SRE Economics Lecture 1

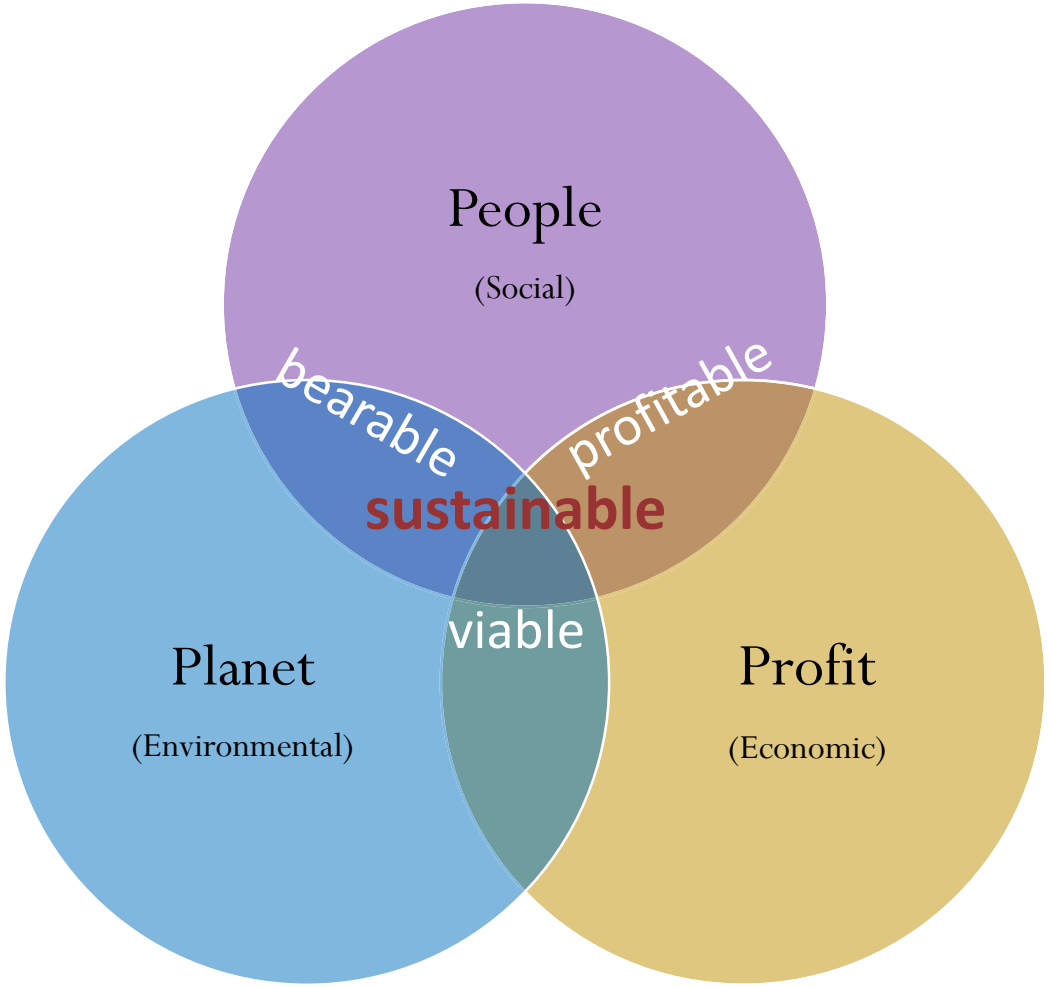
The Economics of Green Buildings (1)

Siqi Zheng

Feb 2023

(MIT Center for Real Estate)

Triple Bottom Lines

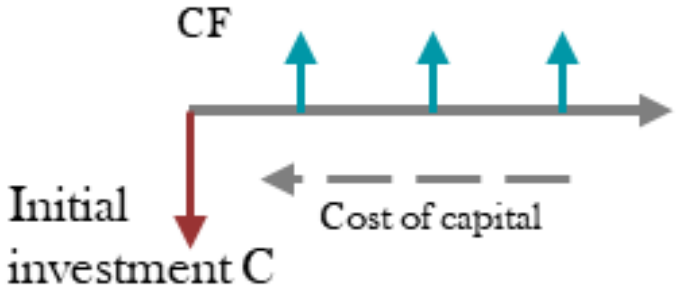


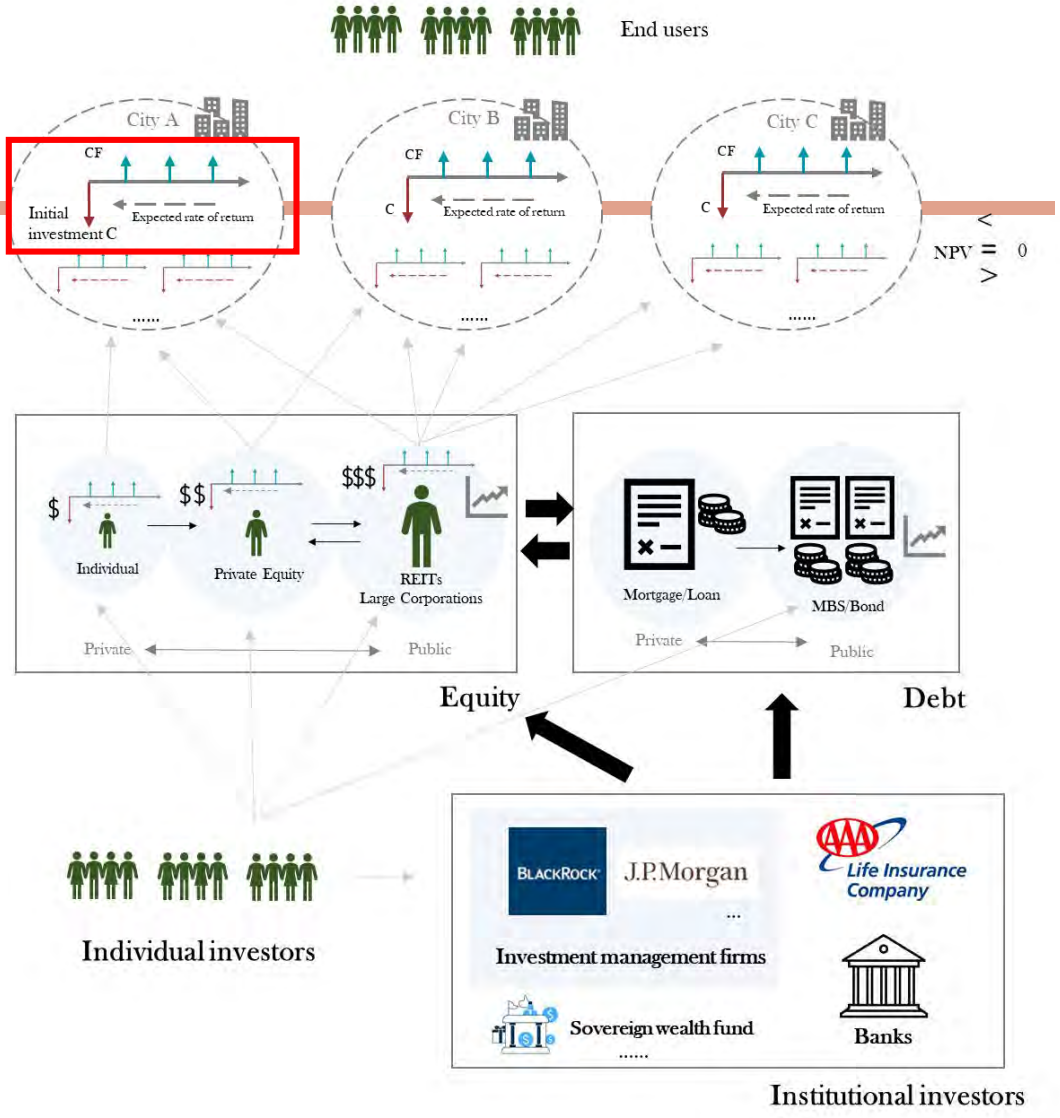
⇦ Lecture today

Knowledge Structure

- Where we are for this class?

A building!





	Private	Public
Equity	• Private Property Assets • PE	• REITs • Stock
Debt	• Mortgage • Loan	• Bond • MBS

r = WACC (weighted average cost of capital)

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)

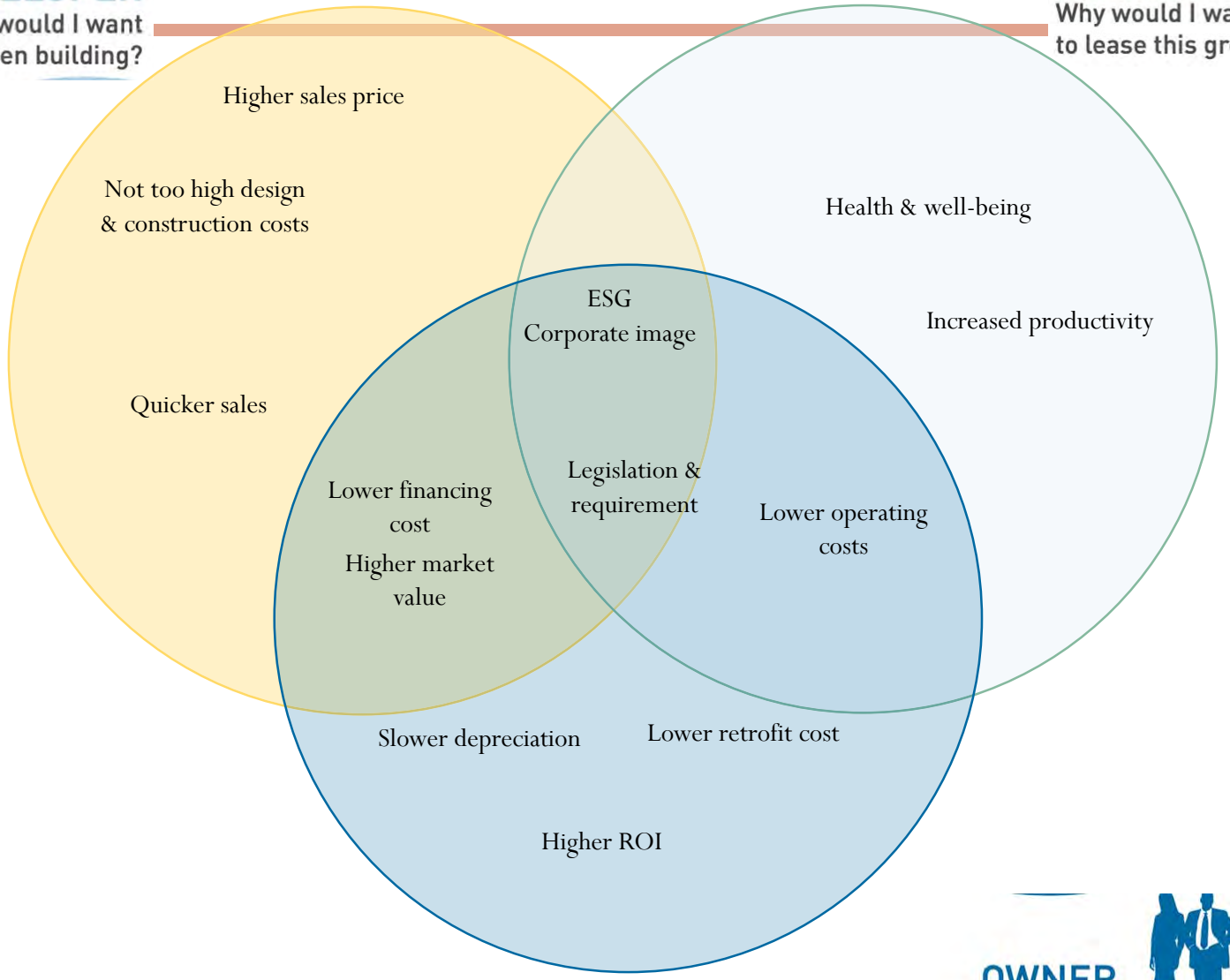
WINTHROP CENTER, 2022
Location: Boston

Sustainability
Passive House (office)
WELL Gold and LEED Platinum

HOW MARKET MAY WORK

DEVELOPER
Why would I want to build this green building?

TENANT
Why would I want to lease this green building?



OWNER
Why would I want to own this green building?

Cost Benefit Analysis (CBA)

- Decision-making process:
  - If B>C (NPV>0): support the action, or B/C >1 when C!=0.
  - Otherwise, oppose the action.

$$NPV(CF_0, \ldots, CF_n) = \sum_{i=o}^{n} \frac{CF_i}{(1+r)^i}$$

Risk

Discount rate: cost of capital

Cash flow for each period:

$$CF_i = B_i - C_i$$

Hypothetical Pro-forma

What will green buildings affect?

Owner perspective: (compare PV with the purchasing price)

Year:	0	1	…	10	11
Item:					
Potential gross income (Rent/SF × Square feet)		50,000.00	…	59,754.63	60,949.72
Vacancy allowance (Vacancy rate × PGI)		4,000.00		4,780.37	4,875.98
Effective gross income		46,000.00		54,974.26	56,073.74
Operating expenses (OpEx)		17,500.00		20,914.12	21,332.40
Net operating income (NOI)		28,500.00		34,060.14	34,741.34
Capital improvement expenditure (CapEx)		4,275.00		5,109.02	5,211.20
Net cash flow (NOI - CapEx)		24,225.00		28,951.12	29,530.14
Reversion (only in last year and years of partial sales)				579,022.35	
Net cash flow incl. reversion		24,225.00		607,973.47	
PV @ 8%	$443,979.91				

Last year CF/Cap rate (6%)

Green Building

Hypothetical Pro-forma

What will green buildings affect?

