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Center for Buildings, Infrastructure and Public Space

AI-Driven Decarbonization in Construction and Beyond

CBIPS Advisory Board Meeting

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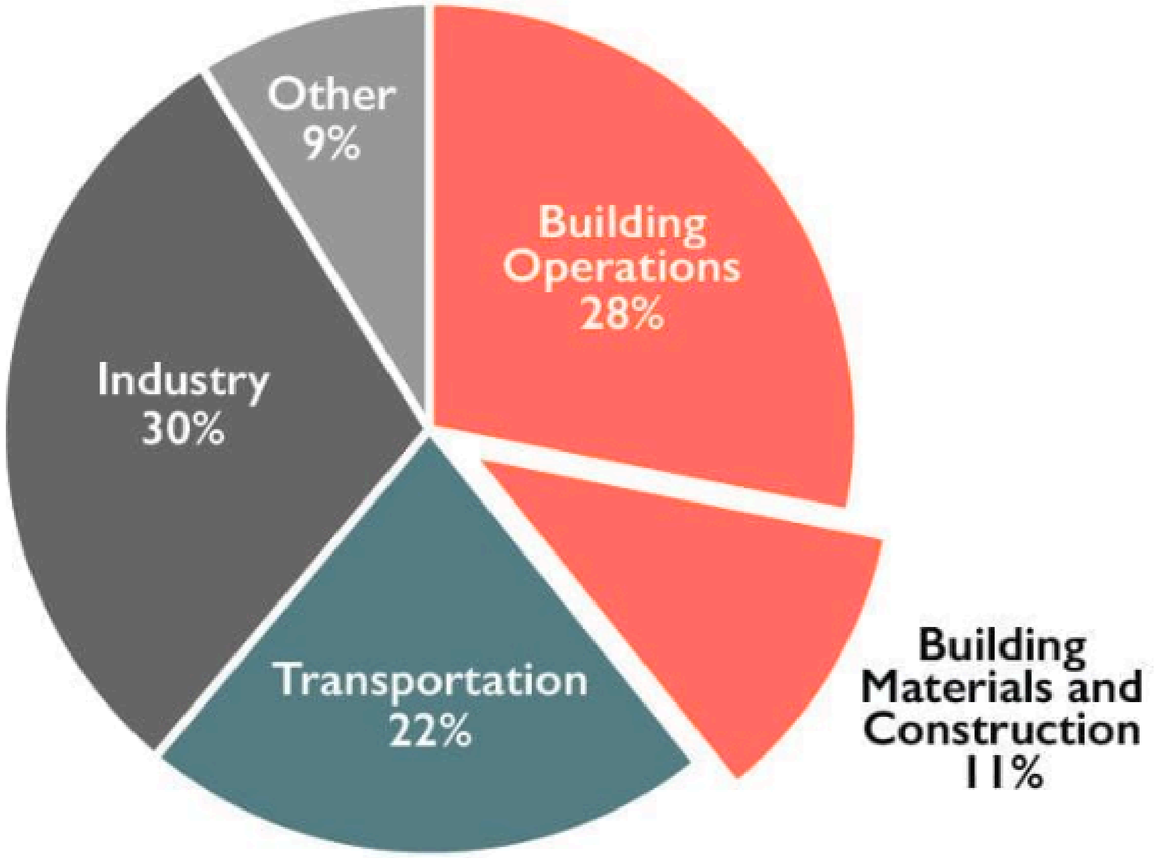
1. DECARBONIZATION

- Cut greenhouse gas emissions from building **construction and operation.**
- Reduce **embodied carbon** in materials and construction processes.
- Improve energy efficiency and shift to **electric, renewable-powered systems.**
- Aim for **net-zero emissions** across the full building lifecycle.



