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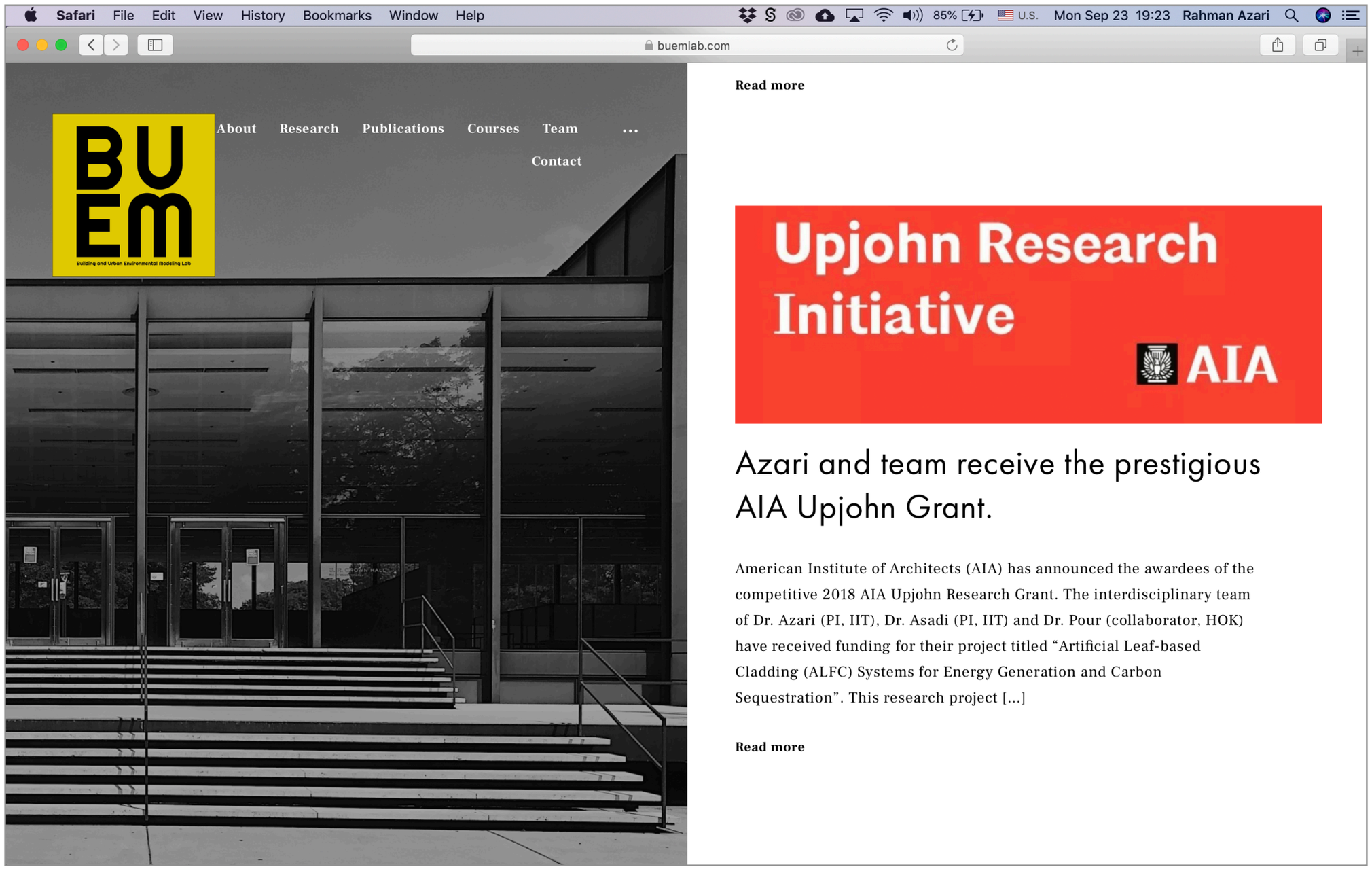
Building and Urban Environmental Modeling Lab

