

RESEARCH ON TAP

# **Accelerating the Energy Transition: Transformative Pathways to Decarbonization and Sustainability**

December 4, 2019

[bu.edu/research/events](https://bu.edu/research/events)



**Boston University** Office of Research

# **Methane Emissions Detection: Technology vs Regulation**

# Robert Kleinberg

Senior Fellow  
Institute for Sustainable Energy



# Methane is an Important but Elusive Greenhouse Gas

## EPA-Approved Method

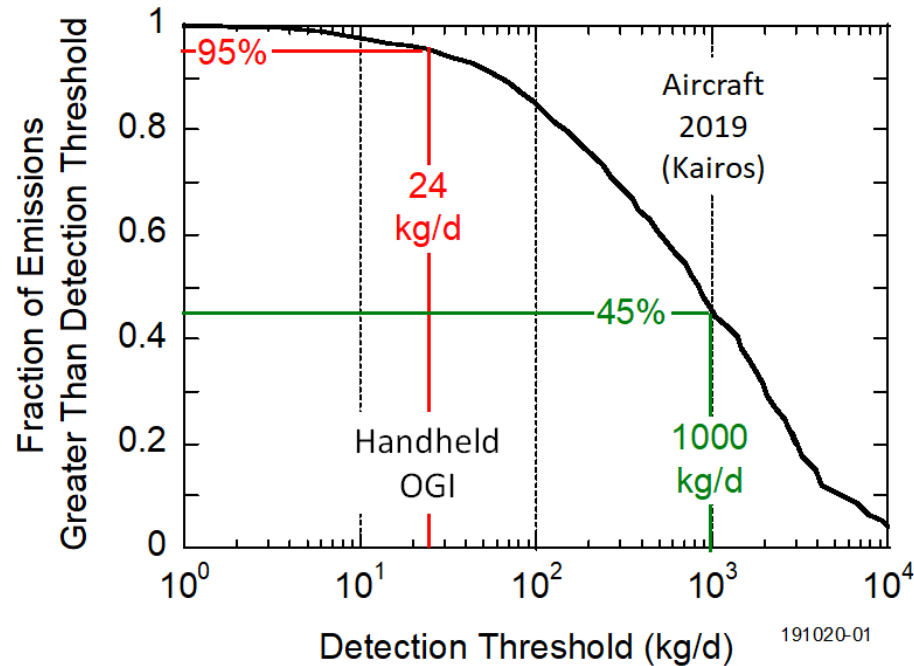


Kleinberg Checking Every Flange

## No Path to Approval



Kairos Aerial Survey



## BU-ISE & Colleagues Were Asked to Provide an Outline for an Amendment to a Bill Before Congress

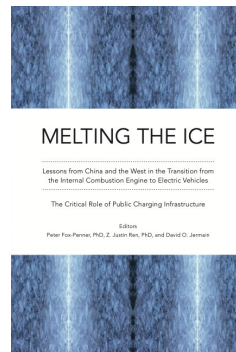
	2016 Regulation	BU/Duke/Columbia /SLB Proposal
Focus	Components	Groups of Facilities
Applicants	Only Owners or Operators	Inventors, Manufacturers, “Anyone”
Validity	Single Site	Multiple/Universal
Validation	On Site Comparison to Old Tech	Approved Test Centers & Modeling
Test Period	12 months	-----
Criterion	Sensitivity $\geq$ Present Techniques	GHG Reduction
Encourages Further Innovation	No	Yes

Suggestions for Improvement of H.R. 2711, the Methane Waste Prevention Act  
12 November 2019

# Melting the ICE: The Critical Role of Public Charging Infrastructure for Electric Vehicles

Z. Justin Ren

Boston University Institute for Sustainable Energy



*Peter Fox-Penner, Z. Justin Ren,  
and David O. Jermain*

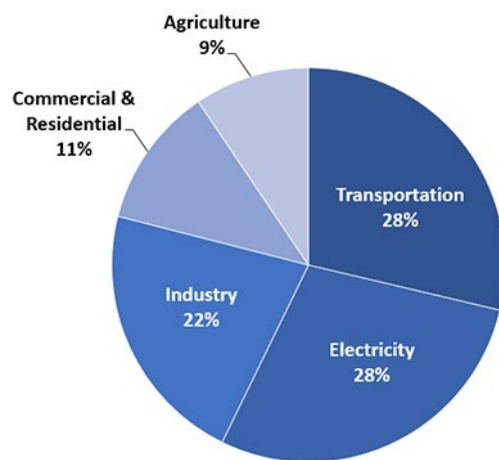


Boston University Office of Research

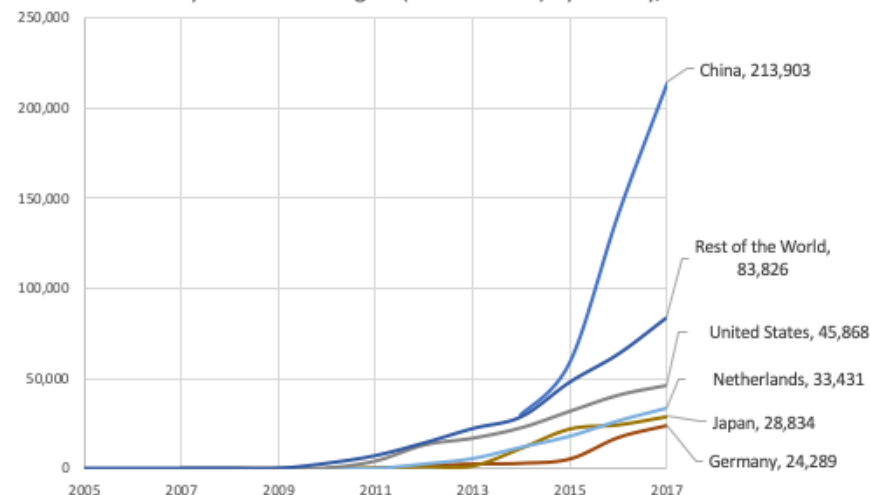
# What are the lessons that we learned from cities around the world in the transition from the Internal Combustion Engine (ICE) to Electric Vehicles (EV)?

- ✓ Cities are the right level of action and analysis
- ✓ It is not just about adding more EV chargers
- ✓ Each successful cities are successful in its own way, but there are some key commonalities