SPEAKER: Sreeja

MAPPING THE GREENHOUSE GAS EMISSIONS OF NYC BUILDINGS

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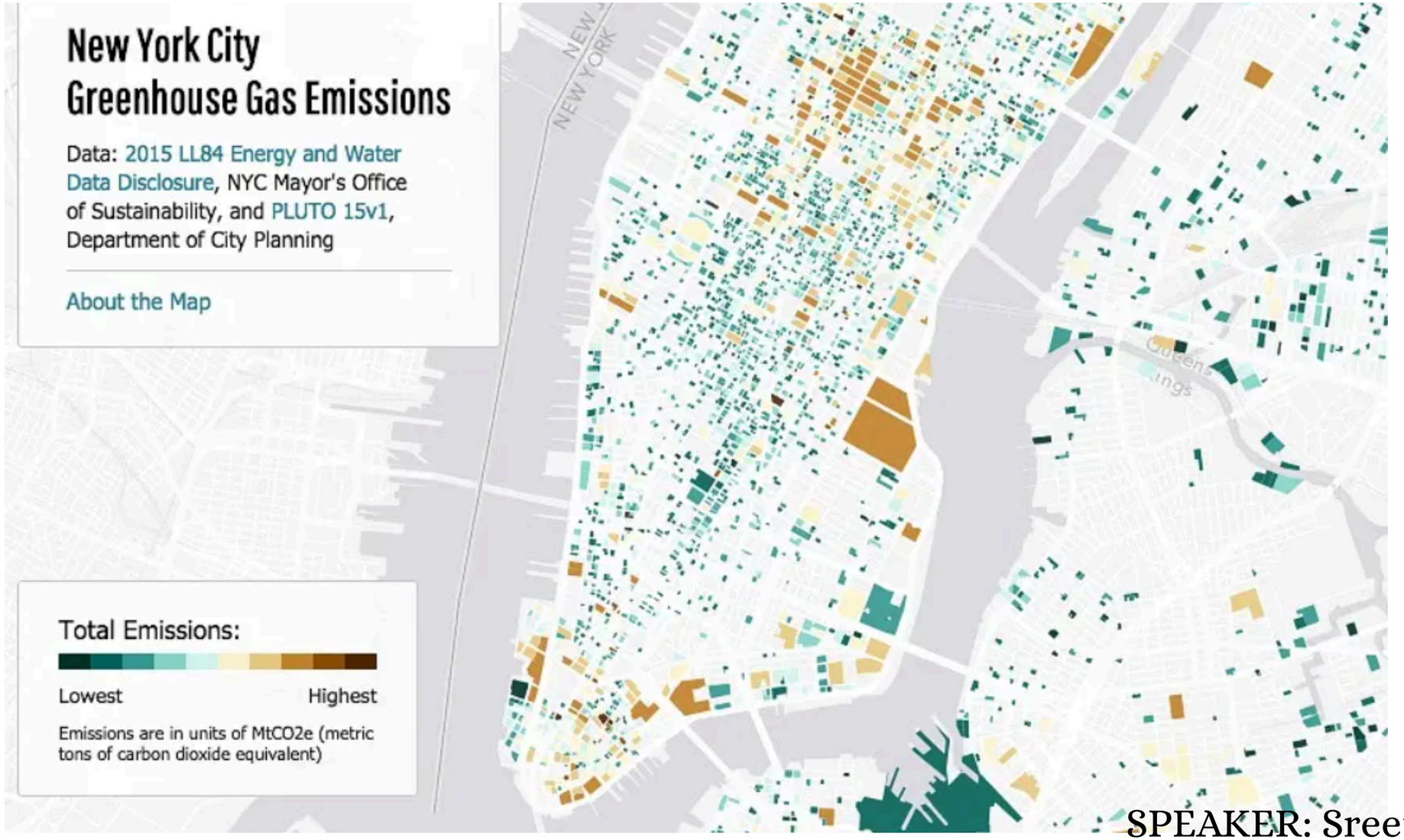

SPEAKER: Sreeja

2. WHY DECARBONIZATION

- Construction is a major source of **carbon emissions**, so reducing them helps fight global warming.
- Low-carbon methods make buildings more **energy-efficient, lowering long-term energy bills**.
- Greener buildings create healthier environments and support a more sustainable future.

