Back to the Future:
Re-Cladding to the Past

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Goals & Topics of Discussion

• Why are present-day buildings performing similarly to early 1900’s buildings?
  – Energy code and how it evolved to allow this to happen
  – High-rise commercial building glass exteriors

• Do we have to design with mostly glass assemblies?
  – Case study showing differences between recladding in fully-glazed systems vs. partially-glazed systems (40% WWR)
Agenda

1. Benchmarking
2. Energy Code
3. High-Rise Commercial Repositioning
4. Case Study: One South Wacker, Chicago, IL
5. Conclusions
01
Benchmarking
Benchmarking

Fast Facts on Energy Use

Facts About Energy Use in Commercial and Industrial Facilities

- Combined number of commercial buildings (4.8 million) and industrial facilities (350,000) in the United States: over 5 million
- Combined annual energy costs for U.S. commercial buildings ($107.9 billion) and industrial facilities ($94.4 billion): $202.3 billion
- Portion of energy in buildings used inefficiently or unnecessarily: 30 percent
- Combined percentage of U.S. greenhouse gas emissions generated by commercial buildings (17 percent) and industrial facilities (28 percent): 45 percent
- Percentage of energy use reduction targeted by the ENERGY STAR Challenge: 10 percent
- Amount of money that would be saved if the energy efficiency of commercial and industrial buildings improved by 10 percent: $20 billion
- Amount of greenhouse gas emissions that would be reduced if the energy efficiency of commercial and industrial buildings improved by 10 percent: equal to about 30 million vehicles
- Number of registered automobiles in Illinois, New York, Ohio, and Texas combined: about 30 million

Source: www.energystar.gov
Benchmarking

End-Use Sector Shares of Total Consumption, 2011

- Residential: 22%
- Commercial: 19%
- Transportation: 28%
- Industrial: 31%

Less than 1% of buildings in Chicago are larger than 50,000 ft², but they represent 22% of the total energy used by all buildings.

**Building Energy Use and Sector Breakdown**

<table>
<thead>
<tr>
<th>Chicago Building Energy Use</th>
<th>Sector Breakdown of Large Buildings (&gt;50,000 ft²)</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>All Chicago buildings</td>
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<tr>
<td>Total Buildings</td>
<td>452,000 buildings</td>
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<tr>
<td>Total Energy Use (million kBTu)</td>
<td>223,000 MkBtu</td>
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<td>Total Electricity (million kWh)</td>
<td>20,800 MkWh</td>
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</table>

If all buildings larger than 50,000ft² reduced energy use by 5%, it would amount to annual savings of “2 trillion Btu energy, ~$40 million, & ~50,000 cars” worth of CO₂e.

Note: (*) With gas or electricity service. 488,000 total buildings
Source: Chicago Building Retrofit Acceleration project September 2011 (2010 data)
Benchmarking

Per Ordinance:

"Benchmark" means to track and input a building's energy consumption data and other relevant building information for twelve consecutive months, as required by the benchmarking tool, to quantify the building's energy use.
Mayor Rahm Emanuel

• “Do you check the mileage before you purchase a car? Do you check the energy-efficiency of a utility before you purchase it? Do you do comparative? What is wrong with providing people information?”

• “Good data drives markets and innovation.”
Benchmarking

Chicago is building upon other cities’ successes as we continue to lead on energy efficiency

Overview of US Cities with Benchmarking & Disclosure Legislation

**Chicago:** (pop. 2.7M)
- Introduced 6/2013
- Public, commercial, & residential bldgs >50Kft²
- Data verification
- Public disclosure

**Seattle:** (pop. 0.6M)
- Passed 1/2010
- Public & commercial bldgs >10Kft²
- Multifamily 5+ units
- Transactional & tenant disclosure

**Minneapolis:** (pop. 0.4M)
- Passed 2/2013
- City-owned bldgs >25Kft²
- Commercial bldgs >50Kft²
- Public disclosure

**San Francisco:** (pop. 0.8M)
- Passed 2/2011
- Benchmarking for bldgs >10Kft²
- Disclosure via website for bldgs >50Kft²
- Tenant disclosure
- Performance: Mandatory audits every 5 yrs

