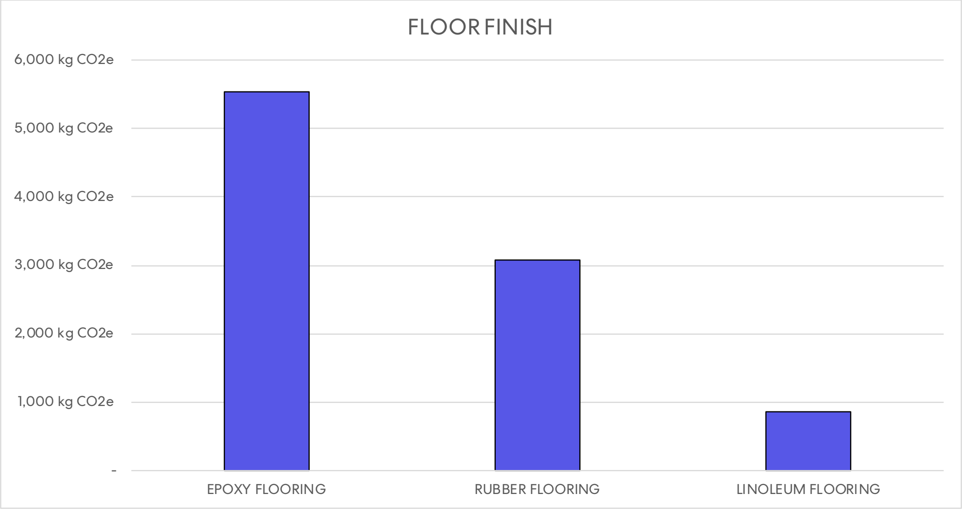
LAB	Baseline	Improved	Reimagined	Alt 1
FLOOR FINISH	EPOXY FLOORING	RUBBER FLOORING	LINOLEUM FLOORING	NONE
Category	*FLOOR FINISH*	*FLOOR FINISH*	*FLOOR FINISH*	*FLOOR FINISH*
EPD	*Dur-A-Flex Epoxy Flooring*	*Noraplan Environcare Sentica (part of 913 line)*	*Forbo Marmoleum*	*None*
PCR Name	Part A (IBU/UL v1.2), Part B (IBU) Requirements for floor coverings. UL Part B addendum	IBU Part B: Requirements on the EPD for Floor coverings, version 1.2 02-2018	EN 16810: 2017 Resilient, Textile and Laminate floor coverings - Environmental Product Declarations - Product Category Rules	0
EPD Type	Product Specific	Product Specific	Product Specific	0
EPD Declared Unit	1 m²	1 m²	1 m³	-
EPD Scope	A1-A3	A1-A3	A1-A3	A1-A3
EPD GWP (kg CO2e/m²)	9.3 kg CO2e	5.9 kg CO2e	- 0.0 kg CO2e	0.0 kg CO2e
Biogenic Carbon (BCRP)	-	-	-	0.0 kg CO2e
Embodied Carbon (kg CO2e/m²)	9.3 kg CO2e	5.9 kg CO2e	- 0.0 kg CO2e	0.0 kg CO2e
Adjustment to common units (m²)	1.000	1.000	1.000	1.000
Embodied Carbon (kg CO2e/m²)	10.3 kg CO2e	6.9 kg CO2e	1.0 kg CO2e	1.0 kg CO2e
LCA Duration (building lifespan)	75 yrs	75 yrs	75 yrs	75 yrs
Lifespan of Product / Replacement Cycle	25 yrs	30 yrs	15 yrs	75 yrs
Replacements in building lifespan	2.0	1.5	4.0	-
Total Embodied Carbon (kg CO2e/m²)	31 kg CO2e	17 kg CO2e	5 kg CO2e	1 kg CO2e
Total Quantity in Module (m²)	179	180	179	-
Total Embodied Carbon (kg CO2e)	5,543 kg CO2e	3,083 kg CO2e	856 kg CO2e	-



FLOORS



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Materials Analyzed

EMBODIED CARBON - SYSTEM SUMMARY

LAST UPDATED:	10/15/2021	Baseline	Improved	Reimagined
	BUILDING STRUCTURE			
-	**Foundations**	.	.	.
Multiple	*FOUNDATIONS*	*CONCRETE*	*CONCRETE WITH CARBON CURE*	*??*
	FOUNDATIONS	-	-	-
-	**SUPERSTRUCTURE**	.	.	.
-	*SUPERSTRUCTURE - OFFICE (STRENGTH)*	*CONCRETE (22X33)*	*STEEL (22X33)*	*TIMBER (22X22)*
Y	SUPERSTRUCTURE - OFFICE (STRENGTH)	13,068 kg CO2e	9,946 kg CO2e	2,541 kg CO2e
-	*SUPERSTRUCTURE - LABORATORY (VCA)*	*CONCRETE (22X33)*	*STEEL (22X33)*	*TIMBER (22X22)*
Y	SUPERSTRUCTURE - LABORATORY (VCA)	29,403 kg CO2e	28,919 kg CO2e	3,630 kg CO2e
	ARCHITECTURE AND INTERIORS			
-	**BUILDING ENVELOPE**	.	.	.
-	*WALL BACKUP*	*CMU + DRYWALL FINISH*	*METAL STUDS + DRYWALL FINISH*	*WOOD FRAMING + DRYWALL FINIS*
Y	BUILDING ENVELOPE - WALL BACKUP	417 kg CO2e	399 kg CO2e	572 kg CO2e
07 00 00	*INSULATION*	*XPS INSULATION*	*SPF INSULATION*	*MINERAL WOOL INSULATION*
Y	BUILDING ENVELOPE - INSULATION	3,708 kg CO2e	97 kg CO2e	140 kg CO2e
-	*CLADDING*	*TERRACOTTA CLADDING*	*METAL PANEL CLADDING*	*FIBER CEMENT CLADDING*
Y	BUILDING ENVELOPE - CLADDING	2,712 kg CO2e	822 kg CO2e	629 kg CO2e
08 00 00	*GLAZING*	*ALUMINUM STOREFRONT*	*ALUMINUM STOREFRONT*	*ALUMINUM STOREFRONT*
Y	BUILDING ENVELOPE - GLAZING	27,718 kg CO2e	28,334 kg CO2e	16,528 kg CO2e
-	**INTERIOR**	.	.	.
-	*PARTITIONS*	*CMU + DRYWALL FINISH*	*METAL STUDS + DRYWALL FINISH*	*WOOD FRAMING + DRYWALL FINIS*
Y	INTERIOR - PARTITIONS	5,790 kg CO2e	4,738 kg CO2e	3,570 kg CO2e
08 00 00	*DOORS*	*GLASS DOOR*	*STEEL DOOR*	*WOOD DOOR*
Y	INTERIOR - DOORS	1,195 kg CO2e	650 kg CO2e	555 kg CO2e
09 00 00	**FINISHES**	.	.	.
09 00 00	*OFFICE - FLOOR FINISH*	*CARPET BROADLOOM*	*CARPET TILE*	*CARPET TILE*
Y	FINISHES - OFFICE - FLOOR FINISH	17,905 kg CO2e	3,673 kg CO2e	210 kg CO2e
09 00 00	*LAB - FLOOR FINISH*	*EPOXY FLOORING*	*RUBBER FLOORING*	*LINOLEUM FLOORING*
Y	FINISHES - LAB - FLOOR FINISH	5,543 kg CO2e	3,083 kg CO2e	856 kg CO2e
09 00 00	*OFFICE - CEILING*	*DRYWALL CEILING SYSTEM*	*ACOUSTICAL CEILING SYSTEM*	*ACOUSTIC FINISH*
Y	FINISHES - OFFICE - CEILING	6,799 kg CO2e	5,513 kg CO2e	61 kg CO2e
09 00 00	*LAB - CEILING*	*ACOUSTICAL CEILING CLEANROOM*	*ACOUSTICAL CEILING SYSTEM*	*ACOUSTICAL CEILING*
Y	FINISHES - LAB - CEILING	5,321 kg CO2e	5,321 kg CO2e	1,044 kg CO2e
11 00 00	**EQUIPMENT**	.	.	.
11 53 13	*LAB - FUMEHOODS*	*Conventional 100 fpm*	*High Performance 60 fpm*	*Filter Fumehoods*
Y	EQUIPMENT - LAB - FUMEHOODS	12,271 kg CO2e	5,684 kg CO2e	3,560 kg CO2e
12 00 00	**FFE / CASEWORK**	.	.	.
12 00 00	*OFFICE - CHAIRS*	*TASK CHAIR*	*TASK CHAIR*	*TASK CHAIR*
Y	FFE / CASEWORK - OFFICE - CHAIRS	6,468 kg CO2e	5,652 kg CO2e	5,118 kg CO2e
12 00 00	*OFFICE - SYSTEMS*	*SPINE BASED WORKSTATION*	*PANEL BASED WORKSTATION*	*BENCHING*
Y	FFE / CASEWORK - OFFICE - SYSTEMS	31,041 kg CO2e	28,596 kg CO2e	16,919 kg CO2e
12 35 53	*LAB - CASEWORK - CABINETS*	*STEEL SHEET*	*BAMBOO*	*PLYWOOD*
Y	FFE / CASEWORK - LAB - CASEWORK - CABINETS	5,811 kg CO2e	(1,565 kg CO2e)	(7,846 kg CO2e)
12 35 53	*LAB - CASEWORK - COUNTERTOP*	*EPOXY COUNTER*	*STAINLESS STEEL SHEET*	*PHENOLIC PANEL*
Y	FFE / CASEWORK - LAB - CASEWORK - COUNTER	-	33 kg CO2e	23 kg CO2e
	CARBON IMPACT OF CHOICES	175,169 kg CO2e	129,893 kg CO2e	48,109 kg CO2e
	MODULE SIZE	1,936 sf	1,936 sf	1,936 sf
	CARBON INTENSITY OF CHOICES	90.5 kg CO2e/sf	67.1 kg CO2e/sf	24.8 kg CO2e/sf
	% REDUCTION	0%	-26%	-73%