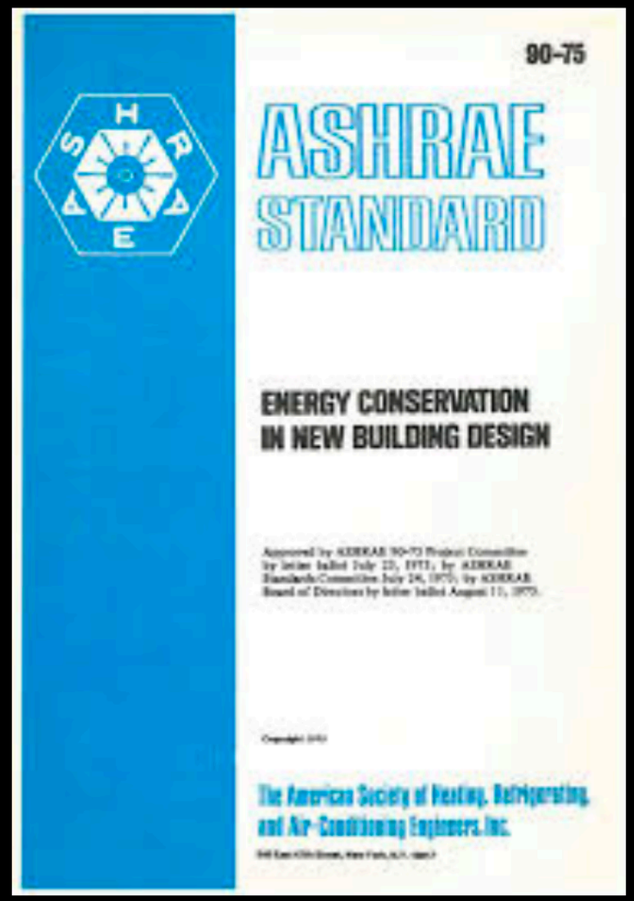
https://buemlab.com



1973
Oil Crisis

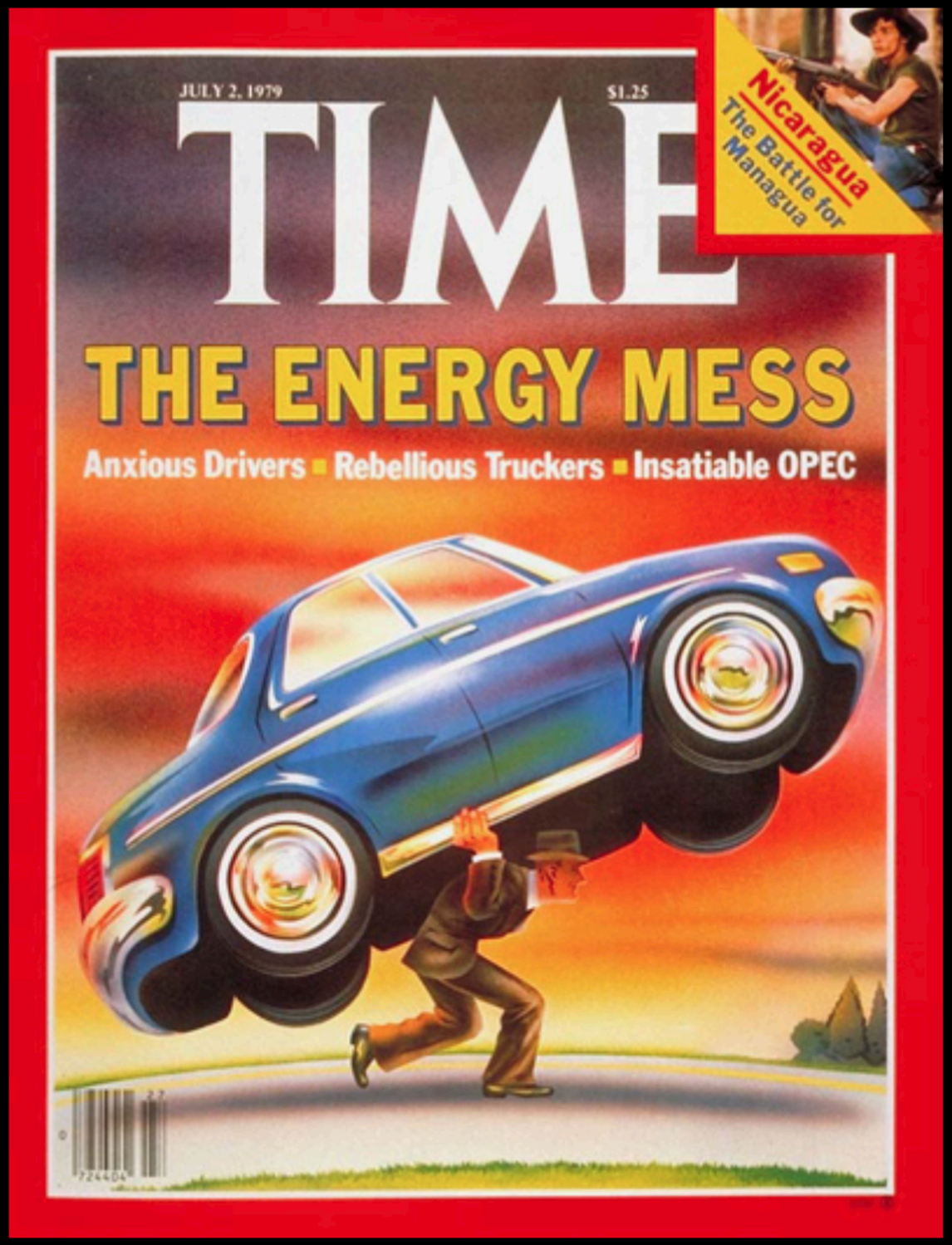
1975

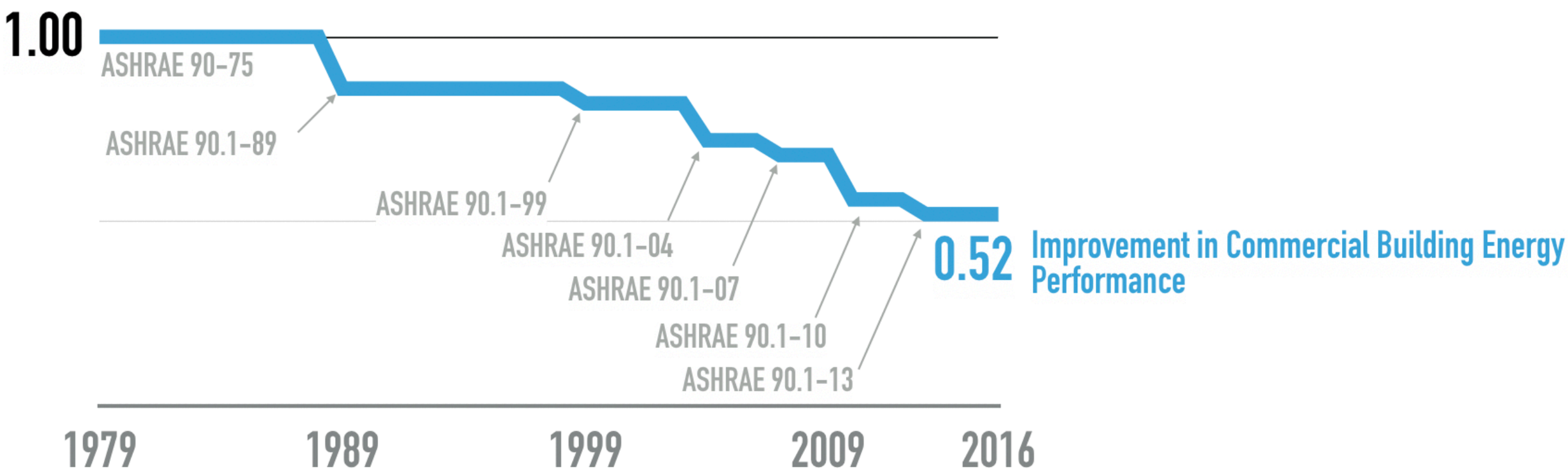
First Energy code
ASHRAE 90-1975

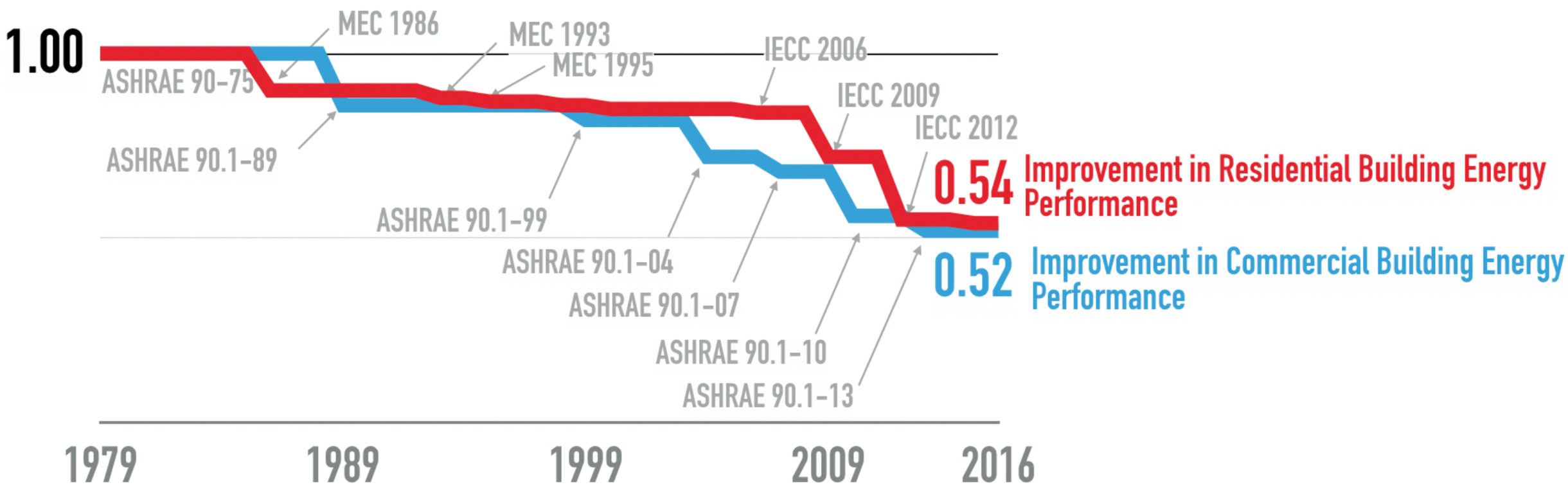


