

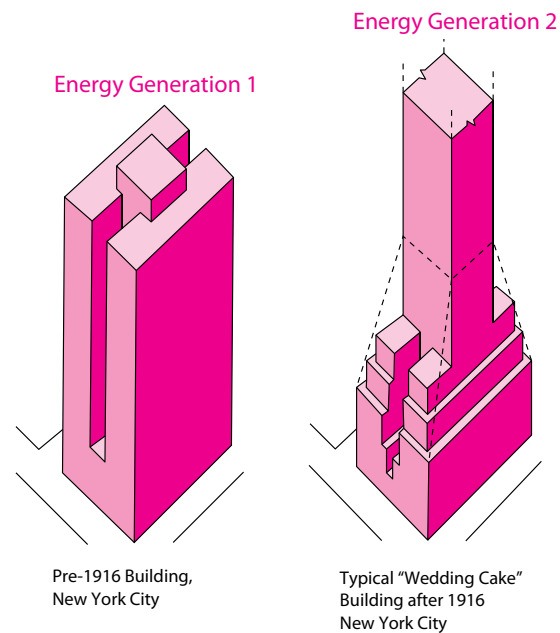
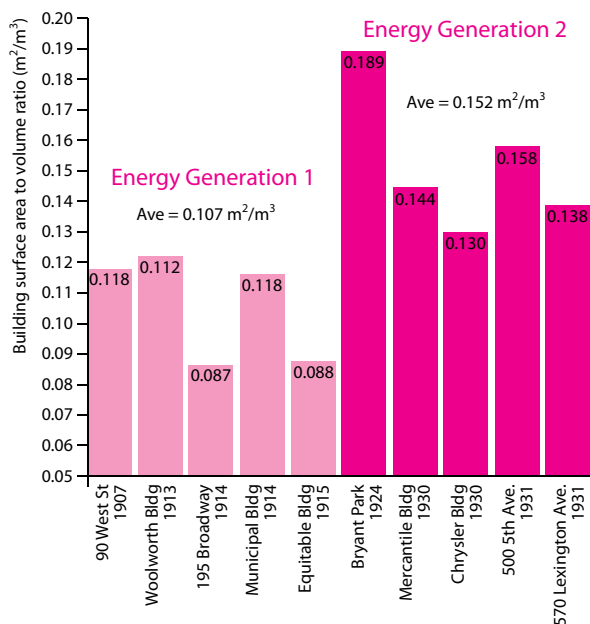
Tall Buildings In Numbers

An Overview of Historical Factors Affecting Tall Building Energy Consumption

Overview: The Five 'Energy Generations'

1. From the Birth of Tall Buildings in 1885, to the 1916 New York City Zoning Law
2. From the 1916 Zoning Law to the Development of the Glazed Curtain Wall, 1951
3. From the Development of the Glazed Curtain Wall, 1951, to the 1973 Energy Crisis
4. From the Energy Crisis of 1973, ongoing to the present day
5. From the Rise of an Environmental Consciousness, 1997 ongoing to the present day

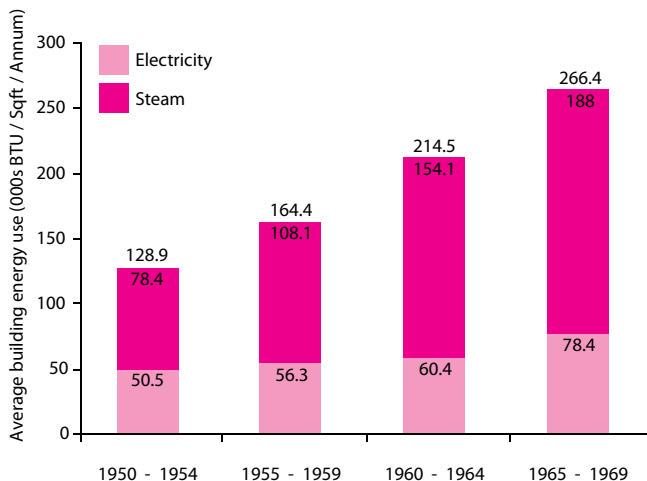
1916: Impact of the New York City Zoning Law – increased building surface area / greater heat loss through envelope



Pre-Zoning Law Buildings: Compact shape, large volume vs. smaller façade area = Reduced heat loss / gain through concentrated building mass

Post-Zoning Law Buildings: Slender shape, small volume vs. larger façade area = Greater heat loss / gain through building envelope but greater natural light penetration

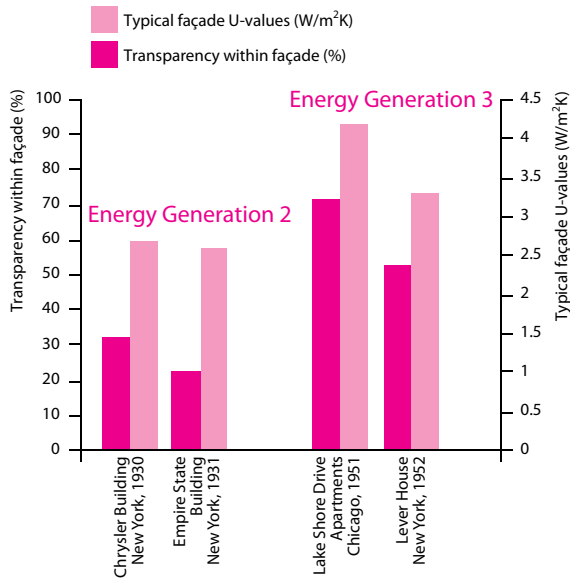
1950 → 1970: Impact of increased use of mechanical conditioning and florescent lighting – increased overall energy consumption



A Study of 86 office buildings constructed in Manhattan shows that on average, buildings completed in the late 1960s had energy requirements more than double those of buildings constructed in the early 1950s

Data from:
STEIN, R. G. (1977). *Observations on Energy Use in Buildings*. Journal of Architectural Education, Vol. 30, No. 3, February 1977. pp.36 – 41.

