SRE Economics Lecture 2

The Economics of Green Buildings (2)

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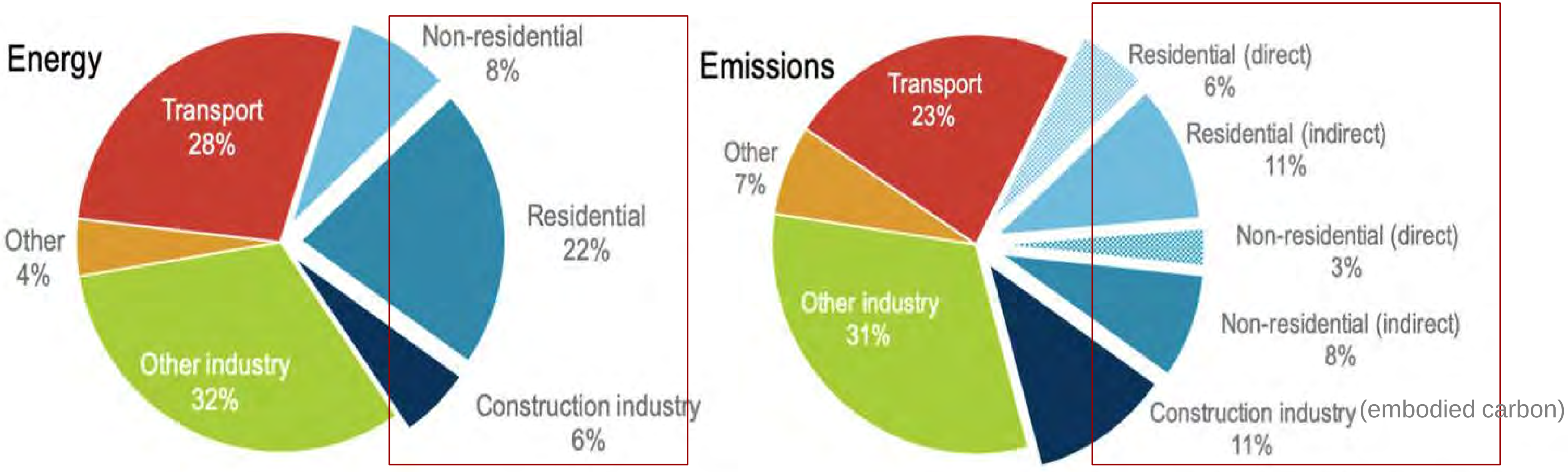
Feb 2023

(MIT Center for Real Estate)

We are responsible, and we are also the target



Notes: *Construction industry* is the portion (estimated) of overall industry devoted to manufacturing building construction materials such as steel, cement and glass. Indirect emissions are emissions from power generation for electricity and commercial heat.

Global Alliance for Buildings and Construction , "The 2019 Global Status Report for Buildings and Construction"

WORLD GREEN BUILDING COUNCIL

Policy pressure to decarbonize across the globe

Australian Government launches net zero building standard with GBCA

European Green Deal: Commission proposes to boost renovation and decarbonisation of buildings

Decarbonizing Mumbai's grid and building energy-resilient infrastructure

Features

Inflation Reduction Act Doubles Tax Credits for Building Retrofits

Proptech VC fund says $5/SF deduction will spur energy-saving fixes previously deemed too costly.

By Jack Rogers | August 19, 2022 at 08:08 AM

Mexico and Mexico City Introduce Energy Efficiency Standards for Buildings

December 22, 2016 Cover Image by: Lars Plougmann, Flickr

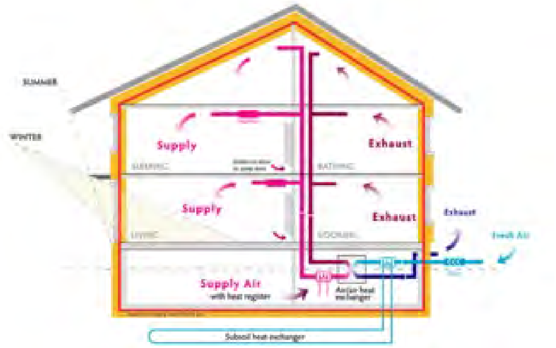
Graphic by Stacy Smedley, 2021 Used with permission.

Understanding a Building's Carbon Footprint

Three major strategies for building decarbonization (operational carbon)

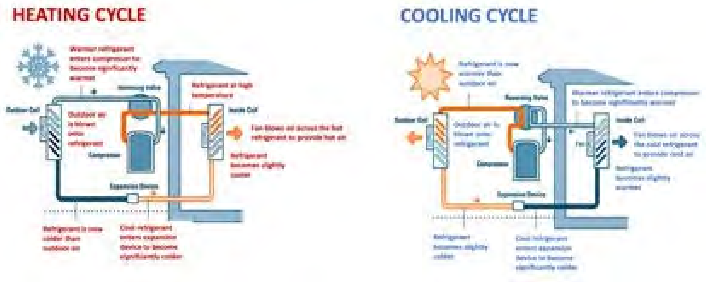
Improve energy efficiency

- Better energy conservation (insulation) and more efficient operations, e.g., passive house.

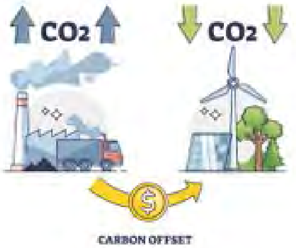


Switch to renewable energy: onsite and offsite

- Solar panels, offsite renewable energy procurement
- Electrification: gas-based heating → electricity-based heating (heat pump)



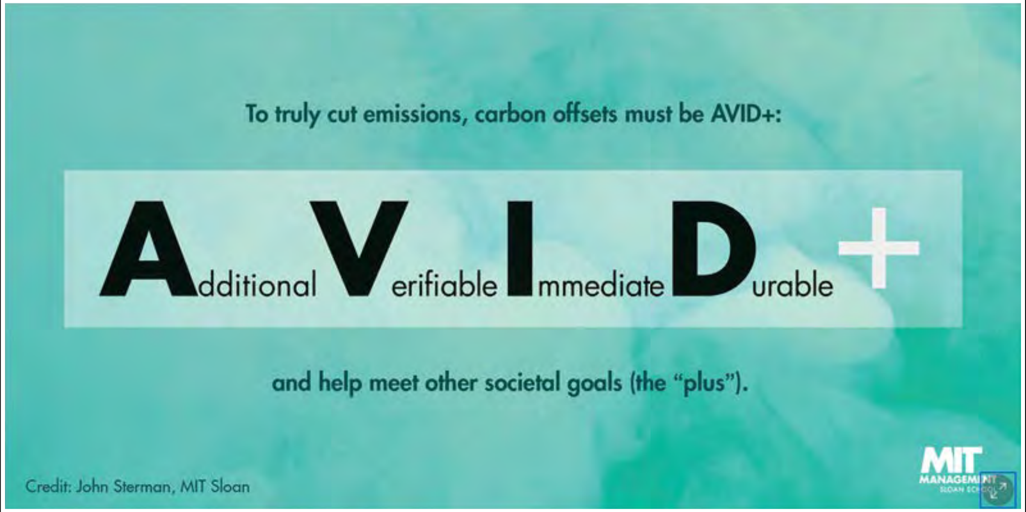
Purchase carbon offsets



Carbon Offsets

Challenges:

- **Additionality** (offsetting carbon that would not have been offset anyways
- Effectiveness of offsets in reducing emissions
- Offsets may be based on questionable assumptions / modeling
- Difficulty in measuring / verifying impact of offsets
- Duration of offsets does not match the lifecycle of CO2 being offset



Additional: Must reduce emissions that would not otherwise be cut.

Verifiable: Emission reduction must be verifiable.

Immediate: Emissions cut today are worth more than emissions cut in the future.

Durable: Offsets must last as long as CO2 stays in the atmosphere (century or more).

+(Plus): Offsets should contribute to other societal issues such as employment, equity, or public health.

TECHNOLOGY SIDE:

Passive house
Building electrification: heat pump

Millennium Partners

MILLENNIUM TOWER, 2008
Location: San Francisco

Focused on **ultra-luxury** furnishes and amenities for wealthy condo owners
(2016: had sunk 16 inches and tilted)

MILLENNIUM PLACE (HAYWARD PLACE), 2013
Location: Boston

Focused on **job creation**, downtown revitalization

MILLENNIUM TOWER, 2017
Location: Boston

Focused on **ultra-luxury** + **health and wellness** (two-story club, the largest residence-only fitness center)

WINTHROP CENTER, 2022
Location: Boston

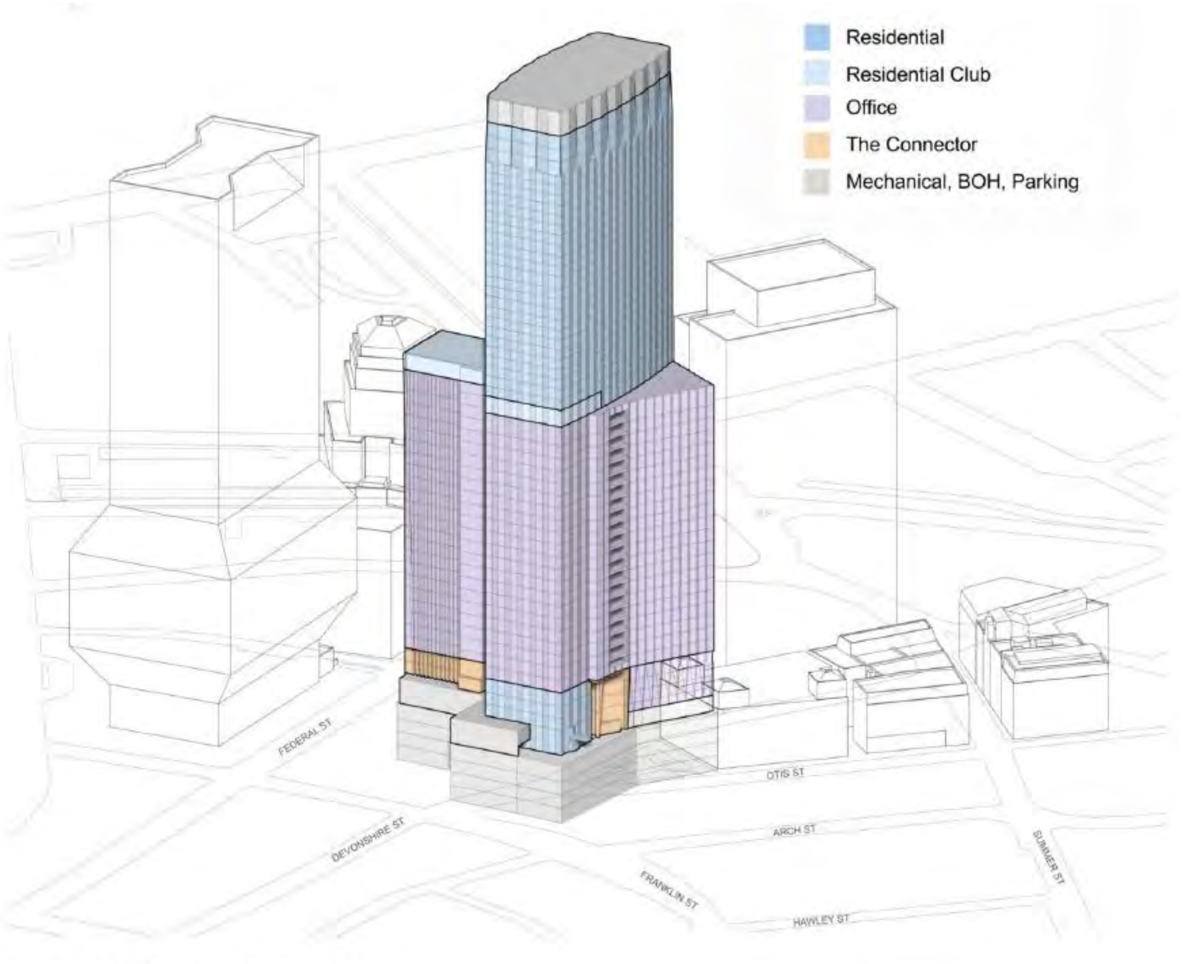
Sustainability
Passive House
WELL Gold and LEED Platinum

Source: Ashley Katz. Industry Mapping of Sustainable Real Estate.