SPEAKER: Sreeja

POLICY DRIVERS

GLOBAL

Paris Agreement (2015)

- Limit global warming to 1.5°C
- Requires deep building-sector decarbonization

UN SDG 7 & 13

- Affordable clean energy
- Climate action

Global Net Zero commitments

- 140+ countries have announced 2050 net-zero targets

- LOCAL
- **Local Law 97 (LL97)**
  - Applies to buildings >25,000 sq. ft.
- Carbon caps starting 2024 → much stricter in 2030
- Penalties: $268 per metric ton of CO_2 over limit
- Direct pressure on NYC buildings to decarbonize rapidly

SPEAKER: Sreeja

AI VS. TRADITIONAL DECARBONIZATION:

Metric	Traditional	AI	Source
Energy Savings	5–10%	20–40%	KPMG(2024), JLL(2024), Zhou et al., Energy Informatics (2025)
Carbon Reduction	Low	20–40%	Rahman & Chowdhury, AI-BEMS Integration Study (2025)
Time to Analyze	Months	Hours–Days	UtilityDive (2024), EI
Payback	8–12 yrs	~3.3 yrs	AI-BEMS Study
Scalability	Low	High	Huang et al., Nature Communications (2024)

SPEAKER: Sreeja

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4. AI-DRIVEN SOLUTIONS

BRAINBOX AI

- **Brainbox AI** is a cloud-based AI platform that optimizes building HVAC in real time
- Three-Step Decarbonization Approach:

01

Measure

- **Automated** data collection & carbon accounting
- Scope 1 & 2 emissions analysis aligned with GHG Protocol

02

Reduce

- AI-driven HVAC optimization
- **Predictive control** using weather, grid carbon intensity, and building thermal behavior
- Autonomous, zone-level energy reduction

03

Offset

- Access to certified carbon offset programs
- Complements emissions reductions to approach **net-zero**

SPEAKER: Jiabao

COST + ADVANTAGES OF BRAINBOX AI

Low or No Upfront Cost

Works on top of existing HVAC and BMS, avoiding major capital upgrades.

Energy Savings (Up to ~25%)

Predictive control reduces heating and cooling energy use, lowering monthly bills.

High ROI and Fast Payback

Energy savings, fewer maintenance issues, and longer equipment life deliver strong financial returns.

Carbon Reduction (Up to 40%)

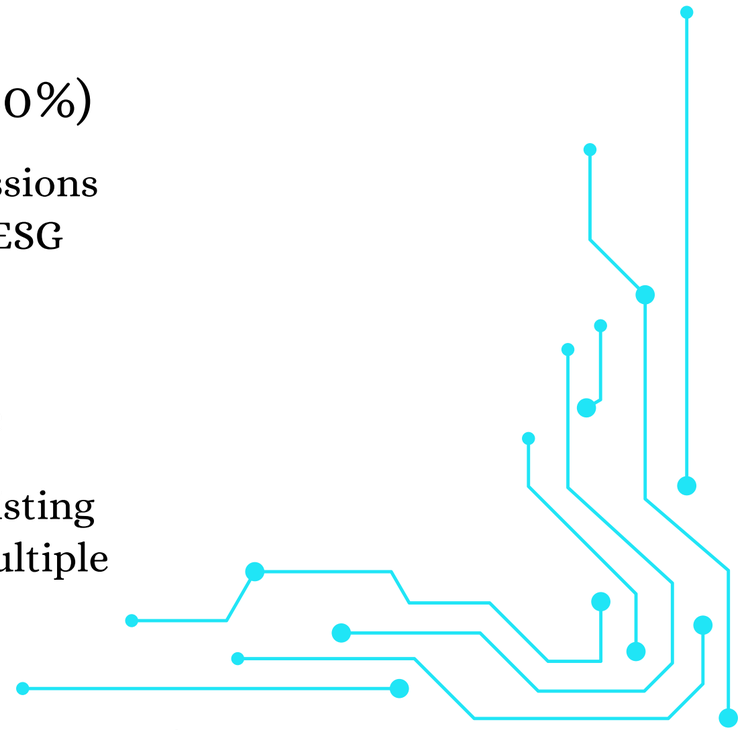
Optimized HVAC operation cuts emissions and supports decarbonization and ESG goals.

Autonomous Real-Time Control

Uses weather, occupancy, and system data to automatically adjust HVAC and maintain comfort.

Easy to Integrate and Scale

Cloud-based AI connects easily to existing systems and supports portfolios of multiple buildings.