A hypothetical office building

Owner perspective: (compare PV with the purchasing price)

Year:	0	1	…	10	11
Item:					
Potential gross income (Rent/SF × Square feet)		50,000.00			
Vacancy allowance (Vacancy rate × PGI)		4,000.00			
Effective gross income		46,000.00			
Operating expenses (OpEx)		17,500.00			
Net operating income (NOI)		28,500.00		34,060.14	34,741.34
Capital improvement expenditure (CapEx)		4,275.00			
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Net cash flow incl. reversion		24,225.00		607,973.47	
PV @ 8%	$443,979.91				

(Tenant) Health + Productivity + Energy saving

Energy saving

Lower depreciation

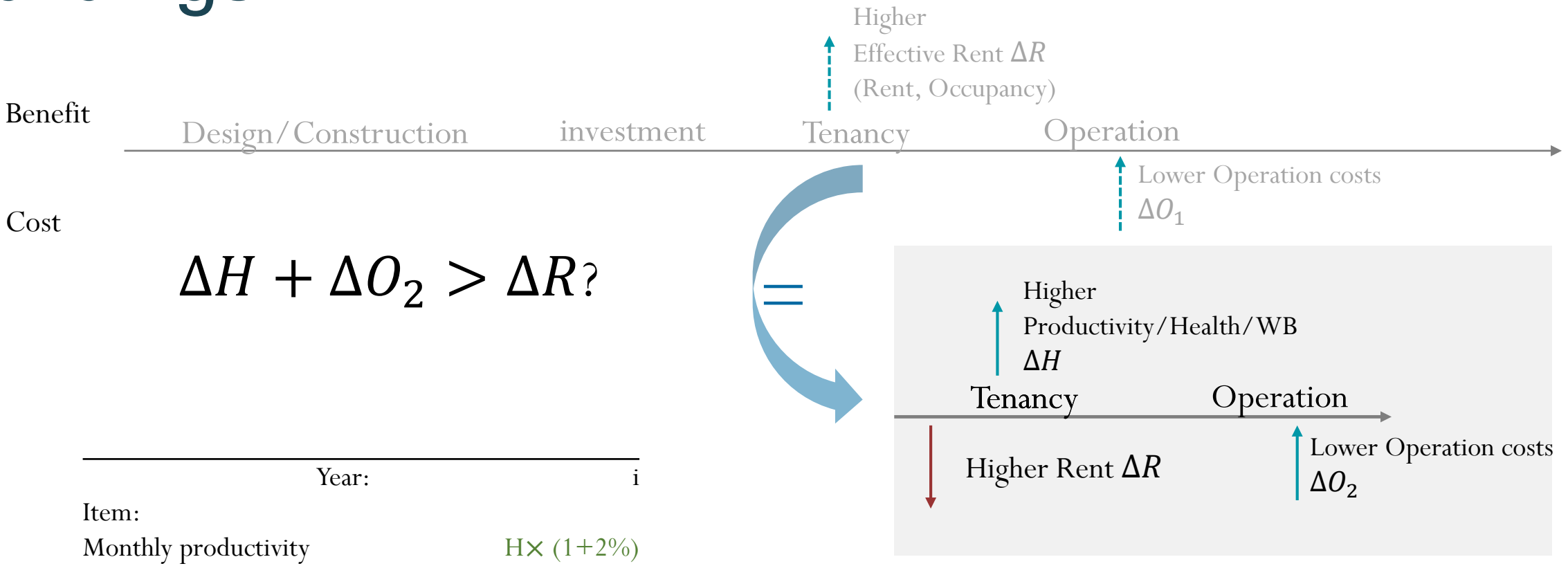
Lower risk, Lower cost of capital

Higher NPV and thus higher Willingness-to-pay (WTP)

Last year CF/Cap rate (6%)

Lower risk, Lower cap rate

Life-Cycle Cost Analysis (LCCA) in Green Buildings



Year:	i
Item:	
Monthly productivity	H× (1+2%)
Operating expenditure	O2 × (1-0.4%)
Monthly rent	R × (1+6.3%)

Tenant's analytical horizon

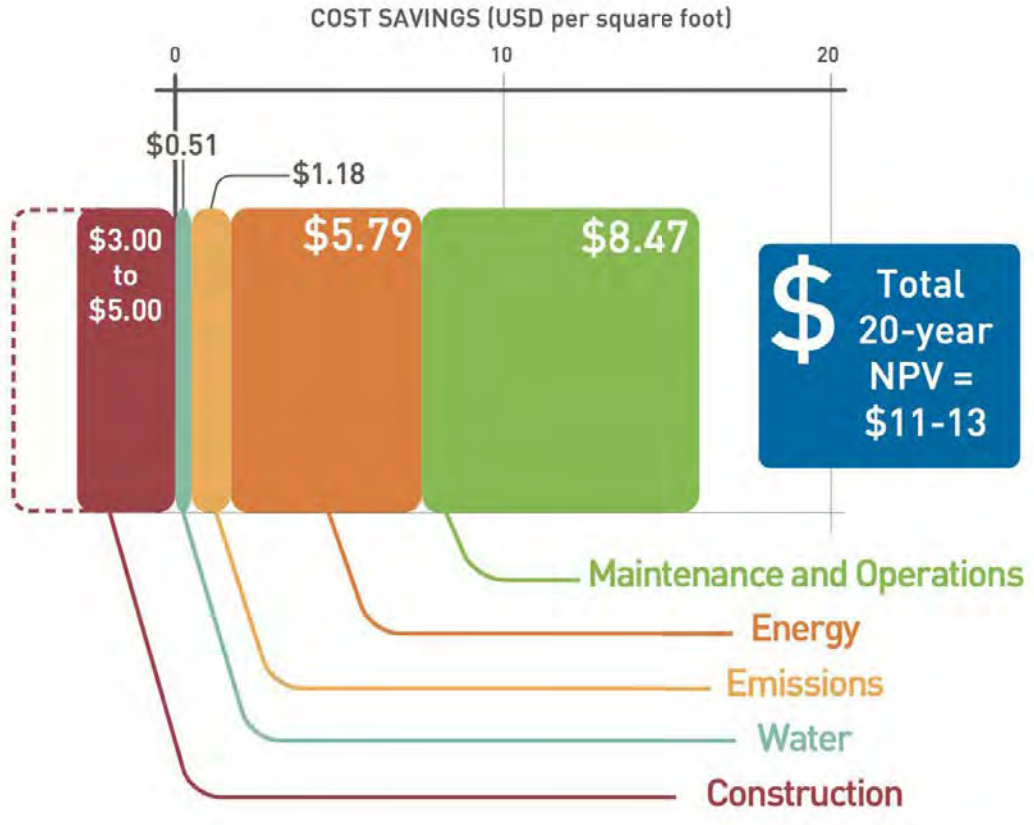
Any other benefits?

Why do green buildings have smaller operating costs?

- Energy & Resource savings

+

- Maintenance cost reduction



Net present value analysis of the operational cost benefits of 33 LEED certified buildings

Operating Cost Split

- Energy & Resource savings

+

- Maintenance cost reduction

Lease contract

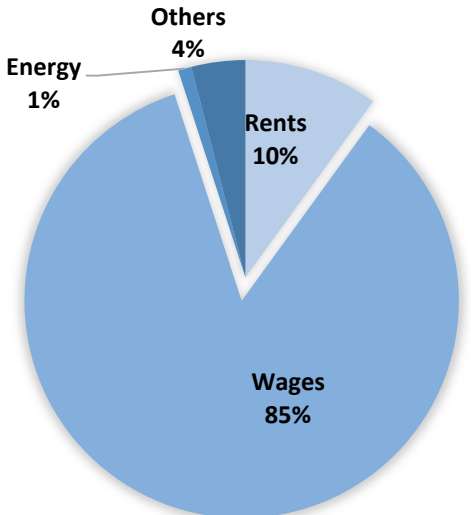
("Split Incentive" in the next lecture)

Owners → Operating Cost $\Delta 0_1$

Tenants → Operating Cost $\Delta 0_2$

- Human Capital Cost: Productivity/Health/Well-being → Tenants → (company)

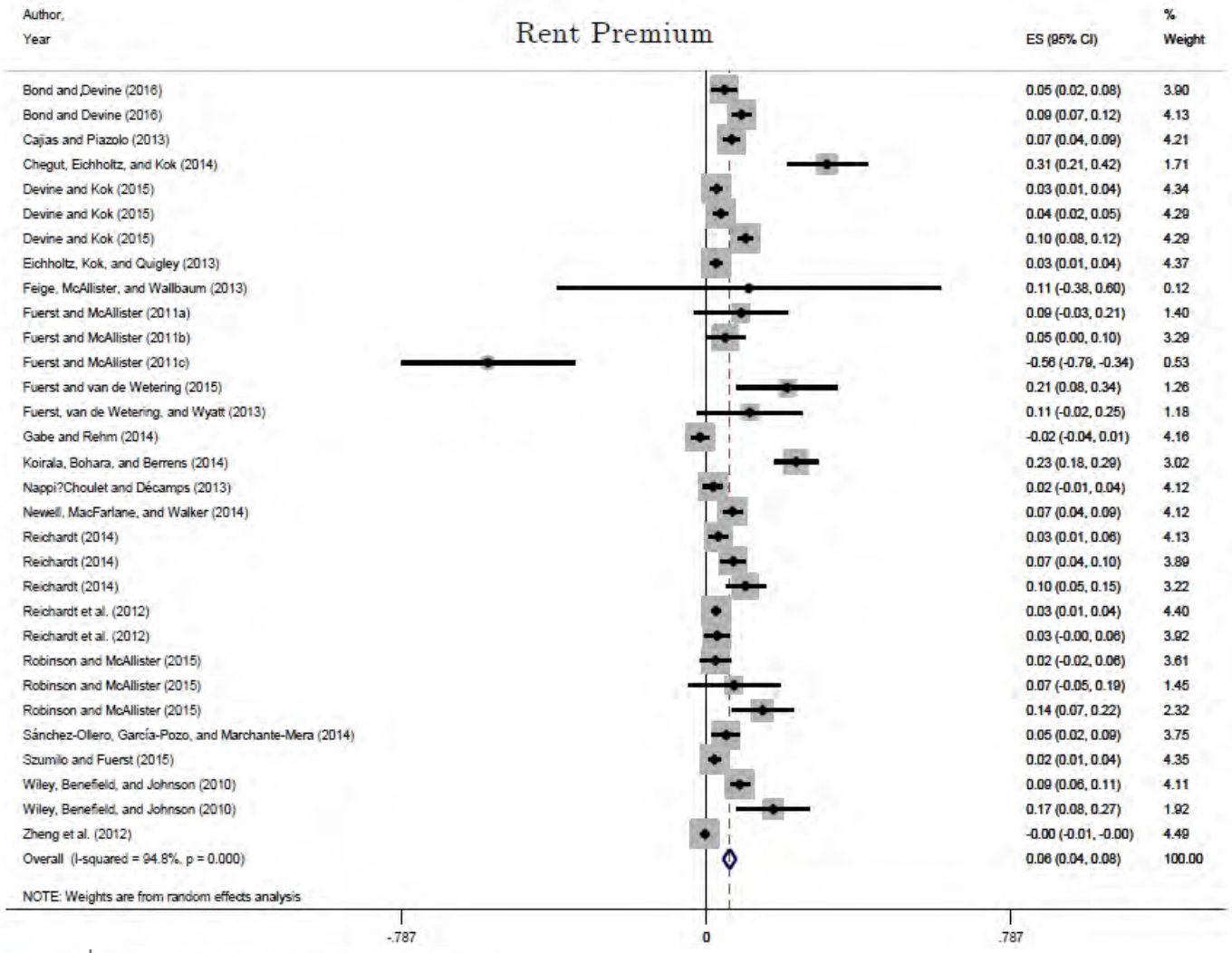
Tenants → Rent ΔR



"Healthy Buildings" lecture

WGBC.2013."THE BUSINESS CASE FOR GREEN BUILDING: A Review of the Costs and Benefits for Developers, Investors and Occupants"

Rental Premium of Green Building



Dalton and Fuerst (2018): meta analysis of green real estate rents

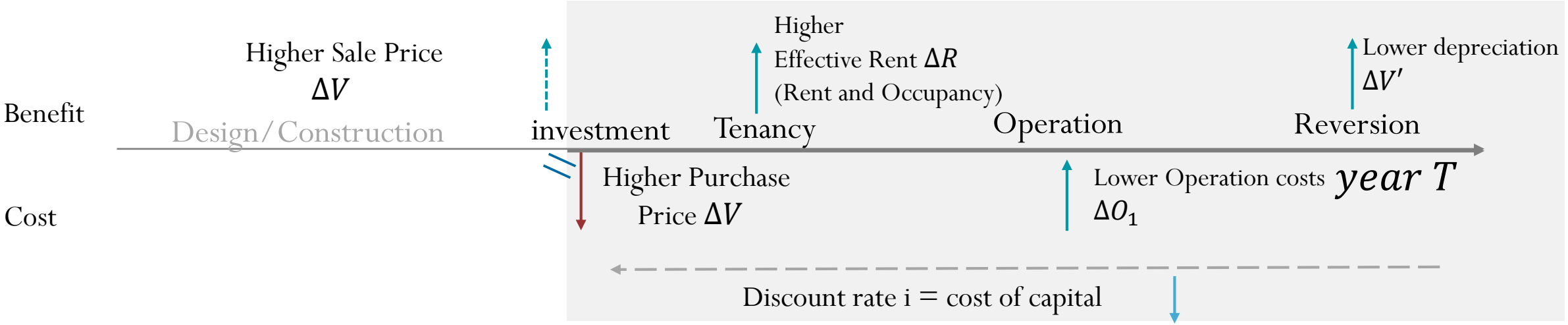
Overall significant rent premium of 6%

- 5.4% commercial
- 8.2% residential

Studies also find 5% - 9% higher occupancy rates for commercial real estate.