Winthrop Center

Sell ← Condo — LEED Gold

Lease ← Office — Passive House + WELL Gold + LEED Platinum



Source: Millennium Partners Boston

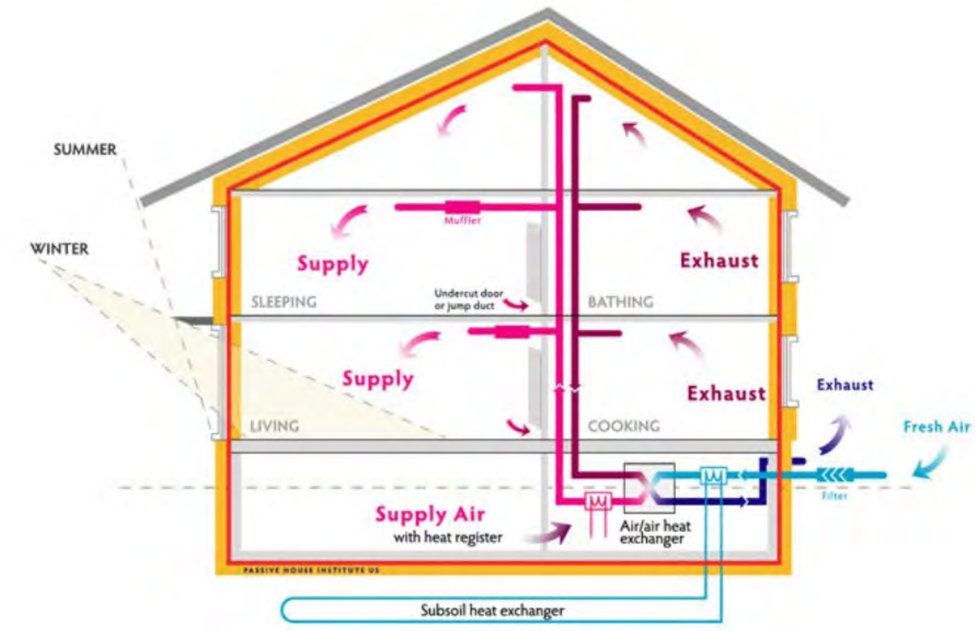
LEED + WELL

	LEED
Full Name	Leadership in Energy and Environmental Design
Launch Date	1998
Governing Body	US Green Buildings Council (USGBC)
Certification By	Green Business Certification Institute (GBCI)
Countries Covered	176
Ratings	•Certified •Silver •Gold •Platinum
Assessment	USGBC
Schemes	•New Construction; Existing: Operations and Maintenance; Commercial; Interiors; Core & Shell; Schools; Retail; Healthcare; Homes; Neighborhood Development

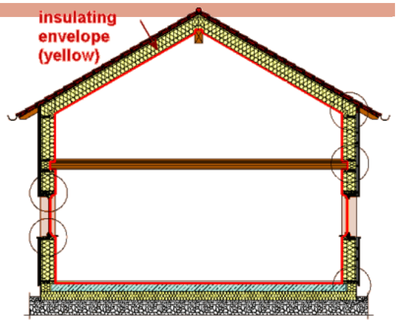
Passive House Technology

Additional Cost

(Estimated cost premium +3-10%)



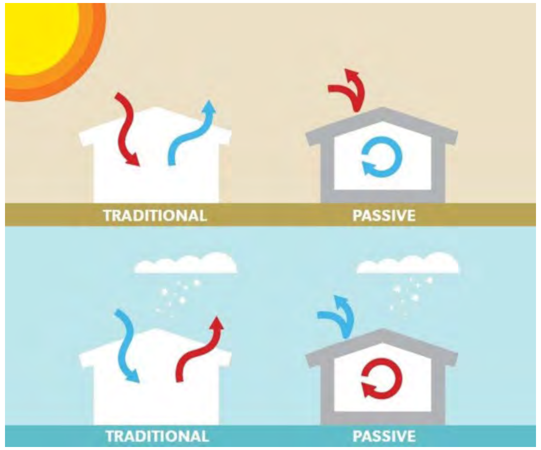
- **Highly Insulated Building Envelope**
(Continuous layer and high-performance and double/triple-glazed windows)



- **Continuous Air Sealed Layer**
(Add air barriers such as high-performance tapes to control heat energy loss, unwanted heat gain, and infiltration of pollutants)

- **Eliminate Thermal Bridges**
(Use double stud walls to reduce pathway of heat energy to travel through the envelope from inside to outside)

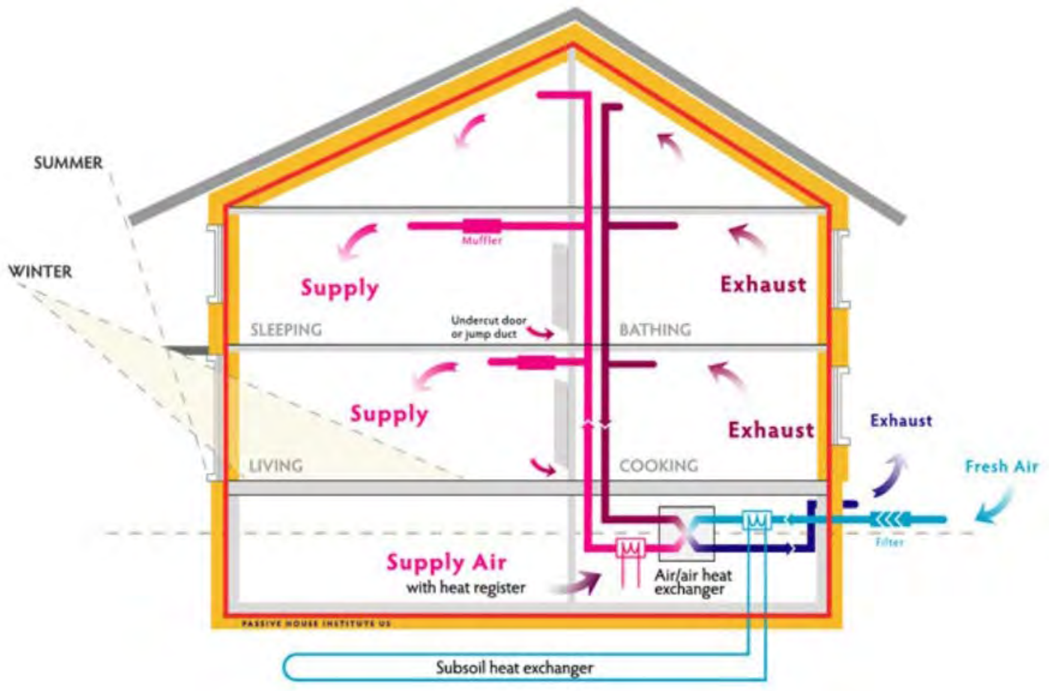
- **Heat Recovery Ventilation**
(controlled ventilation and heat exchanger to remove smell, air pollutants, excess humidity)



+ Window Orientation
(Orientation of windows depending on the location, e.g., south-facing for heat gain)

Passive House: Benefits

Benefit



- **Energy Saving**

90% reduction in heating energy
(due to insulation, air tight, and high performance window)

- **Resilience**

Lower energy demand means better resilience to power outages during climate disasters.

- **Health**

Not living in a plastic bag just controlled ventilation! The balanced ventilation systems supply filtered fresh air.

- **Comfort**

Stable indoor temperature, fresh air, quiet, dust free, no unwanted moisture …

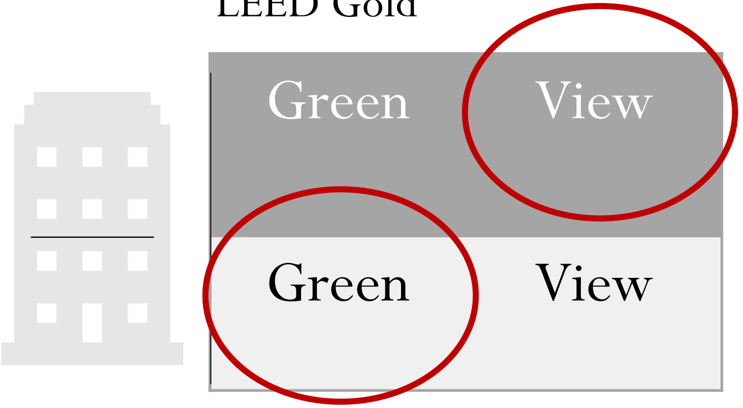
- **Reputation**

If you move earlier and get a certificate :)