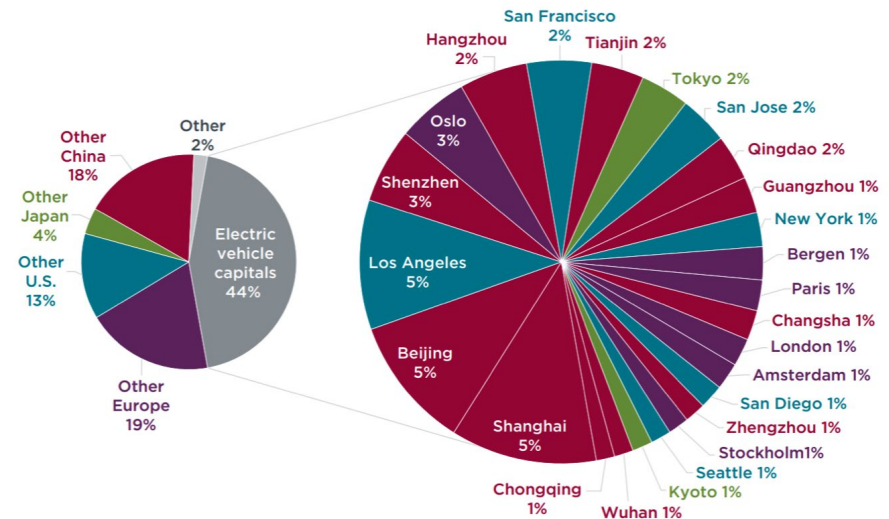
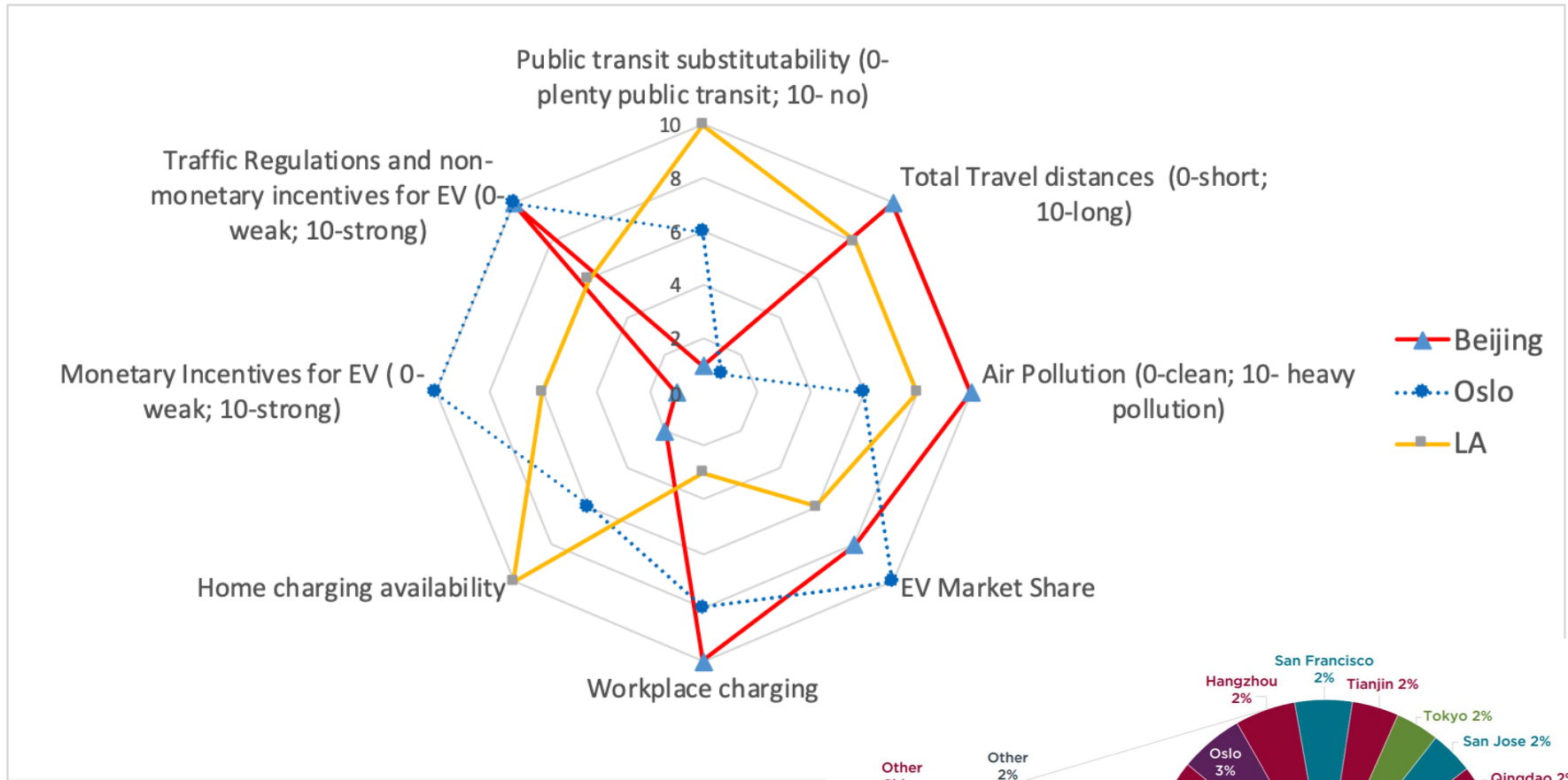
Total U.S. Greenhouse Gas Emissions  
by Economic Sector in 2016



Publicly accessible chargers (slow and fast) by country, 2005-17



# Each Successful City is Successful in its Own Way...



## Coordination of Renewable Generation and New Loads

# Michael Caramanis

Professor

Mechanical Engineering and Systems Engineering

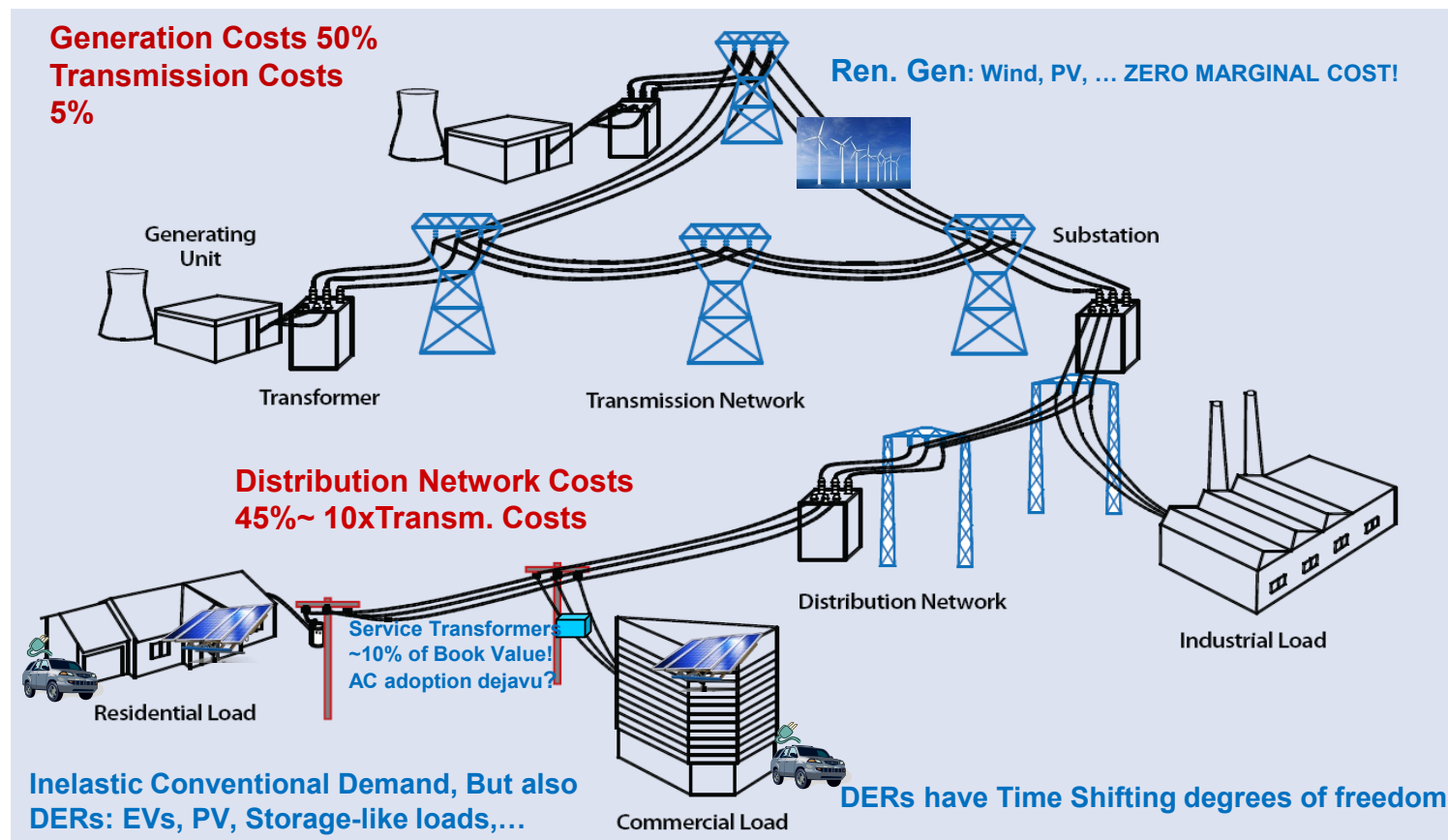
College of Engineering

[mcaraman@bu.edu](mailto:mcaraman@bu.edu)





Power System Costs: Generation (Capital and Fuel, **Zero** for Renewable Gen?), T&D Wires, Congestion (Ampacity, Voltage), Losses (quadratic), Transformers (Loading duration)



Distribution Network Dominant Costs: Losses, Voltage Control, Service Transformer Loss of Life => Reactive Power and Voltage Modeling Required! **Spatiotemporal DER Capacity Scheduling Important!**

# Research Objectives

- Understand Distribution Network Short Run Marginal Costs (SRMC)
- Model: 1. Conventional Generation and Demand, 2. Renewable Generation, and DER Degrees of Freedom, Capabilities, and Preferences
- Model Spatiotemporally Varying MCs of Real and Reactive Power at Distribution Network Nodes
- Model SRMC-driven Optimal Scheduling of DERs
- Investigate DER/Renewable Generation Coordination Benefits to Discover Value Proposition.
- Quantify Short Run Variable Cost and Long Run Investment/Infrastructure Impacts.
- Is RG-DER Coordination Implementable? Scalable? Equitable to Various Stakeholders?