Life-Cycle Cost Analysis (LCCA) in Green Buildings

Owner's analytical horizon



$$\sum_{t=0}^{T} \frac{\Delta R + \Delta O_1}{(1+i)^t} + \frac{\Delta V'}{(1+i)^T} > \Delta V \ ?$$

What about the risk?

Risk Mitigation

- Regulatory Risks: "Brown discount"
  - Case: NYC Local Law 97
- Market Risks: Green buildings have:
  - Lower cap rate
  - Higher resilience during down times
- Physical Risks
  - Higher resilience against climate and other environmental risks

Why do green buildings have higher asset value?

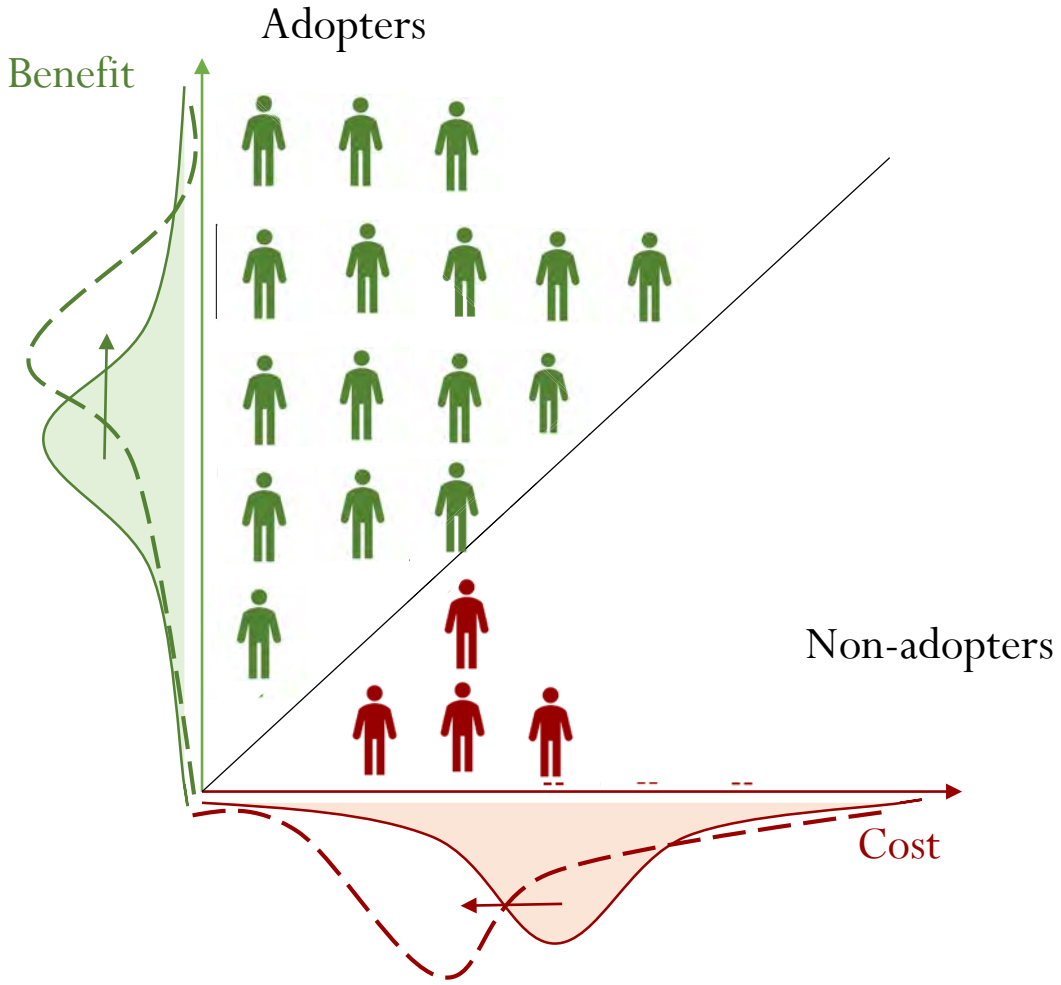
- Higher rents, higher occupancy, lower turnover ΔR
- Lower operating cost ΔO_1
- Lower expected rate of return i

Higher WTP; Higher Sales Price

Cash Flow Parameter	Effect	Range	Mean	Median
Rental income	Increased	0.0%–23.0%	6.3%	4.6%
Occupancy	Increased	0.9%–17.0%	6.0%	4.3%
Operating costs	Inconclusive	−14.3%–25.8%	−0.4%	−4.9%
Yield (risks)	Decreased	0.36%–0.55%-point	0.46%-point	0.46%-point
Sales price	Increased	0%–43.0%	14.8%	14.1%

Sample: 71 reviewed publications 2008-2019, mainly in US, UK, AUS, CAN markets. (Leskinen, Vimpari and Junnil, 2020).

Market average vs. individual decision-maker



Trade-offs

Hypothetical Pro-forma

Green Building:

- Higher purchasing price
- Rental revenue ↑ 6.3%
- Occupancy ↑ 6%
- Operating cost ↓ 0.4%
- Cost of capital↓ 0.46%

Should the owner willing to purchase a green building for $50,000 extra?

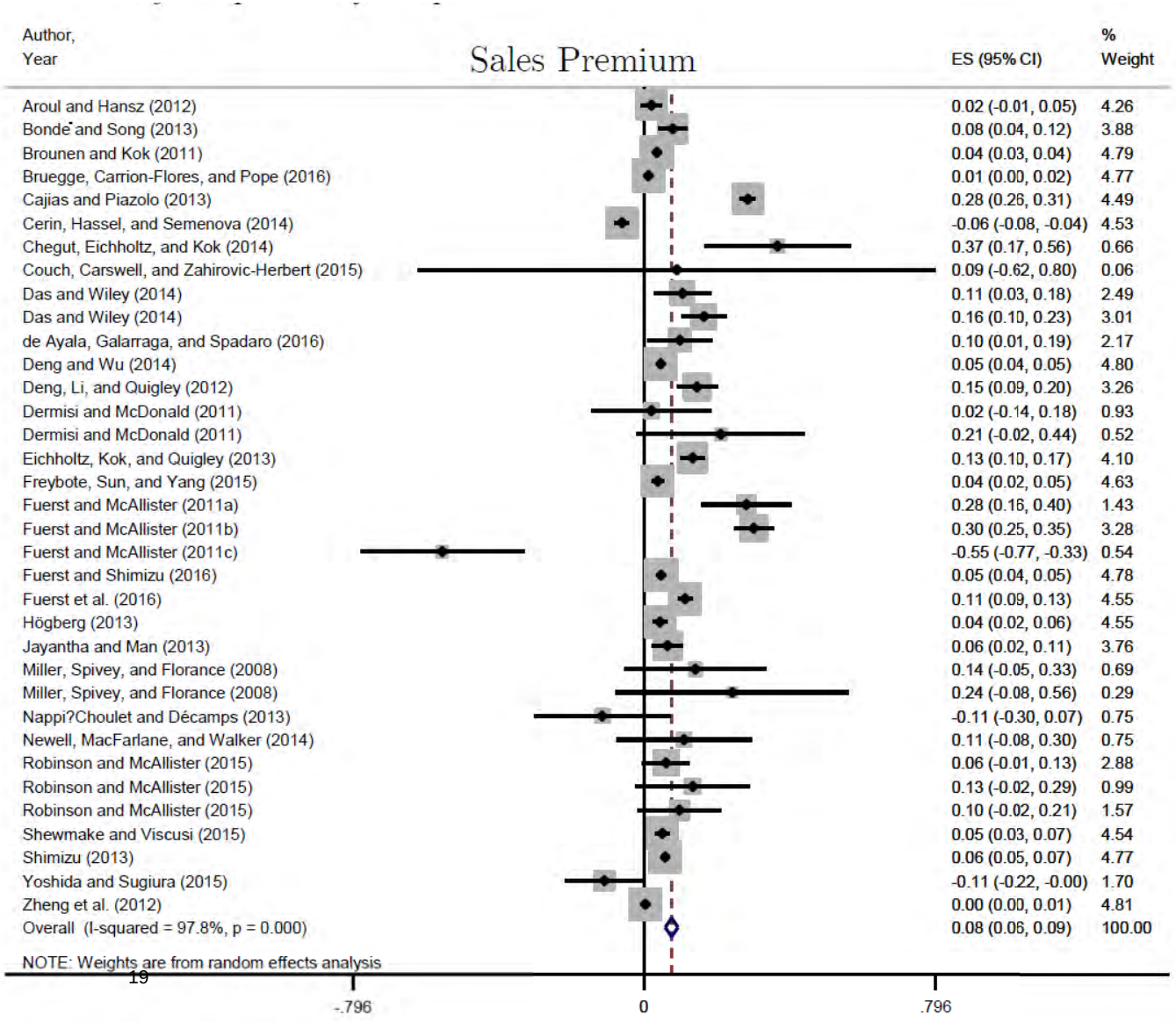
Owner perspective: (compare PV with the purchasing price) **GREEN BUILDING**

Year:	0	1	…	10	11
Item:					
Potential gross income (Rent/SF × Square feet)		53150.00	…	63519.17	64789.55
Vacancy allowance (Vacancy rate × PGI)		1318.12		1575.28	1606.78
Effective gross income		51831.88		61943.89	63182.77
Operating expenses (OpEx)		18528.09		22142.78	22585.64
Net operating income (NOI)		33303.79		39801.11	40597.13
Capital improvement expenditure (CapEx)		4995.57		5970.17	6089.57
Net cash flow (NOI - CapEx)		28308.22		33830.95	34507.56
Reversion (only in last year and years of partial sales)				732800.26	
Net cash flow incl. reversion		28308.22		766631.20	
PV @ 7.5%	**$564,113.22**				

(Traditional building PV) **$443,979.91**

Last year CF/Cap rate

Higher Market Value of Green Building



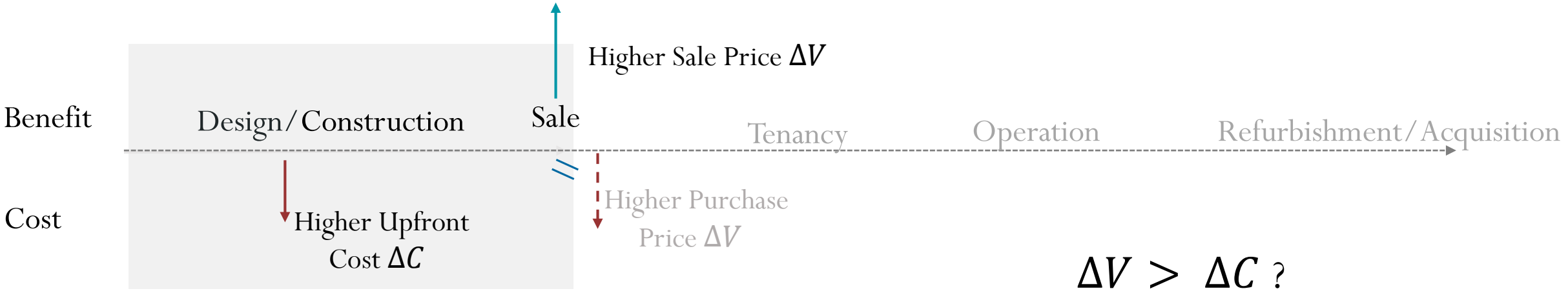
Dalton and Fuerst (2018) also look at evidence sales prices

Overall price premium of 7.6%

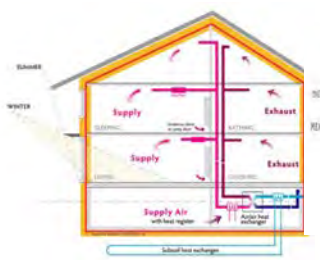
- For commercial 11.5%
- For residential 5.5%

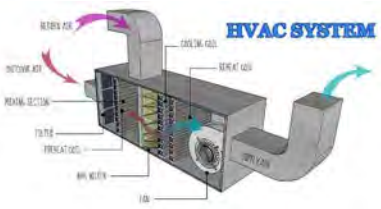
Life-Cycle Cost Analysis (LCCA) in Green Buildings

Developer's evaluation horizon



$$\Delta V > \Delta C\ ?$$





Year:	0
Item:	
Construction cost	C× (1+5%)
Sale price	V× (1 + 15%)

Why do green buildings have higher design & construction Costs?