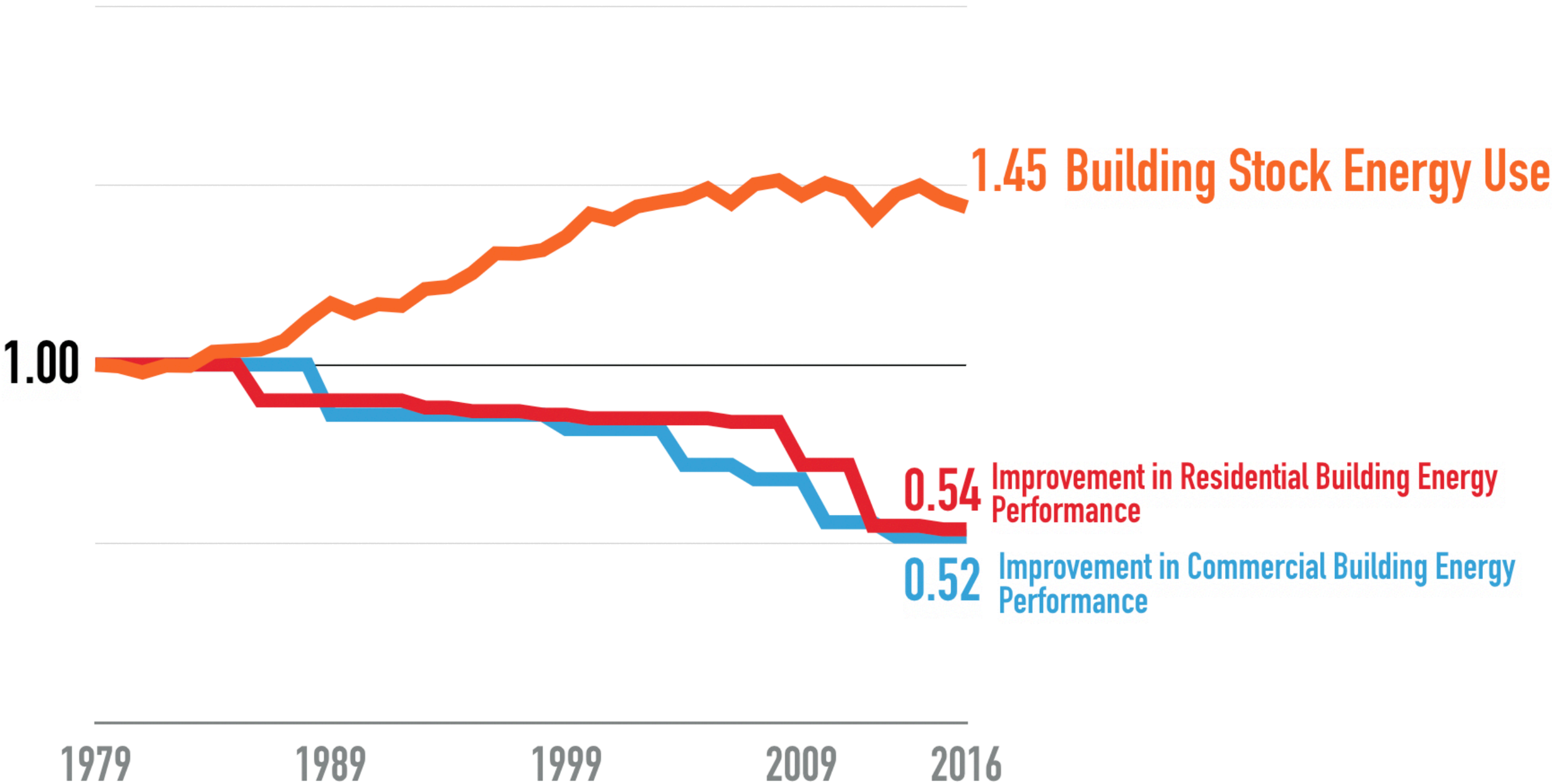
1979

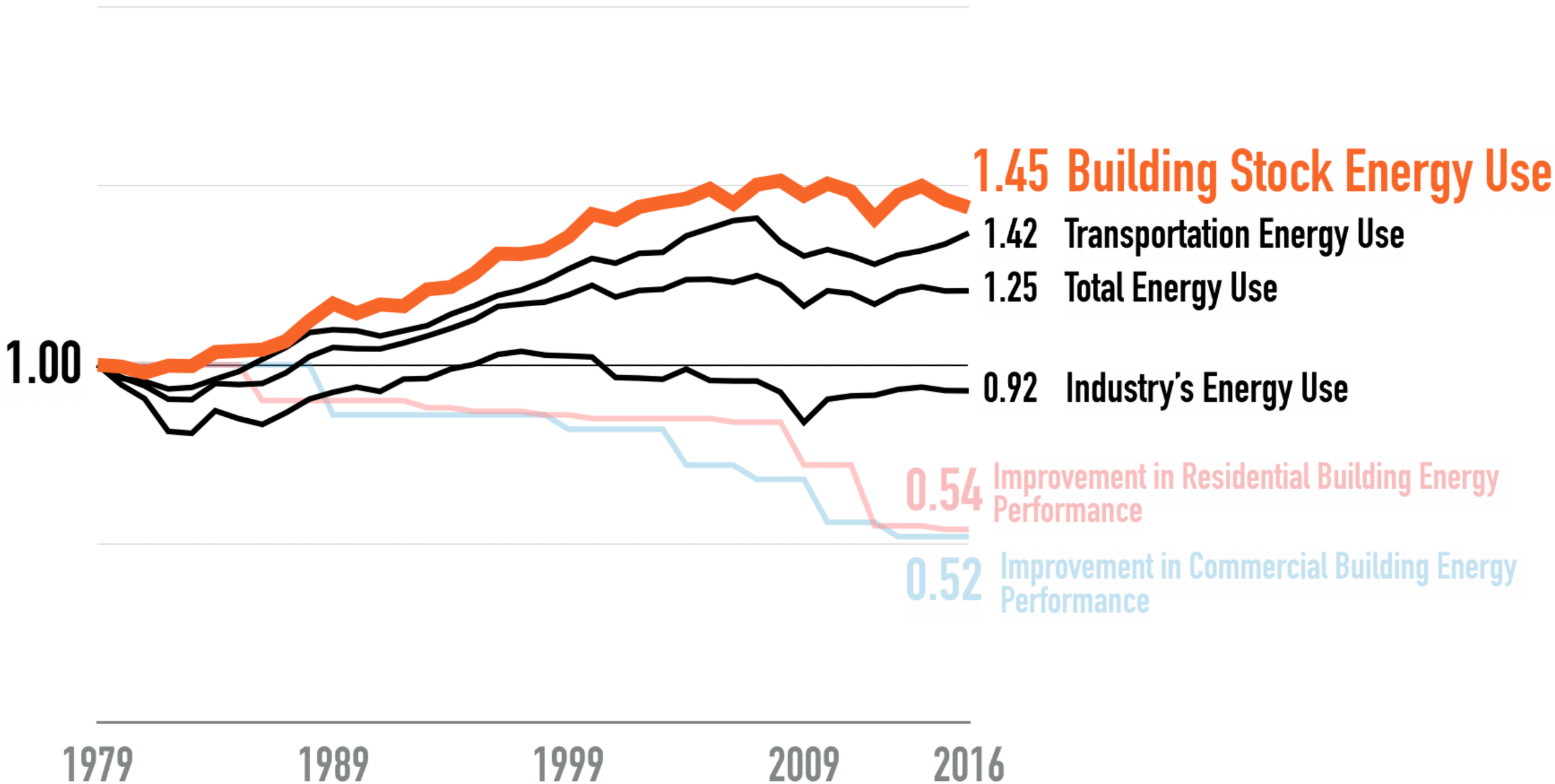
- Second petroleum crisis of the decade
- Shortage in supply of oil by OPEC
- President Carter proclaims a national energy supply shortage and establishes temperature restrictions in buildings