# Understanding Interfacial Stability in High Energy Density Batteries

## Emily Ryan

Assistant Professor

Mechanical Engineering, and Materials Science and Engineering

Associate Director

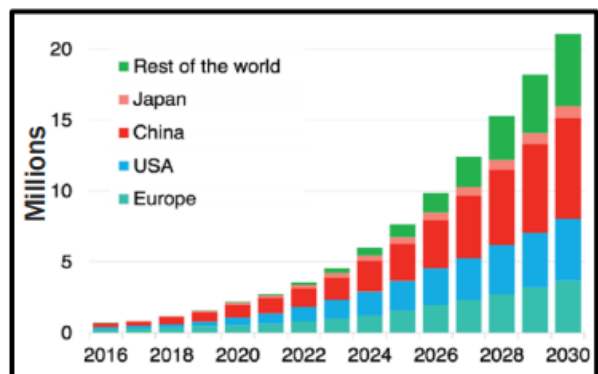
Institute for Sustainable Energy



# Need for High Energy Density Storage

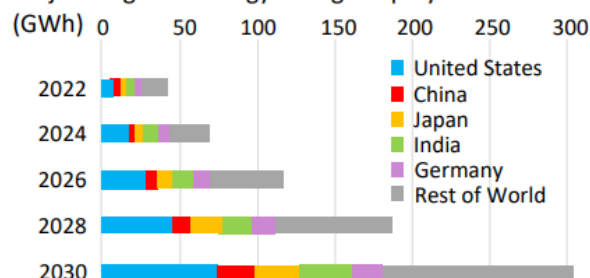
## Growing demand for energy storage

Global EV Forecast



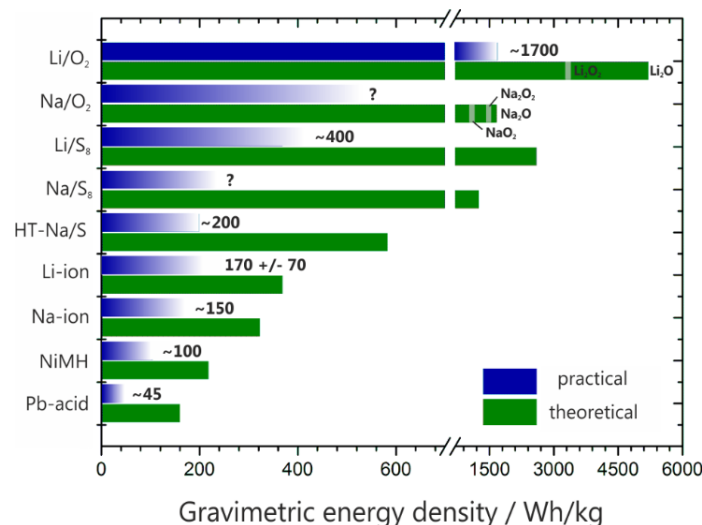
Source: Bloomberg New Energy Finance

Projected global energy storage deployment



[Adapted from Bloomberg New Energy Finance 2017]

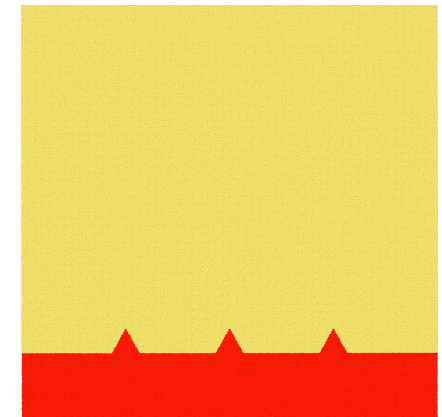
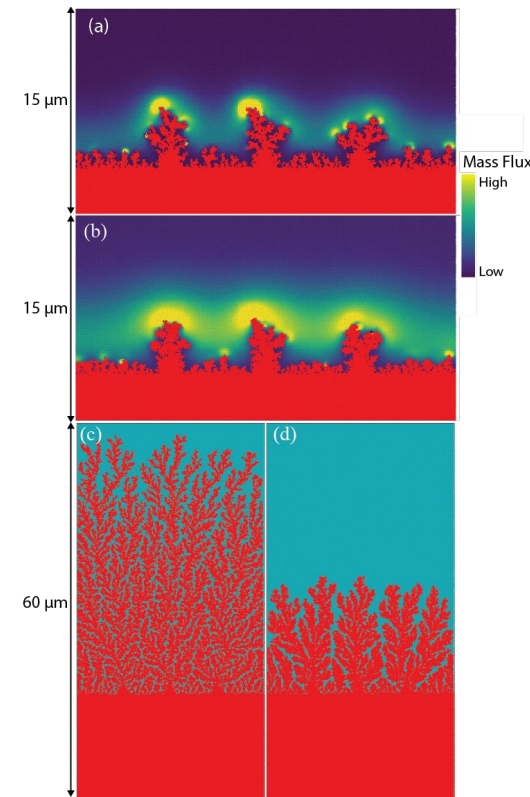
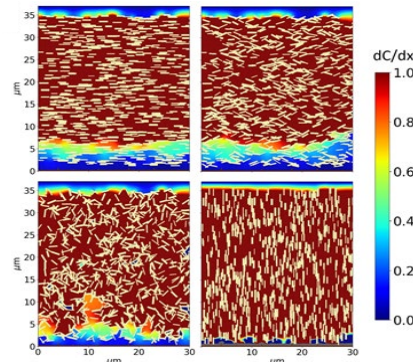
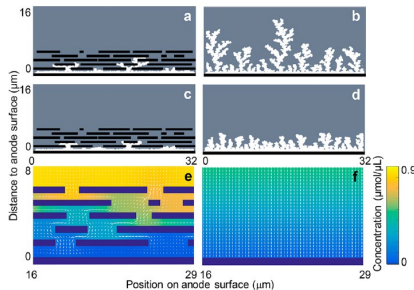
## Potential for higher energy density batteries



- Current Li-ion batteries nowhere near energy density of gasoline
- High energy density batteries face fundamental technical challenges
  - Long term performance
  - Material stability
  - Safety

# Computational Modeling of Interfacial Physics: Stability, Safety and Lifetime in Batteries

- Dendrite growth over multiple charge/discharge cycles causes:
  - Performance loss - capacity fade
  - Safety issues – short circuiting
  - Limits cycle life
- Research: Understand how local conditions effect dendrite growth
  - Develop new materials to suppress growth
  - Design new charging protocols to allow fast charging while minimizing effects on performance



# Improving Sustainability of Commercial Buildings

## Michael Gevelber

Associate Professor, Mechanical Engineering. BU Climate Action Plan  
Newton Energy Commission, founder Aeolus Building Efficiency

Research sponsored by ARPAE, DOE/BTO, & MA CEC



**Why Commercial Buildings:** 12% of US energy use, but 37% electricity, 18% US carbon. **Waste: >> 60 %!**  
- Indoor air quality (IAQ): we spend 90% of our time indoors.