**Washington, DC:** (pop. 0.6M)
- Passed 7/2008
- Public bldgs >10Kft²
- Private bldgs >50Kft²
- Disclosure via public website

**Boston:** (pop. 0.6M)
- Passed 5/2013
- All public bldgs
- Private bldgs >25Kft²
- Disclosure via public website
- Performance: Mandatory audits every 5 years

**New York:** (pop. 8.2M)
- Passed 12/2009
- Public bldgs >10Kft²
- Private bldgs >50Kft²
- Disclosure via public website
- Performance: Mandatory audits, retro-commissioning, lighting upgrades

**Philadelphia:** (pop. 1.5M)
- Passed 6/2012
- Commercial bldgs >50Kft²
- Public and transactional disclosure

Source: City policies, interviews with city staff from New York, Washington DC, Seattle, San Francisco, Philadelphia, and Minneapolis, Institute for Market Transformation

Source: Sustainable Chicago 2015; City of Chicago, September 2012
Benchmarking

Per Ordinance:

- "Benchmarking tool" means the website-based software, commonly known as "ENERGY STAR Portfolio Manager," developed and maintained by the U.S. EPA to track and assess the relative energy use of buildings nationwide.
**Benchmarking**

**City of Chicago**

**Energy Benchmarking**

**Supporting Information Facts**

**City Services**

- I Want To...
- Apply For
- Check Status Of
- Exhaust
- Pay For Buy
- Register
- Report/See
- Request
- Sign up for Volunteer

**Quick Links**

- Chicago Energy Benchmarking Ordinance
- Ordinance Rules and Regulations
- Key Date and Compliance Deadlines
- Covered Buildings by Size and Occupancy
- Frequently Asked Questions
- Obtaining Unique Building Energy Data
- Free Energy Benchmarking Support and Training
- Utility Funding and Other Energy Efficiency Resources
- Energy Benchmarking Champions and Public Support

**Welcome and Introduction:**

In September 2011, Mayor Emanuel and Chicago’s City Council adopted a building energy benchmarking ordinance to raise awareness of energy performance through information and transparency, with the goal of unlocking energy and cost savings opportunities for businesses and residents.

The ordinance calls on existing municipal, commercial, and residential buildings larger than 50,000 square feet to track whole-building energy use, report it for the City annually, and verify data accuracy every three years. The law covers less than 7% of Chicago’s buildings, which together account for 25% of total energy used by all buildings.

Improving energy efficiency is a key element of Sustainable Chicago 2015, Mayor Emanuel’s 3-year action agenda to make Chicago more livable, competitive, and sustainable.

The full text of the ordinance can be found here.

The first compliance deadline is June 1, 2014 for municipal and commercial buildings larger than 250,000 square feet. Benchmarking, verification, and reporting deadlines for additional buildings covered by the ordinance will phase in through 2015.

Please check this website for updates on the ordinance, compliance guidance, support, and training opportunities.
### Benchmarking

**Site EUI**

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**Chicago Energy Benchmarking - 2016 Data Reported in 2017**

The Chicago Building Energy Use Benchmarking Ordinance calls on existing municipal, commercial, and residential buildings larger than 50,000 square feet in building size to report building energy use. The energy data is used to identify high performers and provide an industry-average benchmark for comparison. To access this dataset, visit the Chicago Data Portal.
Benchmarking

ENERGY USE INTENSITY (EUI):
The amount of annual energy consumption per square foot of a building (kBtu/sf-yr). This allows comparisons of energy performance across many different categories & sizes of buildings.

Source: Building Performance Database - https://bpd.lbl.gov
Benchmarking

Analysis:

- Chicago, IL
- 2016 Data
- Commercial – Office
- GSF > 1 mil. SF (High-Rise)
## Benchmarking

### Year Built | Average EUI
--- | ---
1902-1934 | **81.7**
1969-1979 | **87.9**
1980-1992 | **64.6**
2001-2010 | **78.2**

### Sorted by Year Built

| Property Name | Address | City | State | Zip Code | Area | EUI | Source
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
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<td>10 East Van Brunt</td>
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## Benchmarking

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<th>Year Built</th>
<th>Average EUI</th>
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<td>1902-1934</td>
<td>81.7</td>
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<tr>
<td>1969-1979</td>
<td>87.9</td>
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<td>1980-1992</td>
<td>64.6</td>
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<td>2001-2010</td>
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### Table