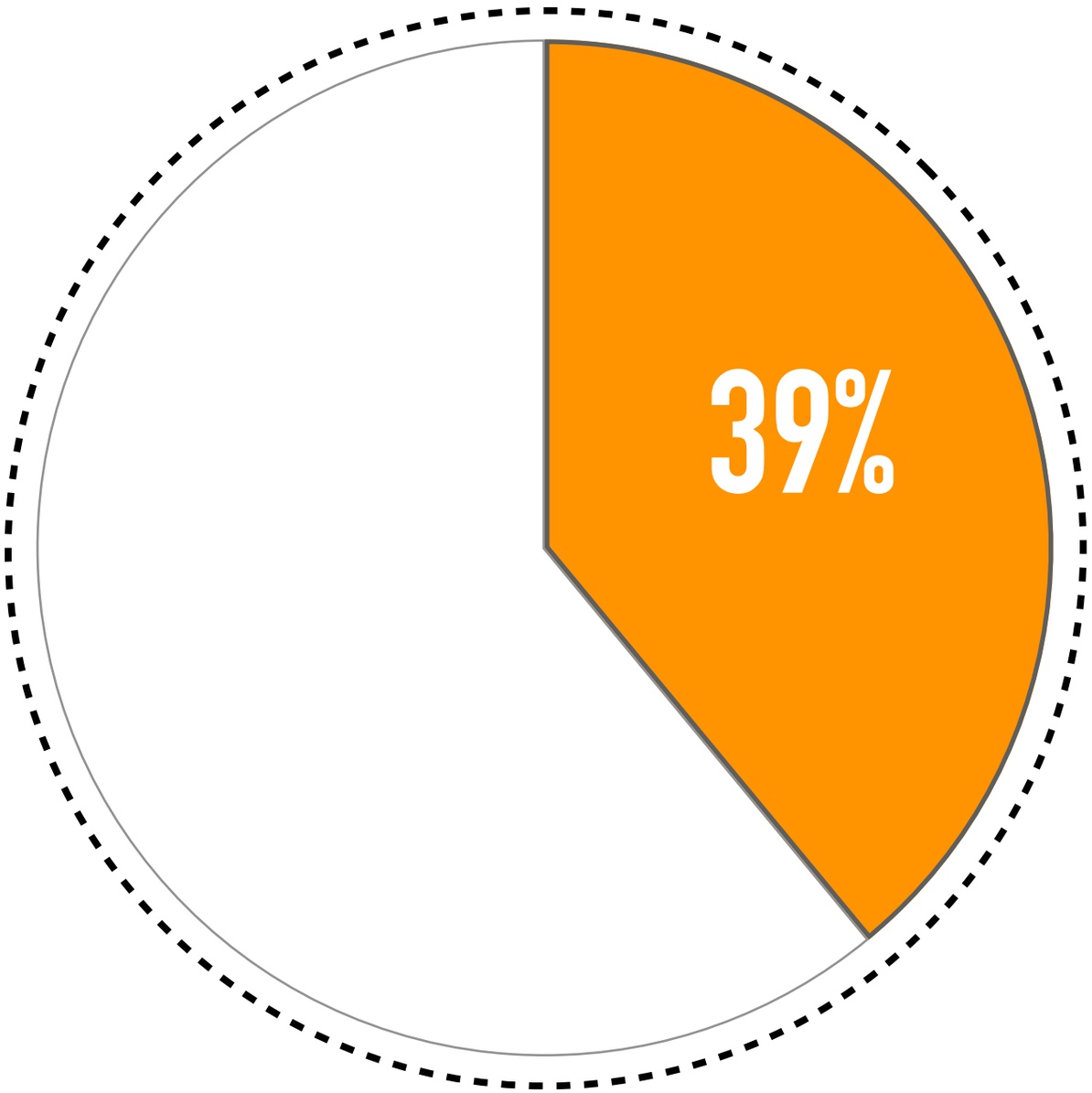



1.00
ASHRAE 90-75
ASHRAE 90.1-89
ASHRAE 90.1-99
ASHRAE 90.1-04
ASHRAE 90.1-07
ASHRAE 90.1-10
ASHRAE 90.1-13
0.52
Improvement in Commercial Building Energy Performance
1979
1989
1999
2009
2016


1.00
MEC 1986
MEC 1993
MEC 1995
IECC 2006
IECC 2009
IECC 2012
ASHRAE 90-75
ASHRAE 90.1-89
ASHRAE 90.1-99
ASHRAE 90.1-04
ASHRAE 90.1-07
ASHRAE 90.1-10
ASHRAE 90.1-13
0.54 Improvement in Residential Building Energy Performance
0.52 Improvement in Commercial Building Energy Performance
1979
1989
1999
2009
2016

