Energy Recovery and Utilization for a Mixed-Use Building

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MOTIVATION FOR ENERGY RECOVERY

NEW YORK
New York State
NYSECC 2020
NYSERDA Stretch Code

MASSACHUSETTS
Boston + Cambridge
ZNE zoning regulations being developed

NEW YORK
New York City
Local Law 97
(2024/2030 CO₂ Limits)

WASHINGTON DC
Carbon Neutral by 2050

CALIFORNIA
Goal to achieve ZNE for 50% of existing buildings

- No statewide code or home rule
- Less energy efficient than 90.1-2007
- IECC 90.1-2007 or equivalent
- Between IECC 90.1-2007 and 90.1-2010
- IECC 90.1-2010 or equivalent
- Between IECC 90.1-2010 and 90.1-2013
- IECC 90.1-2013 or equivalent
- IECC 90.1-2013 or better
MIXED-USE SPACE

• **Definition:** a space with multiple **differing end-uses.**

• The IECC addresses mixed occupancies by stating that:
  • Commercial occupancies must comply with the commercial portion of the code\(^1\).
  • Residential occupancies must comply with the residential portion of the code\(^1\).

• Indoor air quality and ventilation parameters are set to meet the **ASHRAE 62.1-2016** standard\(^4\).

• The range of thermal and RH space conditions are dictated by the **ASHRAE 55-2017**\(^5\) or the **ASHRAE 170-2017** standards\(^6\).
COMPLEXITIES OF A MIXED-USE SPACE

- Multiple building-use types
  - i.e. Residential, Retail, Athletics, Performing Arts and/or Healthcare
- Multiple code requirements
- Differing design conditions
  - i.e. RH%, temperature
- Differing occupancy schedules
MIXED-USE SPACE TYPES

• Example: NYU Mercer
  • Student tower
  • Faculty tower
  • Athletics
  • Classrooms
  • Performing Arts
  • Theater

IMAGE COURTESY OF DAVIS BRODY BOND ARCHITECTS
MIXED-USE SPACE: STUDENT TOWER

• Residential code
• Higher RH% set-point than faculty tower, gym, and classrooms
• Load peaks in evening and morning
MIXED-USE SPACE: FACULTY TOWER

• Greater occupant temperature control
• Residential code

IMAGE COURTESY OF DAVIS BRODY BOND ARCHITECTS
MIXED-USE SPACE: ATHLETICS

• Low discharge RH% required
• Large zones
• Varying occupancy
• Six lane pool

IMAGE COURTESY OF DAVIS BRODY BOND ARCHITECTS
MIXED-USE SPACE: CLASSROOMS & THEATRES

- Load peaks during the day
- Large swings in occupancy
- \( \text{CO}_2 \) control

IMAGE COURTESY OF DAVIS BRODY BOND ARCHITECTS
ENERGY USE OVERVIEW

• Air handling units consume 39% of total building energy
ENERGY RECOVERY IN A COGENERATION SYSTEM

- Low-grade heat recovery from:
  - Reciprocal engine jacket
  - Reciprocal engine exhaust
  - High temperature hot water

NYU's Tri-Generation Plant Provides:
Electricity, Hot Water and Chilled Water
to New 181 Mercer Street Building
TRI-GENERATION PLANT CHARACTERISTICS

• NYU’s tri-generation plant
  • *Decreases greenhouse gas emissions by 23%²
  • *Reduced air pollutants by 68%²
  • Approaches 90% energy efficiency²

• Electricity
  • Powers 22 NYU buildings
  • Two 5.5MW gas turbines, one 2.4MW steam turbine

• Chilled water
  • Turbine-driven chiller
  • 2,000 tons from centrifugal chillers
  • 8,000 tons from electric chillers

• Hot water
  • Provided to 37 buildings

*Compared to its 30-year-old, oil-fired CoGen predecessor
ENERGY RECOVERY AT AHU LEVEL

• Ability to recycle energy from a waste-source
  • Spill air

• Equipment:
  • Enthalpy and Mass Energy Recovery Wheel (ERW)
  • Active desiccant wheel using waste heat (ADW)
  • Glycol run-around coil
PURPOSE OF DOAS AT 181 MERCER ST.

• To supply **ventilation air** directly to occupied spaces

• **Decouple** the exact method in which **sensible** and **latent** interior HVAC loads are addressed
  
  • Temperature and RH set points are satisfied independently

• **Reduce** the **total energy** required to maintain the desired space conditions within the building
SYSTEM SELECTION

- Student Tower
  - ERW+FCUs
- Faculty Tower
  - ERW+FCUs
- Gymnasium
  - DOAS Dual-wheel (ERW+ADW)
- Classroom
  - DOAS Dual-wheel (ERW+ADW)
SYSTEM ADVANTAGES

• Enthalpy and mass energy recovery wheel
  • Significantly **reduce** preheat load
  • Free **humidification** in Winter
  • Decreases **precool** load
SYSTEM ADVANTAGES

- Active desiccant wheel
  - Uses heated air to remove humidity in the vapor phase
- Fired by waste heat
- Scalable: Wheels range in size up to ~45,000 CFM

ADW – NovelAire Technologies

SELECTION SOFTWARE | NovelAire Technologies
NEW SYSTEM PERFORMANCE

• **25% energy savings** over NYCECC
• **40% energy-cost reduction** compared to baseline using LEED v4 New Construction³

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<th>Fuel</th>
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<th>Virtual Utility Rate ($/unit)</th>
<th>Baseline Design Total Charge ($)</th>
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³ LEED refers to the Leadership in Energy and Environmental Design, a rating system for green buildings developed by the U.S. Green Building Council.
CHILLED WATER: ANNUAL SAVINGS

• Chilled water savings:
  • ERW reduces precool load
  • Increased $\Delta T$ lowers flow rate, decreasing pumping energy at campus level plant

![](Chilled Water Comparison)

Baseline Proposed
63%

$0 \quad $100,000 \quad $200,000 \quad $300,000 \quad $400,000 \quad $500,000 \quad $600,000 \quad $700,000 \quad $800,000

CampusEnergy2020
THE POWER TO CHANGE
FEBRUARY 10-16 • SHERATON DENVER DOWNTOWN • DENVER, CO

INTERNATIONAL DISTRICT ENERGY ASSOCIATION
ELECTRICITY: ANNUAL SAVINGS

• Electricity savings:
  • Decreased fan energy using FPUs for sensible loads

![Electric Comparison Chart](image)

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11% improvement
HOT WATER: ANNUAL SAVINGS

• Hot water savings:
  • Generated by **low-grade waste heat**
  • Reduced preheat load using ERWs
  • Free humidification from ERW
  • Need for reheat at the zone level is minimized
  • Consistent load throughout year

• Hot water load increase:
  • ADW uses heat for dehumidification
  • Primary/secondary systems increase ΔT to plant
LESSONS LEARNED: BUILDING LEVEL

• DOAS provides **first cost** and **operational cost savings**

• Use of **8,760hr modeling methods** and post-processing of data to optimize equipment selections

• **Sensors, controls, and continuous commissioning** are key to attaining and preserving energy conservation goals

• Future Building AHU equipment is subject to continuous **incremental performance improvements** as new technology becomes available
LESSONS LEARNED: CAMPUS LEVEL

• Building level equipment selections improve $\Delta T$ to plant equipment
  • Lower pump flow
  • Higher equipment efficiency

• Active desiccant wheel regeneration provided by reciprocating engine heat throughout year
WORKS CITED

Thank you

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