



Keys to Successful Passive House Implementation Group B, Deliverable 33 Case Study 5

Matthew Joyce and Mark Wilhelm

Tierra Resource Consultants, LLC

December 2, 2021



Imagine buildings that are ...



- So well constructed they need virtually no heating or cooling and can cut normal utility bills by 50%–80%.
- So airtight there is almost no air leakage or outside street noise, yet they provide healthy, fresh, filtered air throughout the day whether windows or doors are open or not.
- Light, bright, spacious structures with modern architectural design.
- Designed to produce nearly zero carbon emissions when paired with high efficiency all electric appliances and on-site photovoltaics (PV).
- Can be residential or commercial, new construction or retrofit, and adaptable to historic, traditional, and contemporary aesthetics as well.

Passive House (PH) buildings aren't pipe dreams.

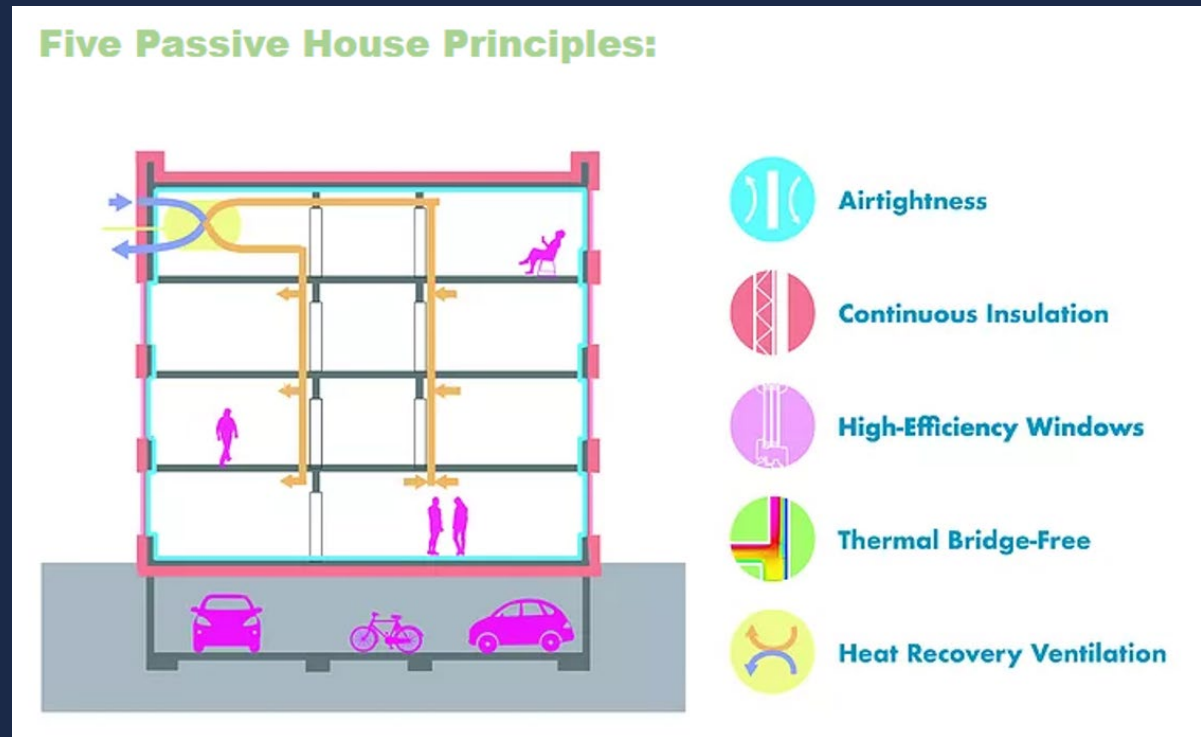


GRAPHIC SOURCE: Vancouver project photos. Passive House Canada Project Database – <https://www.passivehousecanada.com/projects/>

- These “passive house” buildings are common in some parts of the world
 - Built worldwide for over 30 years
 - Applicable to all types of residential and commercial buildings
- Helpful for California for many resiliency challenges
 - Extreme weather conditions
 - Wildfire smoke
 - Antiviral air handling
 - Energy grid outages
- Despite these many advantages, buildings of this type are rare in the State of California

Passive House Design Principles

- To achieve these results, Passive Houses utilize five primary design strategies:
 1. An airtight building envelope
 2. Exceptionally high levels of insulation
 3. Well insulated window frames and glazing
 4. Thermal bridge free design and construction
 5. Ventilation systems with high efficiency heat- and energy-recovery