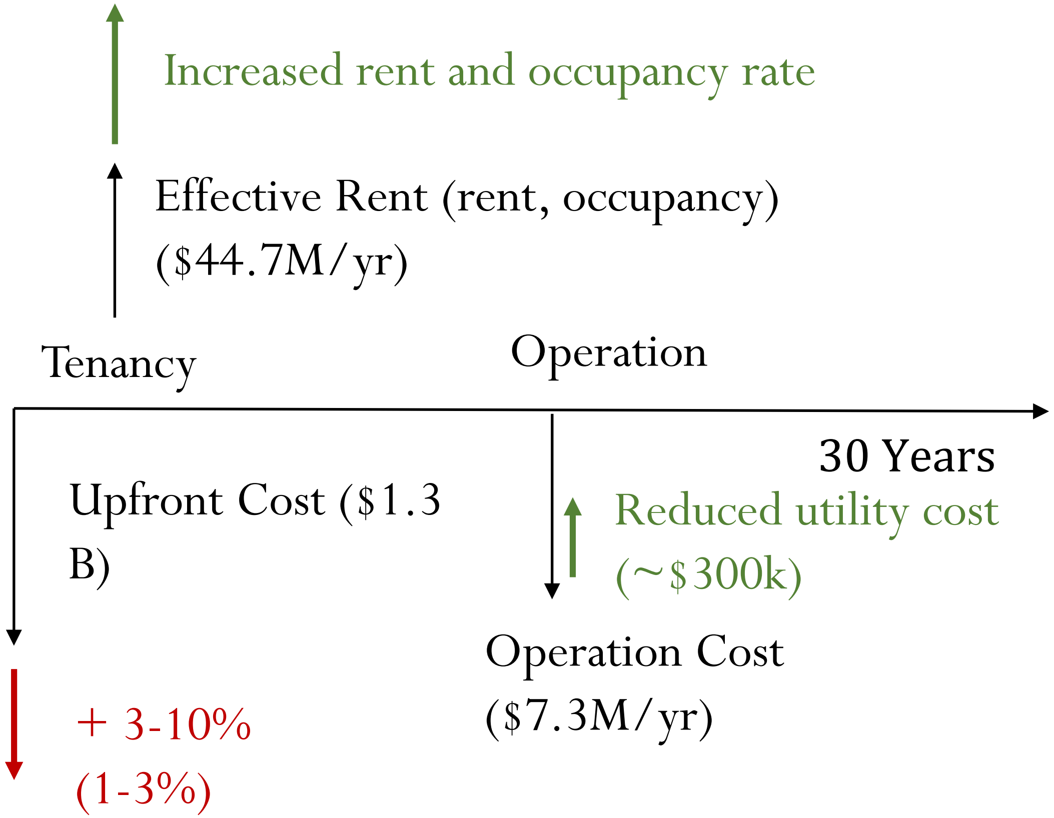
Winthrop Center

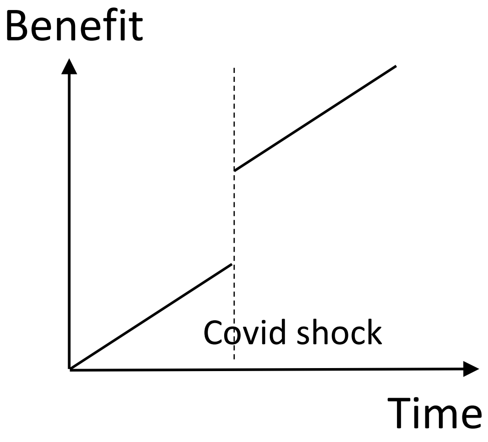
Comparative Advantage

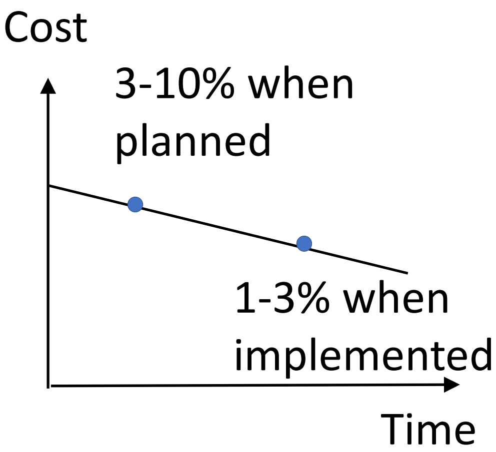
LEED Gold



Passive House
+ WELL Gold
+ LEED Platinum

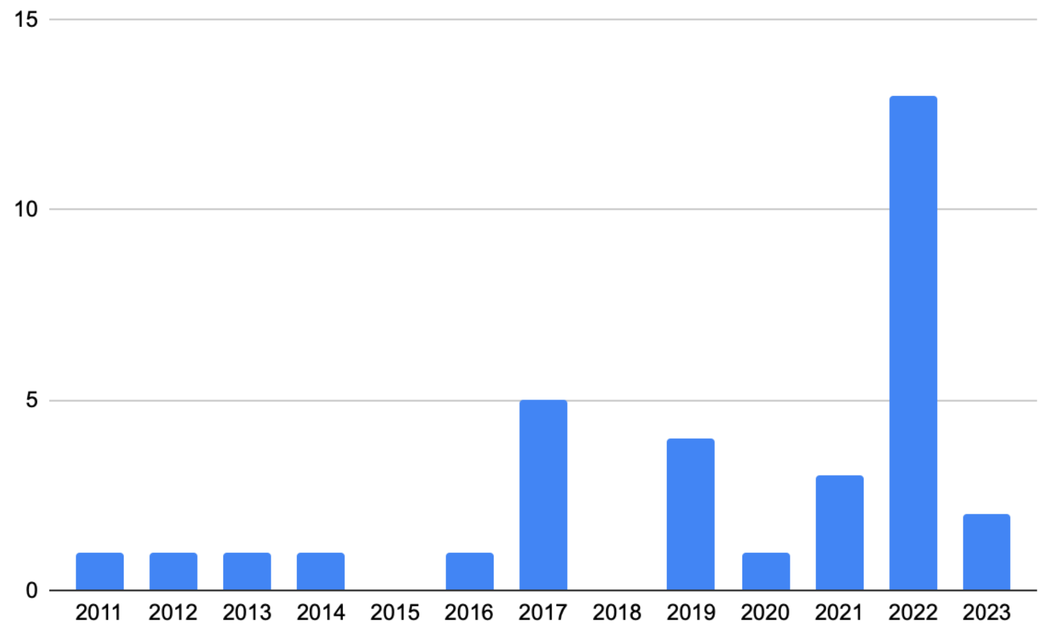


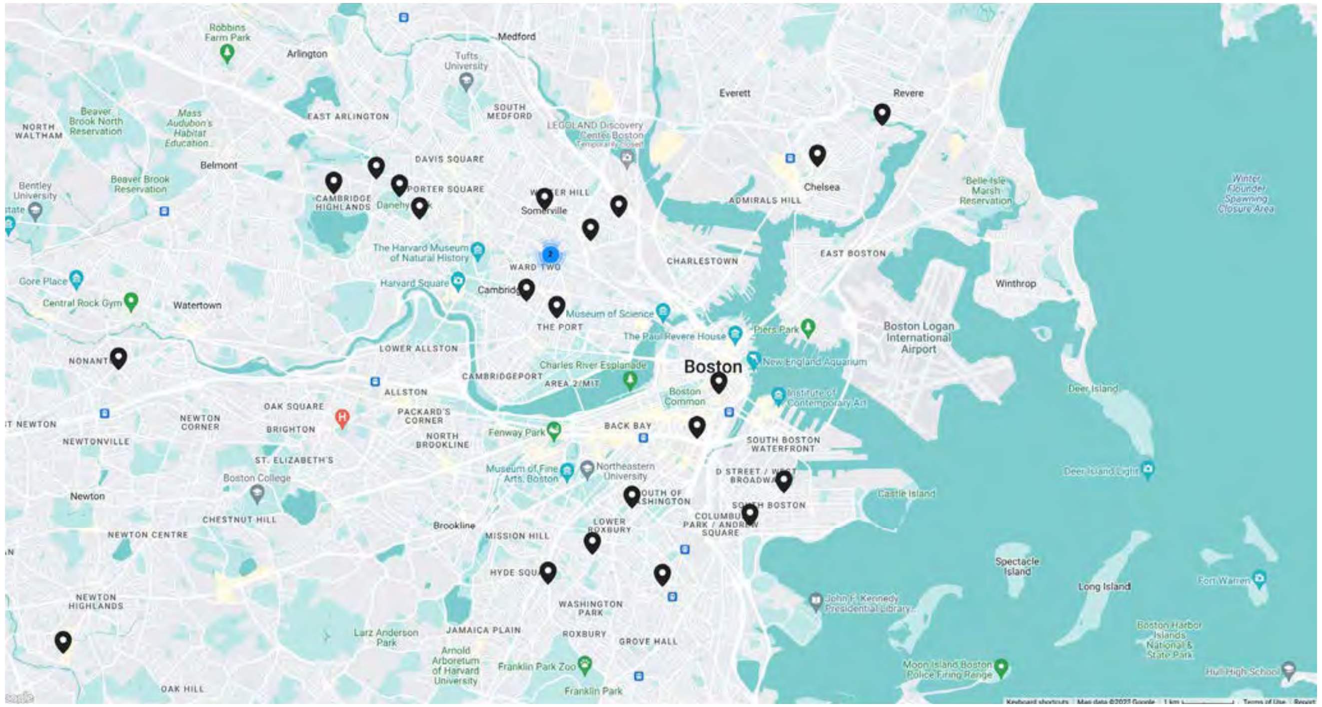




Passive Houses in the Boston Area

Number of Passive Houses Built in MA by Year





MIT Center for Real Estate

Passive House: 12 Fayette Street

Features:

- Super insulated, airtight construction
- Triple pane windows
- Heat recovery ventilation
- Efficient heating and cooling systems
- Reduced thermal bridging

80% reduction in energy use relative to similar houses built to the current building code

Inman Square

Passive House: 152 – 158 Broadway

Features:

- Five-story, mixed use commercial / residential building
- Façade provides shading to reduce cooling loads
- Low embodied carbon of construction materials
- Highly efficient, 100% electric

Somerville, MA

Passive House: 71 Bow St

Features:

- Airtight insulation
- High performance windows
- Heat recovery ventilation
- Highly efficient heating
- Solar ready

Union Square

80% reduction in energy use relative to similar houses built to the current building code

Passive House: Northland Newton Development

Features:

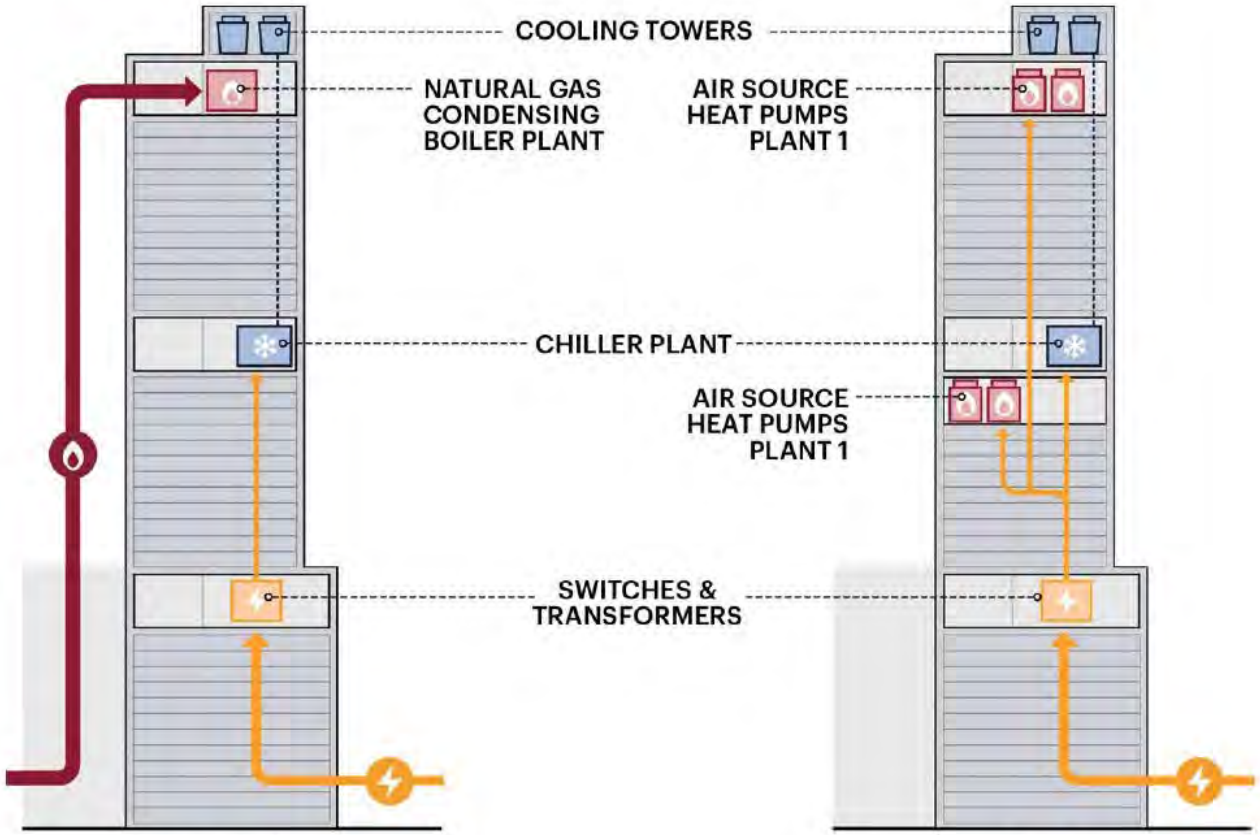
- Largest passive house residential community in the US
- LEED Gold building standards
- Efficient use of daylighting
- Highly efficient heating
- Solar energy

Kent Gonzales
(MSRED 1985)

Electrification: Pathway to Net Zero

Cooling

Figure 3. Schematic floorplan and axonometric view of the tower



Heating

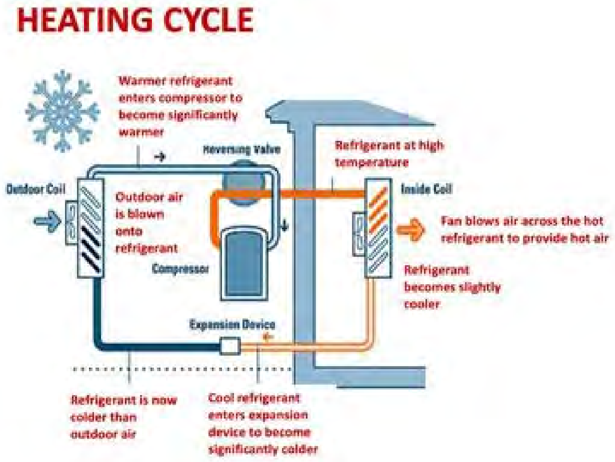
Heat pump technology

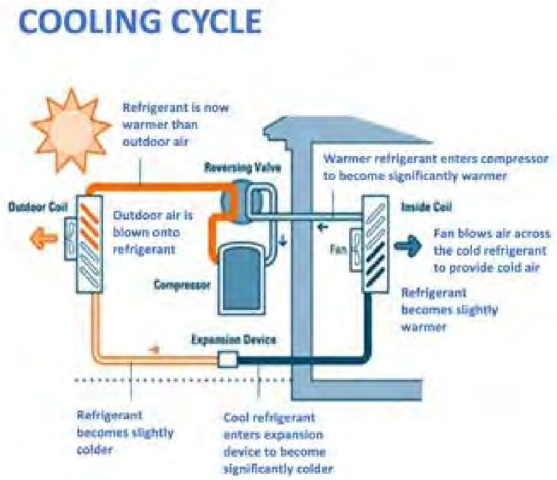
Temperate Climates

- Highly efficient heating and cooling
- Eliminates need for separate heating + cooling systems
- Health benefits from reduced natural gas use
- Improved occupant comfort from reduced noise and better humidity control