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Materials Analyzed

EMBODIED CARBON - SYSTEM SUMMARY

LAST UPDATED:	10/15/2021	Baseline	Improved	Reimagined
	ARCHITECTURE AND INTERIORS			
-	**BUILDING ENVELOPE**	.	.	.
-	*WALL BACKUP*	*CMU + DRYWALL FINISH*	*METAL STUDS + DRYWALL FINISH*	*WOOD FRAMING + DRYWALL FINIS*
Y	BUILDING ENVELOPE - WALL BACKUP	417 kg CO2e	399 kg CO2e	572 kg CO2e
07 00 00	*INSULATION*	*XPS INSULATION*	*SPF INSULATION*	*MINERAL WOOL INSULATION*
Y	BUILDING ENVELOPE - INSULATION	3,708 kg CO2e	97 kg CO2e	140 kg CO2e
-	*CLADDING*	*TERRACOTTA CLADDING*	*METAL PANEL CLADDING*	*FIBER CEMENT CLADDING*
Y	BUILDING ENVELOPE - CLADDING	2,712 kg CO2e	822 kg CO2e	629 kg CO2e
08 00 00	*GLAZING*	*ALUMINUM STOREFRONT*	*ALUMINUM STOREFRONT*	*ALUMINUM STOREFRONT*
Y	BUILDING ENVELOPE - GLAZING	27,718 kg CO2e	28,334 kg CO2e	16,528 kg CO2e
-	**INTERIOR**	.	.	.
-	*PARTITIONS*	*CMU + DRYWALL FINISH*	*METAL STUDS + DRYWALL FINISH*	*WOOD FRAMING + DRYWALL FINIS*
Y	INTERIOR - PARTITIONS	5,790 kg CO2e	4,738 kg CO2e	3,570 kg CO2e
08 00 00	*DOORS*	*GLASS DOOR*	*STEEL DOOR*	*WOOD DOOR*
Y	INTERIOR - DOORS	1,195 kg CO2e	650 kg CO2e	555 kg CO2e
09 00 00	**FINISHES**	.	.	.
09 00 00	*OFFICE - FLOOR FINISH*	*CARPET BROADLOOM*	*CARPET TILE*	*CARPET TILE*
Y	FINISHES - OFFICE - FLOOR FINISH	17,905 kg CO2e	3,673 kg CO2e	210 kg CO2e
09 00 00	*LAB - FLOOR FINISH*	*EPOXY FLOORING*	*RUBBER FLOORING*	*LINOLEUM FLOORING*
Y	FINISHES - LAB - FLOOR FINISH	5,543 kg CO2e	3,083 kg CO2e	856 kg CO2e

Low Carbon Labs

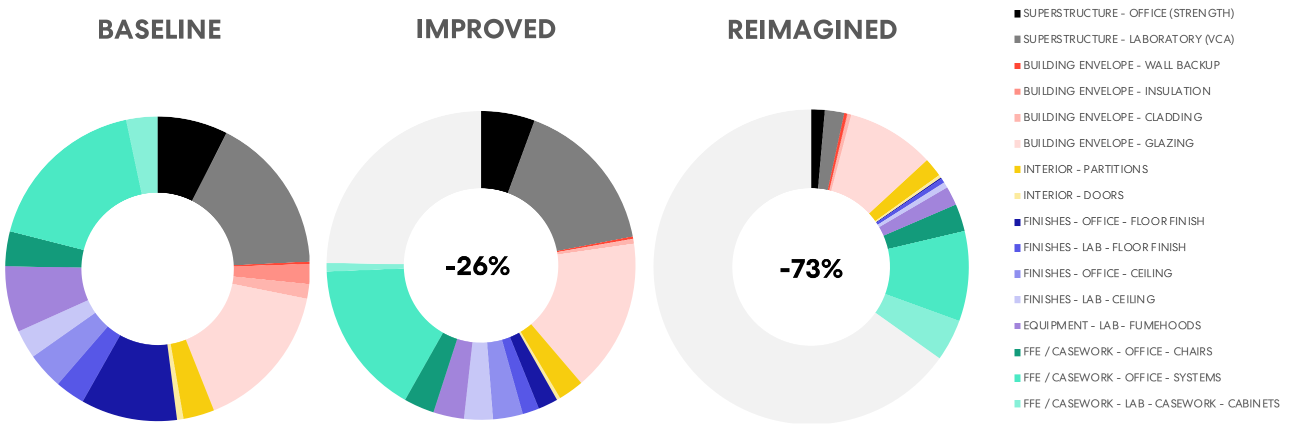
Materials Analyzed

EMBODIED CARBON - SYSTEM SUMMARY				
LAST UPDATED:	10/15/2021	Baseline	Improved	Reimagined
09 00 00	OFFICE - CEILING	DRYWALL CEILING SYSTEM	ACOUSTICAL CEILING SYSTEM	ACOUSTIC FINISH
Y	FINISHES - OFFICE - CEILING	6,799 kg CO2e	5,513 kg CO2e	61 kg CO2e
09 00 00	LAB - CEILING	ACOUSTICAL CEILING CLEANROOM	ACOUSTICAL CEILING SYSTEM	ACOUSTICAL CEILING
Y	FINISHES - LAB - CEILING	5,321 kg CO2e	5,321 kg CO2e	1,044 kg CO2e
11 00 00	EQUIPMENT	.	.	.
11 53 13	LAB - FUMEHOODS	Conventional 100 fpm	High Performance 60 fpm	Filter Fumehoods
Y	EQUIPMENT - LAB - FUMEHOODS	12,271 kg CO2e	5,684 kg CO2e	3,560 kg CO2e
12 00 00	FFE / CASEWORK	.	.	.
12 00 00	OFFICE - CHAIRS	TASK CHAIR	TASK CHAIR	TASK CHAIR
Y	FFE / CASEWORK - OFFICE - CHAIRS	6,468 kg CO2e	5,652 kg CO2e	5,118 kg CO2e
12 00 00	OFFICE - SYSTEMS	SPINE BASED WORKSTATION	PANEL BASED WORKSTATION	BENCHING
Y	FFE / CASEWORK - OFFICE - SYSTEMS	31,041 kg CO2e	28,596 kg CO2e	16,919 kg CO2e
12 35 53	LAB - CASEWORK - CABINETS	STEEL SHEET	BAMBOO	PLYWOOD
Y	FFE / CASEWORK - LAB - CASEWORK - CABINETS	5,811 kg CO2e	(1,565 kg CO2e)	(7,846 kg CO2e)
12 35 53	LAB - CASEWORK - COUNTERTOP	EPOXY COUNTER	STAINLESS STEEL SHEET	PHENOLIC PANEL
Y	FFE / CASEWORK - LAB - CASEWORK - COUNTERT	-	33 kg CO2e	23 kg CO2e
	CARBON IMPACT OF CHOICES	175,169 kg CO2e	129,893 kg CO2e	48,109 kg CO2e
	MODULE SIZE	1,936 sf	1,936 sf	1,936 sf
	CARBON INTENSITY OF CHOICES	90.5 kg CO2e/sf	67.1 kg CO2e/sf	24.8 kg CO2e/sf
	% REDUCTION	0%	-26%	-73%