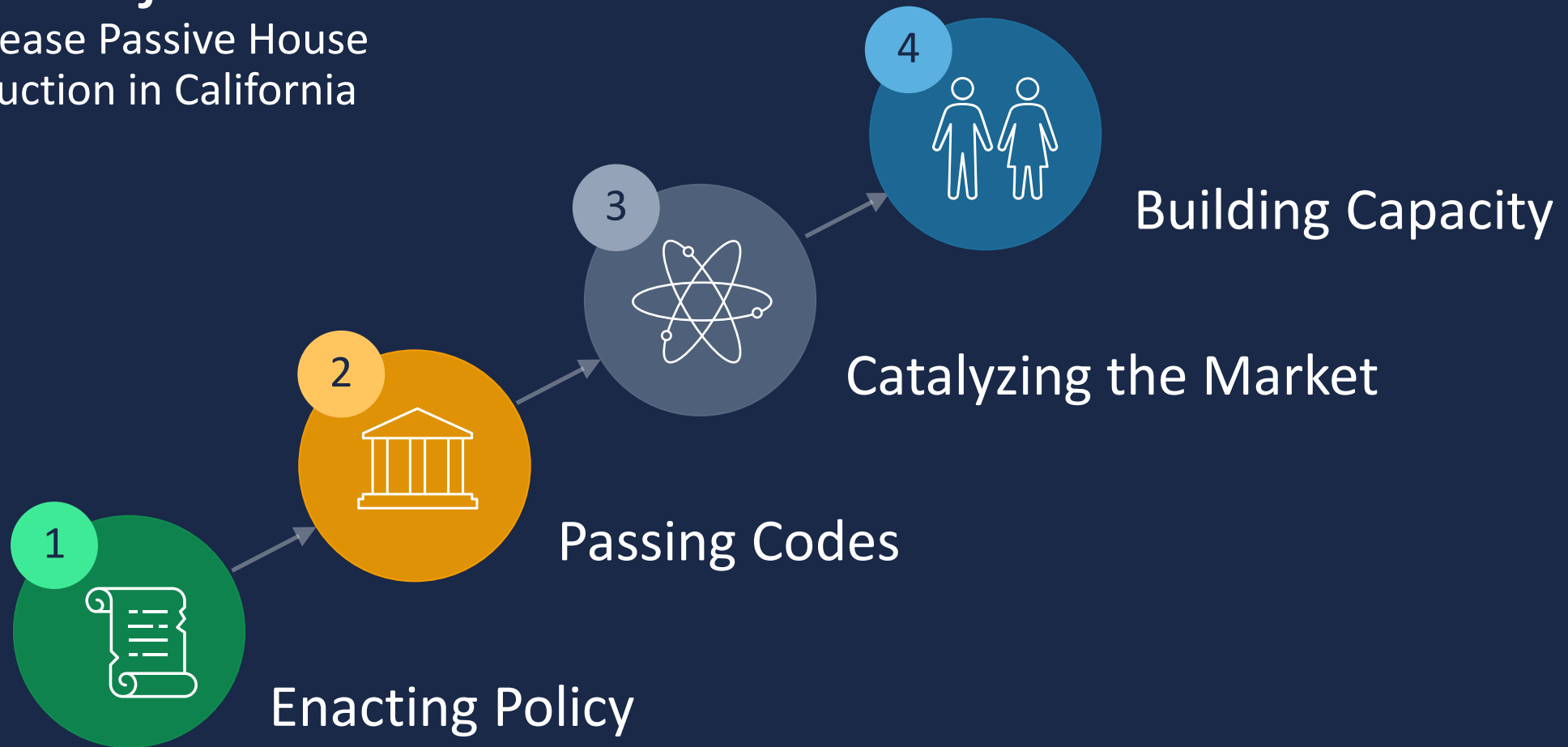
GRAPHIC SOURCE: Passive House New Jersey's website
– <https://www.njpassivehouse.com/copy-of-about-1>

Research Approach

- Assess status in California
- Conduct literature review
 - Find best examples of successful PH implementations throughout North America, Europe, and Australasia
 - Identify similarities across these disparate locations
- Interview 19 subject matter experts to understand the context, activities and outcomes associated with successful PH endeavors in their regions

Four Major Tools

to increase Passive House construction in California



Tool 1: Policy

1



- Set framework for planning strategies, codes, and other regulations
 - Top-down alignment of goals and policies
 - Bold policies and plans