Subtropical / Tropical Climates

- Highly efficient cooling (especially as compared to window ACs)
- Improved occupant comfort from reduced noise and better humidity control





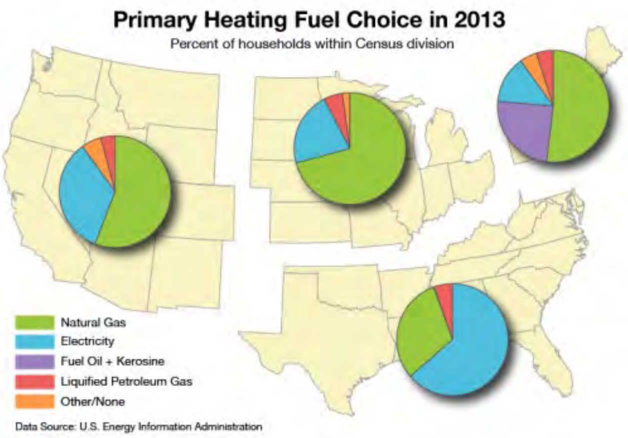
Heat pump adoption in Massachusetts

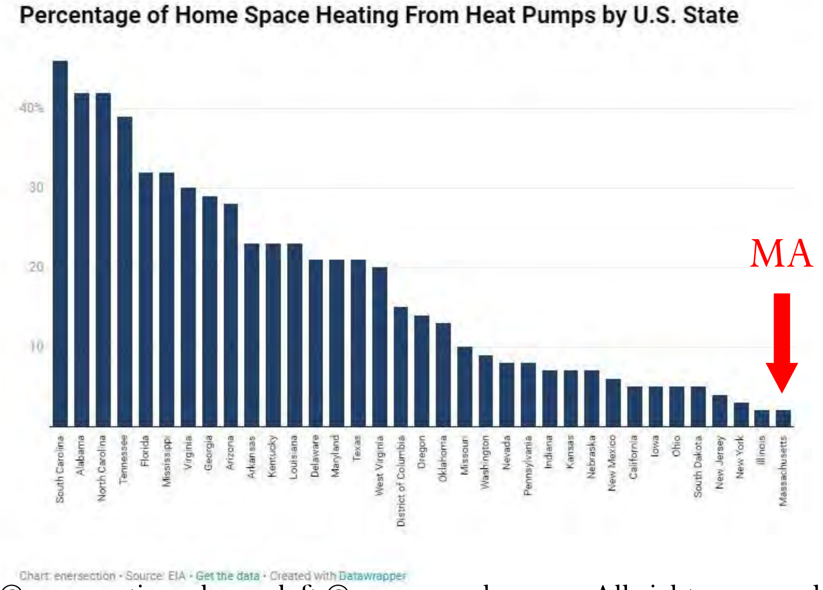
Favorable conditions for heat pumps

- Technological improvement
- Utility / govt subsidies
- Building envelope improvements
- Tax credits / exemptions

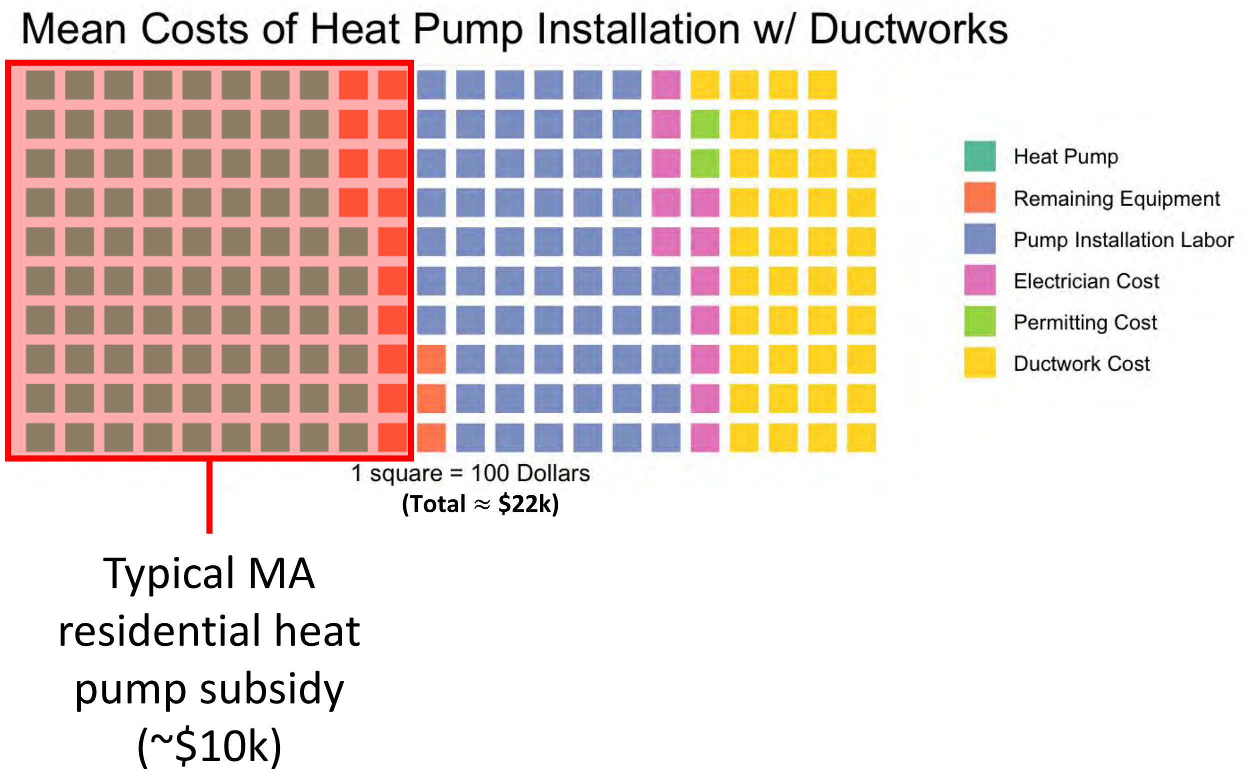
Unfavorable conditions for heat pumps

- Cold climate / high heating loads
- High equipment / labor costs
- High electricity prices
- Low natural gas prices

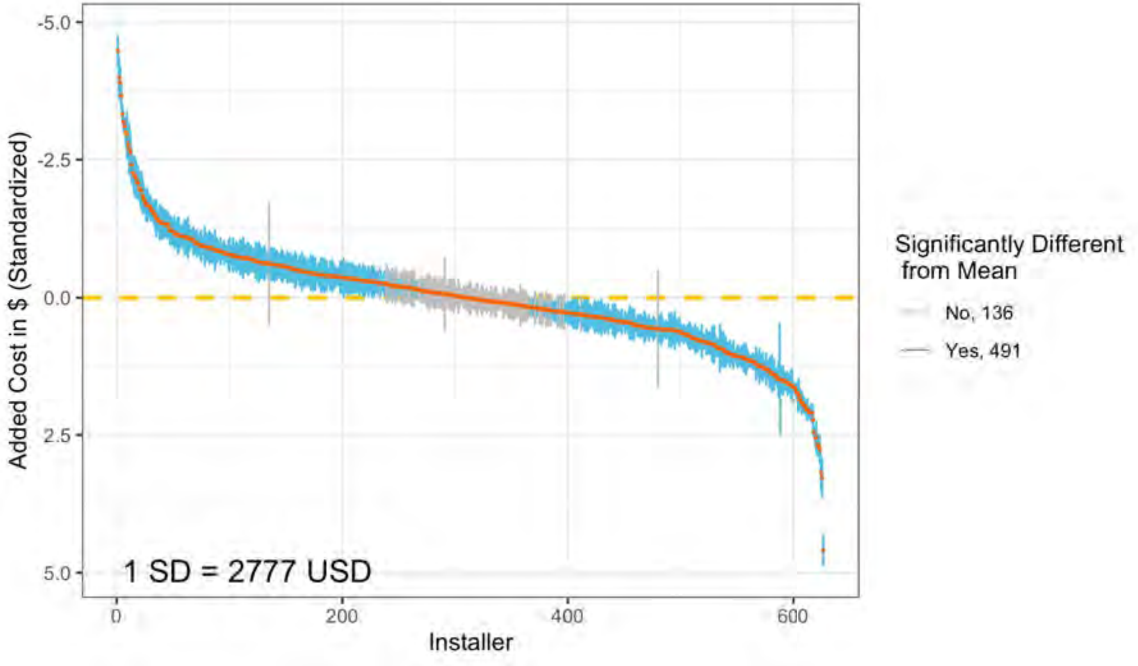




Heat pump costs

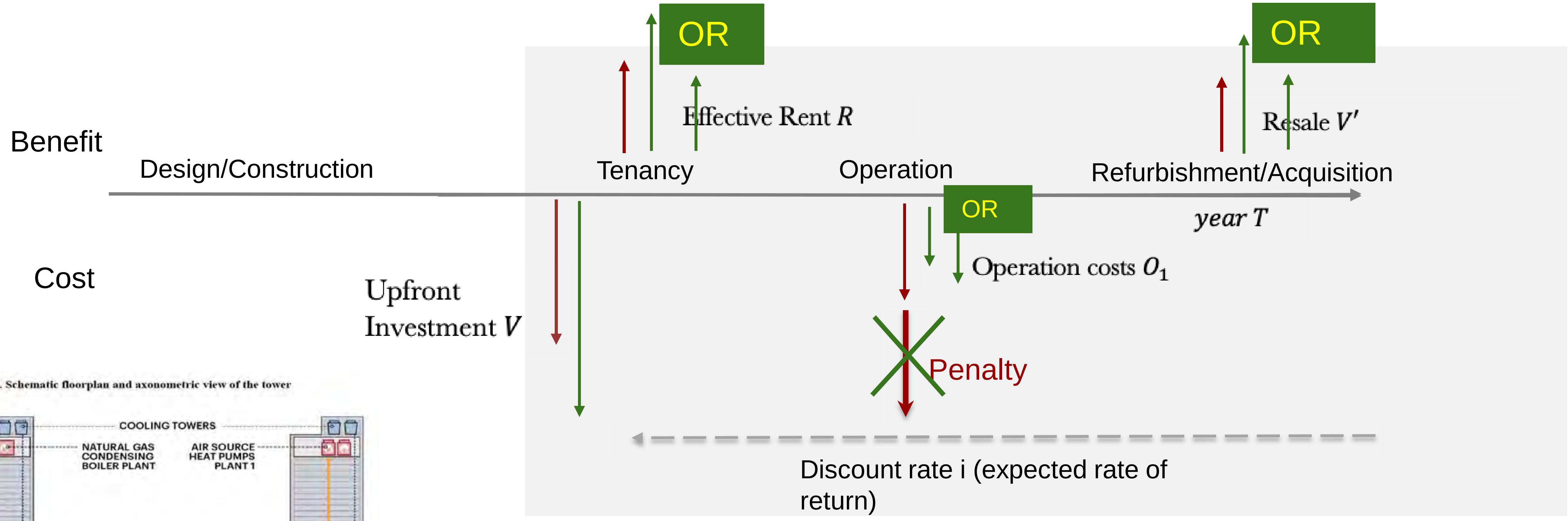


Added cost of heat pump installation by installer



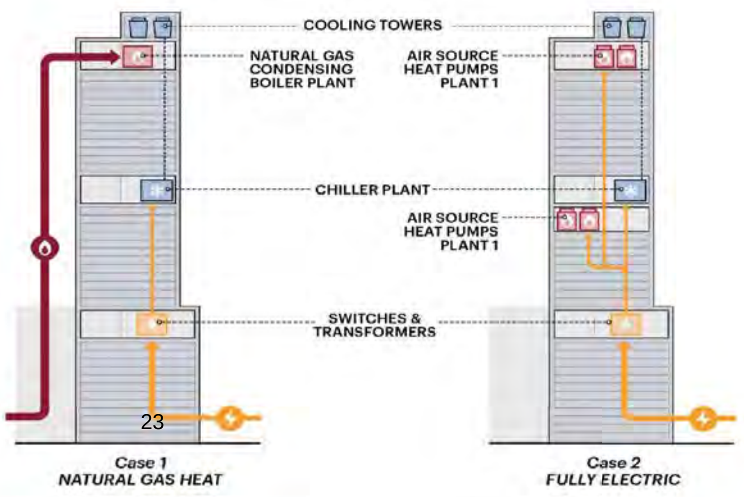
The cost of installing a heat pump varies significantly among installers