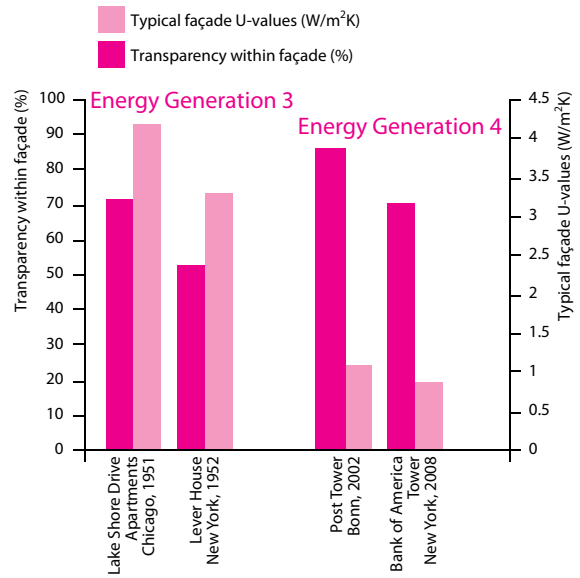
1951: Impact of the modern glazed curtain wall
 – increased facade transparency / reduced envelope insulation / increased heat loss + gain



Prior to the development of the glazed curtain wall: High levels of thermal mass, low percentage of facade transparency.

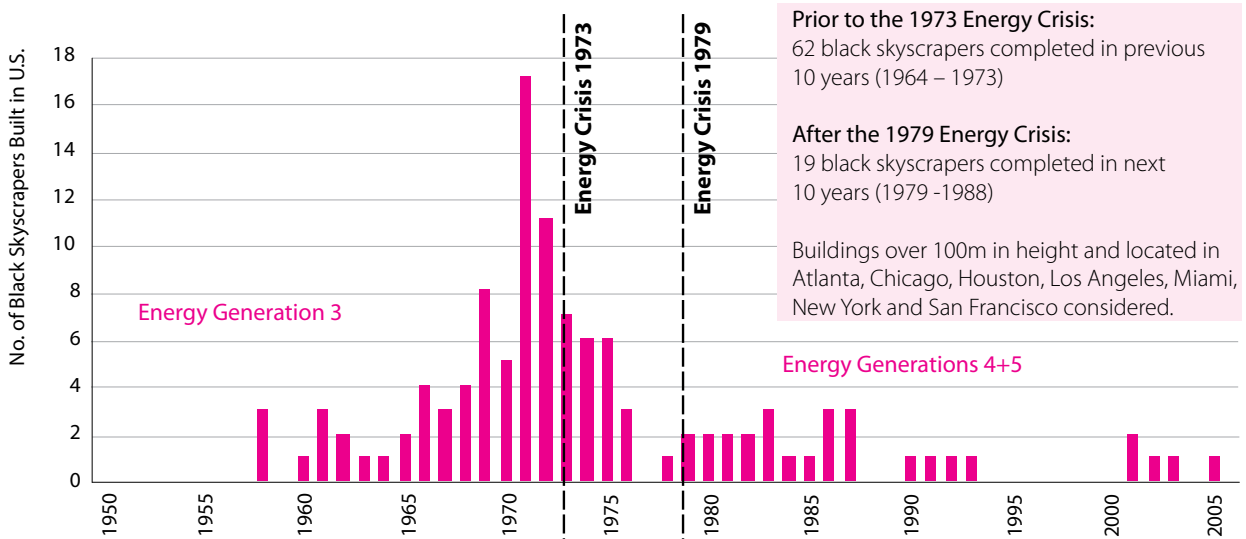
Early glazed curtain wall tall buildings: Poor performance single-glazed curtain wall with tinted glass, high percentage of facade transparency.

1970 → Present Day: Impact of 1973 and 1979 energy crises - Improved envelope thermal properties / reduced overall energy consumption



Early glazed curtain wall tall buildings: Poor performance single-glazed curtain wall with tinted glass, high percentage of facade transparency.

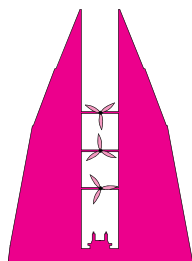
Modern curtain wall tall buildings: High performance double-skin and triple glazed curtain wall with clear glass, high percentage of facade transparency.



Prior to the 1973 Energy Crisis:
 62 black skyscrapers completed in previous 10 years (1964 – 1973)

After the 1979 Energy Crisis:
 19 black skyscrapers completed in next 10 years (1979 -1988)

Buildings over 100m in height and located in Atlanta, Chicago, Houston, Los Angeles, Miami, New York and San Francisco considered.



1997 → Present day: Increased performance of facade, natural and mixed-mode ventilation exploited, atria utilized, on-site energy generation maximized, wind turbines, photovoltaics, CHP, etc. – What does the future hold?

For more depth on this analysis see:
 OLDFIELD, P., TRABUCCO, D. & WOOD, A. (2009) Five Energy Generations of Tall Buildings: A Historical Analysis of Energy Consumption in High Rise Buildings. Proceedings of the CTBUH 8th World Congress “Tall & Green: Typology for a Sustainable Urban Future”, Dubai, March 3 – 5, 2008, pp. 300 – 310. Available to download at: www.ctbuh.org/technicalpapers.htm