0% to 12.5%

Cost premium for new green buildings
(actual costs based on various studies)

0.3% to 12.8%

Cost premium for green retrofits
(actual costs based on various studies)

Decreasing Costs for Green Building Over Time

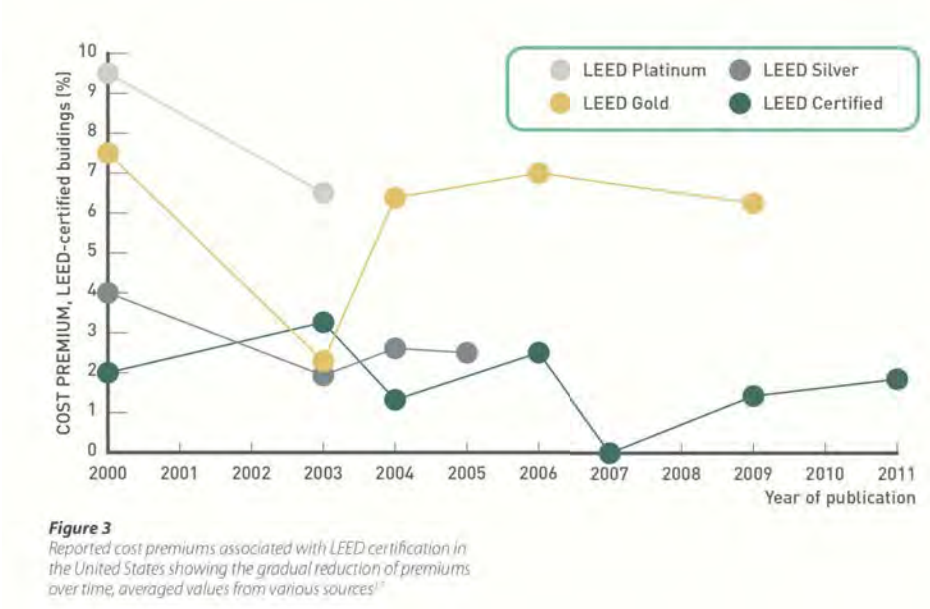
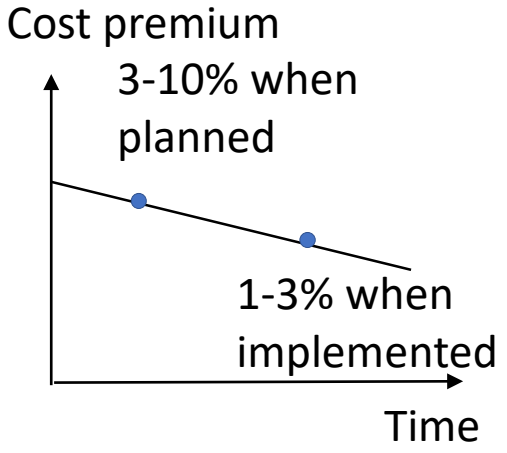


Figure 3
Reported cost premiums associated with LEED certification in the United States showing the gradual reduction of premiums over time, averaged values from various sources[17]

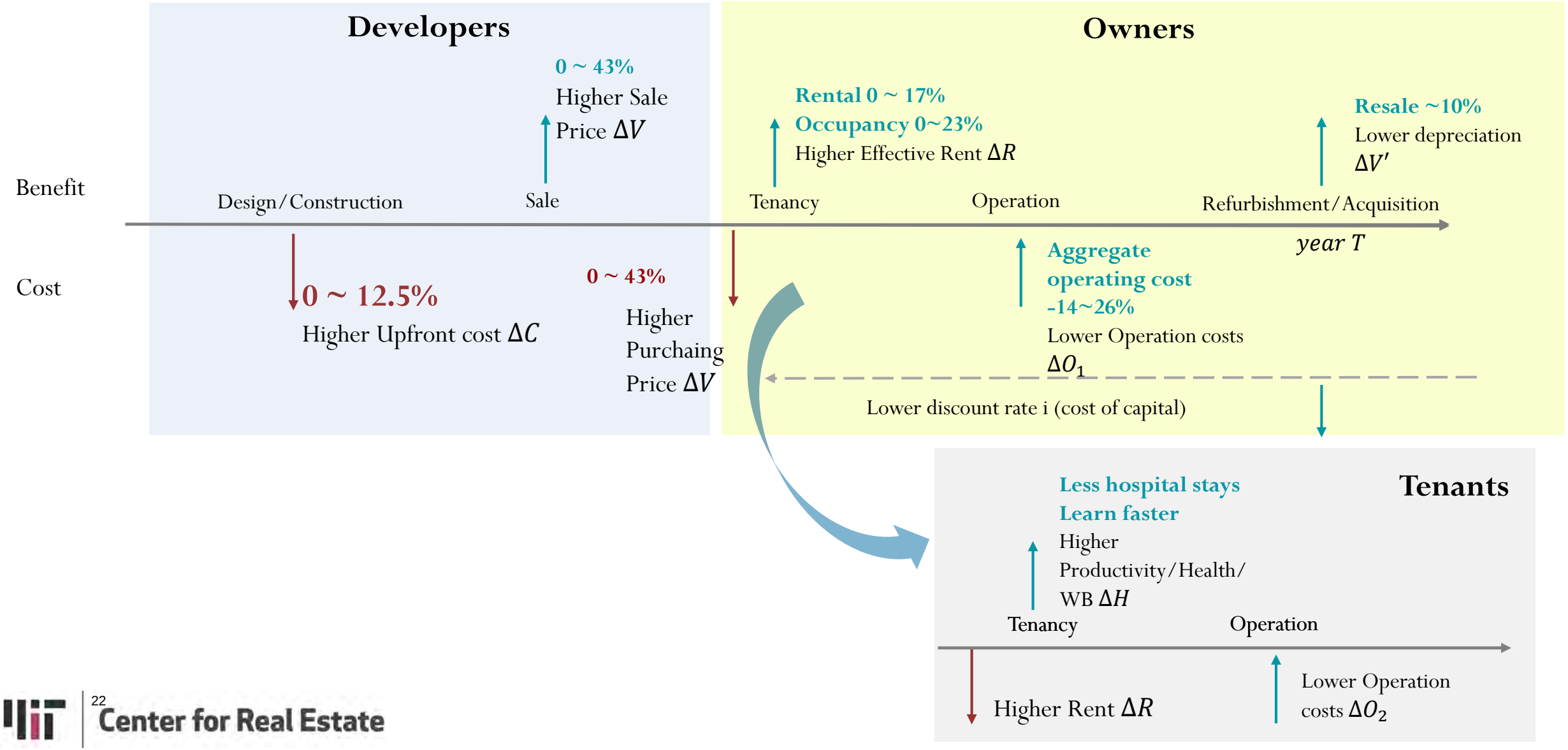
WGBC.2013."THE BUSINESS CASE FOR GREEN BUILDING: A Review of the Costs and Benefits for Developers, Investors and Occupants"

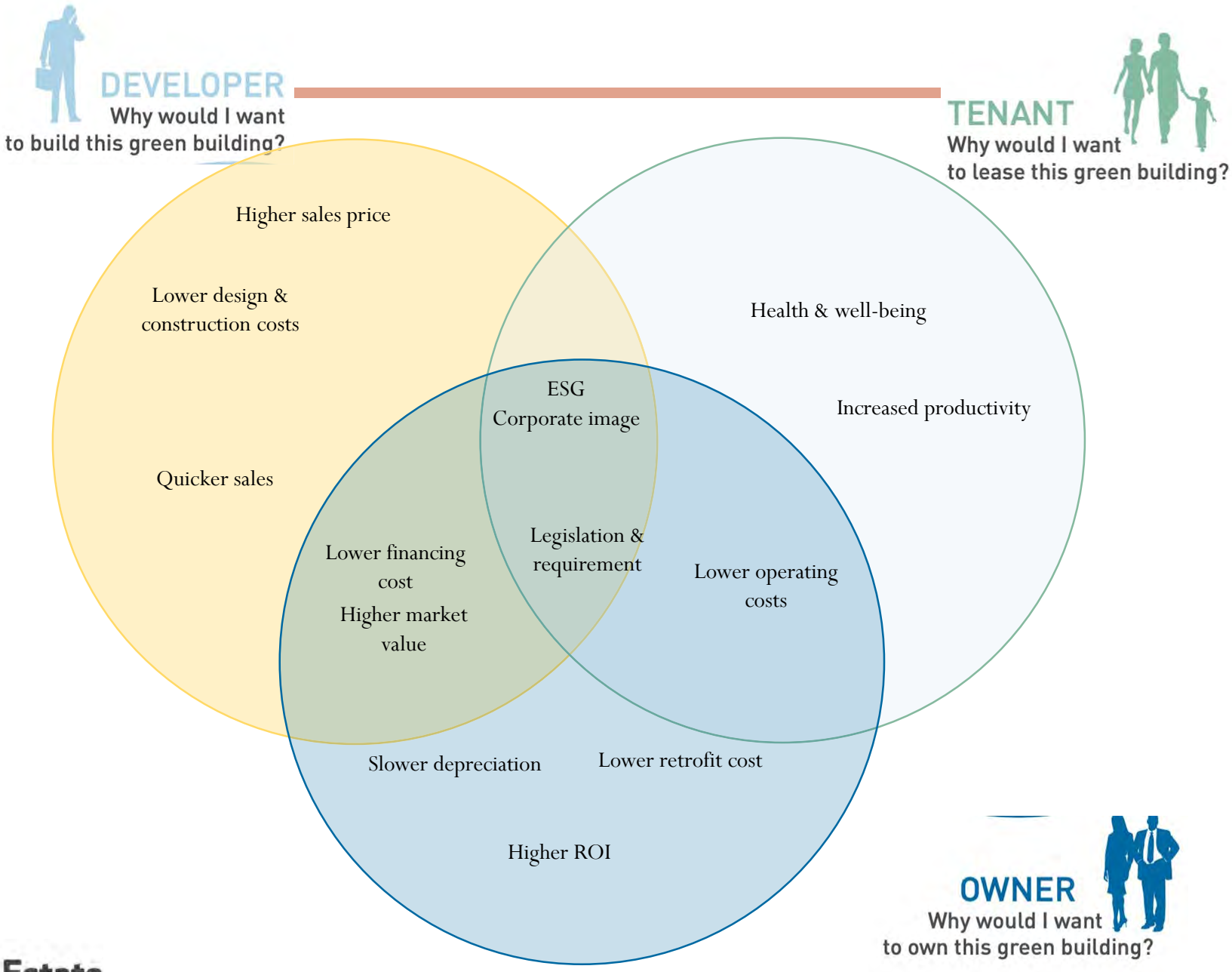


Winthrop Center Passive House cost premium

$$\Delta C = f(skills, \quad innovation, \quad supply\ chain)$$

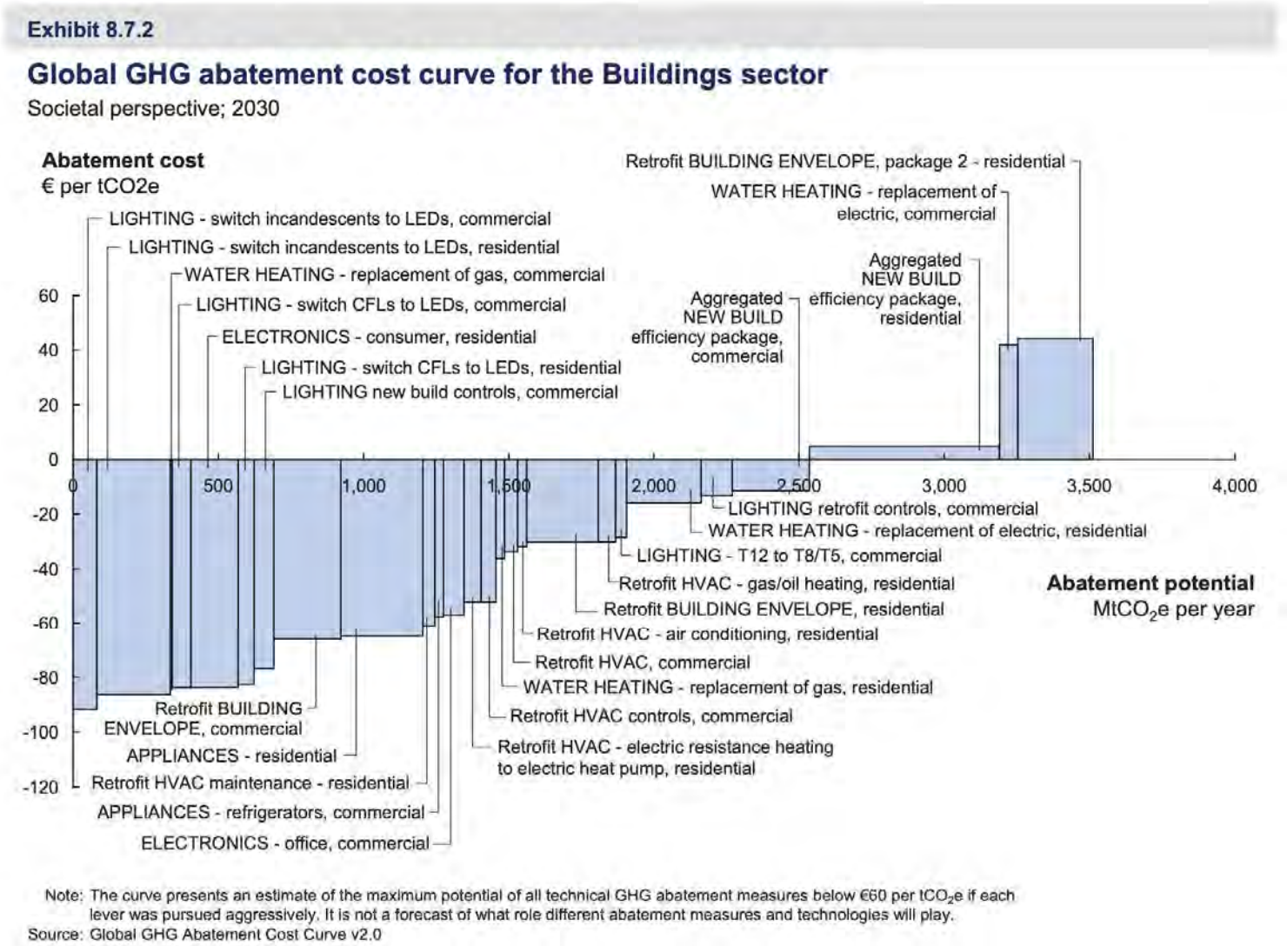
Is There a Business Case for Green Buildings?