The economics of adopting decarbonization technologies



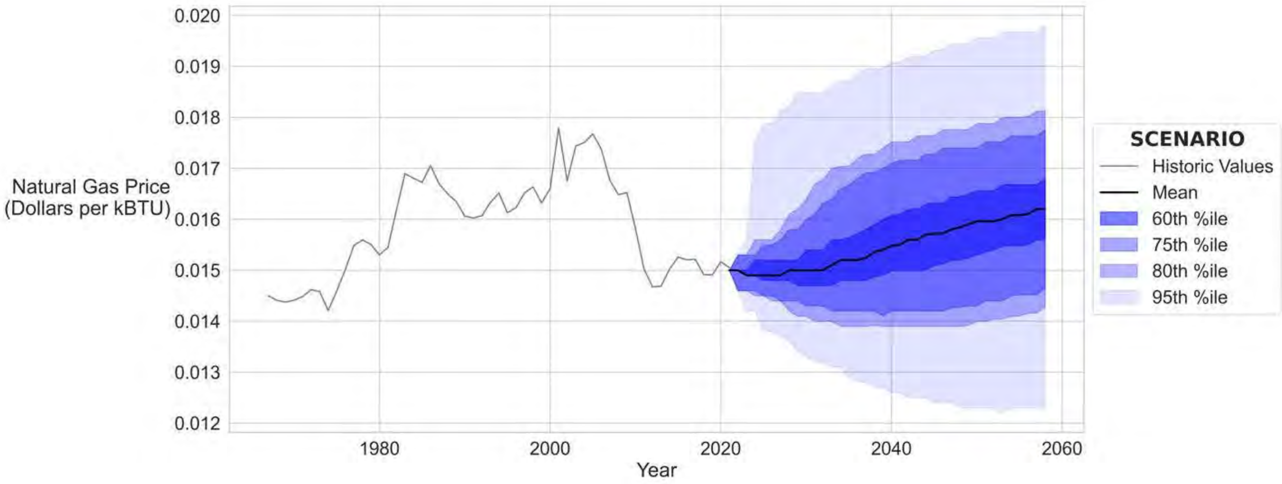
Fully electric building cash flow

Figure 3. Schematic floorplan and axonometric view of the tower

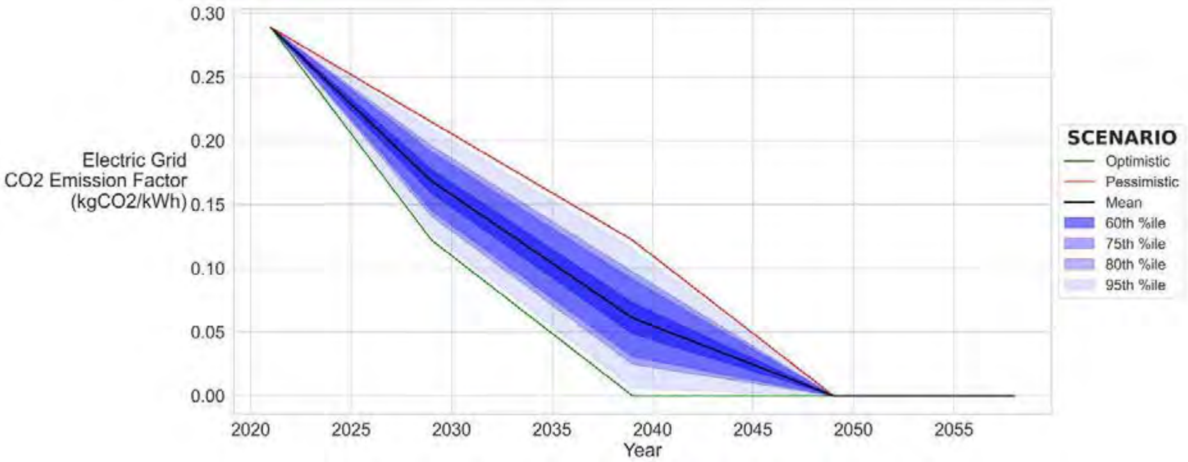


More Uncertainties

Natural Gas Prices

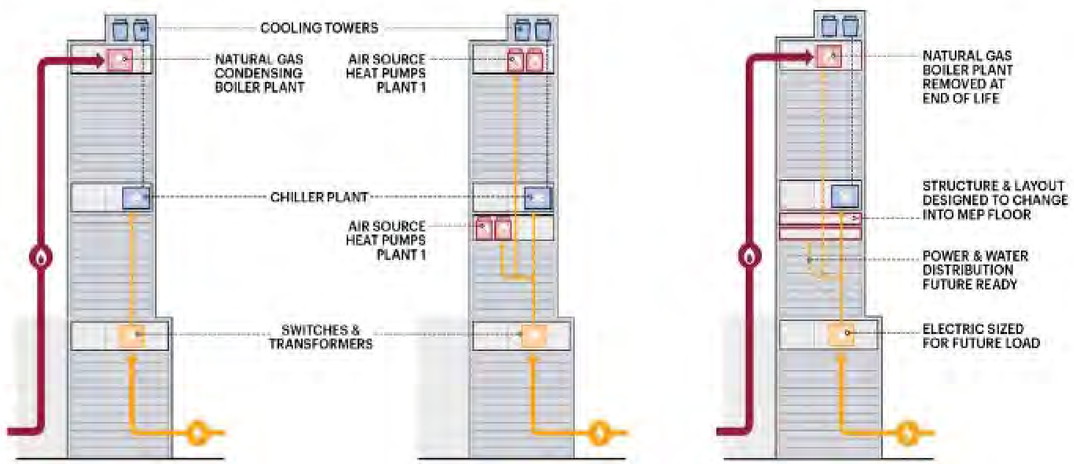


Rate of Grid Decarbonization



Quantifying the financial value of building decarbonization technology under uncertainty

Three design options:



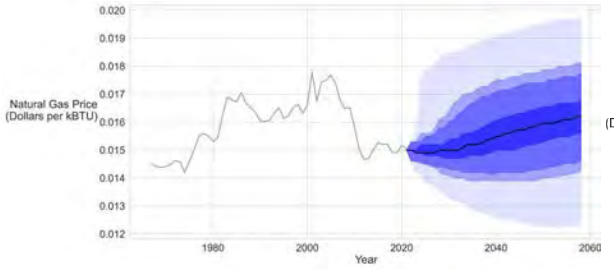
Option A
Building with natural gas heating systems

Option B
Building with fully electric heating systems

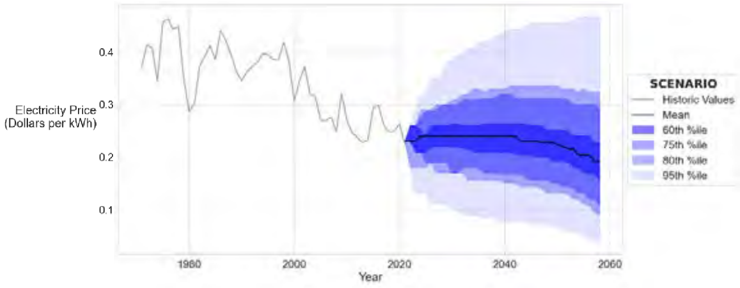
Option C
Building with the flexibility to fully electrify in the future

And a whole lot of uncertainty:

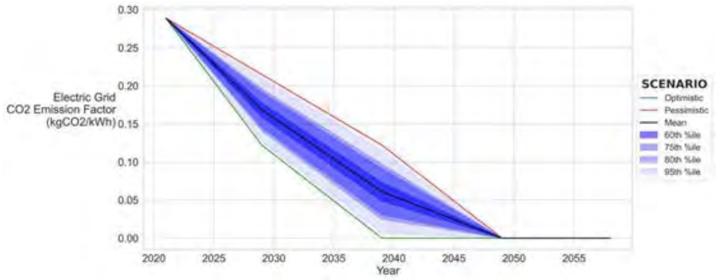
Natural Gas Prices



Electricity Prices



Rate of Grid Decarbonization

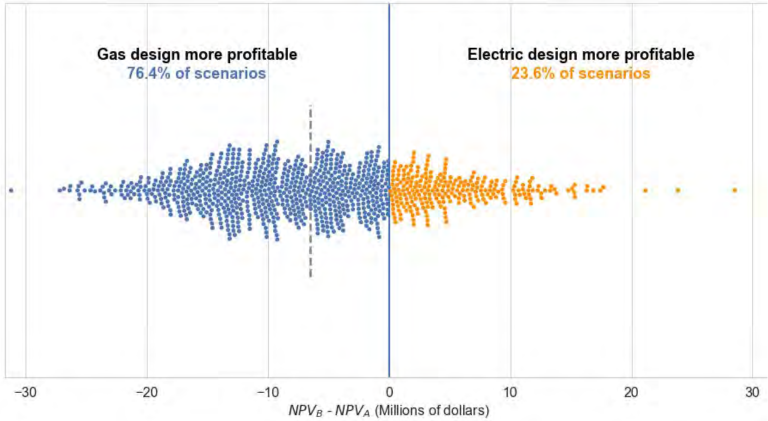


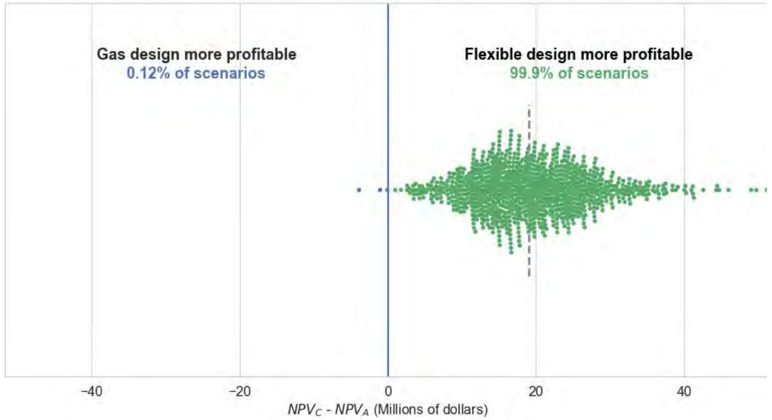
- Building energy use
- Technological development
- Energy efficiency market premiums
- Equipment performance / costs
- **And more…**

In 10,000 different future scenarios, which design option is most profitable most often?