<table>
<thead>
<tr>
<th>Property Name</th>
<th>Address</th>
<th>Property Type</th>
<th>Gross SF</th>
<th>Year Built</th>
<th>Average EUI</th>
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<td>1. One North Boulevard</td>
<td>110 Wabash St</td>
<td>Office</td>
<td>14,900</td>
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<td>2. Subway Center</td>
<td>110 Wabash St</td>
<td>Office</td>
<td>13,121</td>
<td>1904</td>
<td>73.5</td>
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<td>4. 175 S. Jackson</td>
<td>175 S. Jackson St</td>
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<td>14,900</td>
<td>1904</td>
<td>73.5</td>
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<tr>
<td>5. 100 North Wacker Drive</td>
<td>100 N. Wacker Dr</td>
<td>Office</td>
<td>12,000</td>
<td>1904</td>
<td>81.7</td>
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<td>6. Chicago Board of Trade</td>
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<td>Office</td>
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<td>12,000</td>
<td>1905</td>
<td>81.7</td>
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</tbody>
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### Notes
- **Majority Opaque Exterior**
- **Majority Glazed Exterior**
02
Energy Code

February 1974: ASHRAE winter meeting in LA, National Bureau of Standards presented the idea of a building energy standard (Standard 90P) to 200 ASHRAE participants, and ASHRAE took over

January 14, 1975: ASHRAE Standard 90-1975 issued

ASHRAE 2004 edition: Appendix G (Energy Modeling) was added

Source: https://en.wikipedia.org/wiki/ASHRAE_90.1#History_and_development
Energy Code: History of ASHRAE

Year Built | Average EUI (kBtu/sf-yr)
--- | ---
1902-1934 | 81.7
1969-1979 | 87.9
1980-1992 | 64.6
2001-2010 | 78.2

1975: ASHRAE Standard first issued
2004: Appendix G added

THE FUTURE?
Energy Code: Paths

IECC OR ASHRAE 90.1

Energy Code: Paths

Prescriptive OR Envelope Trade-off

- COMcheck

Prescriptive OR Performance OR Envelope Trade-off

- Section 11
  - Energy Cost Budget Method (ECB)

- Appendix G
  - Performance Rating Method (PRM)
Energy Code: Prescriptive

Prescriptive Window to Wall Ratio

30%*

*2 options for 40%
≥50/25% conditioned sf is Daylight Zone
& Daylight Zoned & VT=1.1*SHGC

40%

Prescriptive envelope requirements by climate zone

### Table 5.5-5 Building Envelope Requirements for Climate Zone 5 (A,B,C)*

<table>
<thead>
<tr>
<th>Opaque Elements</th>
<th>Nonresidential</th>
<th>Residential</th>
<th>Semifielded</th>
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<td></td>
<td>Assembly</td>
<td>Max.</td>
<td>Min.</td>
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<tr>
<td><strong>Fenestration</strong></td>
<td>Assembly</td>
<td>Max.</td>
<td>Min.</td>
</tr>
<tr>
<td>Vertical Fenestration, (25%–40% of Wall)</td>
<td>Assembly</td>
<td>Max.</td>
<td>Min.</td>
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<tr>
<td>Nonmetal framing, all</td>
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<td>U-0.42</td>
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<tr>
<td>All types</td>
<td>U-0.50</td>
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* The following definitions apply: SHGC = Solar Heat Gain Coefficient, U = Thermal Transmittance Factor. See Section 5.2.3.2 for requirements. An R value of 1.0 or greater is required (see Section 5.2.3.2). Net area = gross area – glass area.