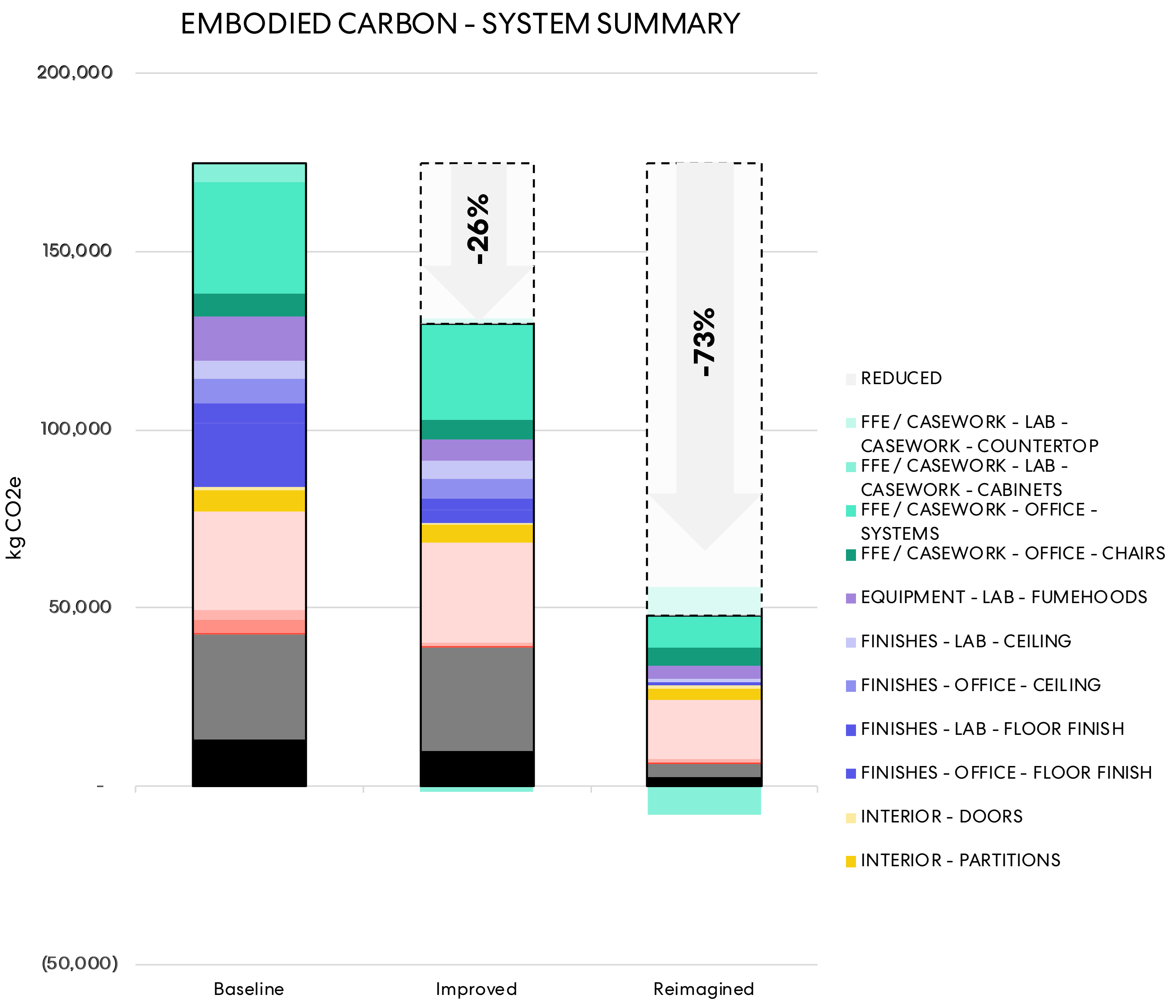
Data Summary

LOW CARBON LABS
EMBODIED CARBON - SYSTEM SUMMARY **10/15/2021**

CATEGORY	Baseline	Improved	Reimagined
SUPERSTRUCTURE - OFFICE (STRENGTH)	13,068	9,946	2,541
SUPERSTRUCTURE - LABORATORY (VCA)	29,403	28,919	3,630
BUILDING ENVELOPE - WALL BACKUP	417	399	572
BUILDING ENVELOPE - INSULATION	3,708	97	140
BUILDING ENVELOPE - CLADDING	2,712	822	629
BUILDING ENVELOPE - GLAZING	27,718	28,334	16,528
INTERIOR - PARTITIONS	5,790	4,738	3,570
INTERIOR - DOORS	1,195	650	555
FINISHES - OFFICE - FLOOR FINISH	17,905	3,673	210
FINISHES - LAB - FLOOR FINISH	5,543	3,083	856
FINISHES - OFFICE - CEILING	6,799	5,513	61
FINISHES - LAB - CEILING	5,321	5,321	1,044
EQUIPMENT - LAB - FUMEHOODS	12,271	5,684	3,560
FFE / CASEWORK - OFFICE - CHAIRS	6,468	5,652	5,118
FFE / CASEWORK - OFFICE - SYSTEMS	31,041	28,596	16,919
FFE / CASEWORK - LAB - CASEWORK - CABINETS	5,811	(1,565)	(7,846)
FFE / CASEWORK - LAB - CASEWORK - COUNTERTOP	-	33	23
REDUCED	-	43,711	119,214
CARBON IMPACT OF CHOICES	175,169	129,893	48,109
REDUCED	-	45,276	127,060

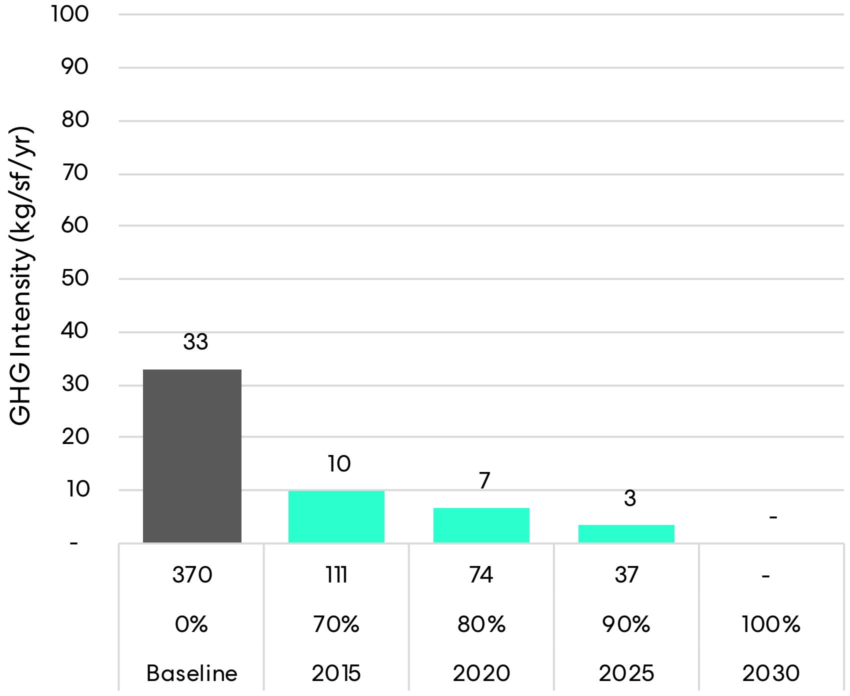


Data Summary



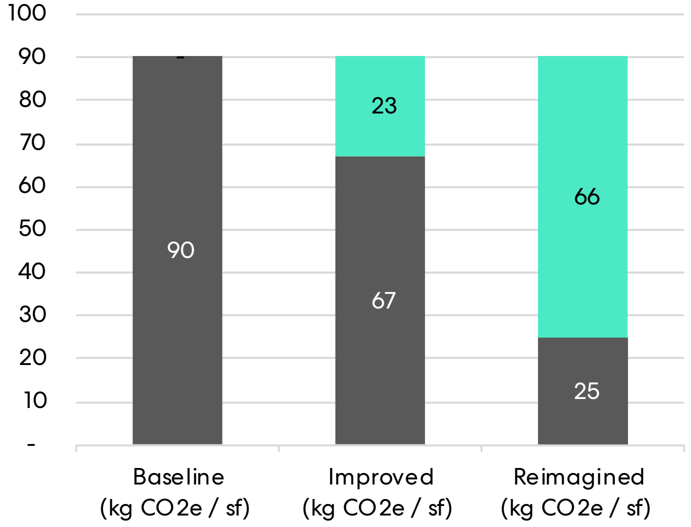
Data Summary

Operational Carbon Intensity Labs



Site EUI (kBtu/sf/yr)
AIA 2020 % reduction
AIA 2030 Target Year

Embodied Carbon Intensity
All Design Choices



Baseline	Improved	Reimagined
9-27 Years of Operation	2-7 Years of Operation Saved	7-20 Years of Operation Saved

Note: the "module" represents "net" program area of lab space. A real building would contain "gross" areas such as corridors, stairways, mechanical spaces, and storage. These may equate to 35-50% of the total building area included in the operational carbon assessments. So, the comparison of embodied carbon reduction to operational carbon may be diluted by a similar factor in practice.

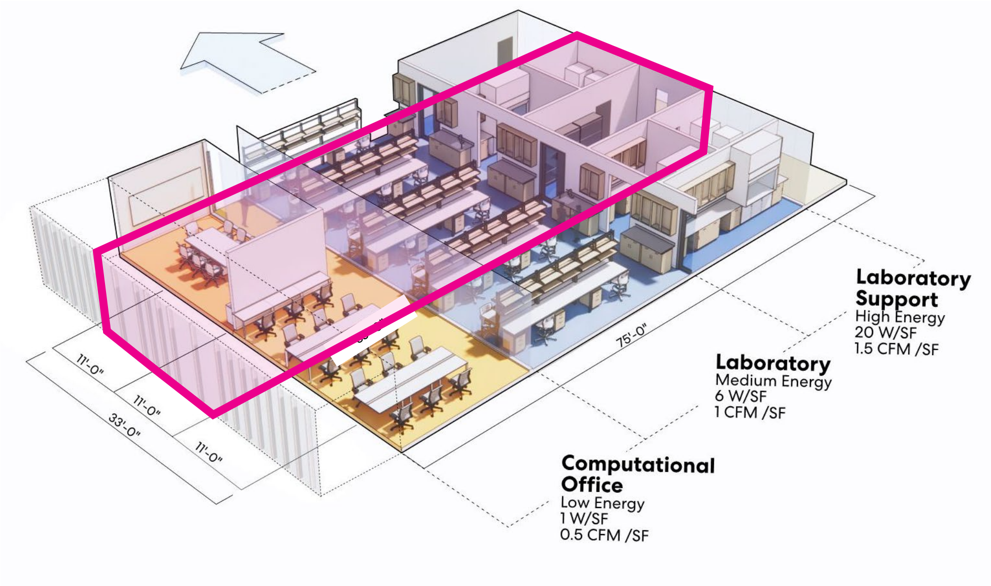
Scope and Strategy

Low Carbon Labs

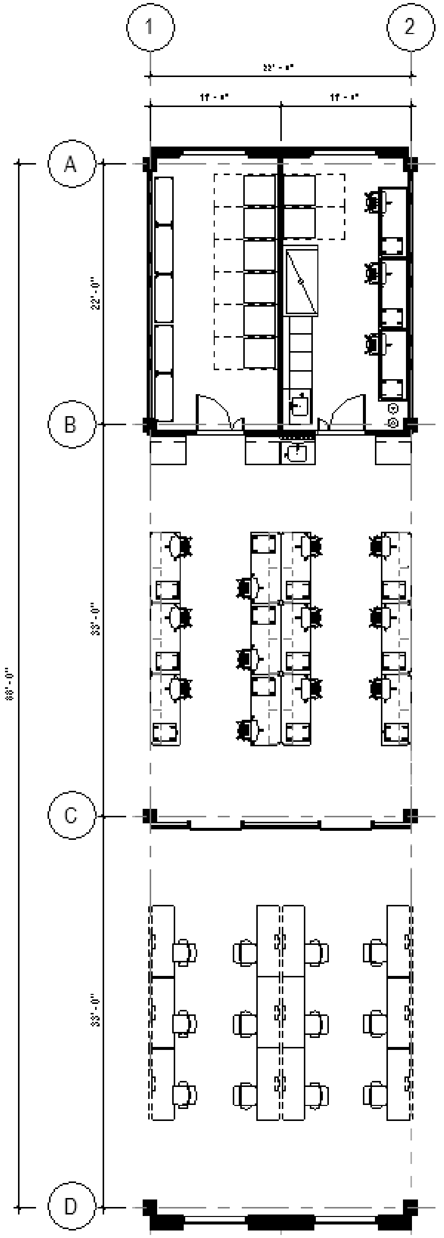
Module for Analysis

Laboratory design planning follows a "best practice" planning standard - a module based on 11'-0". For the purposes of this study, a 22'-0" wide module was selected. Extending in the opposite direction, modules of 22'-0" (Laboratory Support), 33'-0" (Laboratory) and 33'-0" (Office/Write Up)

Programmatically the module for analysis chosen includes lab , lab support, and office/write up.