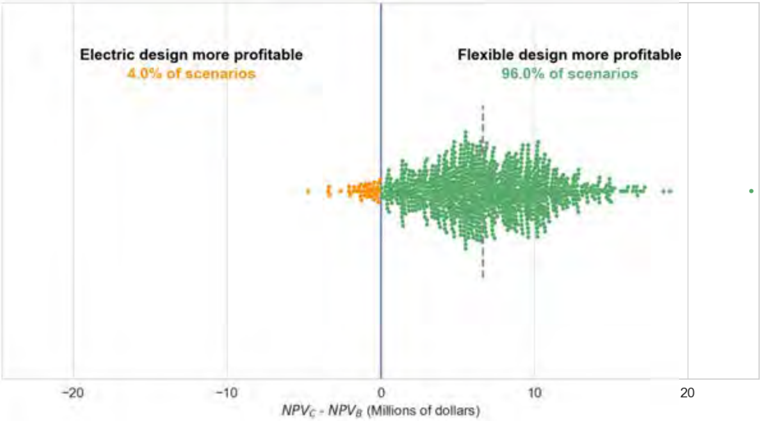
Quantifying the financial value of building decarbonization technology under uncertainty

Results





Each point represents the **difference in NPVs** of two design options in **one scenario**

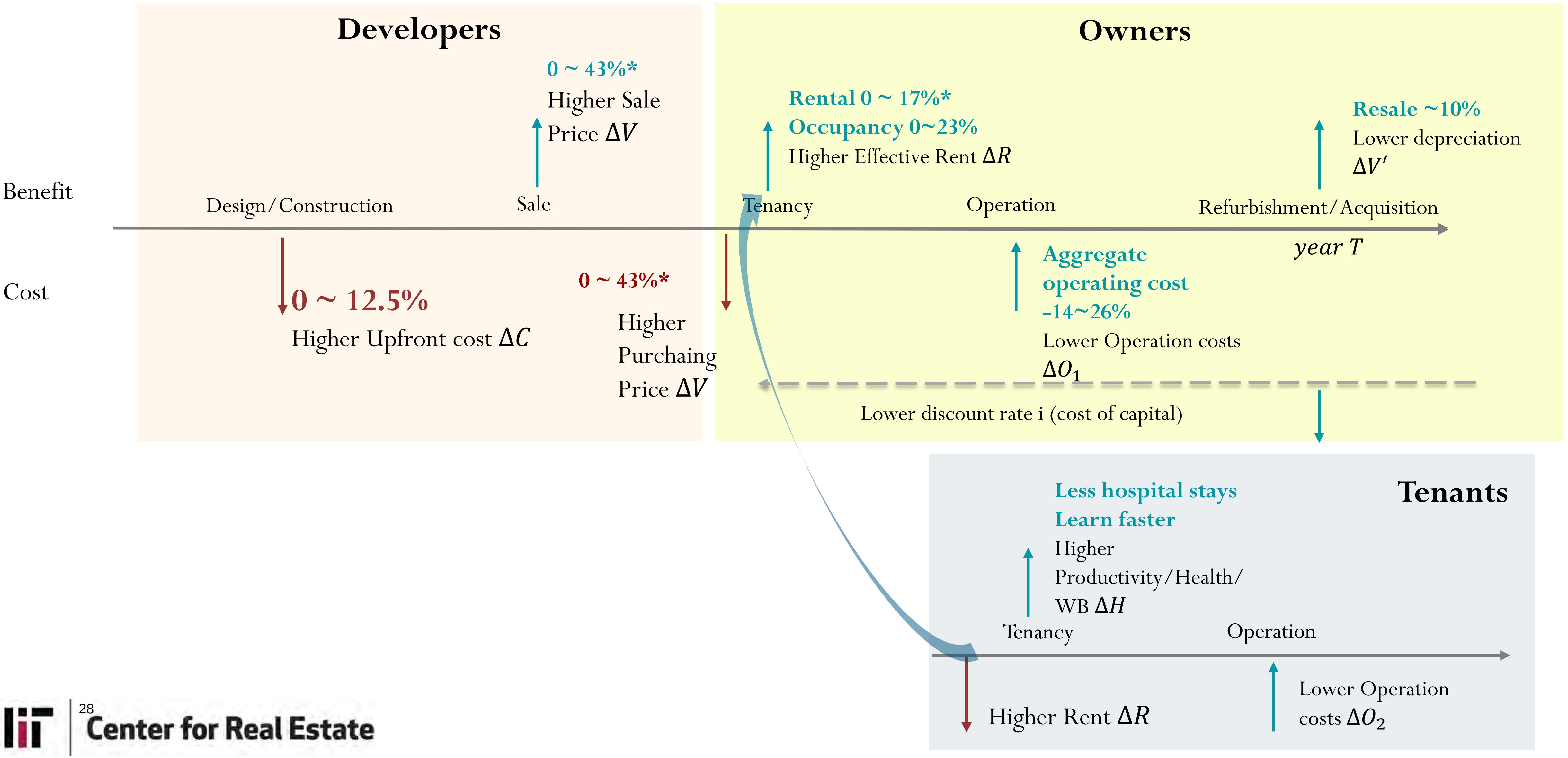


The greater the number of points on one design option's side, the higher the probability that it will be more profitable across different scenarios

PEOPLE SIDE: landlord vs. tenant

Split incentive and green lease
Scope 1-2-3: whose carbon it is?

Is There a Business Case for Green Buildings?



Performance Gaps

Actual energy consumption >> projected energy consumption

- Gas, electricity, energy cost: up to +125%, +275%, +235% (ARUP, 2013)

- Possible reasons
  - Energy models don't consider behaviors
  - Construction/operation practice don't follow design intent
  - Split incentives
- Possible solutions?

Sam Roudman / July 28, 2013

Bank of America's Toxic Tower

New York's "greenest" skyscraper is actually its biggest energy hog

Who should pay the energy bill?

Lease types and expense matrix of tenants:

	Triple net	Double net	Single net	Full Service Gross
Base rent	Y	Y	Y	Y
Utilities and operating costs	Y	Y	Y	
Property taxes	Y	Y	Y	
Insurance	Y	Y		
Maintenance & repair costs	Y			

In terms of energy efficiency, what will be the problems?

Split incentive: Who should pay the energy bill?

If tenants pay the bill (such as the "triple net lease", NNN)

Net Lease

Owner

Does not pay the energy bill thus will not benefit if they pay for energy efficiency upgrades

Tenants

Do pay the energy bill but do not own the building, thus usually hesitant to make long-term investment on someone else's building.

Gross Lease

Similarly, for buildings with a full-service lease structure (i.e., no additional expenditure for utility):

- The owner wants to keep the energy cost down
- Tenants have no incentive to save energy as they pay the flat rate.

Case: Green Retrofit in Rockville, Maryland

- Lundberg owns an old building that he leases to some tenants.
- He has had an energy audit and identified some retrofit opportunities to substantially reduce energy use.
- Should he go for it?

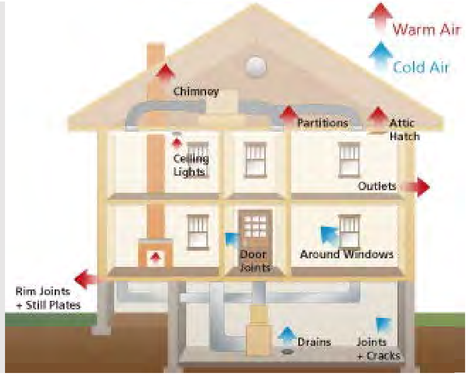
After class reading: HBS case 9-212-067 "**Edward Lundberg and the Rockville Building: Energy Efficiency Finance in Commercial Real Estate**"

Case: Rockville Building

Retrofit opportunities identified in energy audit:

- **Improve building weatherization**

(sealing up air leaks and adding insulation)

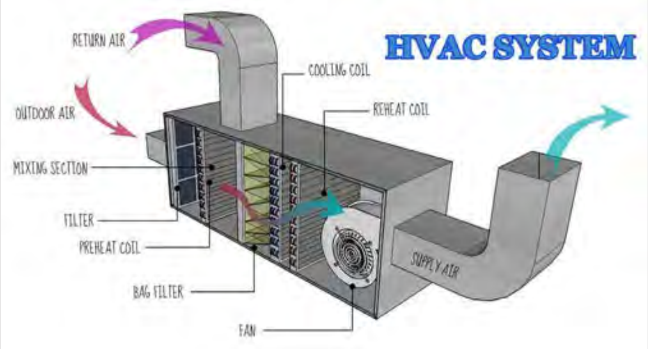


Projected cost and benefit:

COST: $4-8/SF

BENEFIT: 30% Energy Saving

- **Install more efficient HVAC system**



- **Install more efficient lighting system**

- **Retro-commissioning**

(improve control system for HVAC, add motion sensors to lighting, etc.)

Case: Rockville Building

Retrofit Assumption		Property Assumption	
Forecast EE saving	30%	Total sqaure feet	200,405
Choice of EE retrofits	DIY Equity	Rental rate, $/SF, net lease	$41.37
Actual Energy Savings, Variation relative to forecast	0%	Occupancy rate	85%
Rent premium from retrofit, % change	0%	Rental rate annual escalation	3%
Change in occupancy rate from retrofit, %-point change	0%	Maintenance & repairs cost escalation	3%
Energy cost annual escalation	3%	Tenant share of energy costs	90%
Energy demand escalation	2%	Owner share of energy costs	10%
Upfront capital costs of EE project, $/SF	$6.00	Average energy intensity, kWh/SF/yr	30
Upfront capital costs of EE project, $ total	$1,202,430.00	Price per kWh, $	$0.11
Owner Cost of Capital Assumptions:			
DIY Equity	15%		

Pro Forma - Baseline

BASE CASE - PRO FORMA - NO RETROFIT		Year		0	1	…	10
Baseline electrical demand (total, kWh)				6012150	6132393		7328777
Energy price, $/kWh				$0.11	$0.11		$0.15
Total energy cost, entire building				$661,337	$694,800		$1,083,419
Rent, $/SF				$41.37	$42.61		$55.60
Occupancy				85%	85%		85%
Revenues							
Gross rents possible				$8,290,755	$8,539,477		$11,142,081
Parking revenue				$509,040	$509,040		$509,040
Vacancy allowance				($1,319,969)	($1,357,278)		($1,747,668)
Effective gross revenue				$7,479,826	$7,691,240		$9,903,453
Operating expenses							
Energy cost, owner only				$66,134	$69,480		$108,342
Maintenance & repairs, owner	rate ($/SF/yr)		0.5	$100,203	$103,209		$134,664
Other expenses (taxes, G&A, insure, etc.)	rate ($/SF/yr)		7.65	$1,533,098	$1,533,098		$1,533,098
Total operation expenses				$1,699,434	$1,705,787		$1,776,104
Cash flow from operations				**$5,780,391**	**$5,985,453**		**$8,127,349**
Cap rate		8%					
Property value							$101,591,864

Pro Forma - Retrofit Impact (TOTAL)

EE RETROFIT IMPACT	DIY Equity	Year	0	1	…	10
TOTAL BUILDING IMPACT (**LANDLORD AND TENANTS**)						
Annual kWh reduction (forecast)				1,839,718		2198633
Annual kWh reduction (realized)				1,839,718		2198633
Revenue improvement						
Improvements from higher rent				-		-
Improvements from higher occupancy				-		-
Total rent improvements				-		-
Cost savings						
Energy cost savings (forecast)				$208,440		$325,026
Energy cost savings (realized)				$208,440		$325,026
Upfront capital costs			- $1,202,430			
CF impact TOTAL			- $1,202,430	$208,440		$325,026
NPV TOTAL		**$39,470**				
Cost of capital, owner		15%				

Green retrofit seems fruitful!