SPEAKER: Jiabao

APPLICATION ON 45 BROADWAY

- First BrainBox AI deployment in **New York City (2022)**
- 32-story Class-A office tower located in the Financial District
- According to the International Energy Agency (IEA), HVAC accounts for up to 40% of a commercial building's energy use
- **BrainBox AI integrates with existing HVAC & BMS**
  - Uses deep learning + cloud computing for autonomous control
    - Weather forecasts
    - Occupancy & equipment behavior
    - Real-time energy data
  - AI continuously predicts **thermal loads** & **optimises** HVAC operation
  - No need for a full hardware overhaul.
- A verified 15.8% reduction in HVAC-related energy consumption over three months
- By adopting similar AI cooling strategies, they could cut costs and align with ESG targets

SPEAKER: Jiabao

THE PROBLEM WITH CONCRETE

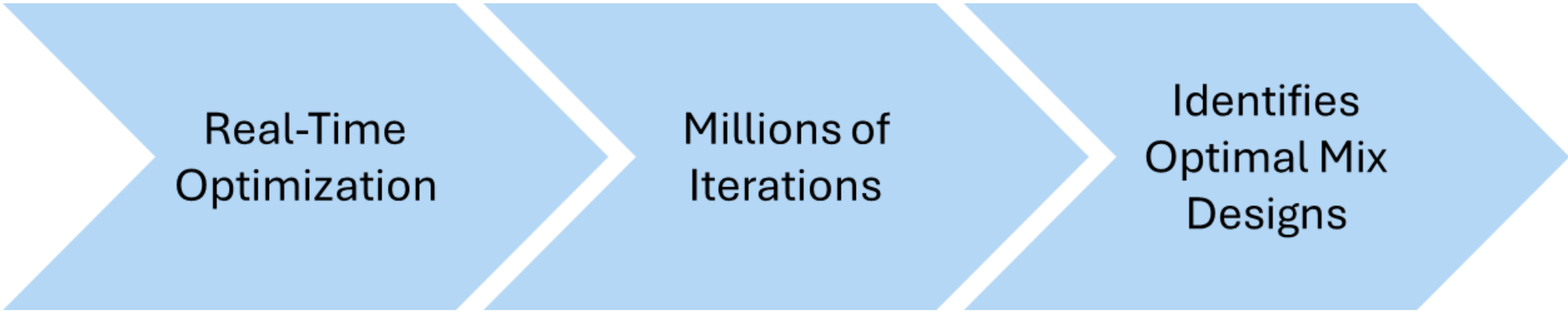
- Massive Carbon Footprint: **~8%** of all global CO2 emissions
- Incredible Complexity
- Slow, Manual Process: "guess and check" method
- Sub-Optimal Designs: most concrete is "over-designed"