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**Table 5.5-5 Building Envelope Requirements for Climate Zone 5 (A,B,C)*

<table>
<thead>
<tr>
<th><strong>Opaque Elements</strong></th>
<th><strong>Nonresidential</strong></th>
<th><strong>Residential</strong></th>
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<tr>
<td><strong>Walls, above Grade</strong></td>
<td><strong>Roofs</strong></td>
<td>Insulation Entirely above Deck</td>
<td></td>
</tr>
<tr>
<td><strong>Walls, below Grade</strong></td>
<td><strong>Below Grade Wall</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Slab-on-grade Floors</strong></td>
<td><strong>Unheated</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Opaque Doors</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*The following definitions apply: SHGC = Solar Heat Gain Coefficient, U = Thermal Transmittance Factor. See Section 5.2.3.2 for requirements. An R value of 1.0 or greater is required (see Section 5.2.3.2).
Performance path (energy modeling):

- Different Purposes: Design assistance, general energy savings, code/LEED Compliance
- Test Energy Conservations Measures (ECMs): envelope, insulation, glazing, HVAC, controls
Most common reasons to perform an energy model rather than use the prescriptive path:

- High WWR
  IECC requires ≤ 30% WWR
  ASHRAE 90.1 requires ≤ 40% WWR
- ‘Transparent’ single pane glass
  > U-value requirements
- Tradeoffs (envelope, lighting, HVAC)
Energy Code

- “Trade-Off:” Envelope vs Mechanical System
- Is it a “fair-trade?”
- *Energy is not the only thing that matters!*
  - Aesthetics
  - Cost
  - Views
  - Usable SF
  - Daylight & visual comfort
  - Thermal comfort
  - Condensation potential & moisture issues
03
High-Rise
Commercial Repositioning
High-Rise Commercial Repositioning

• Mid-Century Modern and Post-Modern High Rises (1950 – 1990)

<table>
<thead>
<tr>
<th>Property Name</th>
<th>Address</th>
<th>Primary Type</th>
<th>Gross SF</th>
<th>Year Built</th>
<th>Site EUI (Btu/sq ft)</th>
<th>Source EUI (Btu/sq ft)</th>
</tr>
</thead>
<tbody>
<tr>
<td>East Venteur Drive</td>
<td>116 East Venteur Drive</td>
<td>Office</td>
<td>1,200,847</td>
<td>1990</td>
<td>70.6</td>
<td>100.1</td>
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<tr>
<td>West Venteur Drive</td>
<td>222 South Boulware Place</td>
<td>Office</td>
<td>634,255</td>
<td>1993</td>
<td>79.7</td>
<td>100.4</td>
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<tr>
<td>600 S. Venteur Drive</td>
<td>600 S. Venteur Drive</td>
<td>Office</td>
<td>621,014</td>
<td>1977</td>
<td>85.2</td>
<td>106.5</td>
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<td>300 N. Venteur Drive</td>
<td>300 N. Venteur Drive</td>
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<td>300 E. Jackson Drive</td>
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<td>525 East Monroe Place</td>
<td>525 East Monroe Place</td>
<td>Office</td>
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<td>86</td>
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<td>River North Plaza</td>
<td>133 East Randolph St.</td>
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<td>705,092</td>
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<td>314 R. Monroe Street</td>
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<td>Two South Wacker</td>
<td>2 South Wacker</td>
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<td>1,343,781</td>
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<tr>
<td>200 North Madison</td>
<td>200 North Madison</td>
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<td>1,079,614</td>
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<td>220 South Wacker</td>
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<td>2,293,452</td>
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<td>525 South Monroe Street</td>
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<td>350 South Riverside Place</td>
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<td>1,222,964</td>
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<tr>
<td>First National Bank</td>
<td>440 North LaSalle</td>
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<td>1,521,744</td>
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<td>130 W. Randolph St.</td>
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<td>102.8</td>
<td>225.5</td>
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<tr>
<td>500 North Monroe Street</td>
<td>500 North Monroe Street</td>
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<td>2,065,870</td>
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<tr>
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<td>1,217,630</td>
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<tr>
<td>320 South Michigan</td>
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<tr>
<td>110 North Michigan Drive</td>
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<td>1,260,426</td>
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<td>232.1</td>
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<tr>
<td>500 North Loop Street</td>
<td>500 North Loop Street</td>
<td>Office</td>
<td>1,260,426</td>
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<td>325 South Dearborn</td>
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<td>1,501,096</td>
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<td>1,686,249</td>
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<td>59.5</td>
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<td>150 North Capitol Street</td>
<td>150 North Capitol Street</td>
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<td>1,642,341</td>
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<td>60.7</td>
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<tr>
<td>101 North Clark</td>
<td>333 North Clark Street</td>
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<td>2,201,490</td>
<td>1992</td>
<td>76.8</td>
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<tr>
<td>77 W. Jackson Boulevard</td>
<td>77 W. Jackson Boulevard</td>
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<td>1,901,240</td>
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<td>58.4</td>
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<tr>
<td>111 S. Wabash</td>
<td>111 S. Wabash</td>
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<td>1,584,750</td>
<td>1992</td>
<td>51.2</td>
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<tr>
<td>135 N. Dearborn Street</td>
<td>135 N. Dearborn Street</td>
<td>Office</td>
<td>2,057,765</td>
<td>1992</td>
<td>57.1</td>
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<tr>
<td>51 W. Jackson Boulevard</td>
<td>51 W. Jackson Boulevard</td>
<td>Office</td>
<td>1,680,357</td>
<td>1992</td>
<td>57</td>
<td>195.9</td>
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<tr>
<td>500 North Michigan Street</td>
<td>500 North Michigan Street</td>
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<td>1,584,507</td>
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<td>74.7</td>
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<td>322 South Dearborn</td>
<td>322 South Dearborn</td>
<td>Office</td>
<td>1,371,770</td>
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<td>70.2</td>
<td>198.7</td>
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<td>First National Bank</td>
<td>110 North Michigan Drive</td>
<td>Office</td>
<td>2,291,832</td>
<td>1992</td>
<td>60.7</td>
<td>198.7</td>
</tr>
</tbody>
</table>
High-Rise Commercial Repositioning