DEVELOPER
Why would I want to build this green building?
TENANT
Why would I want to lease this green building?
OWNER
Why would I want to own this green building?
Higher sales price
Lower design & construction costs
Quicker sales
Health & well-being
Increased productivity
ESG
Corporate image
Legislation & requirement
Lower financing cost
Higher market value
Lower operating costs
Slower depreciation
Lower retrofit cost
Higher ROI

HOW MARKET MAY FAIL

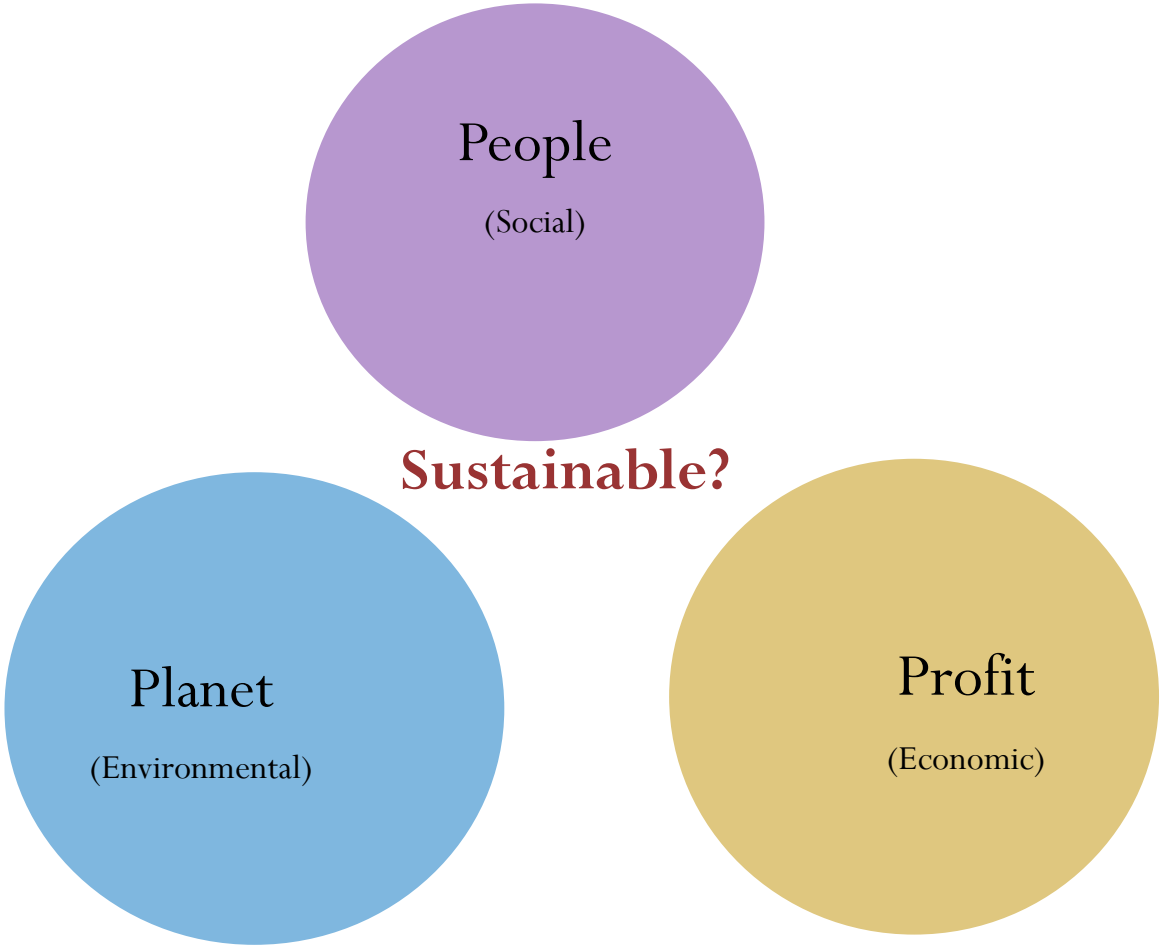
Negative Lifecyle Cost: Market Opportunity Unexploited



Mckinsey:
"Carbon emissions in the Building sector can be substantially reduced, either with net economic benefits or at low cost."

Why are the vast negative cost green opportunity unexploited?

Market Failures Threaten the Three Bottom Lines



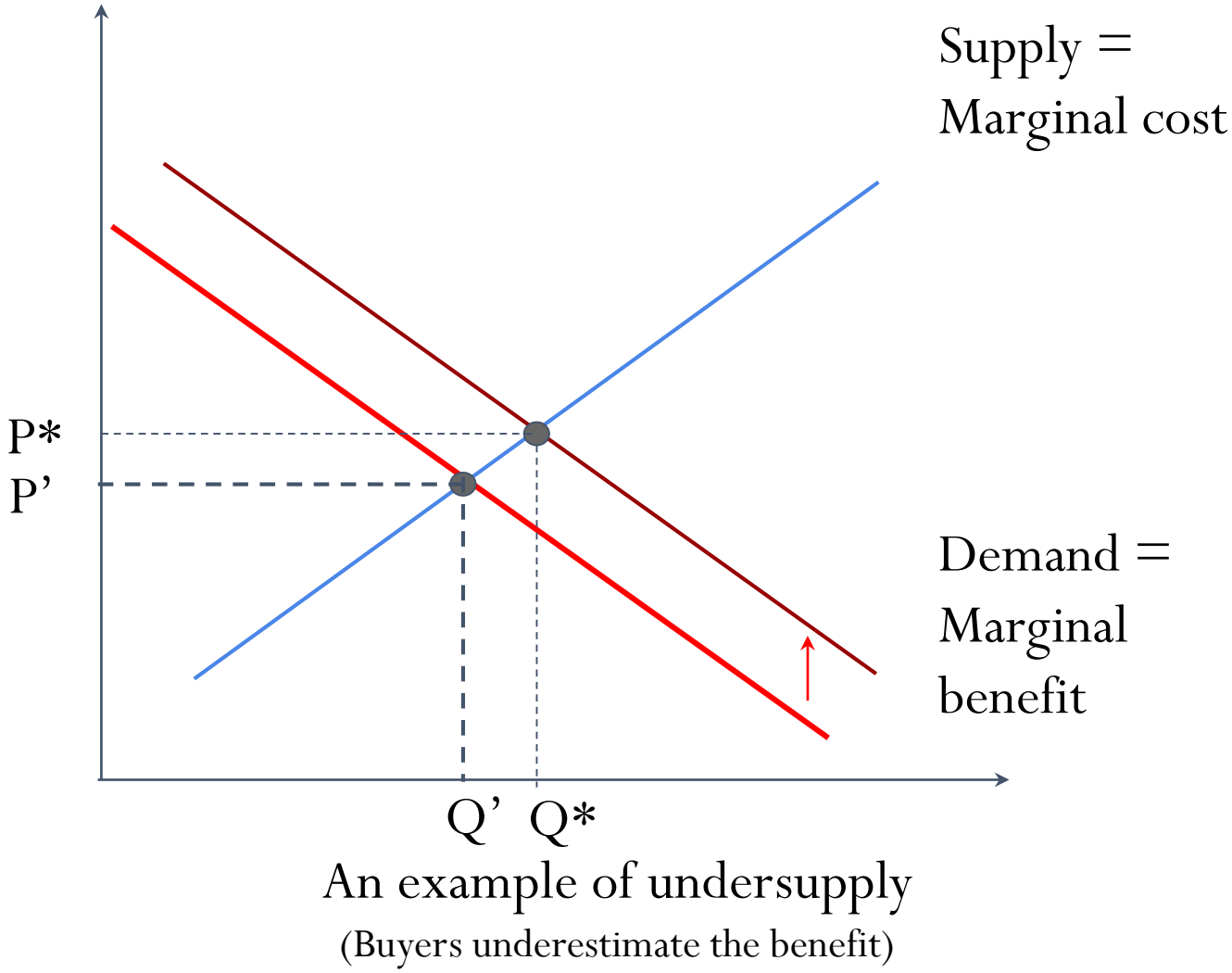
Market Failures:

1. **Information Asymmetry**
2. Split Incentive (Econ Lecture 2)
3. Externality (Econ Lecture 8)

Information Matters!

- Do people really understand the 'greenness'?
  - Benefit underestimated
  - Cost overestimated

- **Information & knowledge** matter!



An example of undersupply

(Buyers underestimate the benefit)

Siqi's Research: Information and WTP for Green Buildings

- "The Role of Public Information in Increasing Homebuyers' Willingness-to-Pay for Green Housing: Evidence from Beijing." (Zhang, Sun, Liu and Zheng 2016, *Ecological Economics*)

Information & knowledge matter!

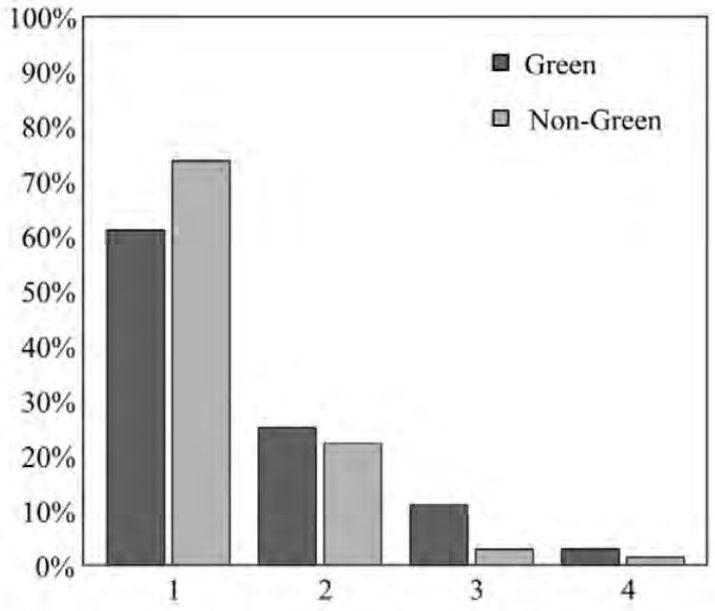
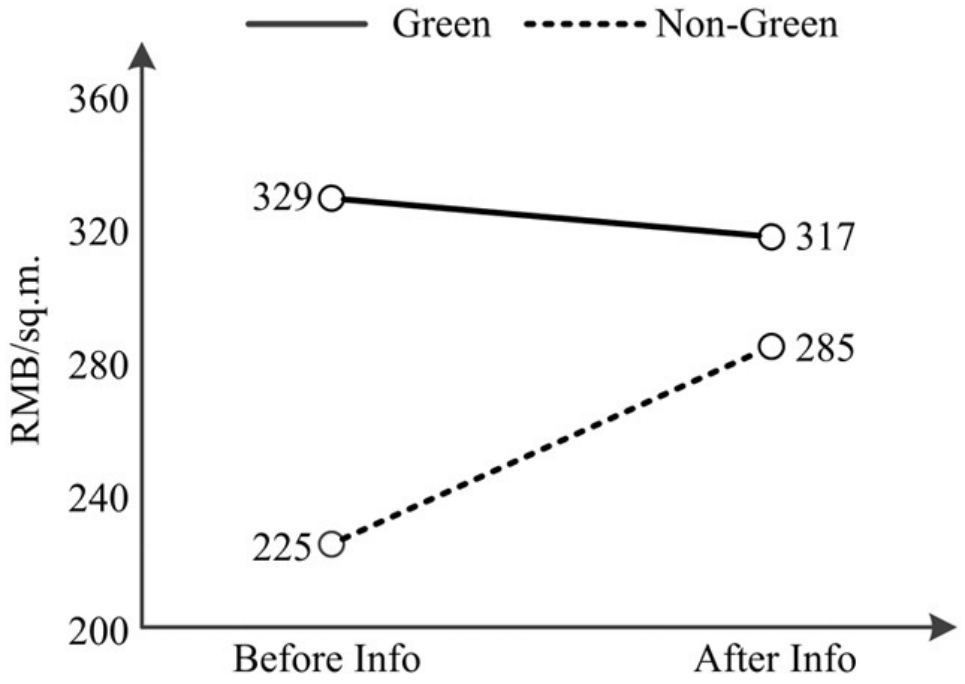


Fig. 3. Respondents' knowledge of Chinese green building label. Notes: 1 = "Do not know it"; 2 = "Only heard of it"; 3 = "Familiar. Know its logo"; 4 = "Very familiar. Has specialized knowledge about it".