SPEAKER: Pierre

THE SOLUTION : CONCRETE.AI

A Generative AI Platform for concrete mix designs

concrete.ai



SPEAKER: Pierre

HOW CONCRETE COPILOT WORKS

Data Integration

Connects to your existing databases

AI-Powered Generation

Analyzes millions of material combinations

Multi-Target Optimization

Minimizes carbon, reduces cost, maximizes performance

SPEAKER: Pierre

THE RESULTS

30%
Carbon Reduction

$5.04
Per Cubic Yard

Seconds
To Optimize

100%
Compliance

SPEAKER: Pierre

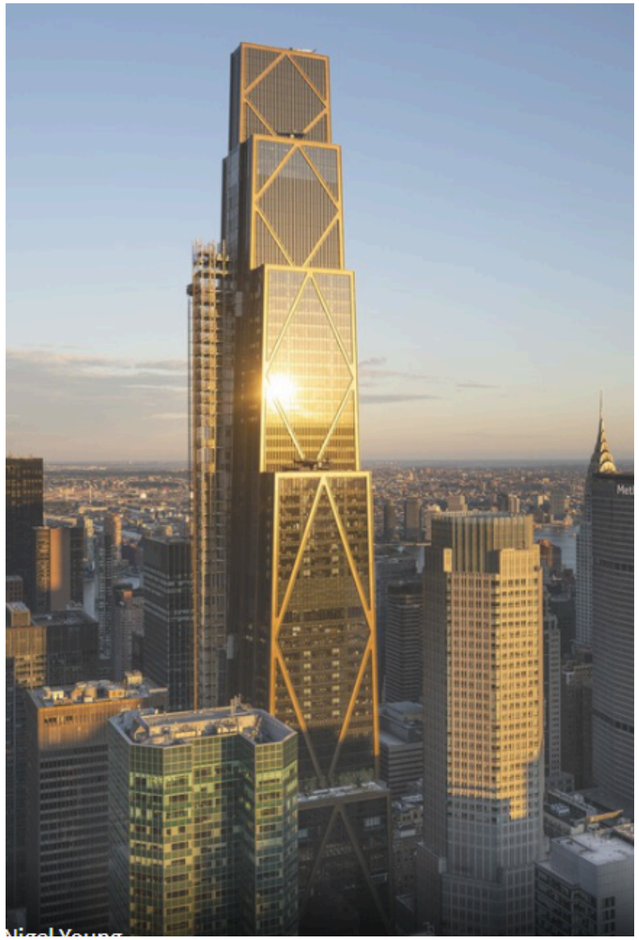
5.CASE STUDY: 1

270 PARK AVENUE

SPEAKER: Metehan

270 PARK AVENUE, JPMorgan Chase Global Headquarters | 1,388 ft | Foster + Partners | 2025

- Steel-framed structure with concrete core | **94,000 tons** of structural steel (**90%+ recycled content)**
- NYC's largest **all-electric tower with net-zero operational emissions**, powered by 100% renewable hydroelectric energy.
- Biophilic design elements: Outdoor terraces with natural green space, workspaces flooded with daylight and fresh air, natural plants and healthier materials integrated throughout.
- **97% of demolition materials recycled**, reused, or upcycled, far above the 75% green building requirement.
- Ground glass pozzolans replace **40-47% of cement in** concrete core → saved **~5,000 tons of embodied CO_2** and diverted 28+ million glass bottles from landfills.
- **Advanced indoor air quality**: Double the minimum outdoor air ventilation rate (40 cfm/person vs. standard 20 cfm/person), continuous air quality monitoring with advanced HVAC filtration.
- **Circadian lighting systems** throughout office floors align with natural human rhythms to enhance wellbeing and productivity.



SPEAKER: Metehan

AI APPLICATIONS FOR 270 PARK AVENUE

- **Proprietary smart building platform**: Custom sensors, **AI**, and **ML** systems integrated by Foster + Partners and engineering team predict and adapt to 270 Park's energy needs across **2.5 million sq ft** in real-time.
- **Multi-system coordination**: AI orchestrates **HVAC**, automated bronze-clad **solar shading**, triple-pane glazing, and circadian lighting across 60 stories and 14,000 occupants simultaneously.
- **Predictive environmental controls**: Advanced sensors regulate air quality (2x building code requirements), temperature zones, and lighting based on occupancy patterns, **NYC weather forecasts**, and the building's unique thermal behavior above Grand Central Terminal.
- **Low-carbon concrete innovation**: Urban Mining Industries' Pozzotive® replaced **40% of cement** with ground glass pozzolan in 52,000 cubic yards of structural concrete (all floors except ultra-high-strength core), saving **~5,500 tons** embodied carbon and diverting 29M+ glass bottles from landfills.
- **Ultra-high-performance concrete**: Custom **16,000 psi** mixes for the building's distinctive fan columns and braced core achieved average strengths of 20,000 psi (max 23,000 psi)—among the strongest ever used in NYC construction.
- **AI Impact**: NYC's first a**ll-electric supertall** headquarters with net-zero operational emissions—AI capabilities designed-in from conception, not retrofitted. Custom systems enable continuous optimization coordinated with 100% New York State hydroelectric power, achieving LEED Platinum v4 and WELL Platinum certification targets.