• Curtain wall and window wall service life
  – Open joints at split-mullion and stack joints
  – Deteriorated seals at sills/jambs
  – Deteriorated sealants and gaskets
  – Deteriorated IGU seals and spacer bars

• Older glazing technology vs. present-day design loads
High-Rise Commercial Repositioning

1095 Avenue of the Americas
New York, NY
High-Rise Commercial Repositioning

5 Manhattan West
New York, NY

1969

2017
High-Rise Commercial Repositioning

Anthony J. Celebrezze Federal Building
Cleveland, OH

1966  2014
Unitized Curtain Wall

Advantages:
- Aesthetics
- Installation
- Cost

High-Rise Commercial Repositioning
High-Rise Commercial Repositioning

Insulated Opaque Wall Advantages:
- Performance
- Durability
- Installation
- Cost

Easi Set: https://easiset.com/

Island Exterior Fabricators: https://islanddef.com

EAG: https://www.eag.uk.com
High-Rise Commercial Repositioning

TYPICAL METAL PANEL | CONSTRUCTION PROCESS

STEP 1 | Island's aluminum and steel stud framing system assembled.
STEP 2 | Shooting + waterproofing membrane application.
STEP 3 | Parapet/doorhead expansion and visual, quilting applied.
STEP 4 | Halar-coated studs and vertical wall framing system installed.
STEP 5 | Seismic isolation and seismic damper applied and waterproofed.
STEP 6 | Weather panels, insulated windows and glazing installed.
STEP 7 | Aluminum composite metal panels and clips installed.
STEP 8 | Panel is water-sealed, dried, checked for quality control, and is ready for shipment + erection.

Island Exterior Fabricators: https://islanddef.com
High-Rise Commercial Repositioning

<table>
<thead>
<tr>
<th>Feature</th>
<th>Fully-Glazed Exterior</th>
<th>Punched Openings w/ Opaque Walls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aesthetics</td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td>Cost</td>
<td>✓</td>
<td>✓*</td>
</tr>
<tr>
<td>Energy Performance</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Occupant Comfort</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Views</td>
<td>✓*</td>
<td></td>
</tr>
</tbody>
</table>
High-Rise Commercial Repositioning

Views?
Usable Square Footage
-Chicago Commercial Office Real-Estate = $140 / SF

-Perimeter Baseboard Systems: (180’x180’ footprint) = 576 SF per Floor

-Potential SF value: $140/SF x 576 SF x 40 Floors = $3,225,600.00
04
Case Study
### Case Study: One South Wacker, Chicago, IL

![Image of One South Wacker, Chicago, IL](image)