**My Focus: HVAC.** 40-60% of building energy  
- What drives HVAC energy use? Its the amount of airflow!  
**~\$16K+/yr for this room alone** (but few recognize this)

**Using the University as a Laboratory:**  
Student education & research  
~14 million ft<sup>2</sup> >300 buildings

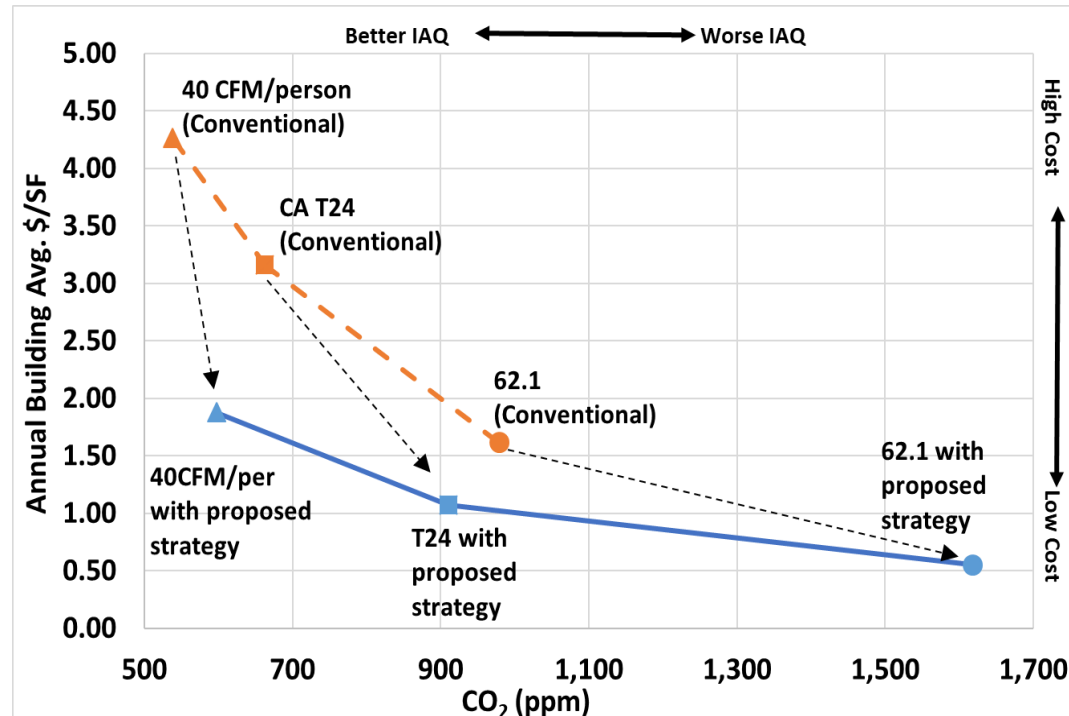


**Research:** - HVAC control strategy  
- Sensors to count number of people to adjust airflow  
- Measurement system for building exterior air leaks (energy loss) & internal air leaks (IAQ)



- **New HVAC control strategy reduces cost while enabling superior IAQ, based on programming change (no CAPx)**

- High CO<sub>2</sub> impacts cognitive performance. Trade-off OA & \$
- Standards ASHRAE (62.1): high CO<sub>2</sub> but cheap. CA T24 better. LBL/Harvard proposal. What standards to follow for good IAQ?



- **Developing Building Air Leak Testing System:** measures both external & internal air leaks.
- Opportunity to work with Public Health to study real apartment buildings.





# **How Do You Decarbonize 86,000 Buildings?**

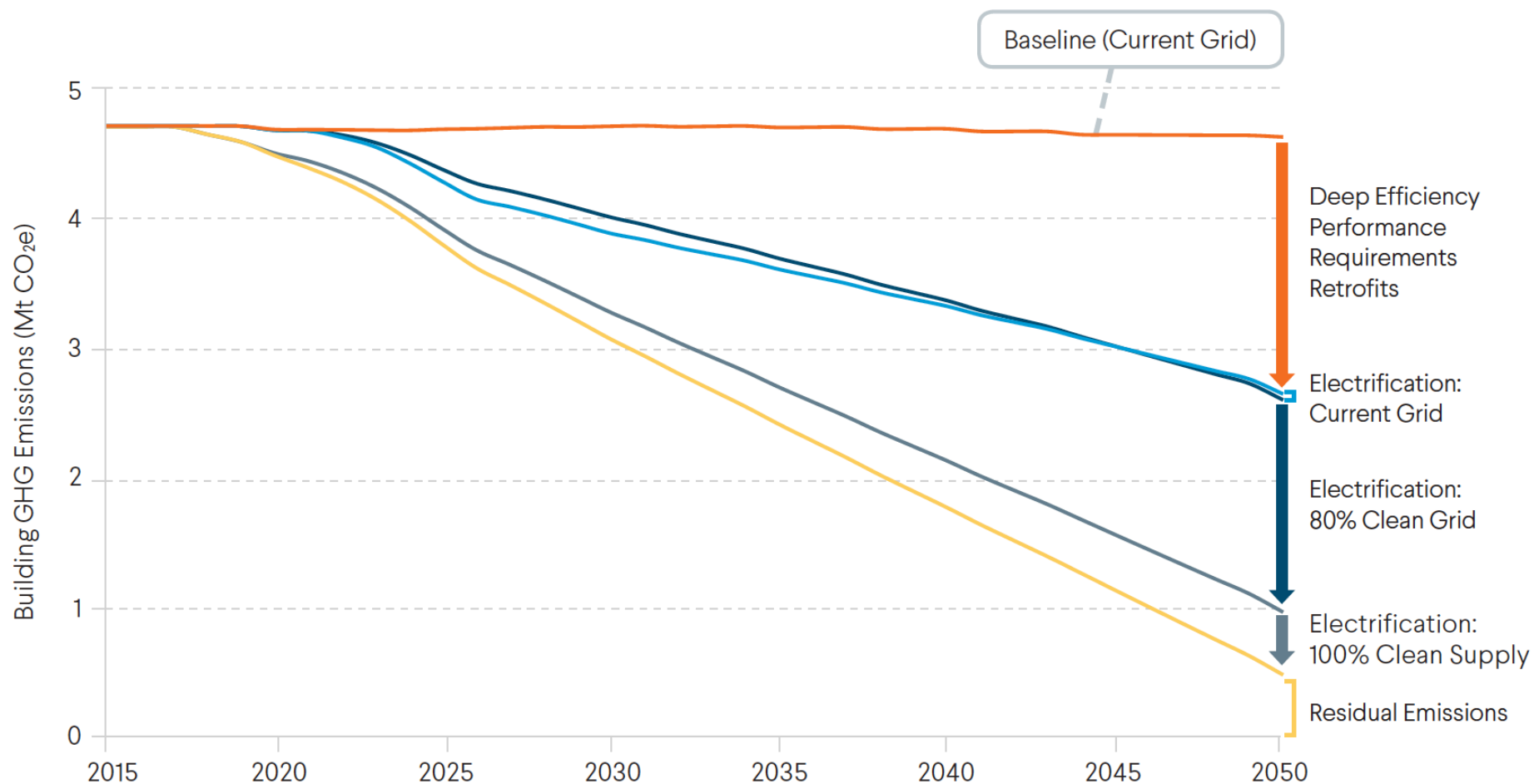
## **Cutler J. Cleveland**

Professor, Department of Earth and Environment  
Associate Director, Institute for Sustainable Energy