SPEAKER: Metehan

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CASE STUDY: 2

ONE VANDERBILT

SPEAKER: Metehan

ONE VANDERBILT, SL Green Realty | 1,401 ft | KPF | 2020

- **1.2 MW onsite cogeneration plant** provides **~50%** of building's electricity; captures waste heat for heating.
- **150,000-gallon** rainwater collection system saves 1 million gallons annually; reduces demand for cooling tower water.
- High-performance glazing + economizers (water-side & air-side) achieve **26% less energy** than baseline building code.
- Regenerative elevator system converts **kinetic energy to electricity**; destination dispatch system groups passengers to reduce energy waste.
- Enhanced indoor air quality: **MERV 16 air filters** capture **95%+** of airborne particles; **HEPA filters** in common areas capture **99.99%** of particles; exceeds outdoor air supply rates by 30%.
- **30,000 SF tenant amenity floor** with outdoor terrace, **green spaces**; highest urban outdoor alpine meadow in the world at Summit observation deck.
- **14,000 SF pedestrian plaza** at base designed by PWP Landscape, enhancing public realm and urban heat island reduction.
- Current Technology: Traditional building automation with sensors and **WellStat** air quality monitoring—**no AI/ML integration.**

SPEAKER: Metehan

AI RETROFIT OPPORTUNITIES FOR ONE VANDERBILT

- **BrainBox AI HVAC optimization**: Could integrate with One Vanderbilt's existing **cogeneration plant**, optimizing timing based on real-time grid carbon intensity signals potential **15-25%** reduction in natural gas consumption while maintaining the building's **1.6M sq ft** of Class A office space comfort standards.
- **AI-driven predictive coordination**: Advanced weather forecasting algorithms could pre-condition the 1,401-foot tower's 77 stories 6+ hours ahead of temperature swings. **BrainBox AI** achieves **96%** predictive accuracy for thermal zones, potentially delivering additional **10-15%** energy savings beyond current BMS capabilities.
- Predictive occupancy algorithms: ML analysis of tenant access patterns, transit schedules from Grand Central connection, and event calendars could eliminate energy waste from reactive systems, dynamically adjusting HVAC zones rather than operating on fixed schedules across 1.6M sq ft.
- **Autonomous emissions reduction**: BrainBox AI's AER algorithm could integrate real-time grid emissions data to shift energy loads to cleaner grid periods, achieving up to **15% additional GHG reductions** beyond energy savings alone—particularly valuable given One Vanderbilt's gas-fired cogeneration.
- **Concrete.AI for future infrastructure:** While too late for One Vanderbilt's construction, AI concrete optimization could inform future Midtown East rezoning projects, validating **low-carbon mix designs,** predicting curing times for ultra-tall construction projects, and optimizing material delivery for constrained Manhattan sites.

SPEAKER: Metehan

6. CHALLENGES AND SOLUTIONS

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Challenges in Adopting AI

- Difficulty trusting AI to make material, energy, and operational decisions.
- Lack of **real-time data** to support **automated workflows** in construction and buildings.
- Concerns about **high upfront investment with unclear** ROI.
- Resistance from engineers and facility teams who rely on traditional methods.

Solutions Provided by BrainBox AI + Concrete AI

- Provide **transparent**, data-backed insights that build trust in AI decisions.
- Deliver continuous **real-time analytics** for materials (Concrete AI) and energy systems (BrainBox AI).
- Show **measurable savings** in cement use and energy bills, proving strong ROI.
- Automate complex tasks, reducing manual effort and helping teams adopt AI more easily.

SPEAKER: Jiabao

WHAT NEXT?

- Using technology to power your sustainability strategy
- Bringing Sustainability to Strategic Maturity
- Integrated digital workflows
- Robust data management

- To continue driving real progress, construction leaders must commit to the **technologies, tools**, and talent that make **sustainability scalable**. That means investing not just in platforms, but in people.
- Success requires ongoing **adoption of AI and integrated systems, paired with robust training to future-proof the workforce.**
- With collaboration, innovation, and bold action, construction can lead the way in building a more **sustainable future.**