Center for Real Estate

Information Asymmetry

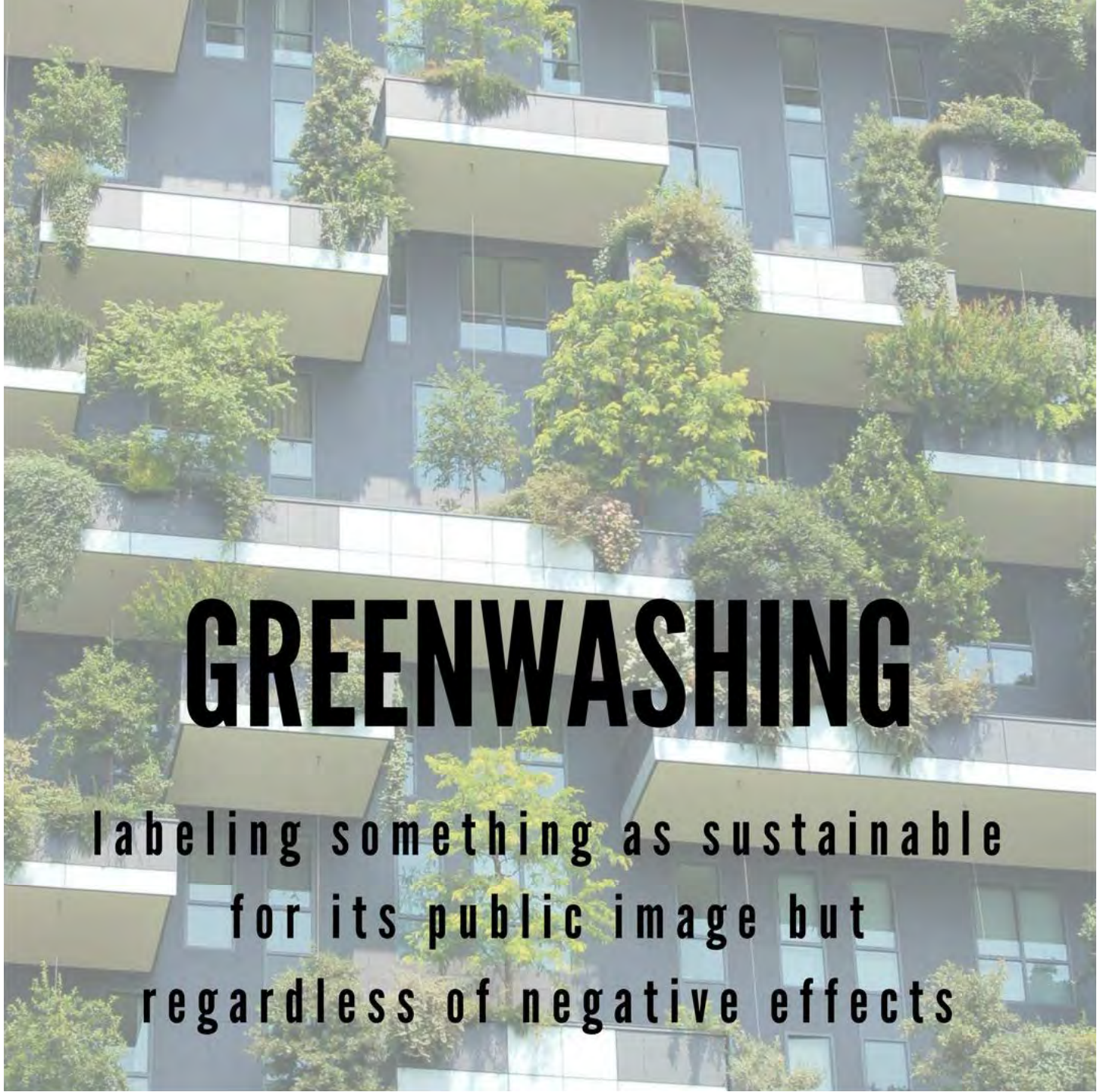
Even if people do understand the benefit in theory, can they distinguish green product?

- Indoor air quality/ energy efficiency
  - **Experience good**
    Quality of good only observed after consumption

- Sustainble materials/ toxic materials
  - **Credence good**
    Quality cannot be observed even after consumption

Any misleading claims regarding the environmental practices of a company or the environmental benefits of a product or service.

Being advertised as an competitive advantage (selling point).



Siqi's Research: Greenwashing in China's Real Estate Market

- "The Nascent Market for 'Green' Real Estate in Beijing." (Siqi Zheng, et al., 2012, *European Economics Review*)

- Early 2000: no official green certificate in China. We used Google to construct each development project's "self-advertised" green index.
- We find:
  - Presale stage: a significant price premium
  - Resale and rental stages: this premium disappeared

Information asymmetry creates the market for lemons

Adverse selection

Developer

Cost:
$1.25 million

Cost:
$0.95 million

Buyer (with information)

WTP:
$1.4 million

WTP:
$1 million

Developer earns:
$0.15 million for green building
$0.05 for other buildings

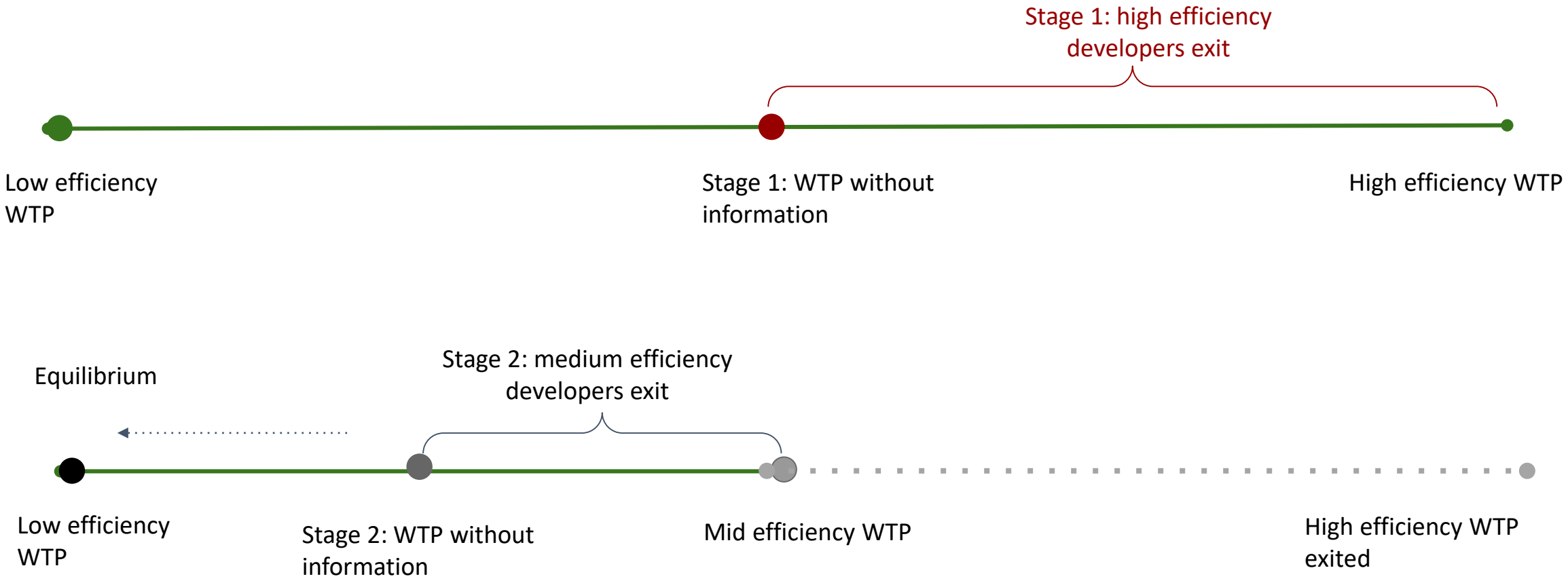
Buyer (without information)

WTP:
$1.2 million

Developer only develop non-green buildings → buyer's WTP drop to $ 1 million

Information asymmetry creates the market for lemons

Green building market breaks down stage by stage.



The role of certificates: Solving Information Asymmetry

- What are the **requirements** for certificates to solve market failure:
  - Must clearly differentiate green buildings from others
    - And be impossible for non-green buildings to be certified (green washing)
  - More valuable to customers than the costs of obtaining certification
    - Reasonable costs + accurate assessment of premiums associated with certifications

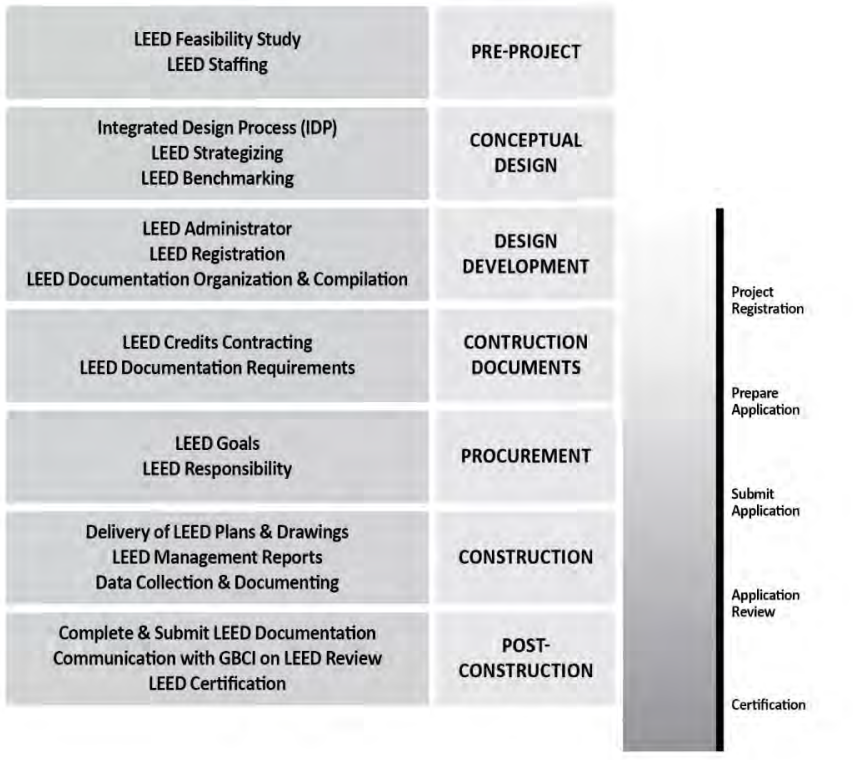
Top 10 Green Building Certifications

measurabl

	Organization	Country Scope	Project type(s)	Focus Areas	Accreditation Details
BREEAM	BRE group	International	New and existing buildings, major renovation projects, community planning	Energy Water Pollution Transport Materials Waste Management processes	Rating & Certification Standard
ENERGY STAR	United States Environmental Protection Agency	US & Canada	Existing buildings	Energy Water Carbon emissions Waste	Data Management System, Ranking, & Certification System
Green Globes	Green Building Initiative	US & Canada	New and existing buildings, sustainable interiors	Project management Energy Water Materials & resources Emissions Indoor environment	Rating & Certification Standard
LEED	U.S. Green Building Council	International	New and existing buildings, major renovation projects	Energy efficiency Water efficiency Materials and resource use Indoor environmental quality Emissions Operations and maintenance	Rating & Certification Standard
Living Building Challenge	International Living Future Institute	International	New and existing buildings	Sustainable sites Energy efficiency Water efficiency Materials and resource use Indoor environmental quality Equity	Certification Program
WELL	Green Building Certification, Inc.	International	New and existing buildings	Lighting Health & Wellbeing Fitness Comfort Indoor Environment Quality Water	Certification Program
Fitwel	Center for Active Design	International	New and existing projects	Shared spaces Health & wellbeing Indoor environment Air quality Employee health Outdoor spaces	Certification Program
BOMA 360	Building Owners and Managers Association International (BOMA)	International	Existing buildings	Building operations & management Utility consumption Sustainability performance Tenant relations Community involvement Risk management	Certification Program
EDGE (Excellence in Design for Greater Efficiencies)	International Finance Corporation - World Bank Group	International	New construction and existing buildings	Energy Water Embodied energy Carbon emissions	Certification Program

LEED Certificate

- Procedures and schemes



	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

LEED Certificate

- Checklist based process
- Ratings:
  - Certified (40-49);
  - Silver (50-59);
  - Gold (60-79);
  - Platinum (80+)

LEED v4 for BD+C: New Construction and Major Renovation
Project Checklist
Project Name: Cambridge Crossing

Y	?	N			
1			Credit	Integrative Process	1

13	3	0	**Location and Transportation**		16
			Credit	LEED for Neighborhood Development Location	16
1			Credit 1	Sensitive Land Protection	1
	2		Credit 2	High Priority Site	2
5			Credit 3	Surrounding Density and Diverse Uses	5
5			Credit 4	Access to Quality Transit	5
1			Credit 5	Bicycle Facilities	1
	1		Credit 6	Reduced Parking Footprint	1
1			Credit 7	Green Vehicles	1

9	1	0	**Sustainable Sites**		10
Y			Prereq	Construction Activity Pollution Prevention	Required
1			Credit 1	Site Assessment	1
1	1		Credit 2	Site Development - Protect or Restore Habitat	2
1			Credit 3	Open Space	1
3			Credit 4	Rainwater Management	3
2			Credit 5	Heat Island Reduction	2
1			Credit 6	Light Pollution Reduction	1

6	3	2	**Water Efficiency**		11
Y			Prereq 1	Outdoor Water Use Reduction	Required
Y			Prereq 2	Indoor Water Use Reduction	Required
Y			Prereq 3	Building-Level Water Metering	Required
2			Credit 1	Outdoor Water Use Reduction	2
2	2	2	Credit 2	Indoor Water Use Reduction	6
1	1		Credit 3	Cooling Tower Water Use	2
1			Credit 4	Water Metering	1

13	4	16	**Energy and Atmosphere**		33
Y			Prereq 1	Fundamental Commissioning and Verification	Required
Y			Prereq 2	Minimum Energy Performance	Required
Y			Prereq 3	Building-Level Energy Metering	Required
Y			Prereq 4	Fundamental Refrigerant Management	Required
6			Credit 1	Enhanced Commissioning	6
5	3	10	Credit 2	Optimize Energy Performance	18
	1		Credit 3	Advanced Energy Metering	1
		2	Credit 4	Demand Response	2
		3	Credit 5	Renewable Energy Production	3
		1	Credit 6	Enhanced Refrigerant Management	1
2			Credit 7	Green Power and Carbon Offsets	2