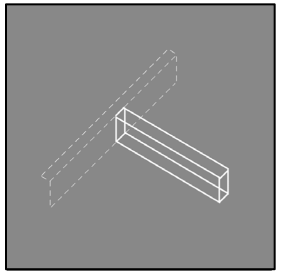


Example Laboratory Building Section



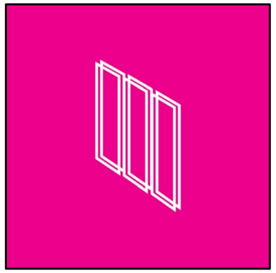
Project Analysis Module

Systems

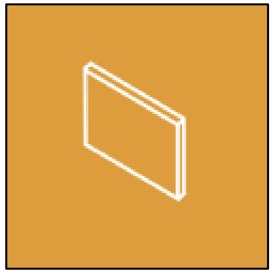


STRUCTURE

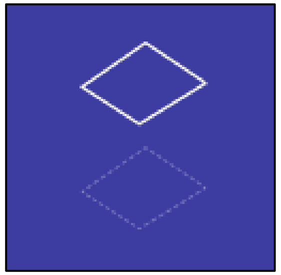
Special thanks to LeMessurier



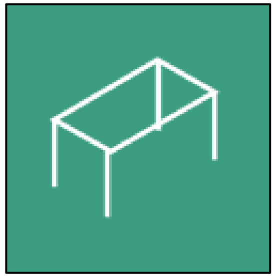
ENVELOPE OPAQUE



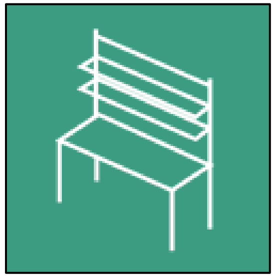
PARTITIONS



CEILINGS



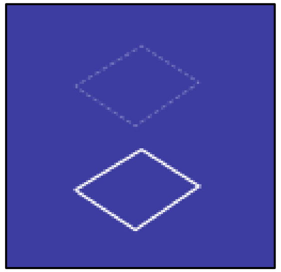
OFFICE SYSTEMS



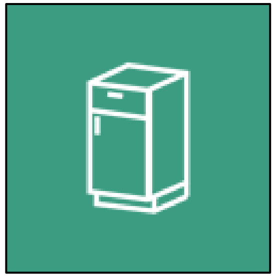
LAB BENCHTOP

ENVELOPE GLAZING (%)

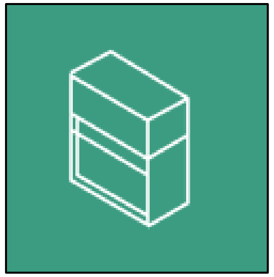
DOORS



FLOORS



LAB CASEWORK



LAB FUMEHOODS

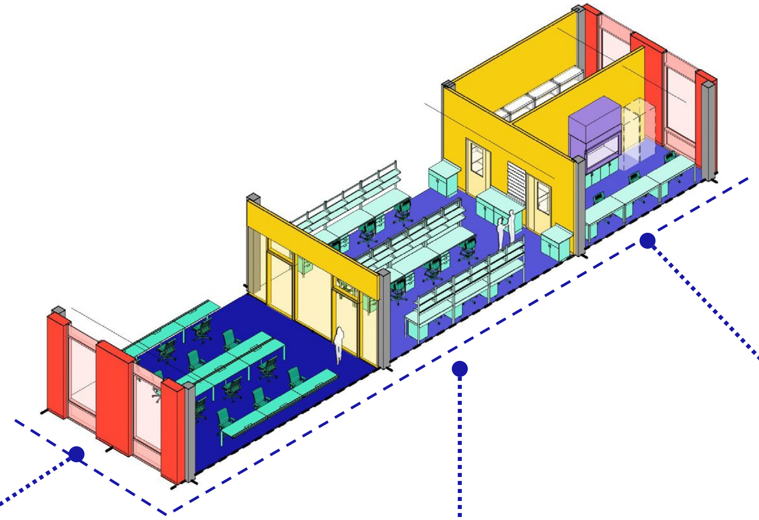
Special thanks to BR+A

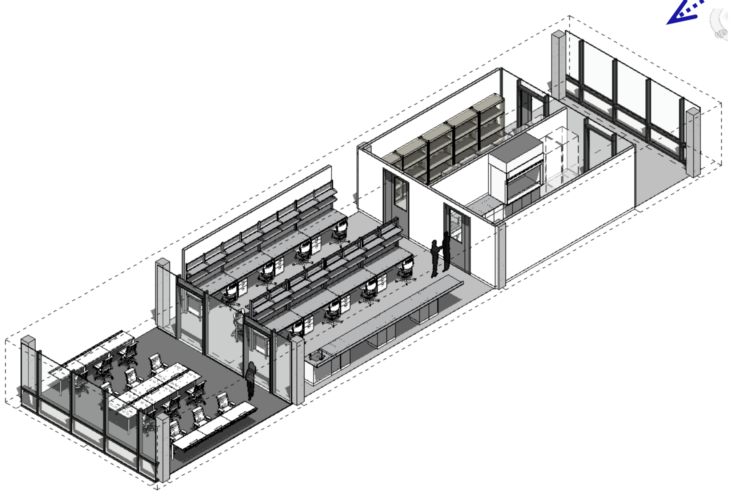
MEP SYSTEMS

Low Carbon Labs

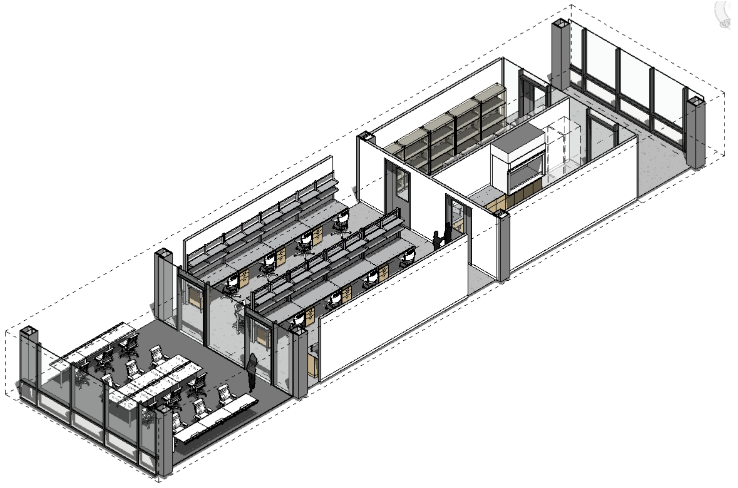
Scope :

Systems Visualized

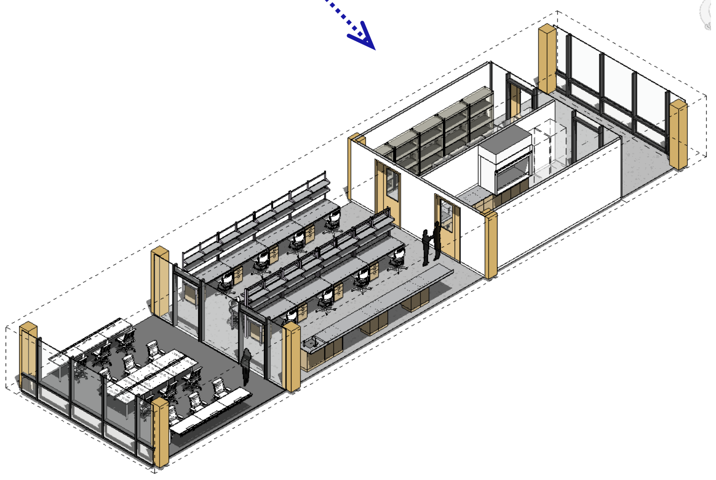




Baseline

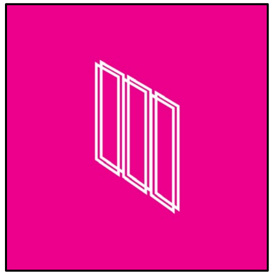


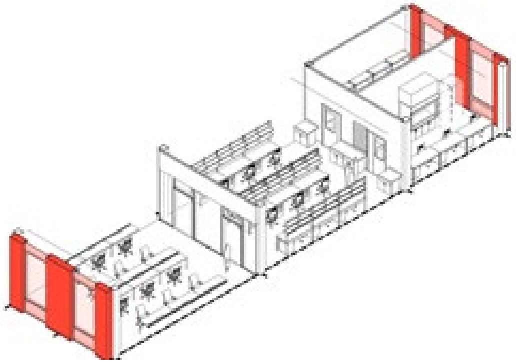
Improved



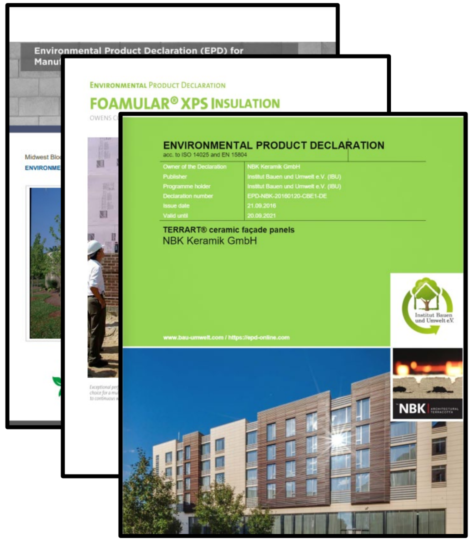
Reimagined

Low Carbon Labs





ENVELOPE OPAQUE



CMU + Drywall + XPS Insulation + Terracotta Cladding

Baseline

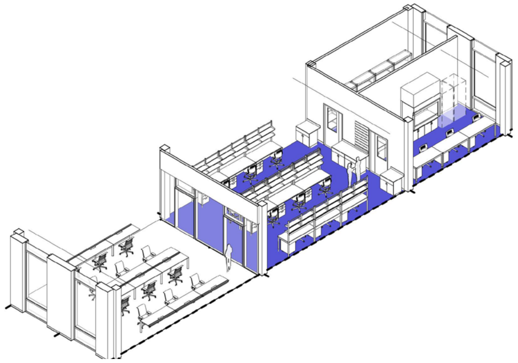
Metal Studs + Drywall + SPF Insulation + Metal Panel Cladding