Tool 2: Codes

2



- Codes support policy by establishing minimum standards, metrics, and methods for measuring compliance
 - Energy modeling alignment
 - Passive House code compliance path
 - Step codes with time-dependent performance targets
 - Compliance targets based on performance metrics. The three most important PH performance metrics include:
 - **Energy Use Intensity (EUI)** – measures total amount of energy externally provided to the structure for all end uses
 - **Greenhouse Gas Intensity (GHGI)** – measures total amount of energy supplied to the building multiplied by that energy's carbon intensity
 - **Thermal Energy Demand Intensity (TEDI)** – measures building envelope performance based on the amount of heating or cooling that is required to maintain the building at a comfortable temperature

Tool 3: Catalysts

3



- Catalysts stimulate market action through financial means or via other incentives
 - Lead by example
 - Financial incentives
 - Nonfinancial incentives
 - Competitions for cash and other awards
 - Early examples of success

Tool 4: Building Capacity

4



- Capacity Building strives to ensure the availability of people and resources necessary for the accomplishment of the goal
 - Outreach and awareness
 - Workforce education and training
 - Expert advisors
 - Supply chain development

Passive House Best Practices In Action

Four Mini Case Studies

Tools	Key Element	Brussels	New York	Vancouver	Pennsylvania
Policy	Top-down alignment of goals and policies	✓	✓	✓	✓
	Bold policies and plans	✓	✓	✓	
Codes	Step codes with time-dependent performance targets	✓	✓	✓	
	Passive House code compliance path	✓	✓	✓	
	Compliance targets based on performance metrics	✓	✓	✓	
	Energy modeling alignment	✓	✓	✓	
Catalysts	Leading by example	✓	✓	✓	✓
	Financial incentives	✓	✓	✓	✓
	Nonfinancial incentives	✓	✓	✓	
	Competitions for cash and other awards	✓	✓	✓	✓
	Early examples of success	✓	✓	✓	✓
Capacity	Outreach and awareness	✓	✓	✓	
	Workforce education and training	✓	✓	✓	
	Expert advisors	✓	✓	✓	
	Supply chain development	✓	✓	✓	

Brussels Passive House Projects



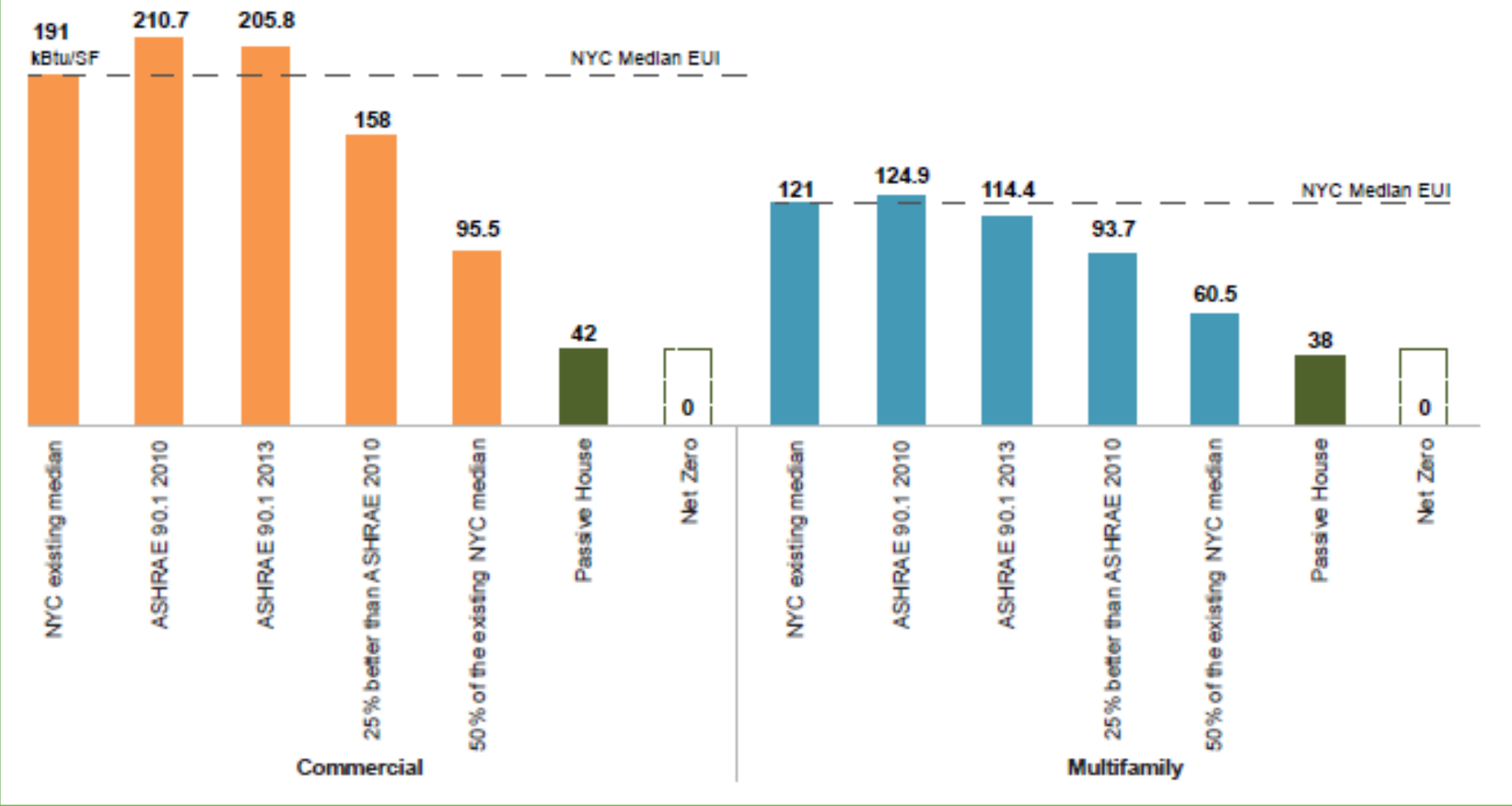
GRAPHIC SOURCE: Sebastian Moreno-Vacca, A2M+M2A