<table>
<thead>
<tr>
<th>Property Name</th>
<th>Address</th>
<th>Primary Type</th>
<th>Gross SF</th>
<th>Year Built</th>
<th>Site EUI (kBtu/sq ft)</th>
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</thead>
<tbody>
<tr>
<td>70 W Madison</td>
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<td><strong>One South Wacker</strong></td>
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<td>Office</td>
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<td>56.3</td>
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<td>10 and 30 South Wacker</td>
<td>10 South Wacker Dr</td>
<td>Office</td>
<td>2,662,457</td>
<td>1983</td>
<td>68.7</td>
</tr>
</tbody>
</table>
Data from Chicago Energy Benchmarking Ordinance shows **One South Wacker** at an **EUI of 49.2 kBTU/sf-yr**

It’s already doing pretty well (relatively), but why not be better? Improvements can be made to optimize for energy, as well as comfort, etc.

Office Buildings in Chicago:

**EUI (kBTU/sf-yr)**

- One South Wacker: 45
- Typical Office: 74

Source: Building Performance Database - https://bpd.lbl.gov
Case Study: One South Wacker, Chicago, IL

Energy Analysis:
1) Existing building
2) Re-Clad: Fully-Glazed Curtain Wall System
3) Re-Clad: 40% Glazed with Opaque Wall Assemblies
Case Study - Existing
Case Study - Existing

- Wall assembly: Overall R-5.2
- Glazing: U-0.68, SHGC 0.47
- WWR: Overall 45%
  (20-65% depending on orientation & floor)
- Mechanical systems:
  VAV w/Electric Reheat + Unit Heaters
Case Study - Existing

VISION GLASS
- Insulated Glass Unit (IGU), Tinted

SPANDREL GLASS
- Single Pane Glazing, Tinted
- Rigid Insulation
- Gyp. Board on Metal Stud Framing above Slab
Case Study – Fully-Glazed

Existing

Re-Clad with Fully-Glazed System
Case Study – 40% Glazed with Opaque Walls

Existing

Re-Clad with Unitized Opaque Panels
Case Study – 40% Glazed with Opaque Walls

- Fully-Glazed Areas
- Unitized-Opaque Wall with Windows (20%)
Case Study – 40% Glazed with Opaque Walls

- Fully-Glazed Areas
- Unitized-Opaque Wall with Windows (20%)
Case Study – 40% Glazed with Opaque Walls

Window-to-Wall Ratio: 39.54%
### Case Study – Comparison Options

#### ENERGY MODEL INPUT PARAMETERS

<table>
<thead>
<tr>
<th>General Info</th>
<th>Weather File</th>
<th>Chicago, IL</th>
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<tr>
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<td>Climate Zone</td>
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</tr>
<tr>
<td></td>
<td>Floor-to-Flr heights</td>
<td>11'-6&quot;</td>
</tr>
<tr>
<td></td>
<td>Floor-to-Clg heights</td>
<td>10'-8&quot;</td>
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</table>

<table>
<thead>
<tr>
<th>Model Input Parameter</th>
<th>Existing Building</th>
<th>Re-Clad with Full Curtainwall</th>
<th>Re-Clad with Curtainwall + Opaque Assemblies</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Building Envelope</strong></td>
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<tr>
<td>Roofs</td>
<td>Metal Frame, &gt; 24 in. o.c.</td>
<td>Same as Existing</td>
<td>Same as Existing</td>
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<td>1.5” polystyrene (R-6) exterior insulation</td>
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<td>U-0.092 (R-10.9)</td>
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<td>Walls - Above Grade</td>
<td>Metal Frame, 2x4, 16 in. o.c.</td>
<td>R-5</td>
<td>U-0.066 (R-15.15)</td>
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<td>U-0.192 (R-6.2)</td>
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<td>Fenestration and Shading</td>
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<tr>
<td>Overall</td>
<td>45.5%</td>
<td>40% overall</td>
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<tr>
<td>South</td>
<td>50%</td>
<td>38%</td>
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</tr>
<tr>
<td>North</td>
<td>50%</td>
<td>40%</td>
<td></td>
</tr>
<tr>
<td>East</td>
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<td>32%</td>
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</tr>
<tr>
<td>West</td>
<td>65%</td>
<td>47%</td>
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<tr>
<td>Vertical fenestration Area (% of Wall area)</td>
<td>75%</td>
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<td>Vertical Glazing Description</td>
<td>Solarban60 Solarblue + Clear</td>
<td>Solarban60 Solarblue + Clear</td>
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<td>Vertical Glazing U-factor</td>
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<td>Vertical Glazing SHGC</td>
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<td>0.30</td>
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Case Study – Energy