SPEAKER: Sreeja

KEY POINSTS FROM XIAOXUAN PENG

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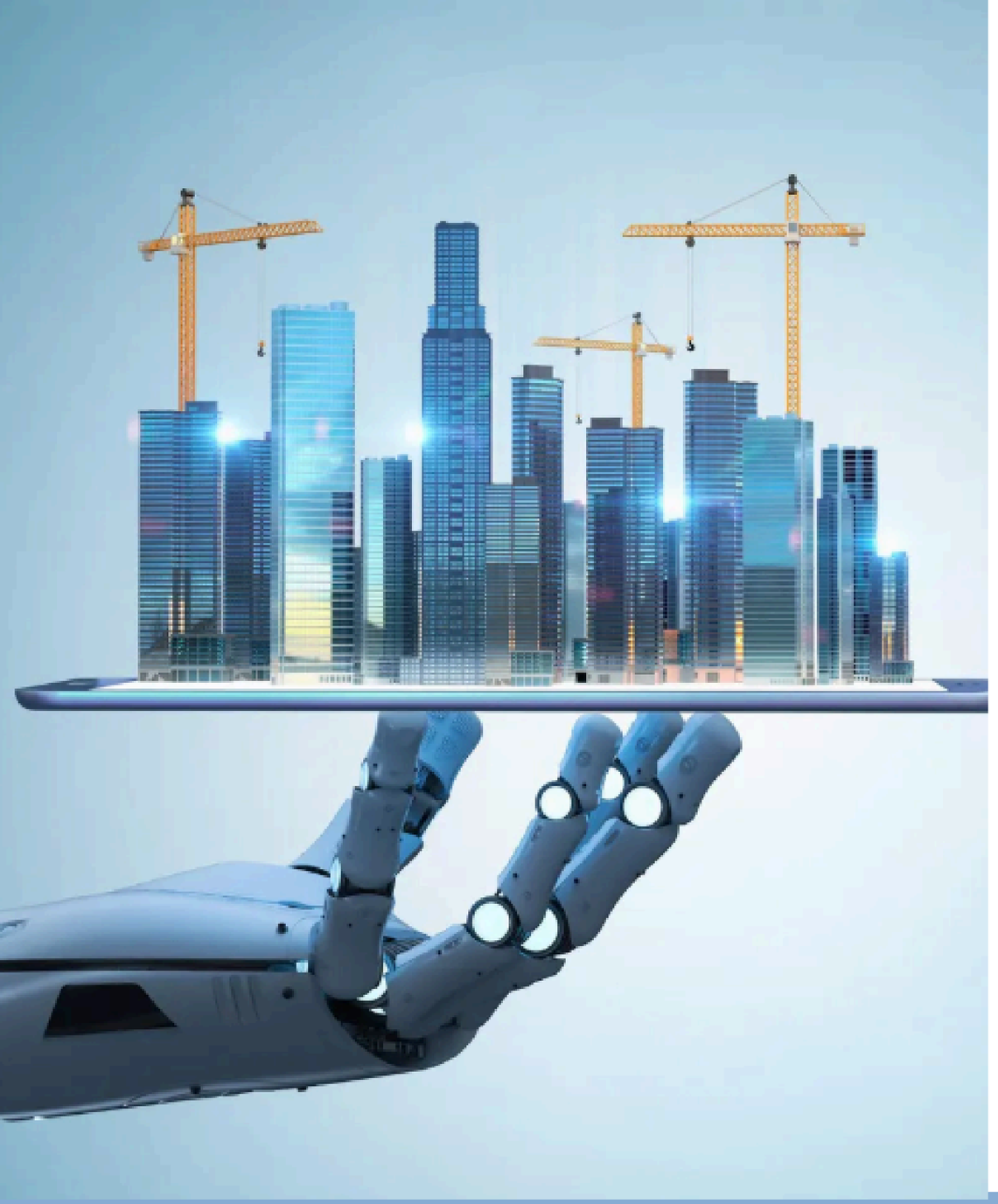
- AI can identify patterns humans cannot — uncovering hidden insights in energy, material, and performance data.
- High planning value — strong potential for improving early-stage strategic decisions across the industry.
- Operations require standardized data — AI is useful, but only when building data is structured and accessible.
- Materials: big opportunity once databases are standardized — AI can generate multiple design options and optimize material selection.
- Legislation will eventually adapt to AI — certain compliance tasks may be automated, but legal responsibility must remain clear.
- AI should be seen as a tool — augmenting human expertise rather than replacing it.
- Design-phase limitations — AI outputs still require human review to ensure feasibility and quality.
- Adoption is polarized — some teams resist due to mindset and momentum; others are developing advanced tools but still don't fully trust automation.
- Technology is largely ready; the industry is not — technical capability exists, but cultural adoption and workflow integration lag behind.