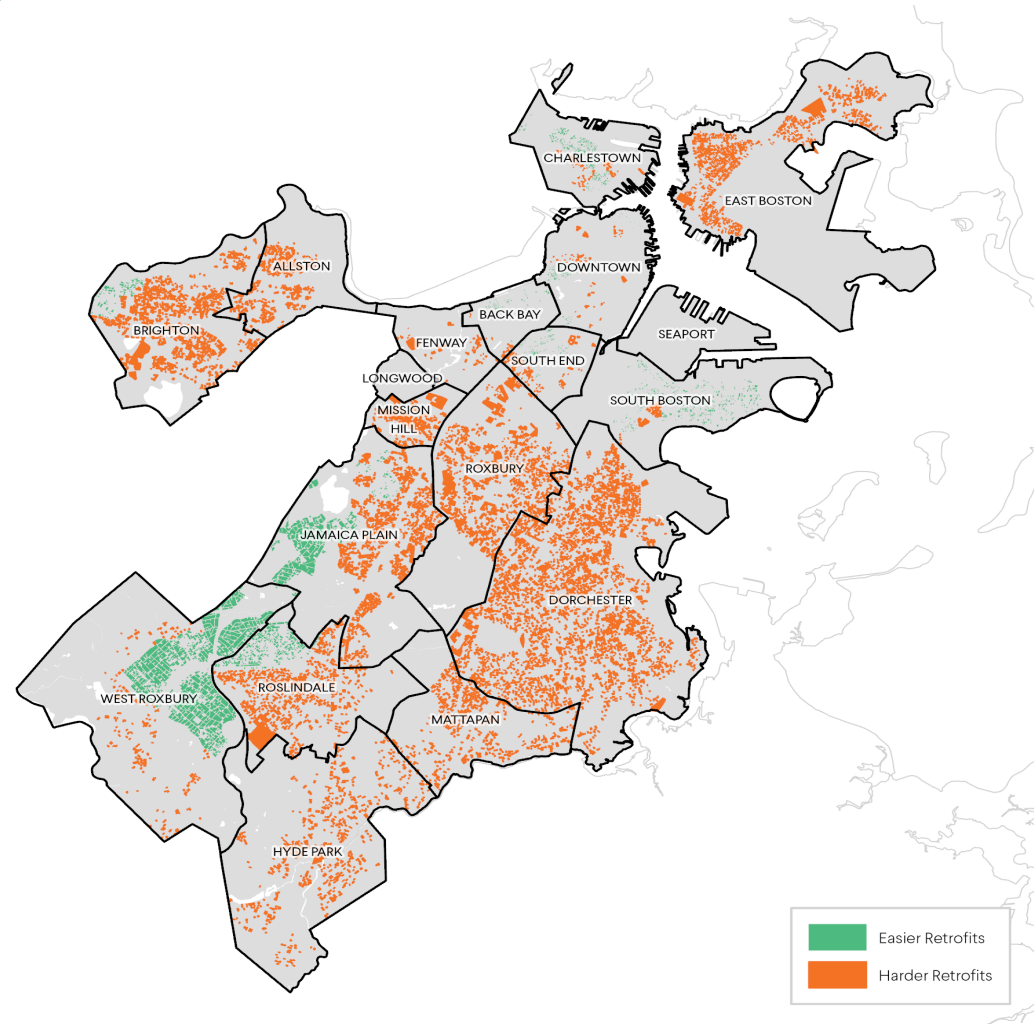
# Carbon Neutral Buildings in Boston

## Strategies: Thermal Electrification, Efficiency, GHG-free fuels



# Challenges to Equitable, Carbon-Neutral Housing

1. Boston has a shortage of affordable housing
2. Socially vulnerable households experience high levels of energy insecurity
3. Socially vulnerable neighborhoods have more harder-to-retrofit buildings
4. Retrofits and rooftop solar can accelerate gentrification and displacement



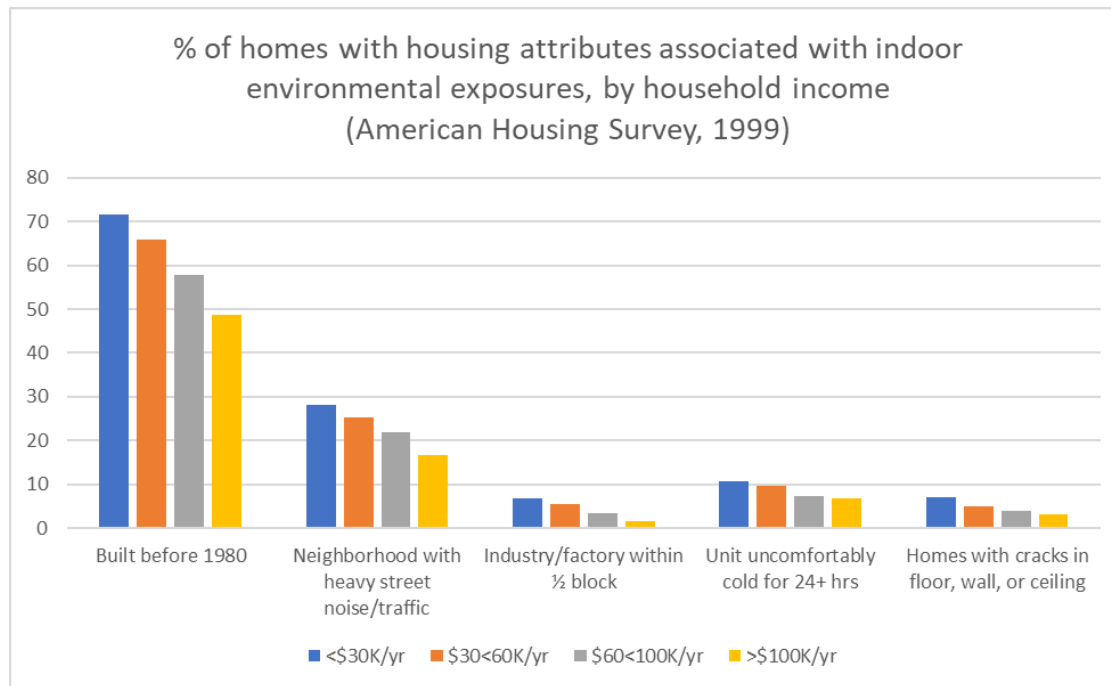
# **The Population Health Consequences of the Energy Transition: The Home and Built Environment**

## **Jon Levy**

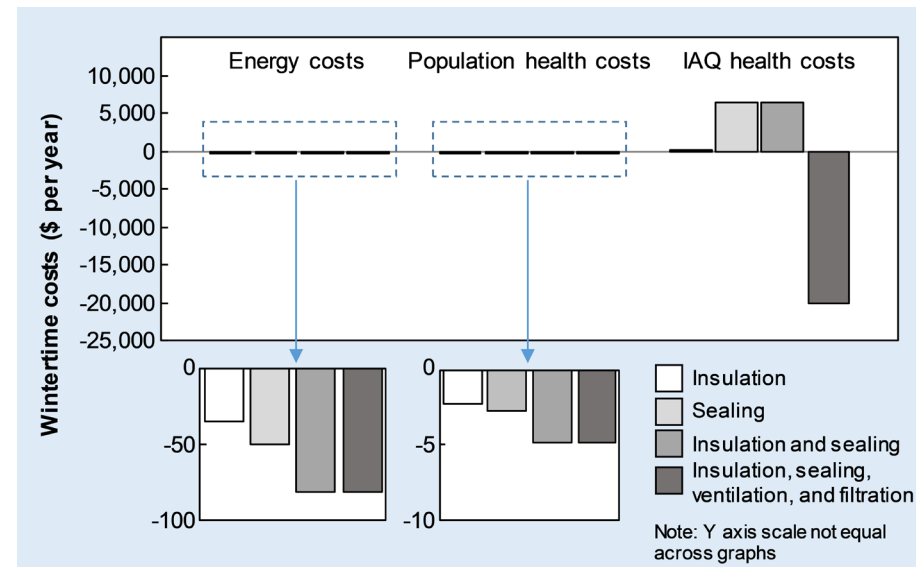
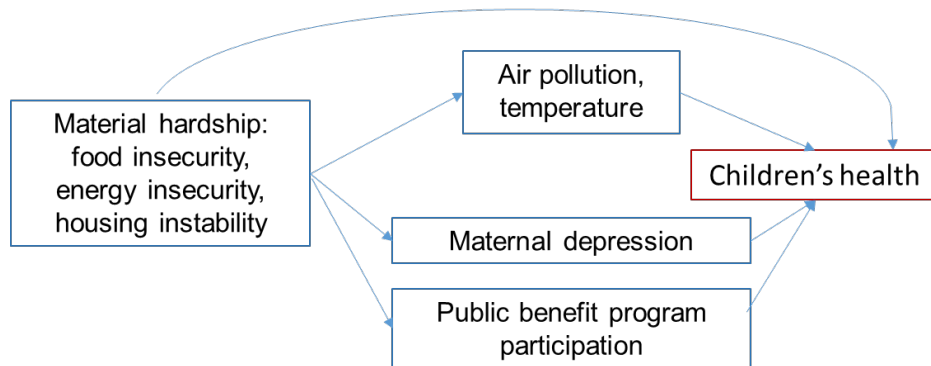
Professor and Chair