- EXISTING w/FULL CURTAINWALL: 49.2 EUI (kBTU/sf-yr)
- RECLAD w/40% WWR: 45.4 EUI (kBTU/sf-yr)

The chart illustrates the energy consumption broken down by category:
- Lights
- Misc
- Pumps
- Fans
- DHW
- Heat Rejection
- Heating
- Cooling
Case Study – Energy

EXISTING

RECLAD w/FULL CURTAINWALL

RECLAD w/40% WWR

- Cooling 10%
- Heating 21%
- DHW 1%
- Fans 13%
- Pumps 6%
- Misc 19%
- Int Lights 29%

- Cooling 11%
- Heating 20%
- DHW 1%
- Fans 13%
- Pumps 6%
- Misc 20%
- Int Lights 29%

- Cooling 11%
- Heat Rejection 1%
- Heating 16%
- DHW 1%
- Fans 2%
- Pumps 13%
- Misc 20%
- Int Lights 31%
Case Study – Other Considerations

Other considerations:

- Reduced loads
  -> reduced HVAC system needs
  -> increased usable SF

- Thermal comfort + usable SF

- Visual comfort

- Views

- Aesthetics
Case Study – Reduced Loads

PEAK LOADS

EXISTING RECLAD w/FULL CURTAINWALL RECLAD w/40% WWR

PEAK LOADS [kBtu/h]

- Infiltration
- Equipment to Space
- Lights to Space
- Occupants to Space
- Underground Surface Conduction
- Window Glass - Solar
- Window Glass - from Conduction
- Roof Conduction
- Wall Conduction

PEAK LOADS [kBtu/h]
Case Study – Reduced Loads

Reduced loads -> reduced HVAC system needs -> increased usable SF

Interactions among CLIMATE, USE, & DESIGN provide opportunities for reducing LOADS

Reduction in LOADS lead to reductions in SYSTEMS size and ENERGY use

Smaller demands are easier to satisfy with ENERGY produced on site
Case Study – Thermal Comfort

Existing:
Comfortable ~12 ft into the space

Reclad w/Full Curtainwall:
Comfortable ~4 ft into the space

Reclad w/40% WWR:
Comfortable ~3 ft into the space

Impacts usable SF!
Case Study – Daylight & Visual Comfort

Daylight levels can be met with all options.

Glare would be much higher in the Reclad w/Full Curtainwall than the Existing & Reclad w/40% WWR.
Case Study – Views

All Glass

Punched Windows

Views can be met with all options, with slightly less view angle from the core of the Existing & Reclad w/40% WWR

View > 20°

No View > 20°
### Case Study – Priority Matrix

<table>
<thead>
<tr>
<th></th>
<th>Existing</th>
<th>Reclad w/Full Curtainwall</th>
<th>Reclad w/40% WWR</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Aesthetics</strong></td>
<td></td>
<td>✓</td>
<td></td>
</tr>
<tr>
<td><strong>Cost</strong></td>
<td>✓</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Energy Use</strong></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
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<tr>
<td><strong>Energy Loads</strong></td>
<td></td>
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<tr>
<td><strong>Thermal Comfort</strong></td>
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<tr>
<td><strong>Daylight</strong></td>
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<td>✓</td>
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<tr>
<td><strong>Visual Comfort</strong></td>
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<td></td>
<td>✓</td>
</tr>
<tr>
<td><strong>Views</strong></td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>
Case Study – Future Work

• Perform energy analysis for all ASHRAE climate zones
• Assess additional HVAC systems
• Evaluate additional ECMs (lighting, equipment, etc.) in addition to envelope & HVAC
05
Conclusions
Conclusions

- Benchmarking and Building Transparency
- The Future of the Energy Code and High-Rise Re-Clads
- Challenging developers, designers, and manufacturers to “Push the Envelope”

Island Exterior Fabricators: https://islanddef.com