STV

Xiaoxuan Peng

- Director of Digital Delivery at STV
- Leads STV's national BIM & digital delivery strategy
- Optimizes project workflows through technology integration
- Develops high-performing teams and scalable digital practices



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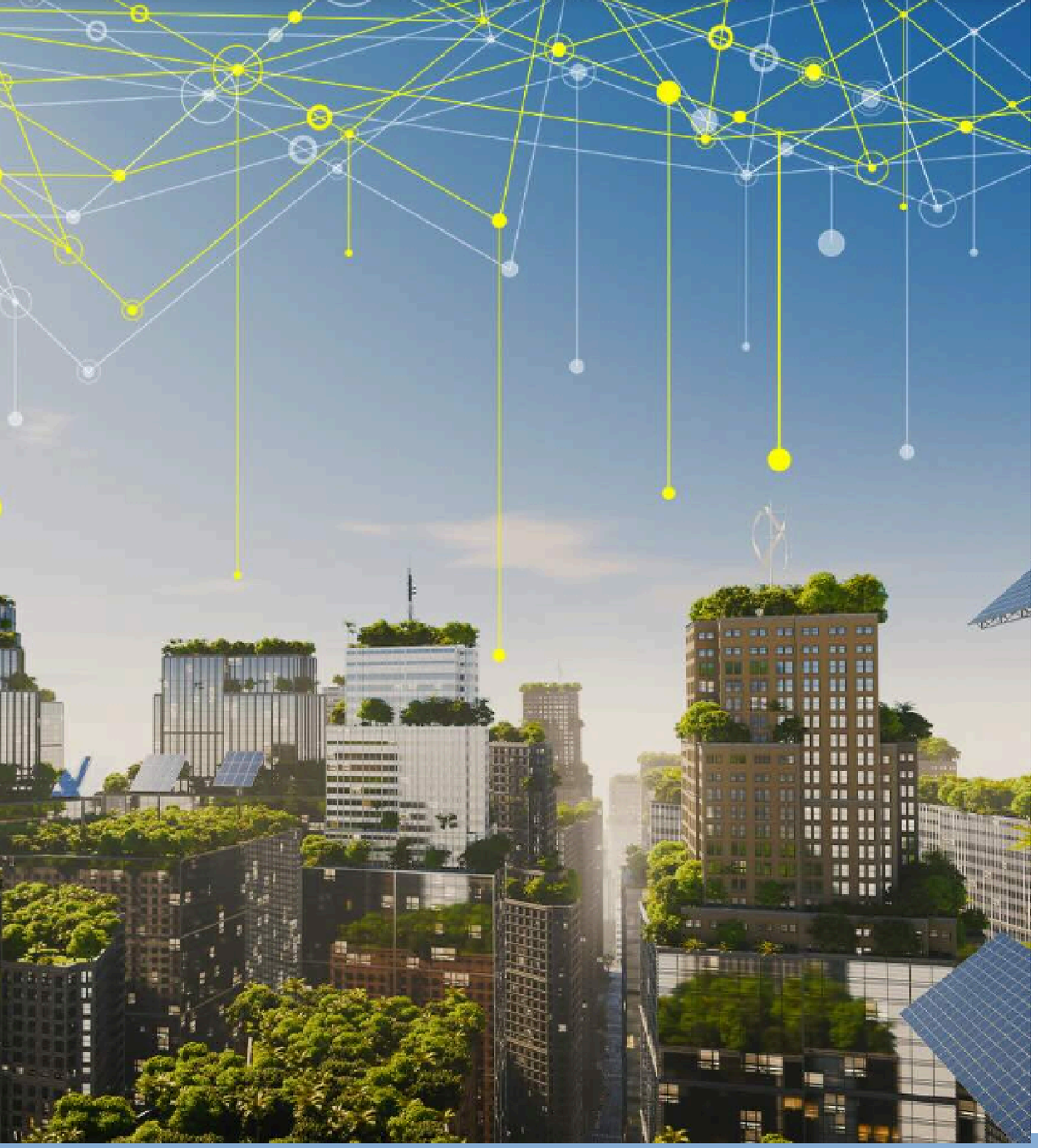
Questions?



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Thank You