Department of Environmental Health, School of Public Health

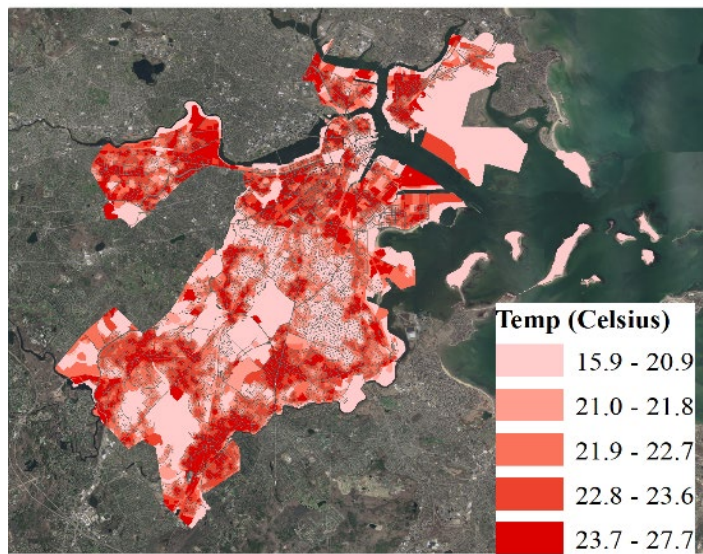




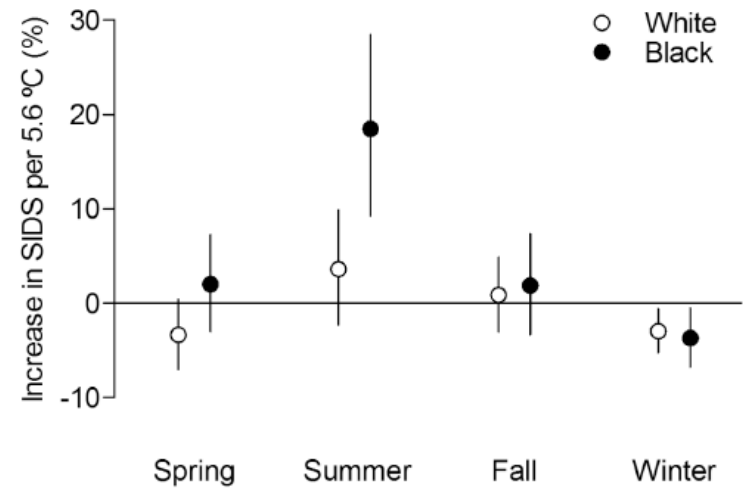
Adamkiewicz 2011



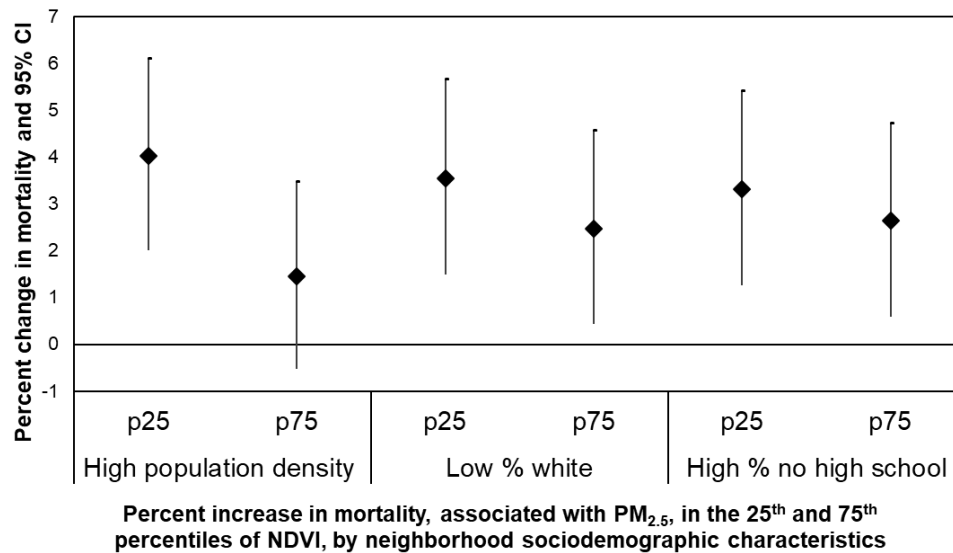
Underhill 2019



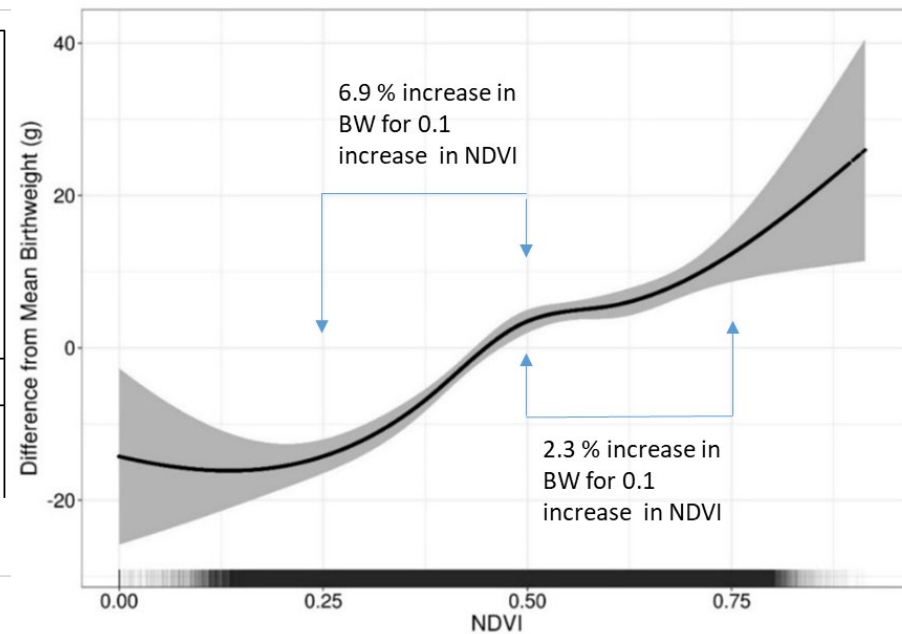
Lane 2019



Jhun 2017



Yitshak-Sade 2019



Fong 2018

## Nature-based Climate Solutions?

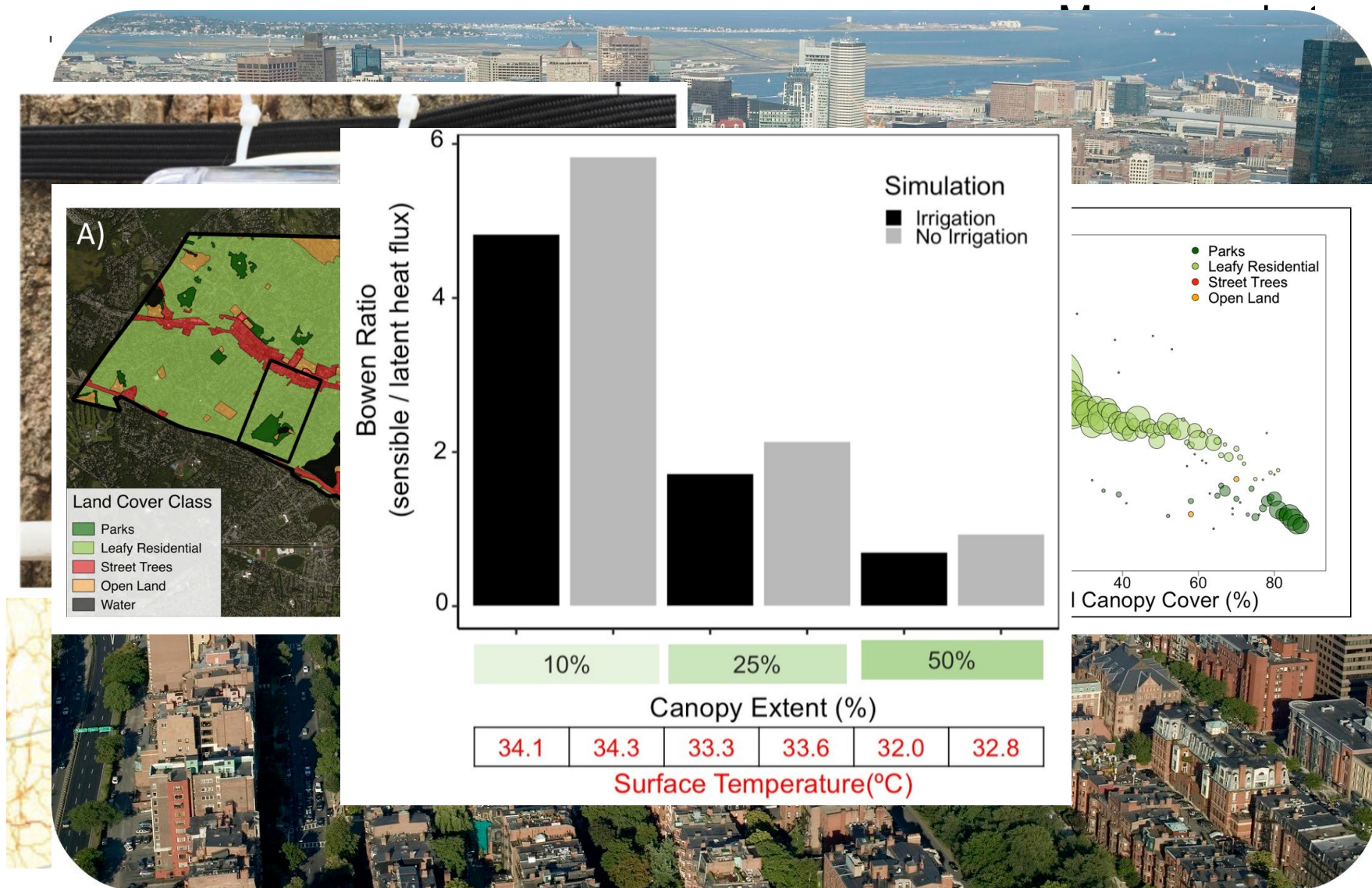
Lucy R. Hutyra

Associate Professor

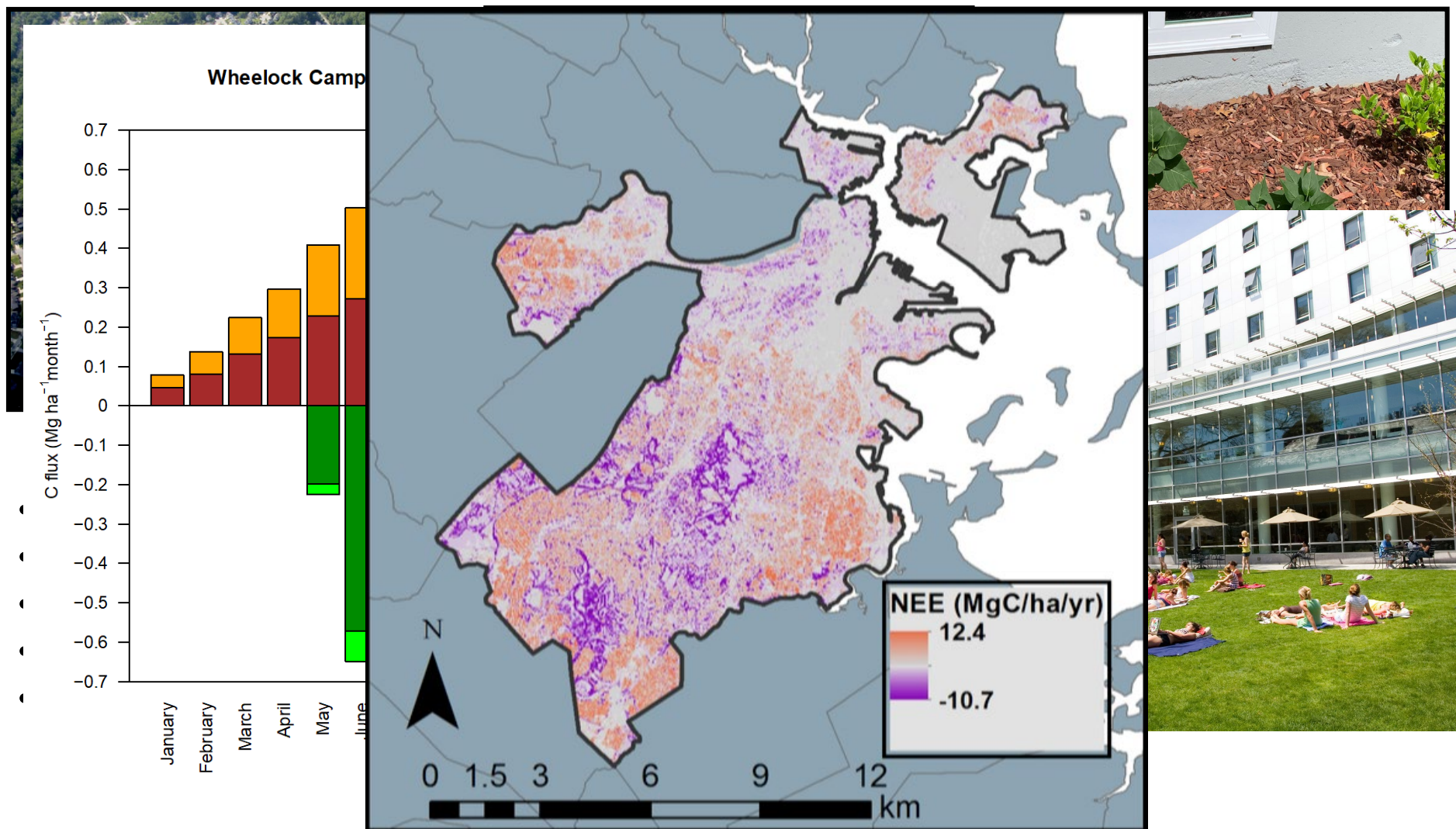
Dept. of Earth & Environment, College of Arts & Sciences