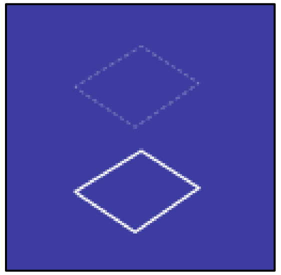
Improved

Wood Framing + Drywall + Mineral Wool Insulation + Fiber Cement Cladding

Reimagined

Low Carbon Labs





FLOORS (LAB)


Environmental Product Declaration

DUR-A-FLEX

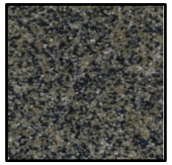
Epoxy Flooring Systems

The Dur-A-Flex family of epoxy flooring systems offer the most protection for your money, providing superior resistance to chemical spills, heavy equipment and continuous traffic. Install a seamless, sanitary, easy to maintain surface that works as hard as you do, in any environment.

DUR-A-FLEX INNOVATION FROM THE FLOOR UP

As one of the leading manufacturers of resinous floor and wall solutions, Dur-A-Flex designs products with people and the environment in mind. Most Dur-A-Flex floor and wall systems are VOC-compliant, phthalate–free, and meet LEED® requirements for low-emitting materials. We strive to give our customers the confidence that they are not only choosing the right floor for the job, but also the right floor for the environment. Now, with our Environmental Product Declarations (EPDs) and Health Product Declarations (HPDs), our customers have tools to efficiently evaluate the environmental and human health impacts of our high-performance products.

CERTIFIED ENVIRONMENTAL PRODUCT DECLARATION UL.COM/EPD



Dur-A-Flex Epoxy Flooring

Epoxy

Baseline


ENVIRONMENTAL PRODUCT DECLARATION

noraplan® standard 913

RUBBER SHEET AND TILE FLOOR COVERINGS

nora® by Interface®

For over 65 years, nora® rubber floor coverings have met the unique demands of facilities worldwide. Extremely durable, ergonomic, sound absorbent, stain and slip resistant, nora flooring solutions address the daily challenges of commercial applications and allow the creation of long-lasting, comfortable, quiet and safe environments.

nora's manufacturing facility maintains 3rd-party certified ISO 14001 and 9001 certifications. This declaration includes every phase of the product life cycle from the production through to installation, usage and maintenance, right up to the end of the product's life cycle in the building.

The superior performance attributes combined with an extended life cycle, 3rd-party certified low emissions and environmentally friendly maintenance make nora the perfect solution for healthcare, education and life sciences.

CERTIFIED ENVIRONMENTAL PRODUCT DECLARATION UL.COM/EPD

noraplan environcare™, University of Tennessee Medical Center

Noraplan Environcare Sentica

Rubber

Improved


ENVIRONMENTAL PRODUCT DECLARATION

MARMOLEUM 2.0 AND 2.5 MM

FORBO FLOORING SYSTEMS

RESILIENT LINOLEUM FLOOR COVERING

Marmoleum Concrete
Color 3709 "Silt"

Forbo FLOORING SYSTEMS

Marmoleum the most globally used brand of linoleum has been manufactured by Forbo for more than 150 years. Marmoleum is produced having low environmental impacts as a result of the combination of natural renewable materials and high recycle content.
Forbo was the first flooring manufacturer to publish a complete Life Cycle Assessment (LCA) report verified by CML in 2000.In addition Forbo is now to publish Environmental Product Declarations (EPD) for all products including full LCA reports. This EPD is using all recognized flooring Product Category Rules and is including additional information to show the impacts on human health and eco-toxicity. By offering the complete story we hope that our stakeholders will be able to use this document as a tool that will translate the environmental performance of Marmoleum into the true value and benefits to all our customers and stakeholders alike.
For more information visit;
www.forbo-flooring.com

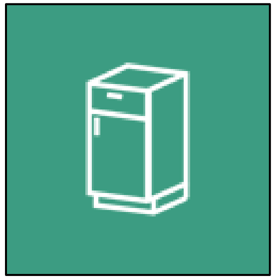
CERTIFIED ENVIRONMENTAL PRODUCT DECLARATION UL.COM/EPD

Forbo Marmoleum

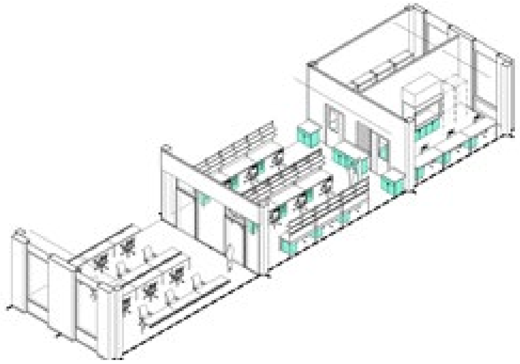
Linoleum

Reimagined

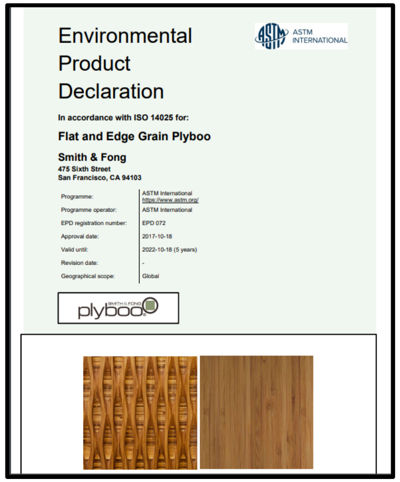
Low Carbon Labs



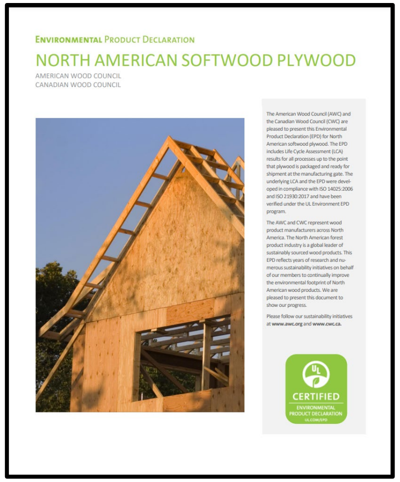
LAB CASEWORK
(RAW MATERIALS)



Cold Formed Steel Framing



Flat and Edge Grain Plyboo



North American Softwood Plywood

Steel Sheet

Baseline

Bamboo

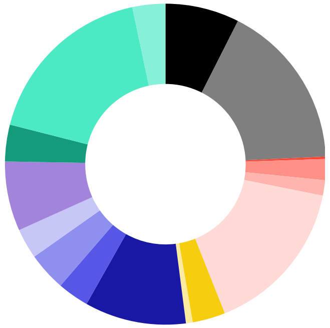
Improved

Plywood

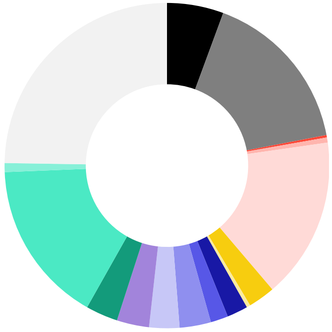
Reimagined

Scenarios

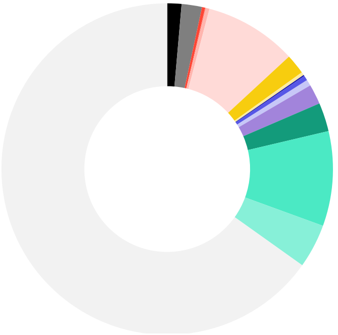
BASELINE



IMPROVED



REIMAGINED



Scenarios : Choose your own Adventure

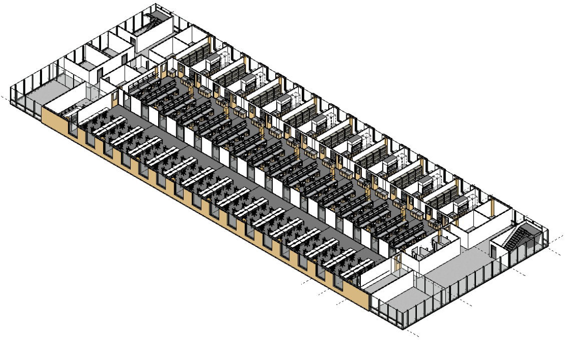
BASELINE
Floor
Ceiling

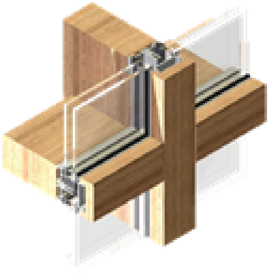
IMPROVED
Lab casework
Fumehoods

REIMAGINED
Structure

Looking Ahead

Future Research





More Systems

MEP ?
Other systems ?