Brussels, Belgium: All the Right Moves

Brussels went from among Europe's "worst to first" in building energy use in under ten years

- In 2007 – Brussels set out to build very low energy, economical, and beautiful “Exemplary Buildings”
- In 2015 – Brussels became the first municipality in the world to require all new and renovated buildings conform to Passive House standards
- Highlights:
 1. Coordinated energy policy and building codes
 2. Annual competitive design process
 3. Subsidies, tax credits and green loans
 4. Required sharing of performance and cost data
 5. Capacity-building training and education programs
 6. Technical expertise and support for obstacles
 7. Support market for necessary PH building components

Median EUI of NYC Buildings – Built to Code Compared to Passive House (kBtu/SF/Year)



GRAPHIC SOURCE: NYC One City Built to Last – <https://www1.nyc.gov/assets/builttolast/downloads/OneCity.pdf>

New York: An Integrated State and Local Effort

New York State and New York City work in tandem to reach tough climate goals

- Highlights:
 1. Aligned state and local goals, policy directives, and strategic plans
 2. Performance-based step codes – AND – alternative, compliance path for PH
 3. Time-dependent targets with penalties for noncompliance
 4. Outreach and stakeholder engagement
 5. Training and education funding
 6. Knowledgeable advisors
 7. Commitment to passive house strategies for all new and retrofit buildings
 8. Financial and non-financial incentives
 9. Requirement to provide performance and cost data
 10. Supply chain / market transformation support

BC Step Codes

Step	Airtightness	Equipment and Systems	Envelope	Approximate Equivalency
Step 1: enhanced compliance	3.5 ACH ₅₀	BCRC using 9.36.5 or ERS v15 ref. house (MEUI of 80 kWh/m ² /year is likely, not required)	Report on TEDI and PTL (TEDI 50 kWh/m ² /year is likely, not required)	Energy Guide Rating System, Built Green Bronze
Step 2: 10% beyond code	3.0 ACH ₅₀	10% better than ERS v15 or MEUI – 60 kWh/m ² /year	TEDI 45 kWh/m ² /year or PTL – 35 W/ m ²	Built Green Silver
Step 3: 20% beyond code	2.5 ACH ₅₀	20% better than ERS v15 or MEUI – 45 kWh/m ² /year	TEDI 40 kWh/m ² /year or PTL – 30 W/ m ²	ENERGY STAR [®] , Built Green Gold and Platinum
Step 4: 40% beyond code	1.5 ACH ₅₀	40% better than ERS v15 or MEUI – 35 kWh/m ² /year	TEDI 25 kWh/m ² /year or PTL – 25 W/ m ²	R2000
Step 5: 50% beyond code	1.0 ACH ₅₀	No ERS option MEUI – 25 kWh/m ² /year	TEDI 15 kWh/m ² /year or PTL – 10 W/ m ²	Passive House, Net-Zero Energy-Ready