2	6	6	**Materials and Resources**		13
Y			Prereq 1	Storage and Collection of Recyclables	Required
Y			Prereq 2	Construction and Demolition Waste Management Planning	Required
		6	Credit 1	Building Life-Cycle Impact Reduction	5
	2		Credit 2	Building Product Disclosure and Optimization - Environmental Product Declarations	2
	2		Credit 3	Building Product Disclosure and Optimization - Sourcing of Raw Materials	2
	2		Credit 4	Building Product Disclosure and Optimization - Material Ingredients	2
2			Credit 5	Construction and Demolition Waste Management	2

6	7	3	**Indoor Environmental Quality**		16
Y			Prereq 1	Minimum Indoor Air Quality Performance	Required
Y			Prereq 2	Environmental Tobacco Smoke Control	Required
1	1		Credit 1	Enhanced Indoor Air Quality Strategies	2
2	1		Credit 2	Low-Emitting Materials	3
1			Credit 3	Construction Indoor Air Quality Management Plan	1
	2		Credit 4	Indoor Air Quality Assessment	2
1			Credit 5	Thermal Comfort	1
	2		Credit 6	Interior Lighting	2
		3	Credit 7	Daylight	3
	1		Credit 8	Quality Views	1
1			Credit 9	Acoustic Performance	1

6	0	0	**Innovation**		6
5			Credit 1-5	Innovation	5
1			Credit 6	LEED Accredited Professional	1

1	2	2	**Regional Priority**		4
	1		Credit 1	Regional Priority: Renewable Energy Production (2 point threshold)	1
		1	Credit 2	Regional Priority: Optimize Energy Performance (8 point threshold)	1
	1		Credit 3	Regional Priority: High Priority Site (2 point threshold)	1
		1	Credit 4	Regional Priority: Building Life-Cycle Impact Reduction (2 point threshold)	1
1			Credit 5	Regional Priority: Rainwater Management (2 point threshold)	
	1		Credit 6	Regional Priority: Indoor Water Use Reduction (4 point threshold)	

57	26	29	**TOTALS**	Possible Points: 110

Certified: 40 to 49 points, **Silver:** 50 to 59 points, **Gold:** 60 to 79 points, **Platinum:** 80 to 110

LEED CERTIFICATION TARGET - SILVER
(57 POINTS)

Source: link

LEED Certificate

- Evolution
  - LEED v1.0 (1998): only for New Construction (NC)
  - LEED NC v2.0 (2001)
  - LEED NC v2.2 (2005)
  - LEED v3 (2009)
  - LEED v4 (2013)
  - LEED v4.1 (2017)

- Category-specific points
  - Energy related: about 30%
  - Increasing attention on location

Table 1. Category-specific points in LEED v2.2, v3 (2009), and v4 [29].

Categories	LEED v2.2	LEED v3 (2009)	LEED v4
Location and Transportation (LT)	-	-	16 (14.6%)
Sustainable Sites (SS)	14 (20.3%)	26 (23.6%)	10 (9.1)
Energy and Atmosphere (EA)	17 (24.6)	35 (31.8)	33 (30)
Water Efficiency (WE)	5 (7.3)	10 (9.1)	11 (10)
Indoor Environment Quality (IEQ)	15 (21.7)	15 (13.6)	16 (14.5)
Material and Resources (MR)	13 (18.8)	14 (12.7)	13 (11.8)
Innovation (ID)	5 (7.3)	6 (5.5)	6 (5.5)
Regional Priority (RP)	-	4 (3.7)	4 (3.6)
Integrative Process (IP)	-	-	1 (0.9)
Total	**69**	**110**	**110**

Source: Amiri, A., Ottelin, J., & Sorvari, J. (2019). Are LEED-certified buildings energy-efficient in practice?. *Sustainability*, *11*(6), 1672.

LEED Certificate

- Remaining problems:
  (1) High cost; (2) Not include embodied carbon; (3) Actual utility bill not used to decertify.

Table 2. The costs of obtaining the Leadership in Energy and Environmental Design (LEED) certificate.

Type of Costs	Value
Registration	1500 USD (1282 EUR)
Verification of the fulfilment of basic Smart Location and Linkage (SLL) requirements	2250 USD (1924 EUR)
Certification fee	18,000 USD (15,389 EUR) for the first 20 acres; 350 USD (299 EUR) for another acre; 123,000 USD (105,159 EUR) for projects over 320 acres
In the case of multi-stage certification for each subsequent stage (optional)	10,000 USD (8550 EUR) for the first 20 acres; 350 USD (299 EUR) for another acre; 115 000 USD (98,320 EUR) for projects over 320 acres

Table 3. Additional certification costs resulting from the process characteristics.

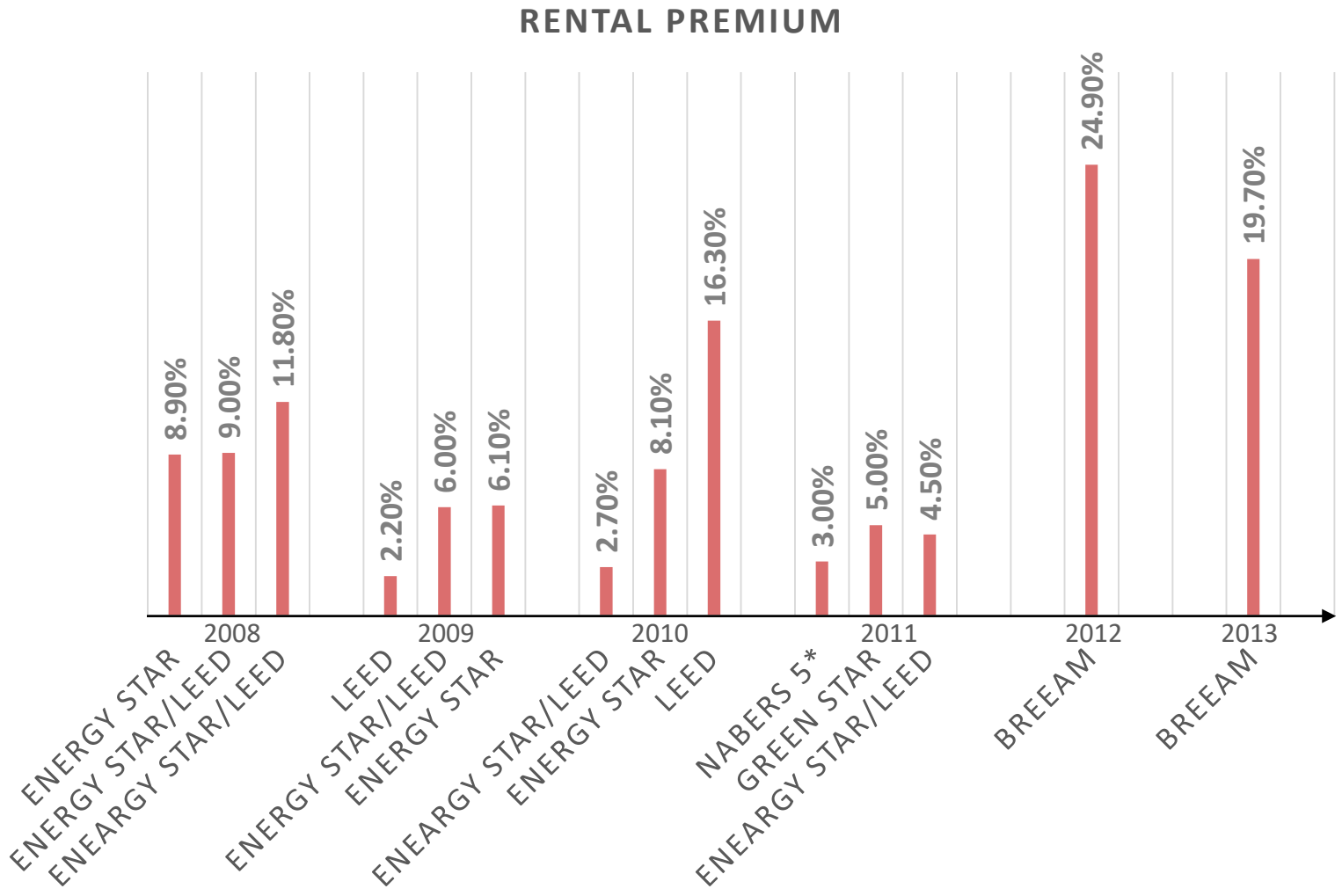
Type of Costs	Value
Explanations of the certification body regarding general interpretations of individual LEED requirements and rules	220 USD (188 EUR) for the issue
Verification by the certification body of the fulfilment of a specific requirement regardless of the certification process	500 USD (428 EUR) for the issue
Verification of the selected criteria after granting the certificate in the appeal process	500/1000/2000 USD (428/855/1710 EUR)

Cost of LEED

DEVELOPMENT SIZE	FEE			
	REGISTRATION	DESIGN STAGE	POST-CONSTRUCTION STAGE	TOTAL
'Simple' Building	£265	£535	£230	£1,030
<500m²	£265	£995	£325	£1,585
≥500m² - <5,000m²	£265	£1,540	£475	£2,280
≥5,000m² - <10,000m²	£265	£2,070	£795	£3,130
≥10,000m²	£265	£2,595	£1,330	£4,190

Cost of BREEAM

Rental Premiums for Green-Certified Buildings



Source: World Green Building Council (2013). The Business Case for Green Building.

Benchmarking and Transparency Policies

Difficulties in evaluating green buildings: multiple certifications make difficult to evaluate "greenness" across buildings and incorporate it in investment decisions

The US and EU are implementing benchmarking mandates where owners need to disclose:

- Energy certification of their assets
- Actual energy consumption

This provides full transparency to the market, and creates a platform for regulation

Benchmarking programs and policies in the US

This image is in the public domain.

Energy Benchmark Goals

Estimated Block Level Annual Energy Consumption

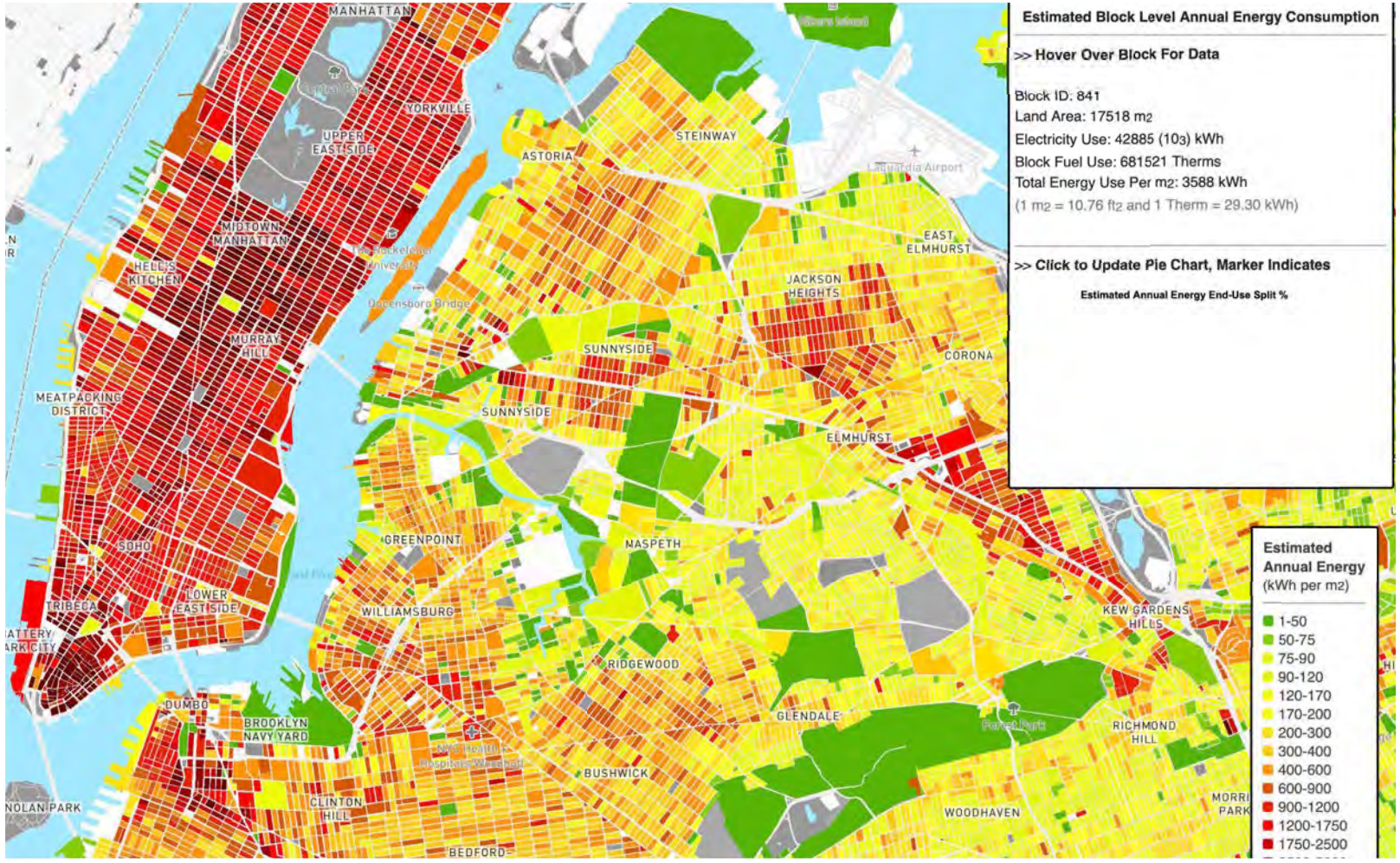
NYC

2009

LL84

Benchmarking

Requirement for buildings to report energy and water usage annually



Energy Benchmark Goals in NYC

2009
LL84

Benchmarking

Requirement for buildings to report energy and water usage annually

2018
LL33

Grading System

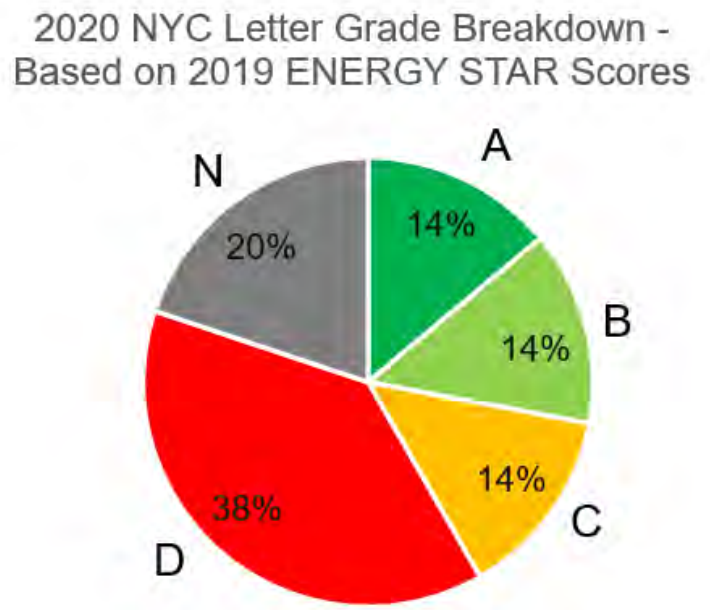
Established scoring for buildings to be rated on energy efficiency and for grade to be displayed in each building