# Sustainable Water Management

Jacqueline Ashmore

Executive Director, Institute for Sustainable Energy  
Research Associate Professor, Department of Mechanical Engineering

 @JacquieAshmore

 /jacquelineashmore



Boston University Office of Research



## A fundamental challenge:

Ensuring sustainability, resilience and affordability

- Urban populations are growing rapidly
- Water infrastructure is aging
- Natural supplies will become more variable

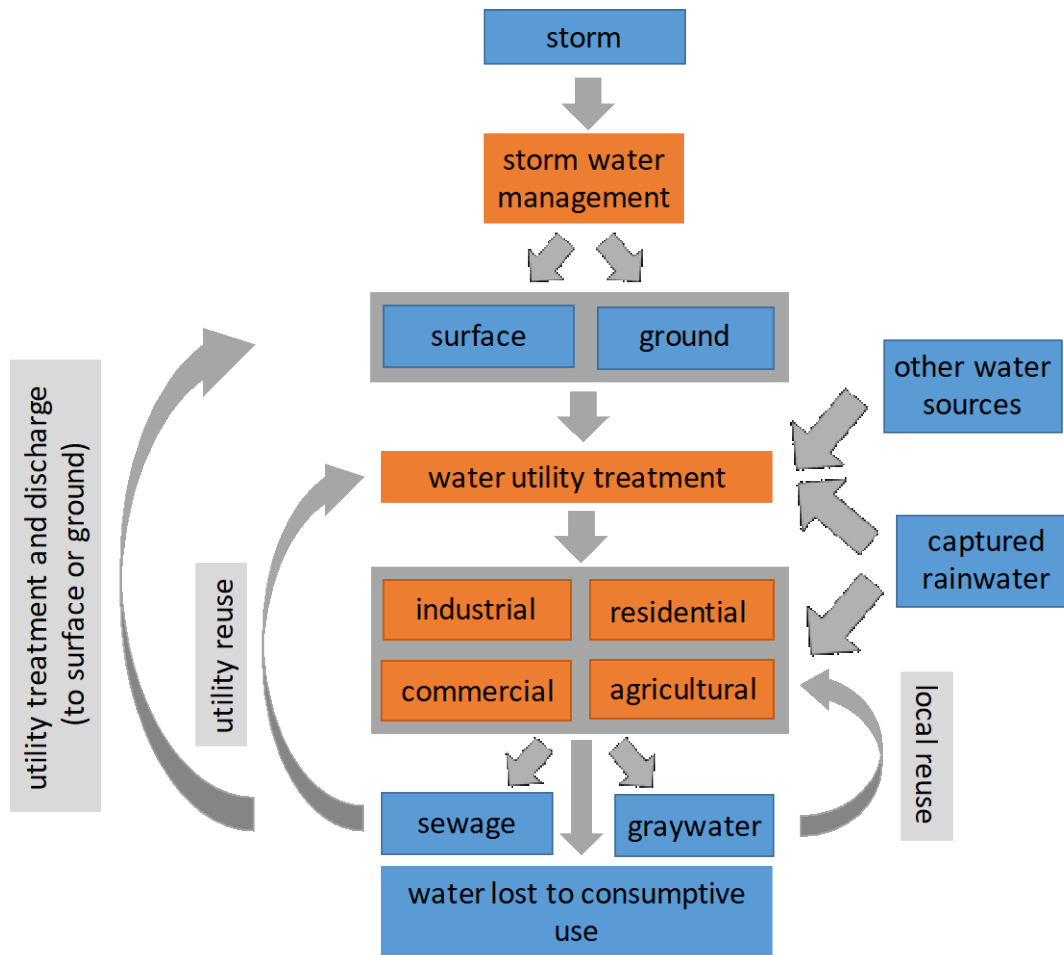
## Tools of change:

- **Planning:** consider demand and supply side
- **Financing:** service-based business models
- **Infrastructure:** reuse, distributed infrastructure, smart metering, storm water management
- **Metrics:** measure sustainability, financial resilience, affordability



*“Water prices will have to increase by 41% in the next five years to cover the costs of replacing aging water infrastructure and adapting to climate change” (Vox, 2017)*

# Integrated water management opportunities



- What are the demand management opportunities?
- What new sources, treatment and reuse opportunities are most viable in each location?
- How can different stakeholders engage in new management paradigms?
- What different utility management practices are necessary?
- What are the revenue opportunities and risks?
- What are the best financing mechanisms?



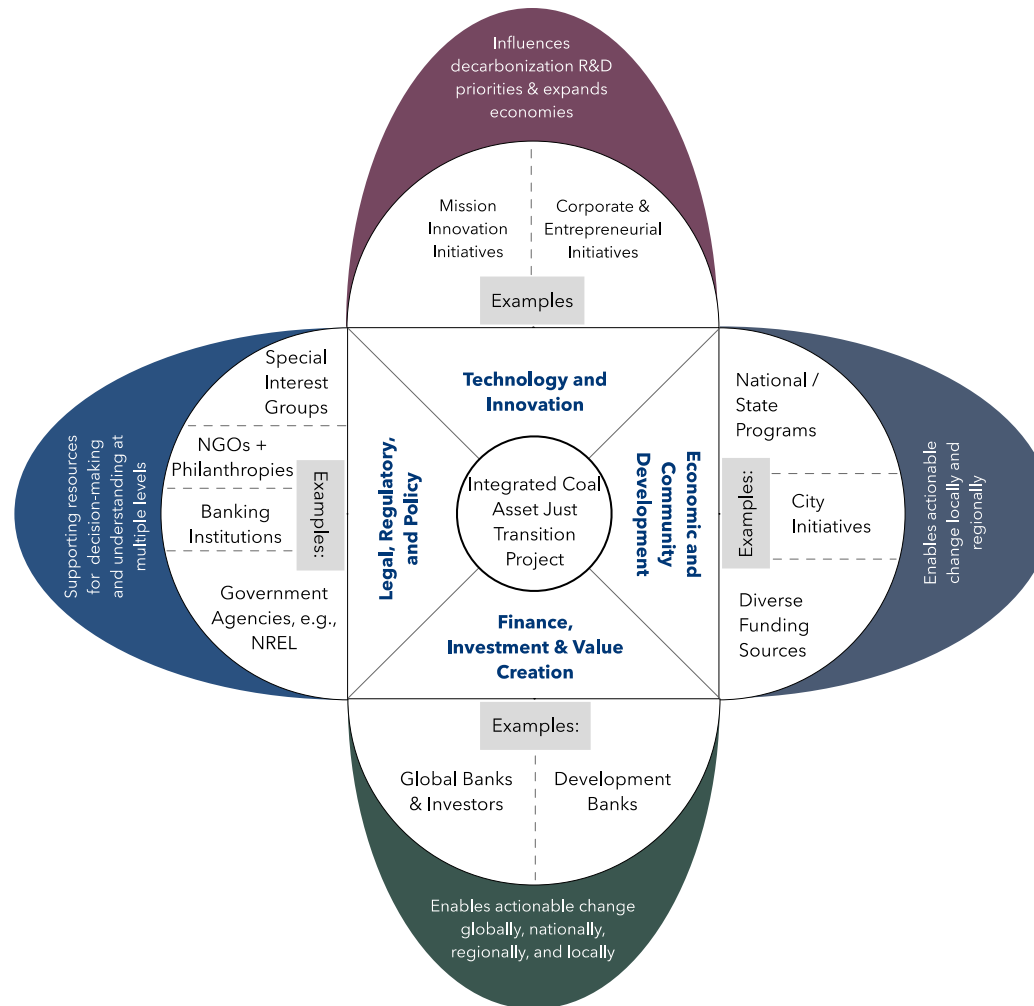
## Framing the Practice of Just Transitions

# David O. Jermain

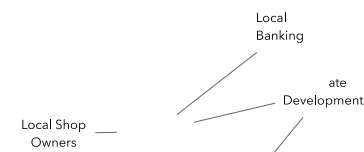
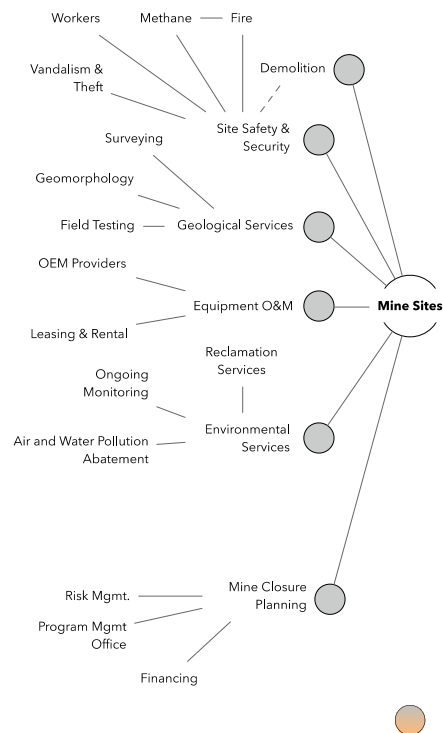
Associate Director  
Institute for Sustainable Energy



# Framework for Just Transition



# Model Coal Asset Just Transition



## Looking Forward

# Jacqueline Ashmore

Executive Director, Institute for Sustainable Energy  
Research Associate Professor, Department of Mechanical Engineering





## Did you like what you heard???

In Q1 2020, look for:

- A report on how Massachusetts can become a hub for energy storage entrepreneurship
- A report on how water rates can be structured to achieve revenue targets and also promote equity and water conservation
- A report on emerging trends in transportation, informed by a stakeholder meeting in November 2019
- Details of the Sustainable Finance symposium on 3/31/20, co-hosted with the BU Energy Club
- And more – connect with the ISE! Sign up for our newsletter at [www.bu.edu/ise](http://www.bu.edu/ise) (go to “contact us”)



@ISE\_BU



@InstituteForSustainableEnergy

## And stay tuned for the next chapter at BU!

- Sustainability@BU leads the implementation of a world-class climate action plan
- BU Schools and Centers are home to excellent researchers and teachers in this field, including:
  - Questrom
  - ENG
  - CAS
  - SPH
  - Pardee School
  - Law
  - COM
  - Initiative on Cities
  - Pardee Center
  - Urban Climate Initiative
  - BU Urban
  - Global Development Policy Center
- What are the future opportunities to collaborate effectively in this multi-disciplinary field?

---

# UPCOMING EVENTS

---

Learn more & RSVP: [bu.edu/research/events](https://bu.edu/research/events)  
Topic ideas & feedback: [bu.edu/research/topic-ideas](https://bu.edu/research/topic-ideas)

**STAY TUNED FOR OUR  
EVENTS NEXT SEMESTER**