Expanded Physical Scope

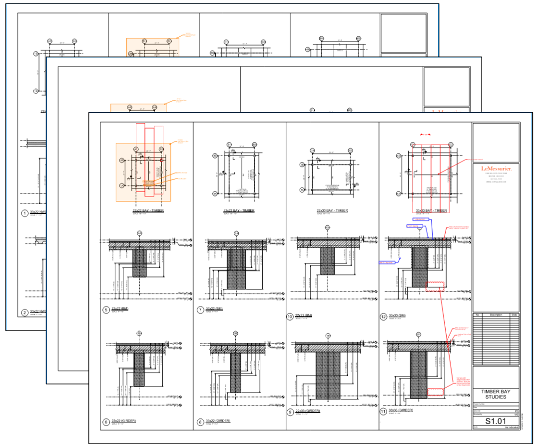
From Module to Floor
From Floor to Building

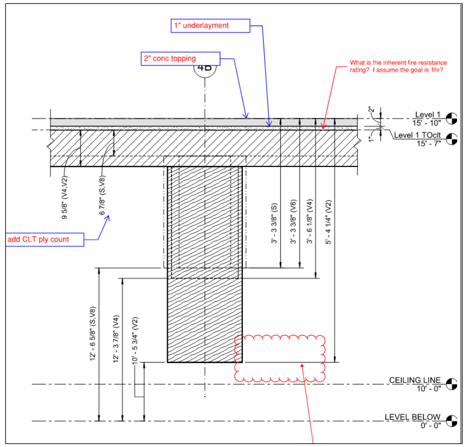
More Products

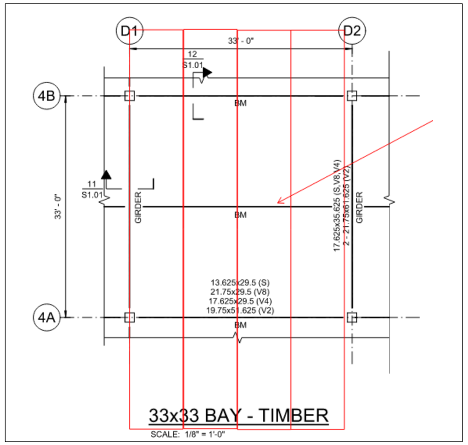
Additional glazing systems
Additional lab casework types

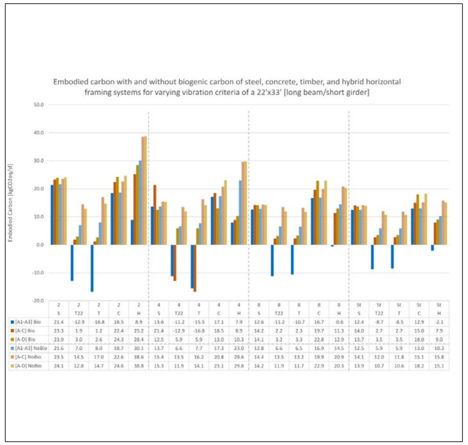
Low Carbon Labs

Parallel Research : Structure - LeMessurier









Structural Options
Concrete, Steel, Timber, and Hybrid Scenarios

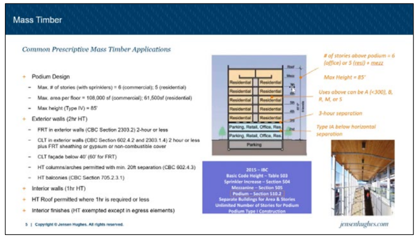
Structural Fire Resistance
Options for Lab Buildings

Low Vibration Design
Options for Lab Buildings

Optimization
Fire Resistance, Low Vibration, with Low Carbon Profiles

** Preliminary Results*

Parallel Research : Code - Jensen Hughes



NFPA 45 considerations for heavy timber labs

‡5.1.5.1 Floors, floor openings, floor penetrations, and floor firestop systems shall be sealed or curbed to prevent liquid leakage to lower floors.

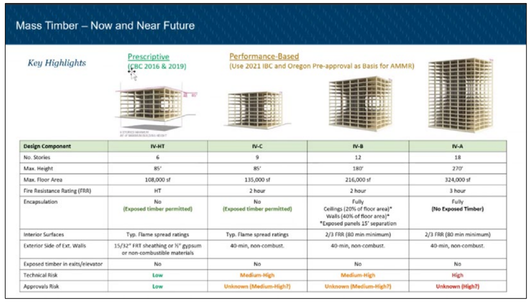
‡5.1.5.2 The sealing material shall be compatible with the chemicals being stored or used in the laboratory, or a program shall be in place to inspect and repair, if necessary, after exposure to leakage.

IBC (2018) Considerations for heavy timber labs

[F] 428.3.3 Floor assembly fire resistance. The floor assembly supporting laboratory suites and the construction supporting the floor of laboratory suites shall have a fire-resistance rating of not less than 2 hours.

Exception: The floor assembly of the laboratory suites and the construction supporting the floor of the laboratory suites are allowed to be 1-hour fire-resistance rated in buildings of Types IIA, IIIA and VA construction, provided that the building is three or fewer stories.

[F] 428.3.8 Liquid-tight floor. Portions of laboratory suites where hazardous materials are present shall be provided with a liquid-tight floor.



Design Component	IV-HT	IV-C	IV-B	IV-A
No. Stories	6	9	12	18
Max. Height	85'	85'	180'	270'
Max. Floor Area	108,000 sf	135,000 sf	216,000 sf	324,000 sf
Fire Resistance Rating (FRR)	HT	2 hour	2 hour	3 hour
Encapsulation	No (Exposed timber permitted)	No (Exposed timber permitted)	Fully Ceilings (20% of floor area)* Walls (40% of floor area)* *Exposed panels 15' separation	Fully (No Exposed Timber)
Interior Surfaces	Typ. Flame spread ratings	Typ. Flame spread ratings	2/3 FRR (80 min minimum)	2/3 FRR (80 min minimum)
Exterior Side of Ext. Walls	15/32" FRT sheathing or ½" gypsum or non-combustible materials	40-min, non-combust.	40-min, non-combust.	40-min, non-combust.
Exposed timber in exits/elevator	No	No	No	No
Technical Risk	Low	Medium-High	Medium-High	High
Approvals Risk	Low	Unknown (Medium-High?)	Unknown (Medium-High?)	Unknown (High?)

Code Pathways Currently Available:

Prescriptive & Performance Based

Code Development Process

Speculate – Which way are we headed?