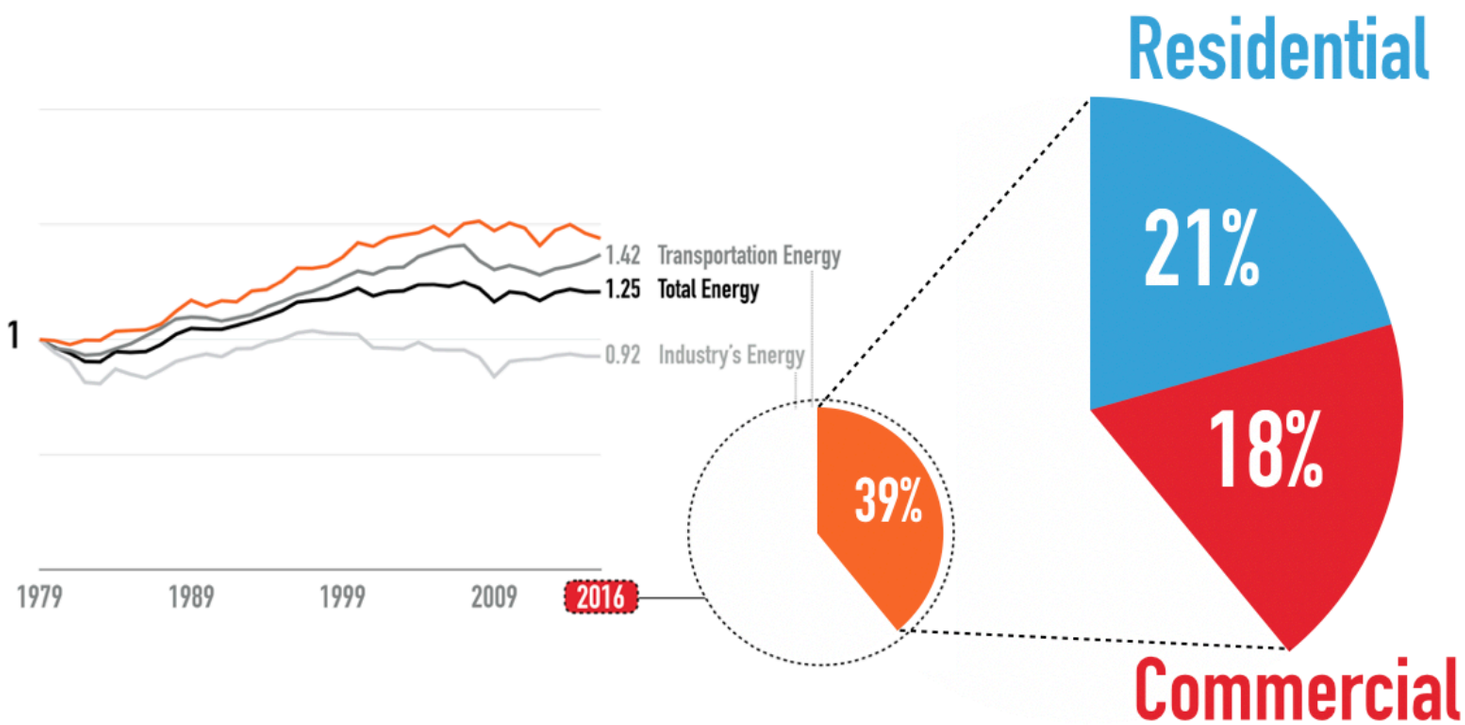

1.45 Building Stock Energy Use
1.00
0.54 Improvement in Residential Building Energy Performance
0.52 Improvement in Commercial Building Energy Performance
1979
1989
1999
2009
2016


1.45 Building Stock Energy Use
1.42 Transportation Energy Use
1.25 Total Energy Use
1.00
0.92 Industry's Energy Use
0.54 Improvement in Residential Building Energy Performance
0.52 Improvement in Commercial Building Energy Performance
1979
1989
1999
2009
2016



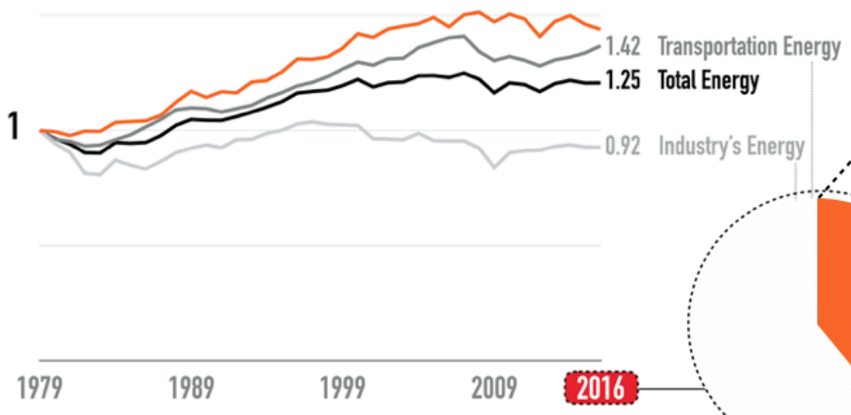
Buildings'