Case: Rockville Building

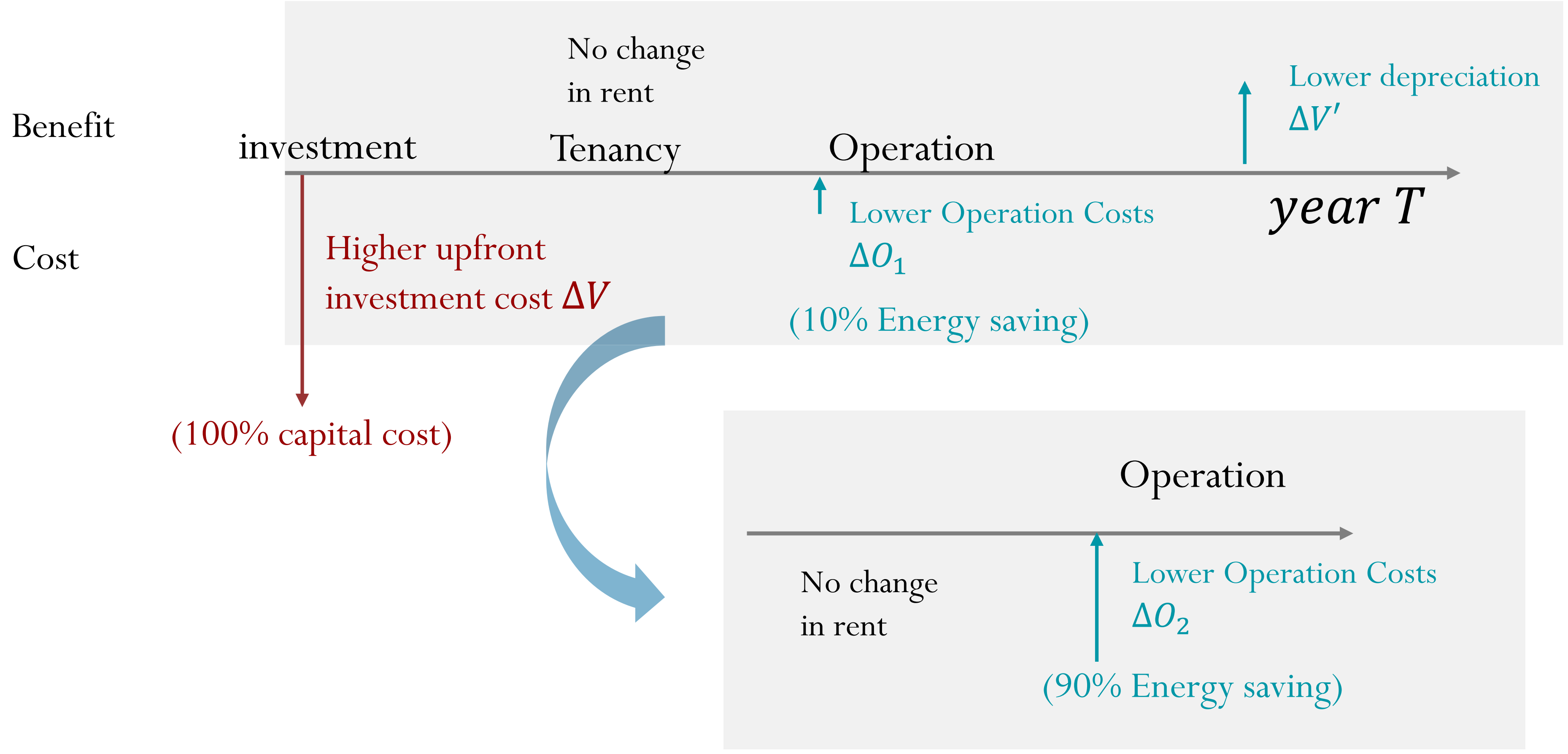
- Is the analysis above missing something?
- Split Incentive under a **NNN lease**:
  - Audit showed clear energy saving benefits, which outweighs the investment cost. BUT,
  - Tenants get energy saving benefits.
  - Owners bear the upfront capital investment cost

Pro Forma - Retrofit Impact (Landlord vs. Tenants)

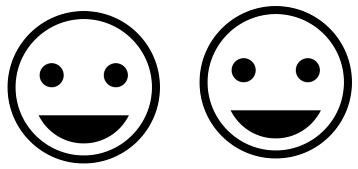
EE RETROFIT IMPACT	DIY Equity	Year		0	1	…	10
<u>OWNER</u>							
Improvement rent revenue							
Energy cost savings	owner's share		**10%**		$20,844		$32,503
Total CF from Ops improvement				$0	$20,844		$32,503
Upfront capital costs	owner's share		100%	- $1,202,430			
Cash Flow impact, Owner				- $1,202,430	$20,844		$32,503
NPV	**- $937,085**						
Cost of capital, owner	15%						
PV of property value improvement*	$100,427						
* Assuming sale in year 10							$406,282
<u>TENANTS</u>							
Rent increase, tenants				-	-	-	
Energy cost savings, tenants	tenant's share		**90%**		$187,596		$292,523
CF impacts, Tenants				$0	$187,596		$292,523
NPV	**$1,271,789**						
cost of capital, tenants	10%						

Win-Lose

Owner's analytical horizon



Owner NPV: **- $937,085**



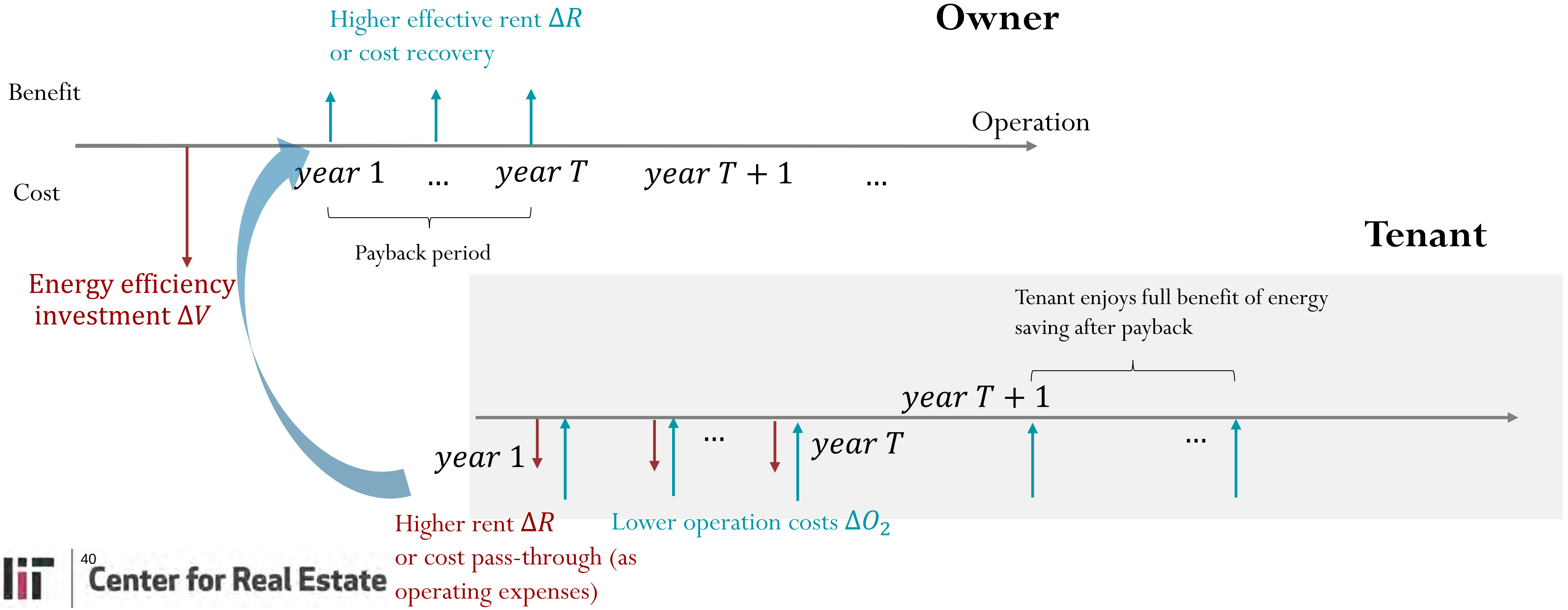
Tenant NPV: **+$1,271,789**

Tenant's analytical horizon

Solutions?

Green Lease: Cost Pass-Through (Cost Recovery)

- 34% of commercial leases already have some green lease conditions with another 40% planning to sign by 2025 (source).
- Logic of green lease:



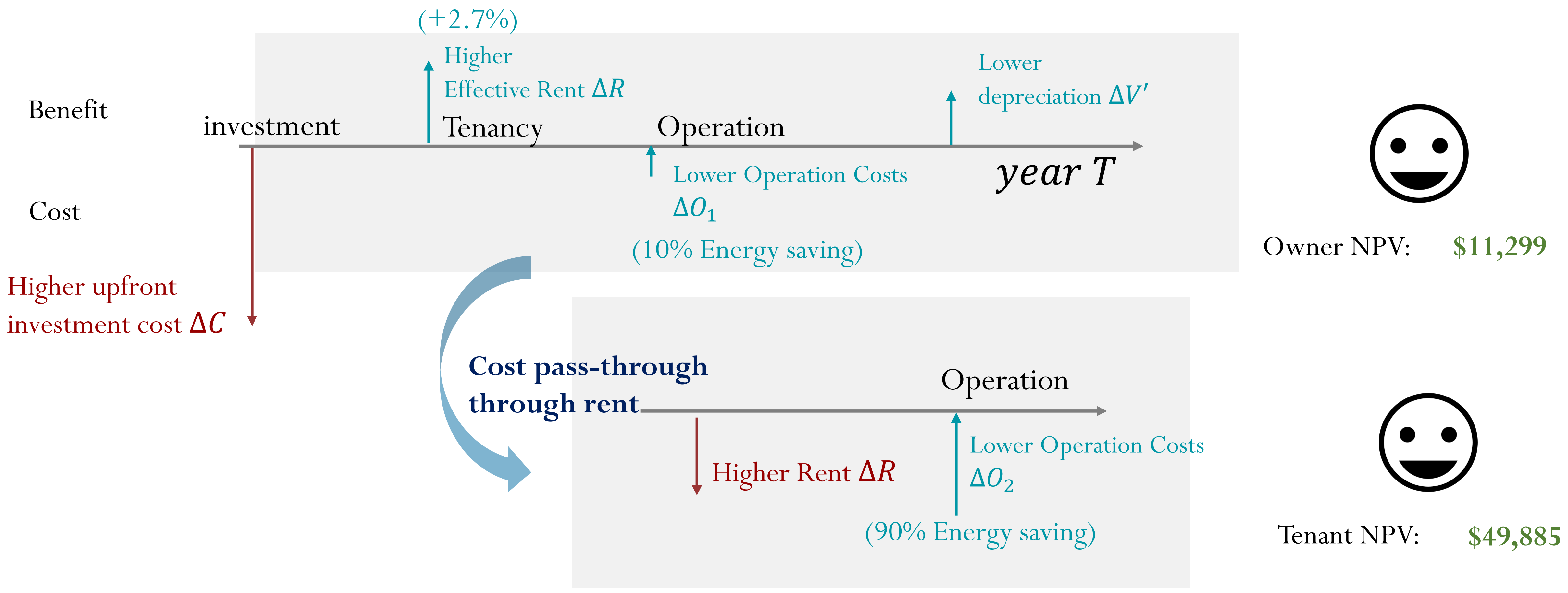
Pro Forma - Retrofit Impact (After Cost Pass-through)

- The owner can increase rent
  - Not too high so that for tenants: Rent increase < Energy saving benefit

EE RETROFIT IMPACT	DIY Equity	Year	0	1	...	10
OWNER						
Revenue improvement						
Incremental rent, $/SF	**rent increase**	**2.7%**	-	$1.15		$1.50
Improvement in gross rent			-	$230,566		$300,836
Vacancy allowance			-	- $34,585		-$45,125
Increase in effective rent revenue			-	$195,981		$255,711
Cost savings						
Energy cost savings	owner's share	10%		$20,844		$32,503
Total CF from Ops improvement			$0	$216,825		$288,213
Upfront capital costs	owner's share	100%	-$1,202,430			
Cash Flow impact, Owner			- $1,202,430	$216,825		$288,213
NPV	**$11,299**					
Cost of capital, owner	15%					
PV of property value improvement*	$890,524					
* Assuming sale in year 10						$3,602,667
TENANTS						
Rent increase, tenants			-	- $195,981		- $255,711
Energy cost savings, tenants	tenant's share	90%		$187,596		$292,523
CF impacts, Tenants			-	- $8,385		$36,812
NPV	**$49,885**					
cost of capital, tenants	10%					

Win-Win

Owner's analytical horizon



Tenant's analytical horizon

Green Lease Clauses

Define the types of capital cost can be recovered from operation expenses.