Both negative and positive trends

Parallel Research : MEP – BR+A

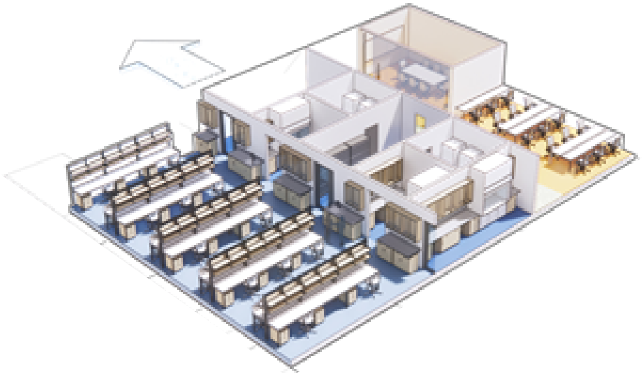
Quantifying Fumehood Embodied Carbon

MEP Systems Embodied Carbon

Embodied vs Operational Carbon - Savings in Context

Graphics

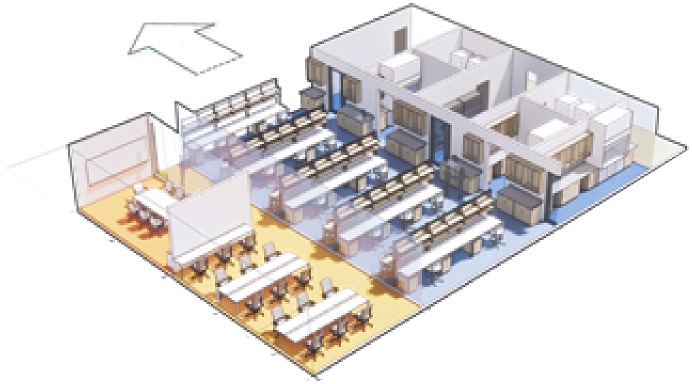
Typical Adaptable Lab
Frameworks



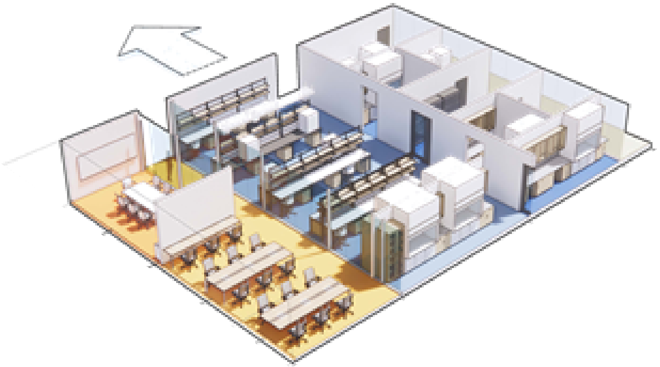
Laminated

Reverse Laminated

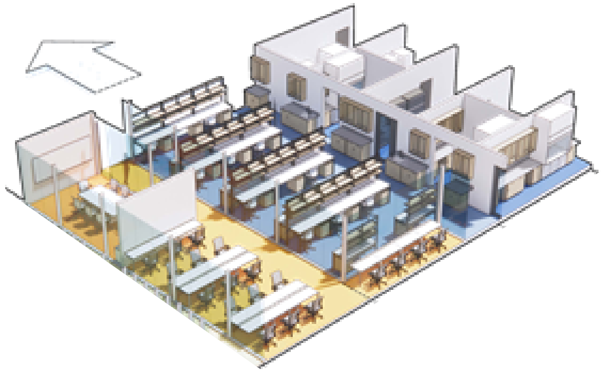
Clustered



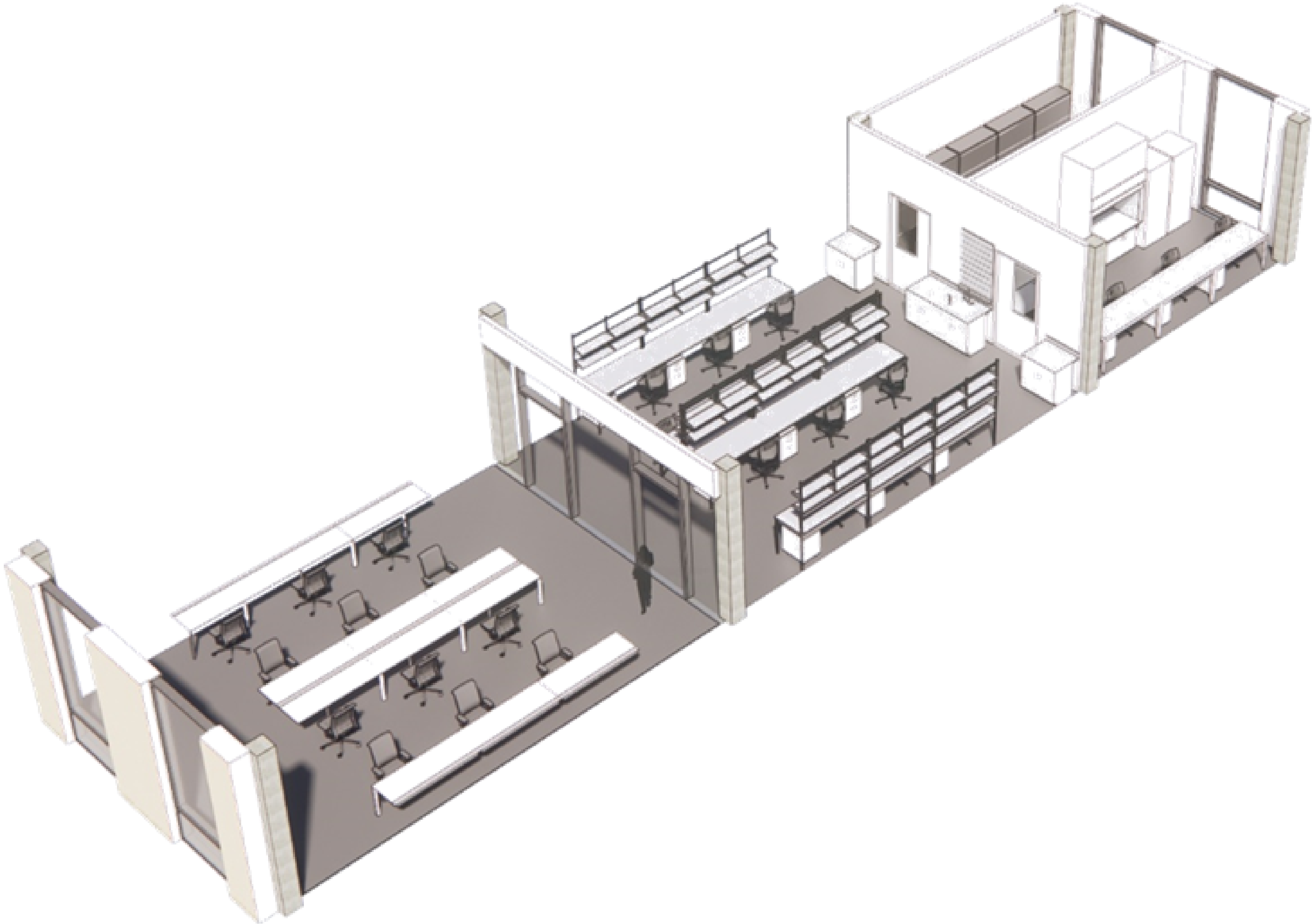
Laminated
Wet Lab + Support



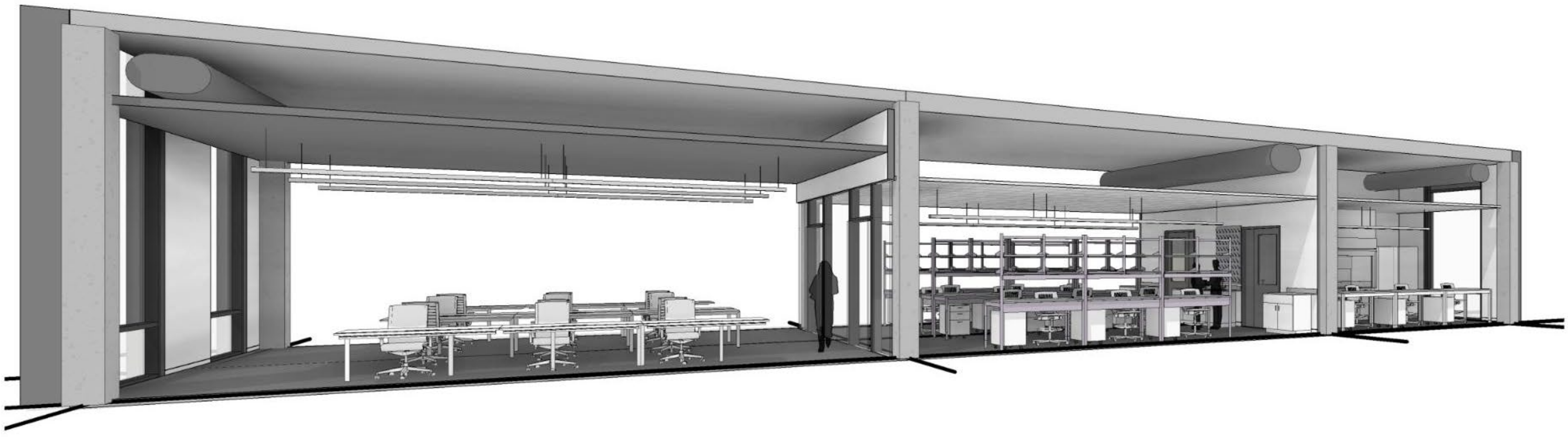
Laminated
Chemistry



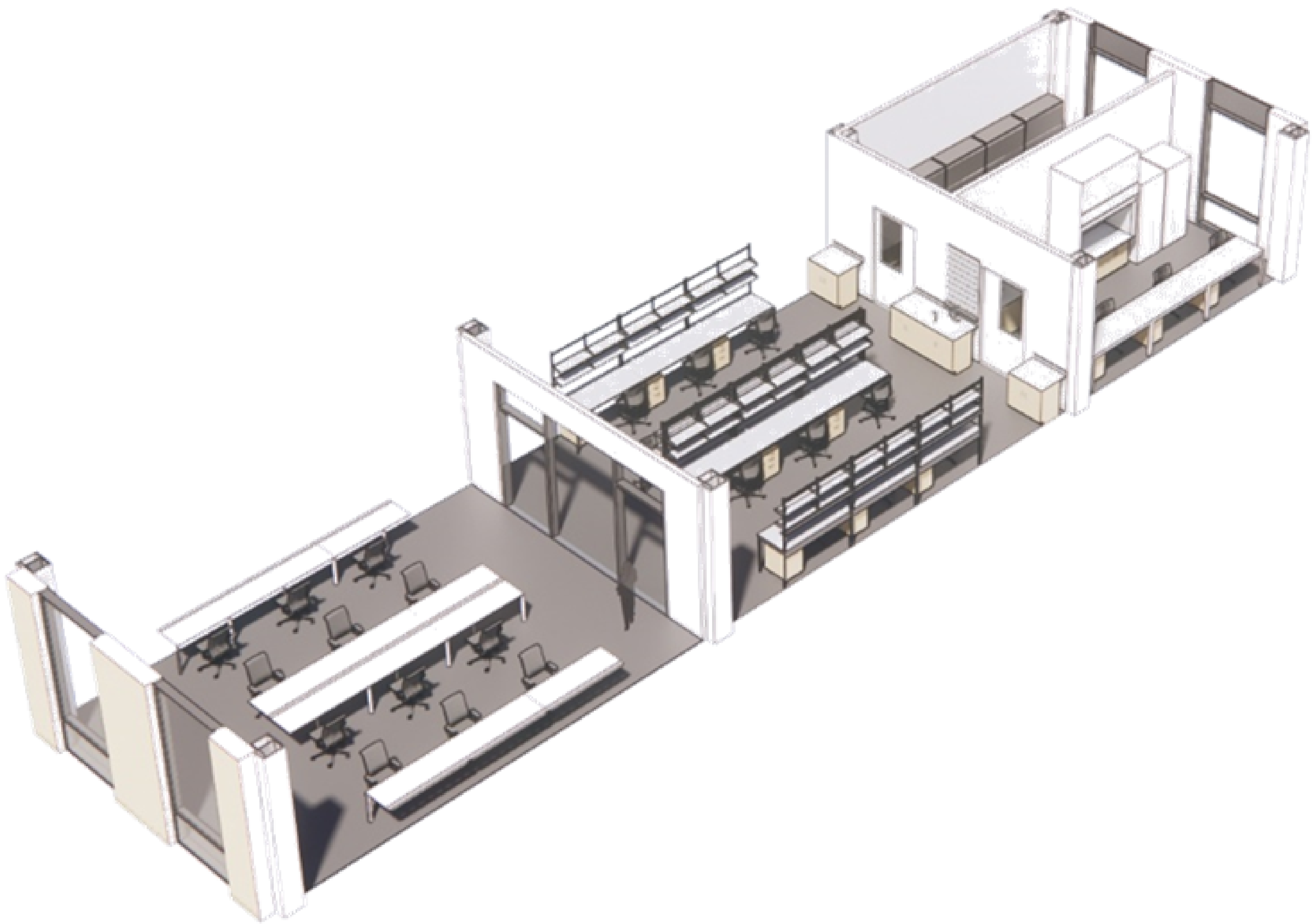
Laminated
Lab + Collaboration



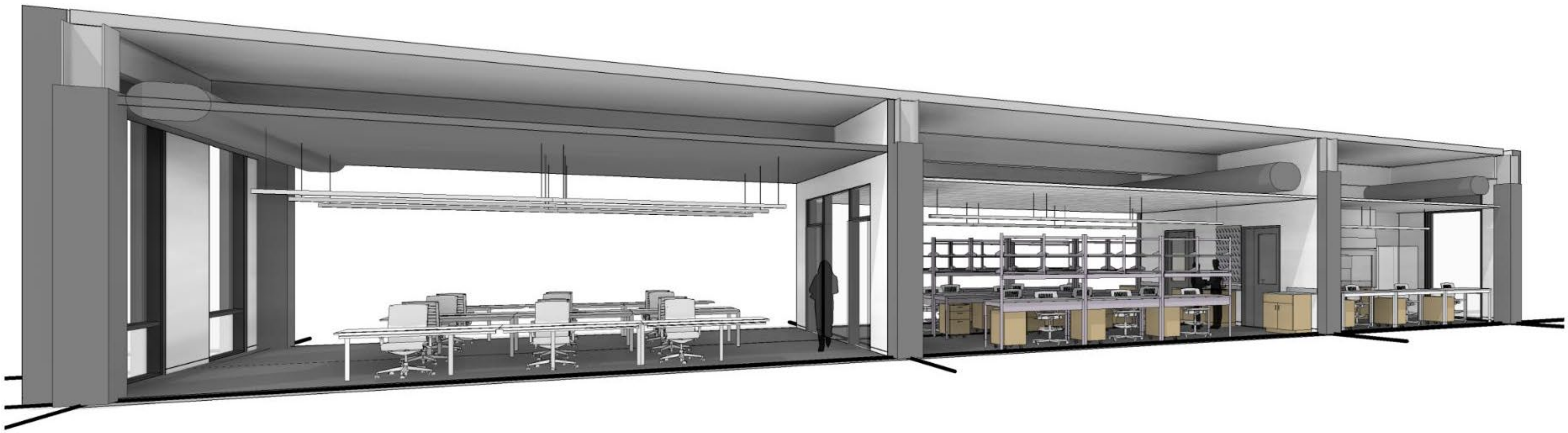
Baseline



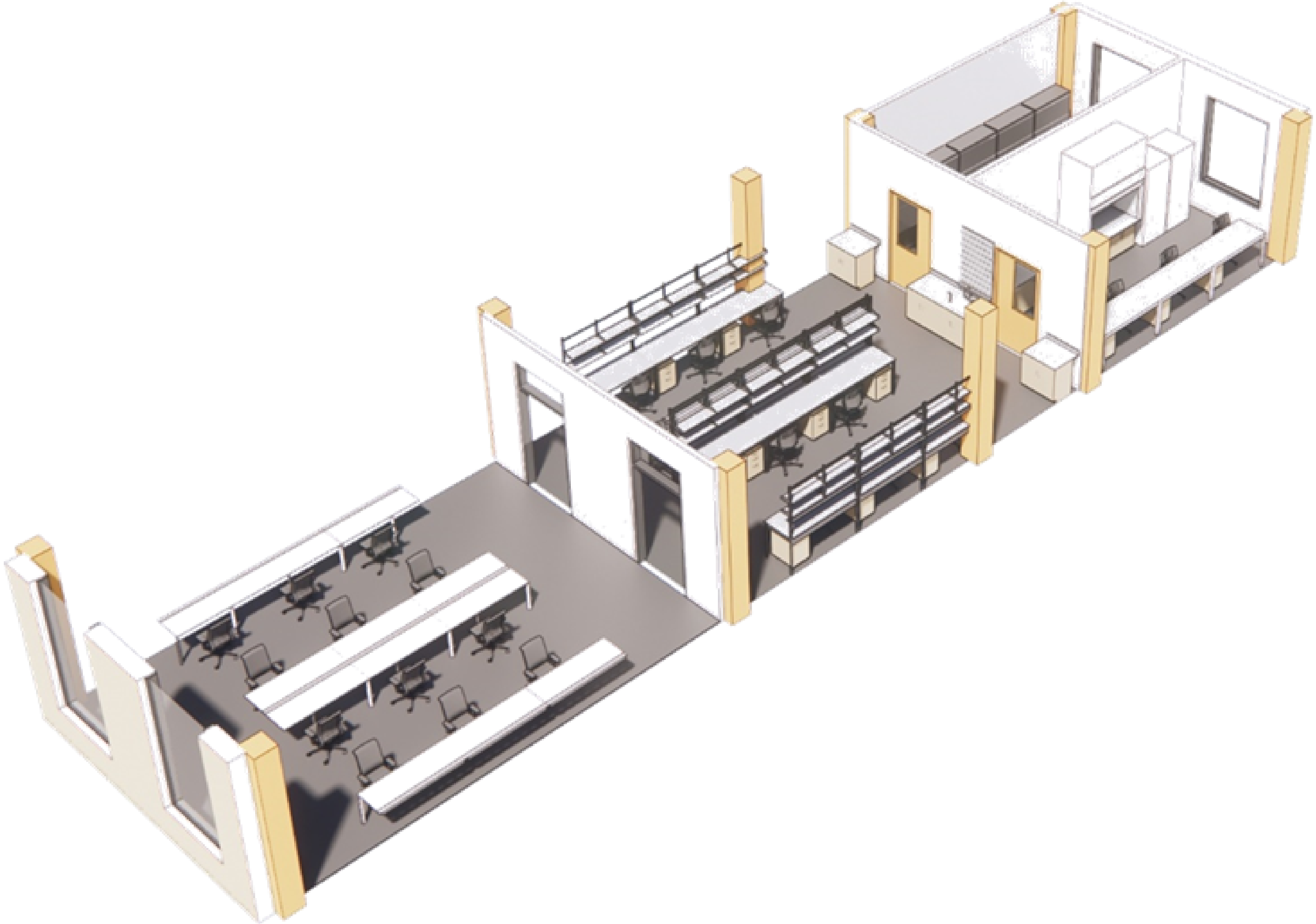
Baseline



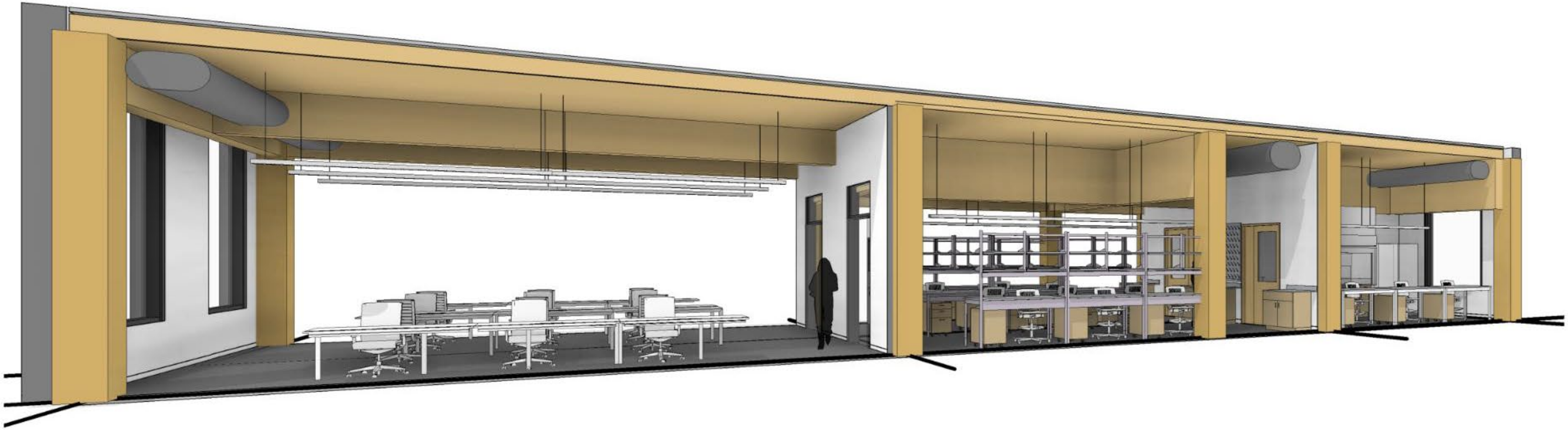
Improved



Improved



Re-Imagined



Re-Imagined

Re-Imagined Laboratory

Re-Imagined Laboratory