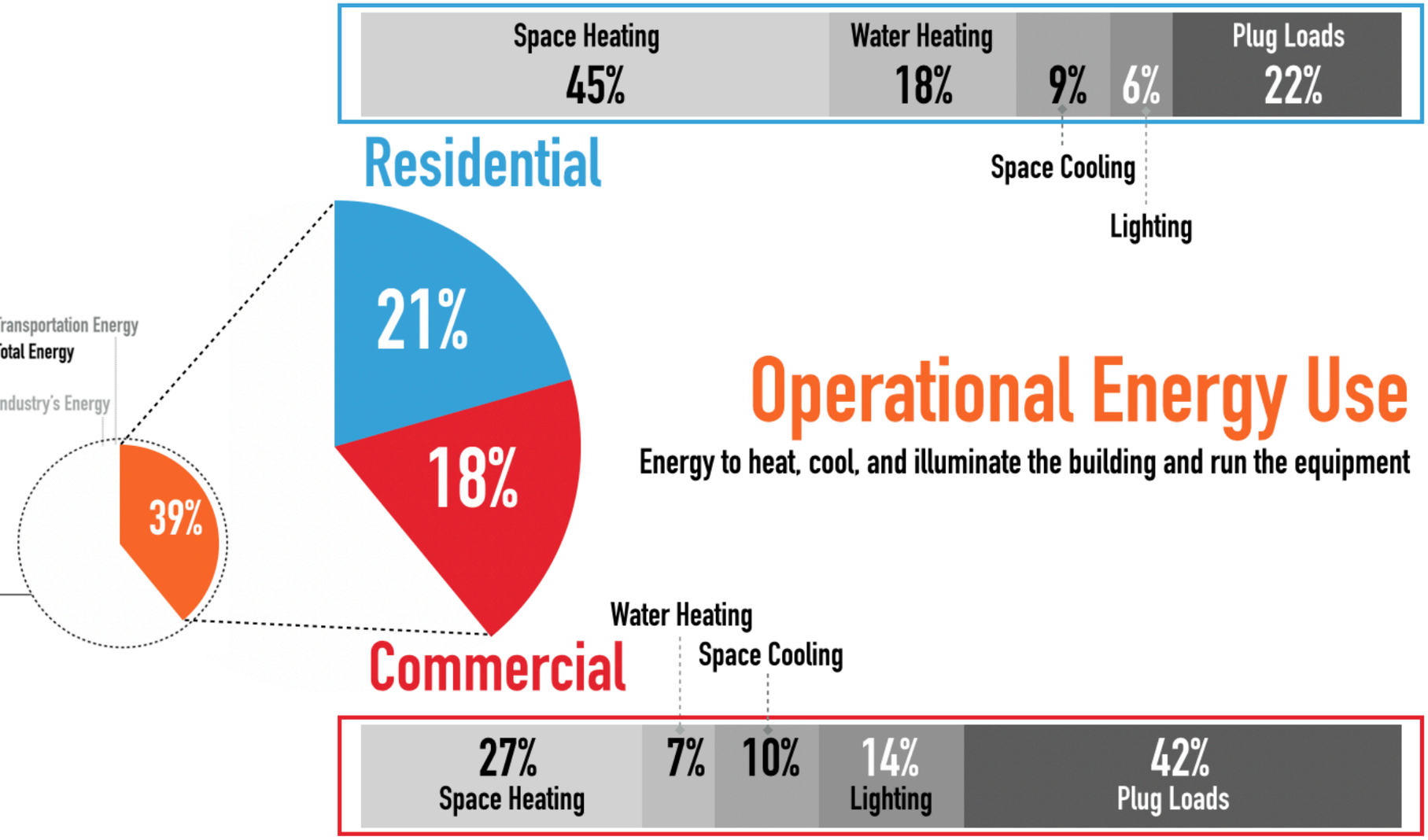
Share in the US Primary Energy Use



Operational Energy Use

Energy to heat, cool, and illuminate the building and run the equipment



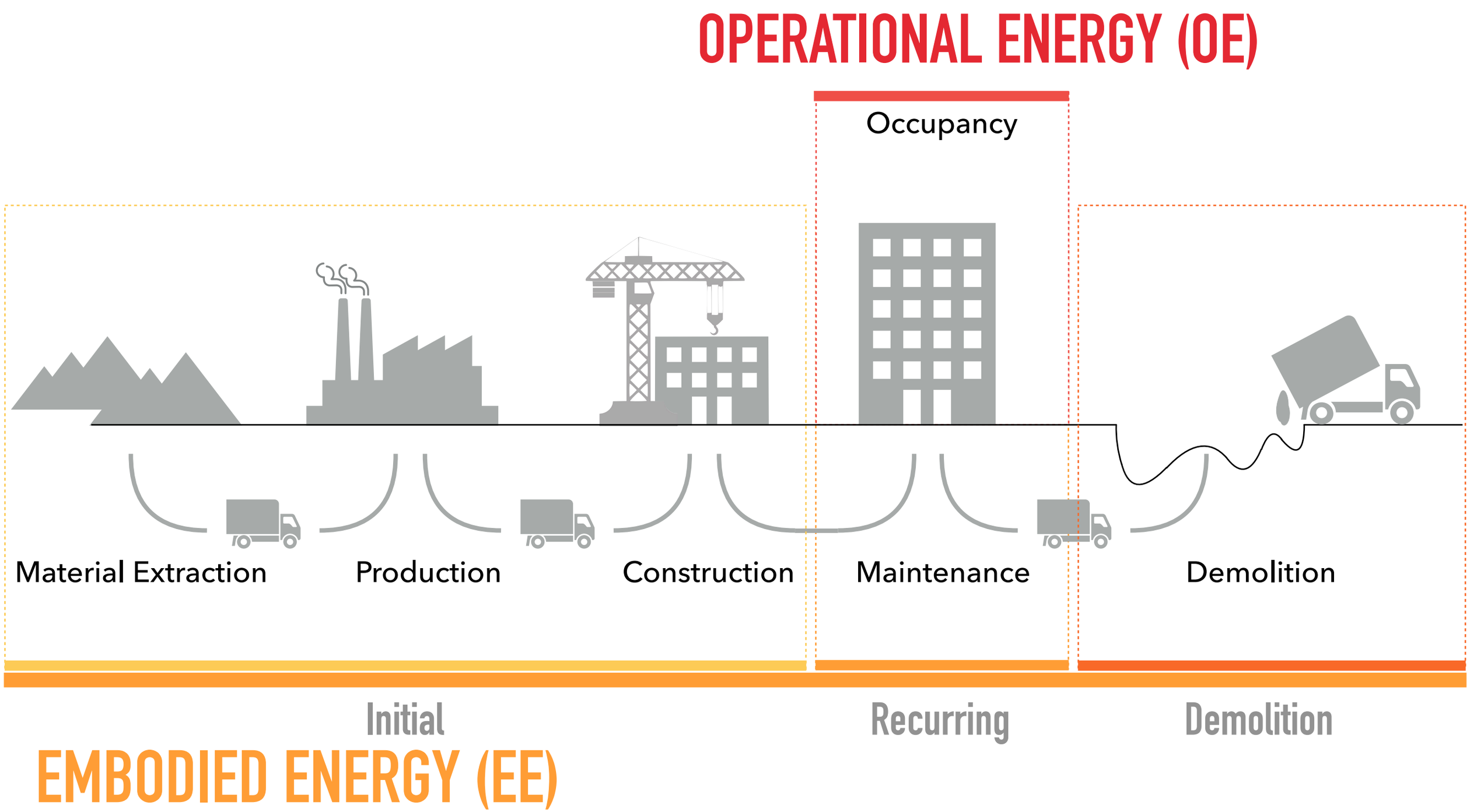


Operational Energy Use

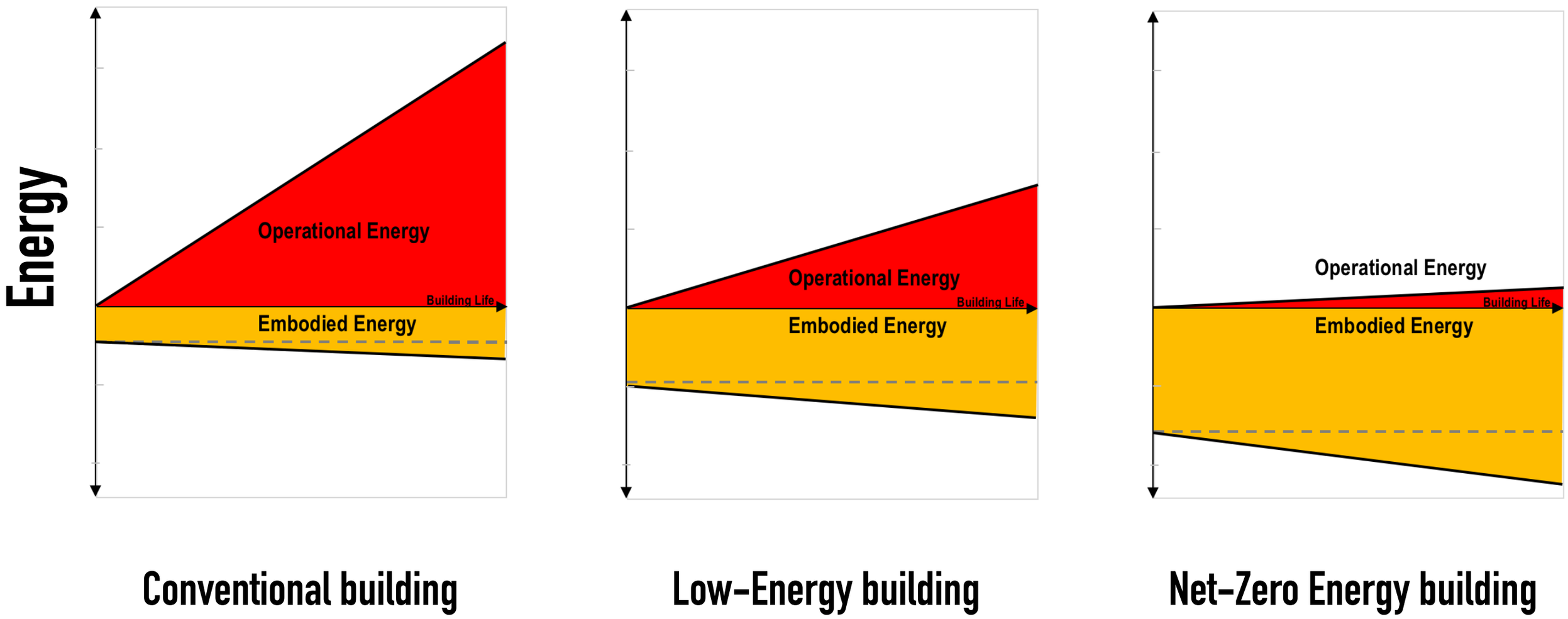
Energy to heat, cool, and illuminate the building and run the equipment

1979 → 2018

- Thicker envelopes
- Insulation (higher R-values)
- Super-performance windows (low U-factor, optimum SHGC, high VT)
- Effective shading systems
- Photovoltaic systems
- Thermal mass


OPERATIONAL ENERGY (OE)
Occupancy
Material Extraction
Production
Construction
Maintenance
Demolition
Initial
Recurring
Demolition
EMBODIED ENERGY (EE)

Operational energy is saved at the expense of increased embodied energy.