Vancouver, Canada: An Orchestrated Approach

Vancouver leaders studied Brussels and New York and executed a comprehensive climate strategy

- Highlights:
 1. Climate goals aligned with strategic plans
 2. Performance-based step codes with clear targets and dates
 3. Key metrics for measuring building performance (GHGI, TEDI, EUI)
 4. Formal alternative compliance pathways, including PH
 5. Walk the talk with city buildings and procurement practices
 6. Financial and non-monetary incentives
 7. Extensive outreach and awareness efforts
 8. Subsidized training for AECO community
 9. Removing barriers by empowering staff and hiring experts



GRAPHIC SOURCE: Vancouver project photos. Passive House Canada Project Database – <https://www.passivehousecanada.com/projects/>

Cost Comparison of Passive House and Conventional Projects in Pennsylvania



GRAPHIC SOURCE: Data from PFHA. Graphic provided by Tim McDonald (Onion Flats Architecture) and Zach Semke (Semke Studio).

Pennsylvania: Aligning Incentives Yields Big Results

Pennsylvania's approach was less comprehensive but innovative: their efforts have been emulated across the nation

- Motivated professionals saw an opportunity to ensure Low Income Housing (LIH) developers and occupants were fully engaged in the state's energy/carbon/comfort transition. They:
 1. Engaged the right market players (PHFA, developers, industry professionals)
 2. Developed a QAP policy approach: no additional funding; rewarded creative proposals from LIH developers
 3. Competition drove cost-effective solutions to meet market needs
- In six years, Pennsylvania showed that PH LIH projects could be delivered at cost parity to conventional projects, yield significant energy bill reductions, and improve occupant comfort
 - Half the states in the U.S. are trying to mimic the success of the Pennsylvania PH QAP experiment
- Next step for PA: see if the LIH sector success can be translated over to other building sectors
 - This will require a focus on additional tools and key elements to drive PH market transformation throughout the state

Contributors

NAME	TITLE	ORGANIZATION
Bronwyn Barry, CPHD	Architect and Certified Passive House Designer (CPHD)	Passive House BB and The Passive House Network
Beverly Craig	Senior Project Manager, Low- and Moderate-Income Programs	Massachusetts Clean Energy Center
Danielle Donnelley	Manager of Sustainability Programs	Community Preservation Corporation
Greg Hale	Senior Advisor for Energy Efficiency Markets and Finance	NYSERDA
Chris Higgins, CPHC, LEED AP Homes	Senior Green Building Planner	City of Vancouver
Atalia Howe	Assistant Vice President, Initiatives and Impact Investing	Community Preservation Corporation
Elizabeth Kelly	Senior Policy Advisor	NYC Mayor's Office of Climate & Sustainability
Christian Kienapfel	Architect, Certified Passive House Designer (CPHD), LEED-AP, Dipl.-Ing. (FH) Architekt (Germany)	Paravant Architects
Jennifer Leone, AIA, LEED	Chief Sustainability Officer	New York City Department of Housing Preservation and Development
Mark Lyles	Senior Project Manager	New Buildings Institute
Timothy McDonald, RA, CPHC	President and Architect	Onion Flats
Sadie McKeown	Executive Vice President	Community Preservation Corporation
Sebastian Moreno-Vacca, AIA, NCARB	Architect and Founding Partner	A2M+M2A Architects
Sean Pander, P.Eng.	Green Building Program Manager	City of Vancouver
Clare Parry, CPHD Building Certifier	Sustainability Manager	Development Victoria
David Salamon, CPHC, CPHD	Architectural Designer and Passive House Specialist	Re:Vision Architecture
Jason Scheurer, CPHT	Building Scientist and Certified Passive House Tradesperson (CPHT)	BEST Techs Contracting Design Build Remodel, Inc.
Zachary Semke, CPHC, LEED AP	Director	Passive House Accelerator
Jeremy Shannon	Director of Sustainable Design and Resilience	NYC School Construction Authority

For More Information



- Matthew Joyce
- Director
- Tierra Resource Consultants
- 303-579-3344
- matthew.joyce@tierrarc.com



- Mark Wilhelm
- Director
- Tierra Resource Consultants
- 602.697.8942
- mark.wilhelm@tierrarc.com