Re-Imagined Office / Write Up

Perkins&Will

Thank you!

Innovation Incubator 2021 J. Werner & E. Mikula

Citations for product images

Structure

Structure

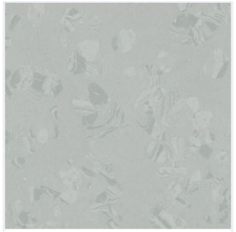
Structure

Structure

Flooring

Baseline – Epoxy

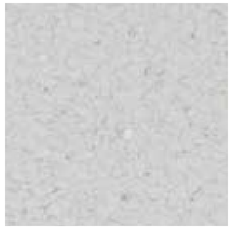
https://www.dur-a-flex.com/products/accelera-hq/



6524 Frost Bite

Improved - Rubber

https://www.nora.com/united-states/en/products/noraplan-sentica



Moon stone

Reimagined - Linoleum

https://forbo.blob.core.windows.net/forbodocuments/1136333/2020%20Colorex%20Brochure.pdf

Other

Baseline – Steel Sheet

https://www.scscertified.com/products/cert_pdfs/SCS-EPD-07103_SFIA_052821.pdf

Improved - Plyboo

https://www.plyboo.com/wp-content/uploads/files-migrated/downloads/Smith_Fong_Plyboo_EPD.pdf

Reimagined - Plywood

https://www.awc.org/pdf/greenbuilding/epd/AWC_EPD_NorthAmericanSoftwoodPlywood_20200605.pdf