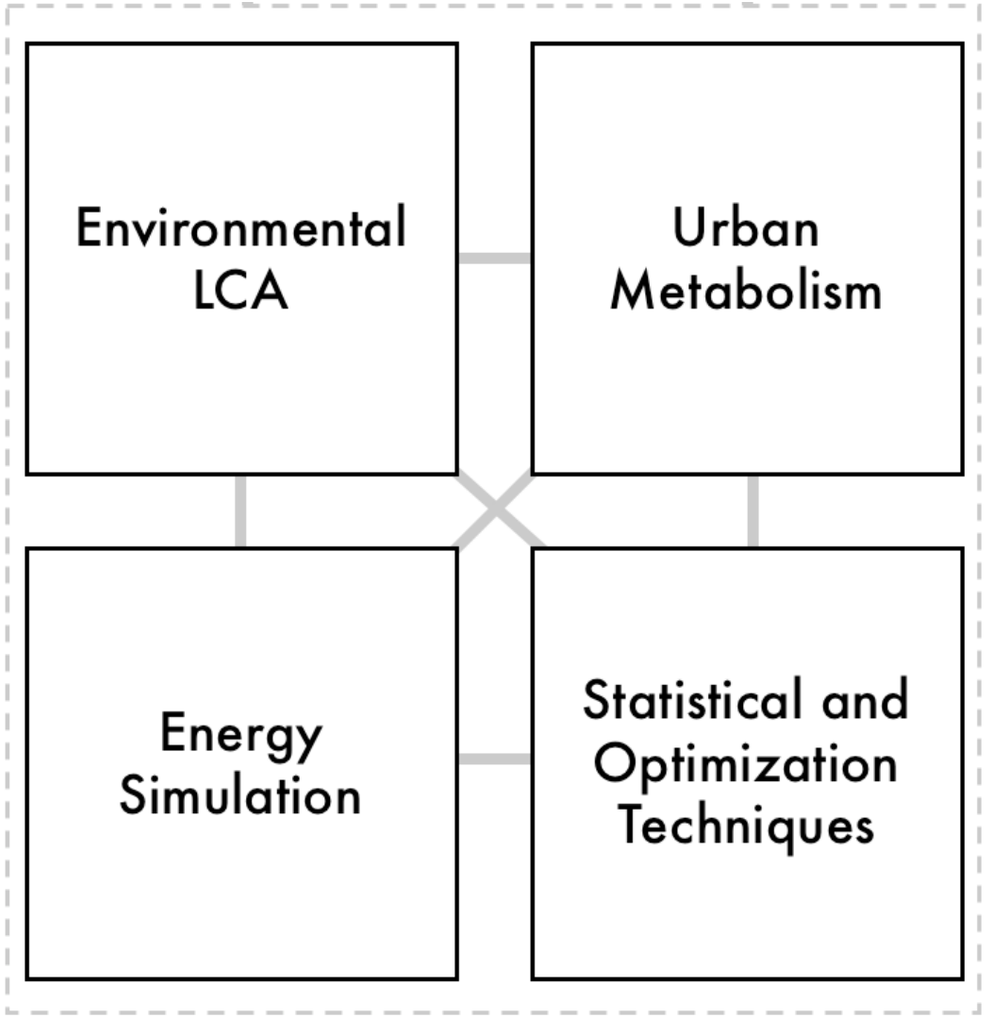
Research Theme 1:

Multi-scalar and Multidimensional Impacts of buildings on the environment

Research Questions

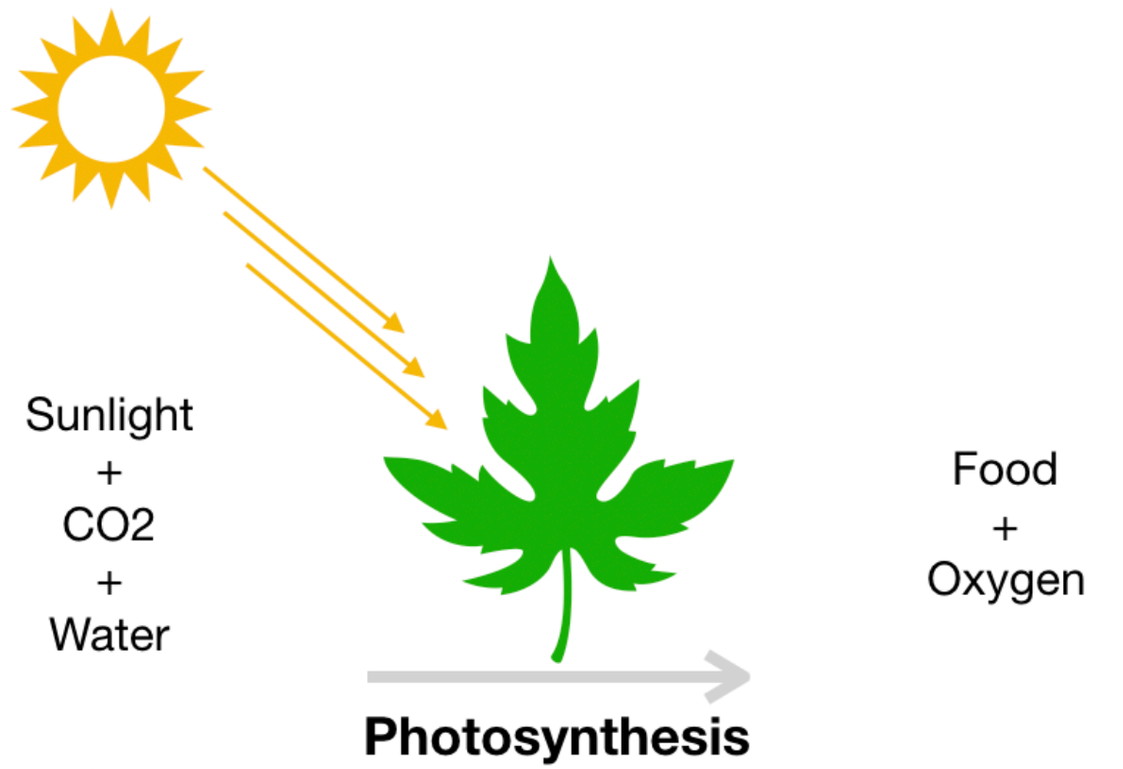
- To what extent and why built environments fail environmentally?
- To what extent buildings contribute to global warming, acidification, eutrophication, and other environmental impacts?
- What are the tradeoffs in operational energy vs. embodied energy savings?