2019
LL95

Amendment to Grading System

Made grading system more stringent and requires grade to be displayed at public entrances

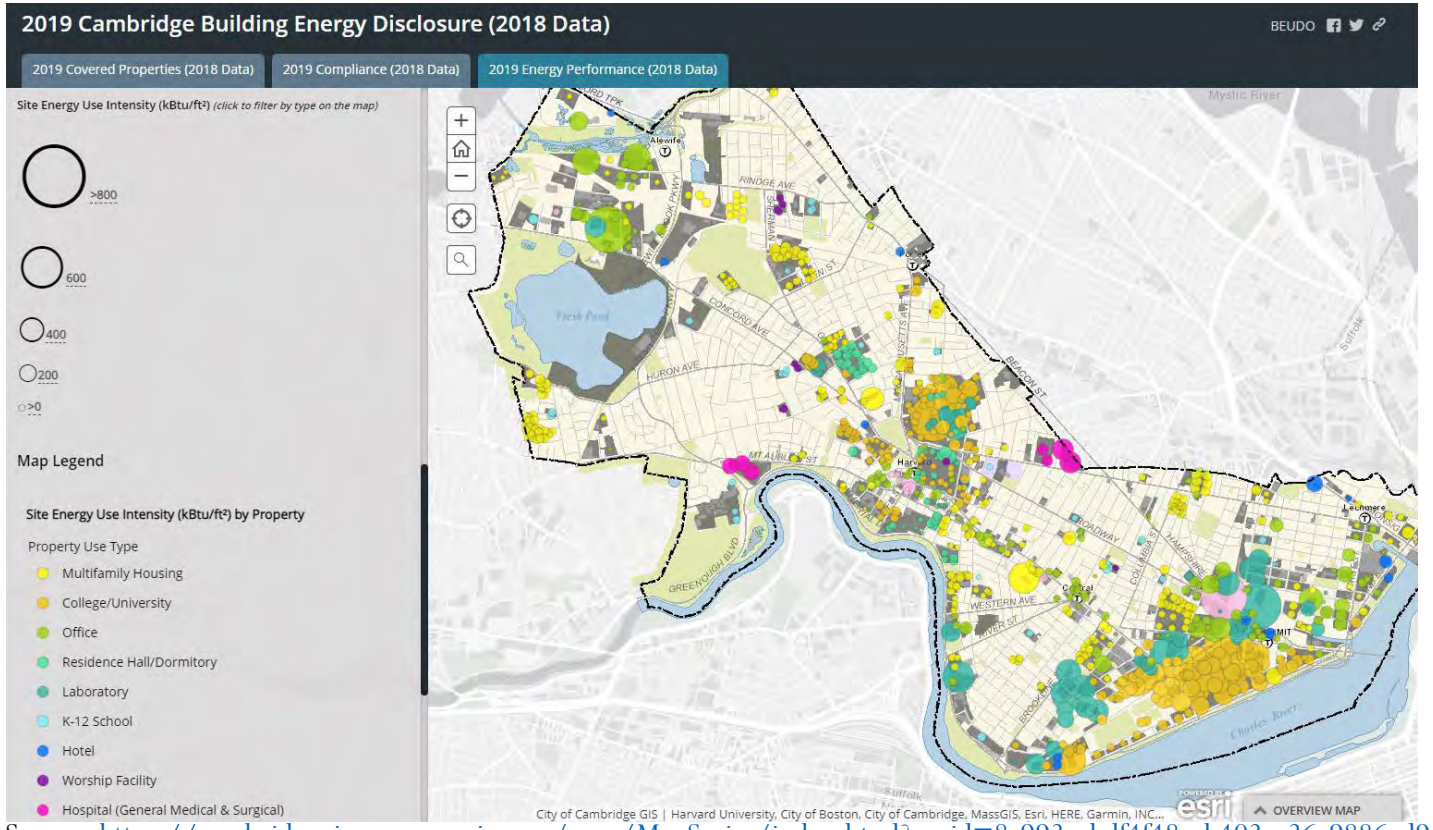
Energy Benchmark Goals



Benchmarking and Transparency Policies

- Cambridge Building Energy Use Disclosure Ordinance:
  - Require owners of larger buildings to track and report annual energy use to the City and publicly disclose the data

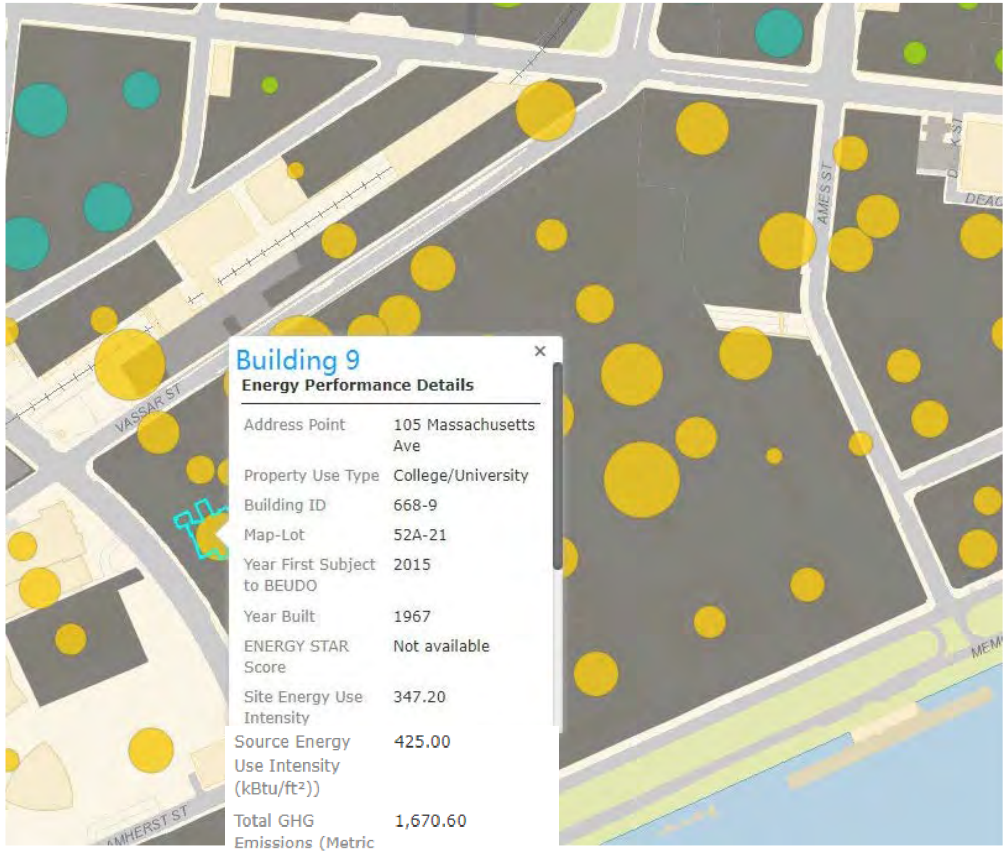
- Certificates: In the EU, 2002/91/EC Directive Member States to ensure that when buildings are constructed, sold or rented out EPC (Energy Performance Certificate) must be disclosed



Source: https://cambridgegis.maps.arcgis.com/apps/MapSeries/index.html?appid=8c993ecbdf4f48eab403ea36c9886ed9

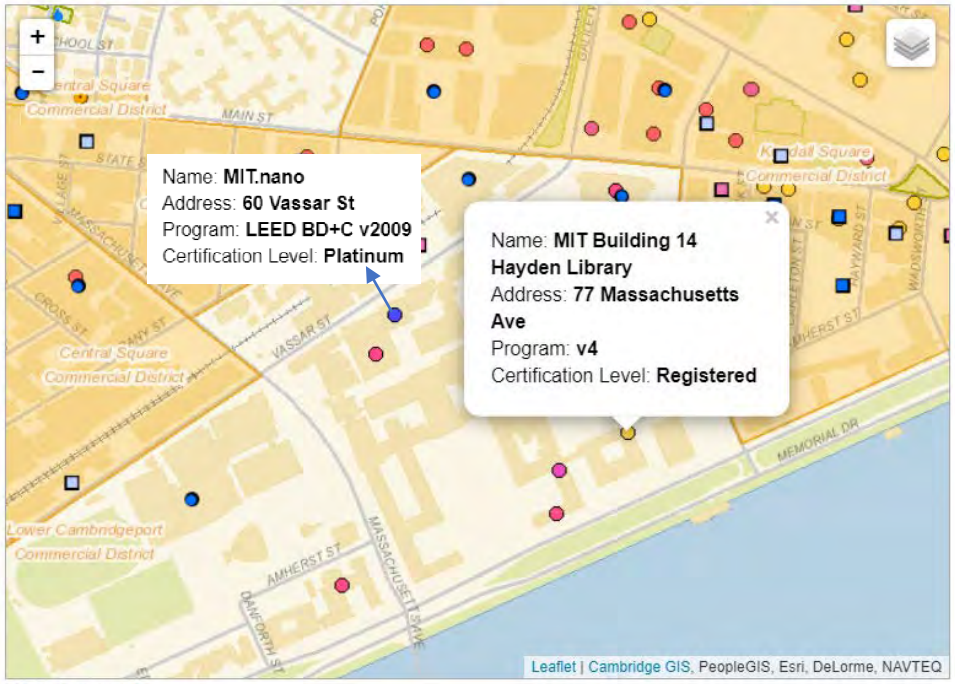
MIT Energy Use Intensity and LEED Certificates

MIT Energy Use Intensity and LEED Certificates.



Source: link.

CDD Locator Map



Map Legend

Active and Completed Special Permits	Green Buildings	Parks and Waterplay	Commercial Districts
Built (older)	Registered	Public Park	Commercial Districts
Built (recent)	Certified	Privately-Owned Park	**CPA Supported Housing**
Under construction	Silver	Waterplay	Affordable Housing
Permitted	Gold		
Applied	Platinum		

Source: https://www.cambridgema.gov/CDD/cddlocatormap#map.

2018 performance (gets better after the retrofit)

Year Built	1951
ENERGY STAR Score	Not available
Site Energy Use Intensity (kBtu/ft²)	169.50
Source Energy Use Intensity (kBtu/ft²))	228.50
Total GHG Emissions (Metric Tons CO2e)	1,701.40
Total GHG Emissions Intensity (kg CO2e/ft²)	11.01

MIT Hayden Library

STATUS
In construction

COMPLETION DATE
2021

THEMES AND PRIORITIES
Renovation and renewal
Sustainability
Enhancement of life and learning

Originally designed by Voorhees, Walker, Foley & Smith, Hayden Library first opened in 1951 and has served for nearly 70 years as a central element of the campus. MIT is undertaking a project to renew and restore the Library's first two floors, updating the main reading rooms and office spaces to reflect the changing nature of the research library for today's students and faculty.

- LEED Gold V4 Certification
- Fitwel Health Certification

- Material:
  "Red List Free" materials for all interior finish materials and fabrics
- Water:
  Use 1.0 gallon-per-flush toilets.

- Energy:
  - Reduce thermal loss by replacing single-pane glass in the large bay windows with high-performance sealed insulated windows.
  - Update air-handling units and perimeter radiators with new controls to optimize energy use.
  - Upgrade all lighting to low-energy LEDs controlled with daylight and occupancy sensors.
  - EnergyStar appliances throughout the building.

TECHNOLOGY: ONLINE APPAREL STARTUP PUTS ITSELF UP FOR SALE B4

BUSINESS & FINANCE

* * * * * THE WALL STREET JOURNAL. Tuesday, March 22, 2022 | B1

See more at WSJ.com/Markets

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