The cost recovery should deduct government subsidies.

The cost recovery should base on projected energy saving within payback period.

(b) Capital Improvements.

Landlord may include the costs of certain Capital Improvements in Operating Expenses pursuant to Section 1.1(a)(v)(16) in accordance with the following:

(i) Capital Improvements Intended to Improve Energy Efficiency. In the case of any Capital Improvement that the Independent Engineer certifies in writing will, subject to reasonable assumptions and qualifications, reduce the Building's consumption of electricity, oil, natural gas, steam, water or other utilities, and notwithstanding anything to the contrary in Section 1.1(a)(v):

A. The costs of such Capital Improvement shall be deemed reduced by the amount of any NYSERDA or similar government or other incentives for energy efficiency improvements actually received by Landlord to defray the costs of such Capital Improvement, and shall further be reduced by any energy efficiency tax credits or similar energy-efficiency-based tax incentives actually accruing to Landlord as a result of such Capital Improvement.

B. For the purposes of this Section 1.1(b)(i), "simple payback period" means the length of time (expressed in months) obtained by dividing (x) the aggregate costs of any such Capital Improvement, by (y) the Projected Annual Savings. By way of example: If the aggregate costs of such Capital Improvement are $2,000,000 and the Projected Annual Savings are $500,000, then the simple payback period for such Capital Improvement is forty-eight (48) months.

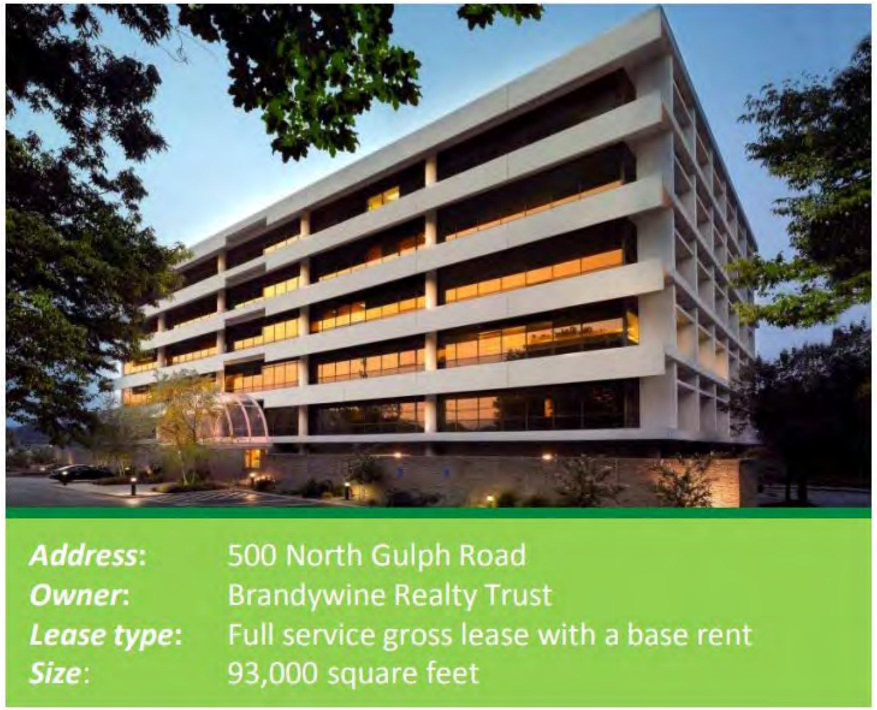
Green Lease Mini Case I

Brandywine Realty Trust: one of the largest full-service integrated real estate companies in the nation. **[cost pass-through + submetering clause]**

1. Provide financial evidence
   Show tenants the cost and utility savings.

2. Monitoring the performance
   Make the cost pass-through spreading over time for the tenants. If the upgrade underperform, reduce the repay amount and extend repayment period.

3. Address tenant turnover
   If a tenant moves out before fully repaid, new tenant assumes the payback obligation.



Green Lease Mini Case II

[Brixmor Property Group](#): publicly traded real estate investment trust (REIT); owns and operates the nation's largest open-air shopping centers in 36 states.

In the lease:

- Brixmor (landlord) can install renewable energy systems.
  → partner with Blue Sky Utility
- Tenants
  - need to purchase electricity from the landlord/ landlord designee.
  - Need to install submeters.

A new pressure on both landlords and tenants

TECHNOLOGY: ONLINE APPAREL STARTUP PUTS ITSELF UP FOR SALE B4

BUSINESS & FINANCE

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SEC Pushes on Climate Disclosure

Plan would mandate that public companies estimate greenhouse gas emissions

By Paul Kiernan

WASHINGTON—Regulators proposed stringent requirements for publicly traded companies to report information on greenhouse-gas emissions and risks related to climate change, in one of the Biden administration's potentially most significant environmental actions to date.

The Securities and Exchange Commission formally offered a 534-page proposal Monday that would force publicly traded companies to report greenhouse-gas emissions from their own operations as well as from the energy they consume and to obtain independent certification of their estimates.

In some cases, companies also would be required to report greenhouse-gas output of both their supply chains and consumers, known as Scope 3 emissions. An SEC official said most companies in the S&P 500 would likely have to report Scope 3 emissions. Companies would have to include the information in SEC filings such as annual reports.

The proposal comes as President Biden's efforts to address global warming through legislation have stalled in Congress, putting pressure on regulatory agencies to deliver on a core Democratic priority. That has drawn criticism from Republicans, who accused Democratic SEC Chairman Gary Gensler of overreach.

Mr. Gensler said investors and asset managers representing tens of trillions of dollars have called for companies' climate-related disclosures to be more standardized. While hundreds of companies have already begun reporting data about their carbon emissions and other climate-related metrics, SEC officials say current disclosures are inconsistent and hard for investors to compare.

"Companies and investors alike would benefit from the clear rules of the road proposed in this release," Mr. Gensler said.

Meredith Cross, a partner at corporate law firm WilmerHale and former SEC division director, said the proposed rule is "the most extensive, comprehensive and complicated disclosure initiative in decades."

SEC members voted 3-1 to issue the proposal, which will be open for public comment for at least two months before the agency will begin work on a final rule. Commissioners voted along party lines, with all three Democrats voting yes.

Republicans and some industry groups have been gearing up for months to fight the new requirements, which are a hallmark of Mr. Gensler's ambitious policy agenda. They say the proposed rules would increase compliance costs and go far beyond a strict interpretation of the SEC's mandate to protect inves-

Please turn to page B10

FAA Staffer Testifies Ex-Boeing Pilot Lied

By Andrew Tangel

FORT WORTH, Texas—A Federal Aviation Administration training specialist said a former Boeing Co. pilot lied to her about how a 737 MAX flight-control system worked before two of the jets crashed three

Press Release Details

Boston Properties Announces Long-Term Lease with Google for Kendall Square Redevelopment

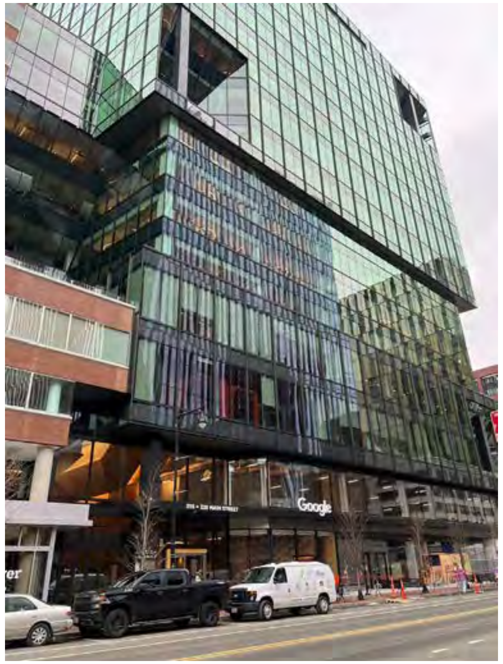
February 14, 2019 PDF Version

New Boston Properties Building Expands Relationship with Google in Kendall Square

Google Headquarters, 325 Main Street, Cambridge MA

Landlord

Tenant



Public companies need to report Scope 1 and Scope 2 emissions, and in some cases also Scope 3 emissions.

Graphic by Stacy Smedley, 2021

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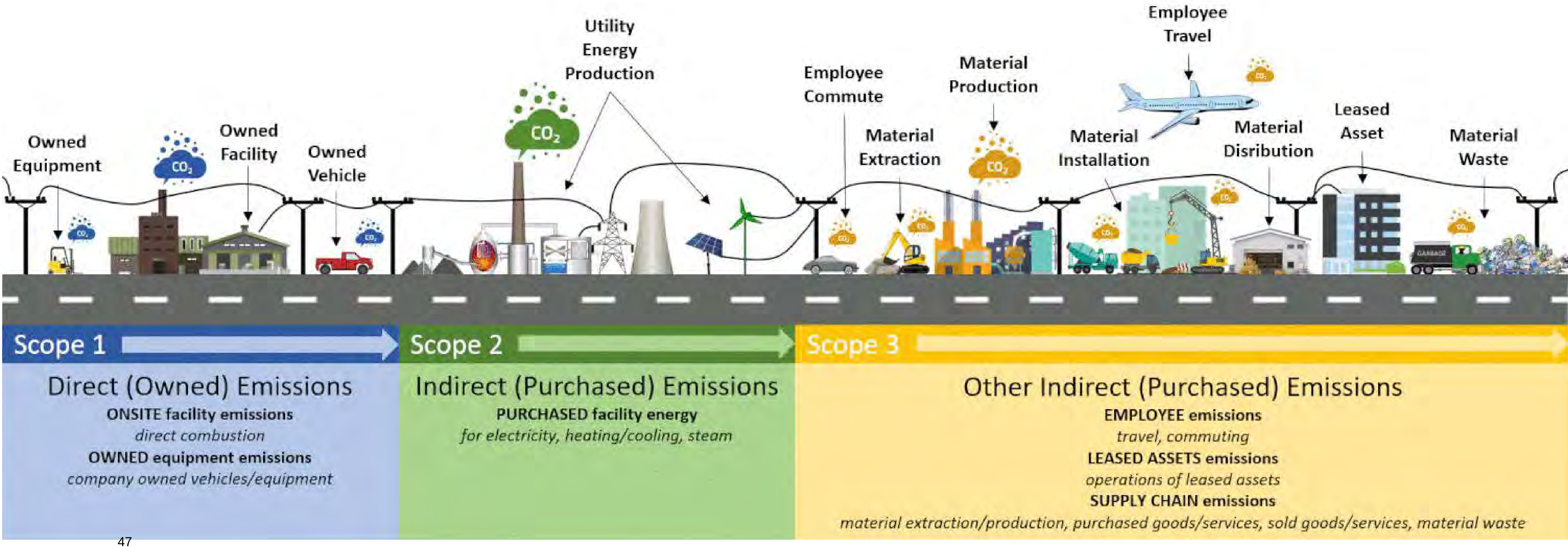
Understanding Scope 1, 2 and 3 Emissions



	Scope 1	Scope 2	Scope 3
	BXP has the operational control; Google does not.		
bxp (landlord)	Fuel combustion	Purchased electricity	
Google (tenant)			Fuel combustion Purchased electricity
	BXP does not have the operational control; Google has.		
bxp (landlord)			Fuel combustion Purchased electricity
Google (tenant)	Fuel combustion	Purchased electricity	

https://ghgprotocol.org/sites/default/files/standards_supporting/Categorizing%20GHG%20Emissions%20from%20Leased%20Assets.pdf