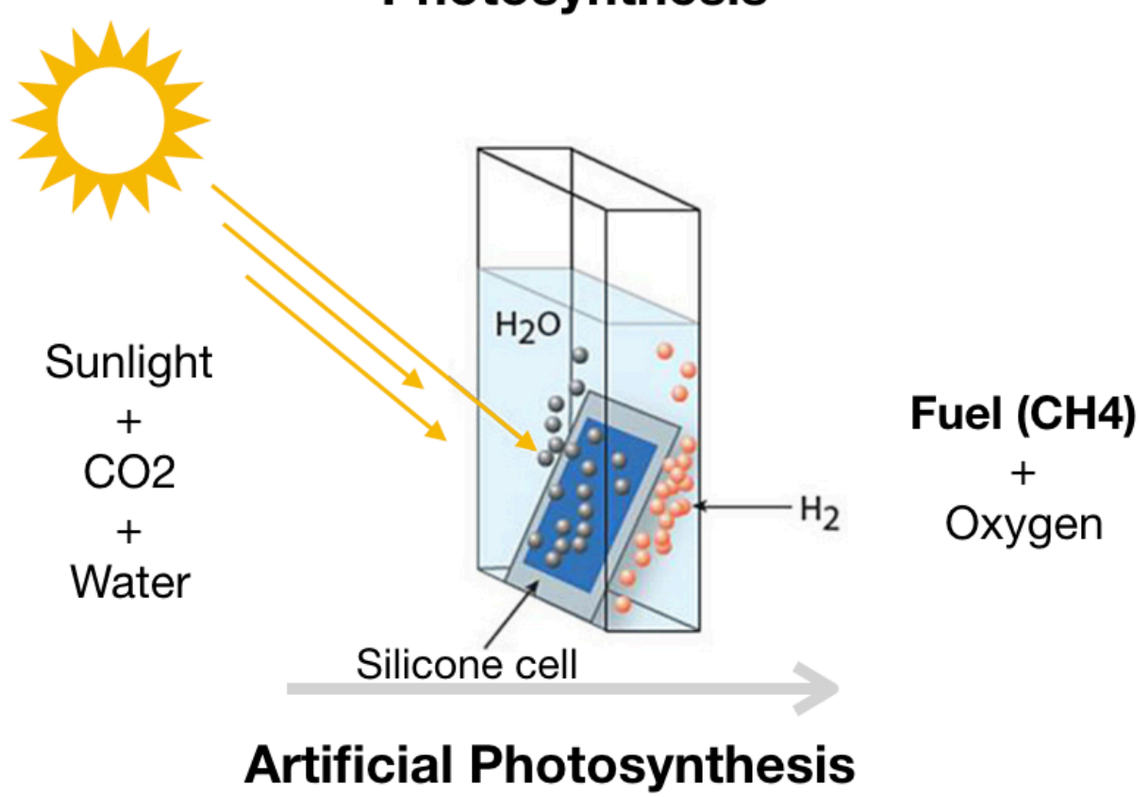
Research Methods



Research Theme 2:

Innovative building materials with energy production and carbon sequestration capabilities



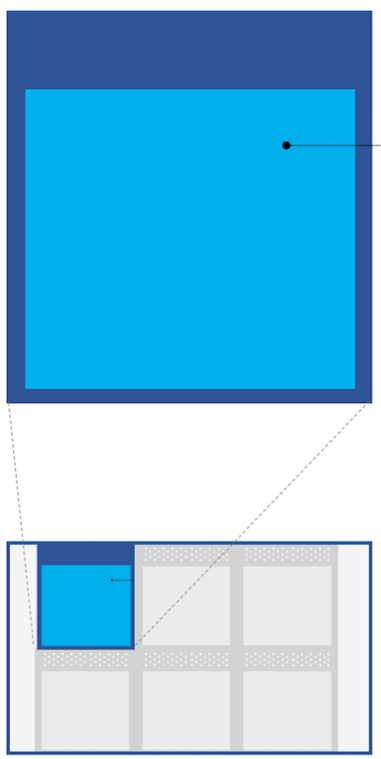


Artificial-Leaf based Facade Cladding (ALFC) Systems for Energy Production and Carbon Sequestration

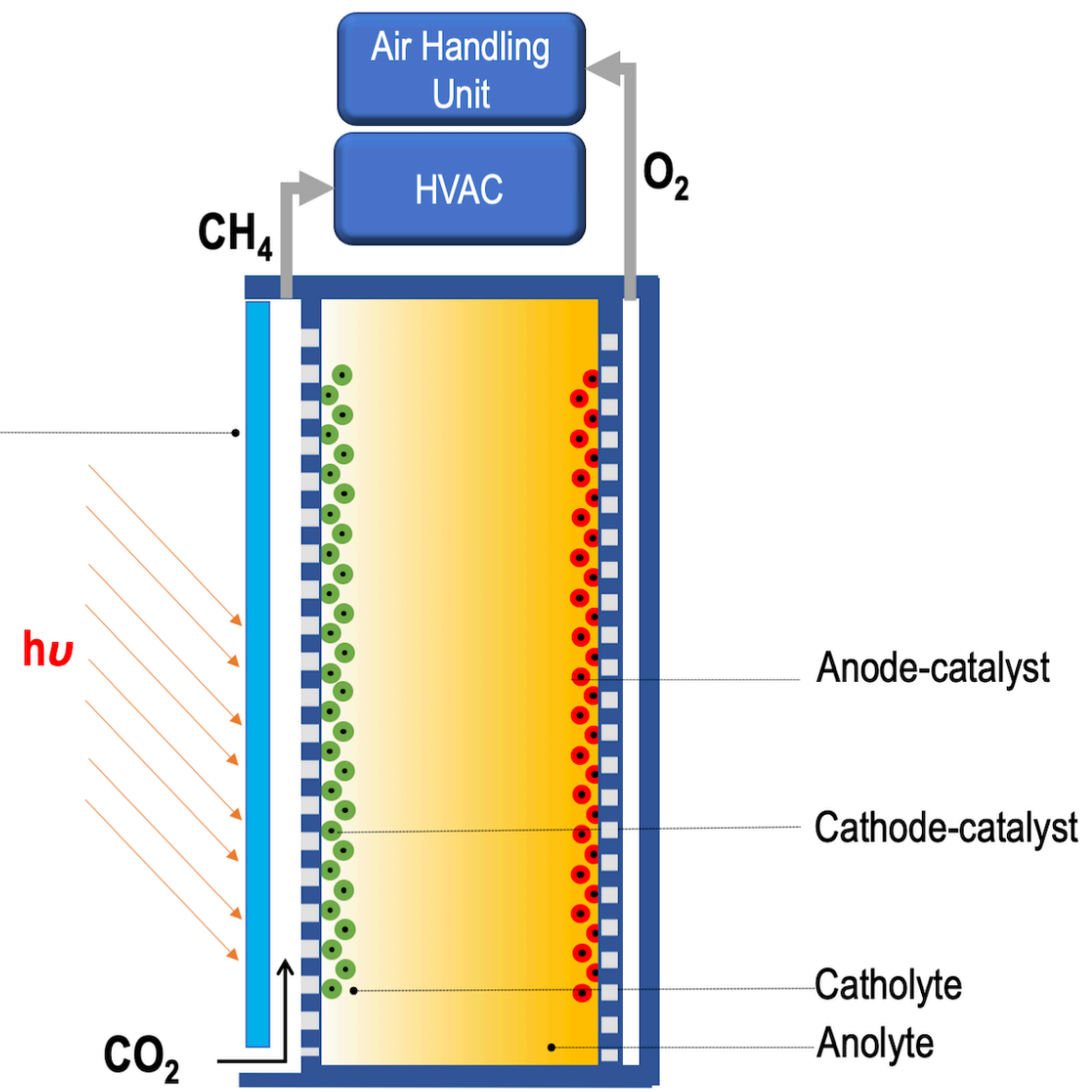
1. CO_2 from air is captured. In an artificial photosynthesis process, CO_2 and sunlight are converted into CH_4 and O_2.

2. CH_4 is generated which can be transferred for the use as fuel in HVAC equipment.

3. O_2 is generated which can be sent to Air-Handling Unit (AHU) to be mixed with fresh or return air.



ALFCs are connected to clad the façade.



Thank you.

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