Energy Recovery and Utilization for a Mixed-Use Building

Andrew Kozak, PE, AEE Fellow: Engineer of Record
Principal, Director of Mechanical Engineering
646.205.7207
AKozak@brplusa.com

Anthony Thompson, LEED BD+C, EMIT: Energy Modeling & System Design
HVAC/ENERGY Engineer
646.205.7315
AThompson@brplusa.com

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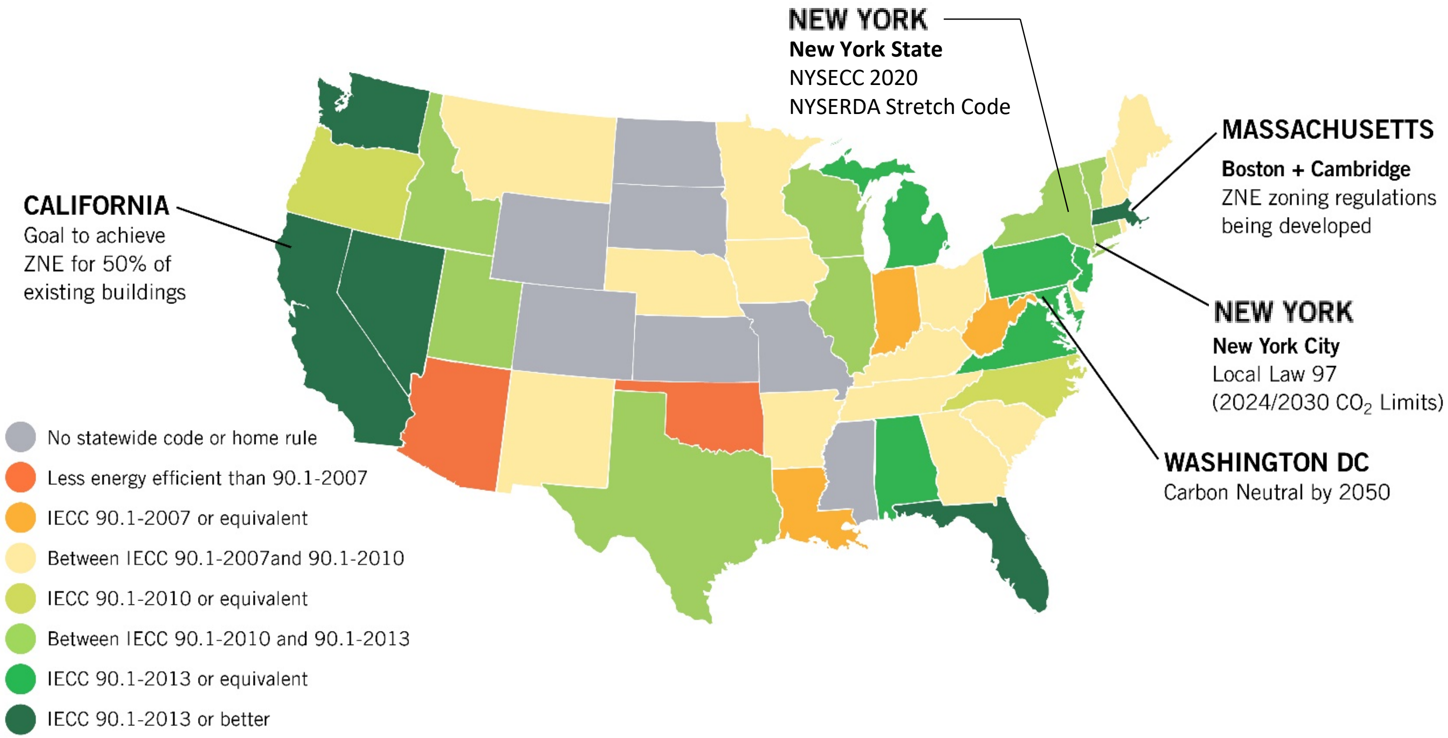
BR+A
105 Madison Ave, 10th Floor
New York, NY 10016
www.brplusa.com

INTERNATIONAL DISTRICT ENERGY ASSOCIATION

MOTIVATION FOR ENERGY RECOVERY



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

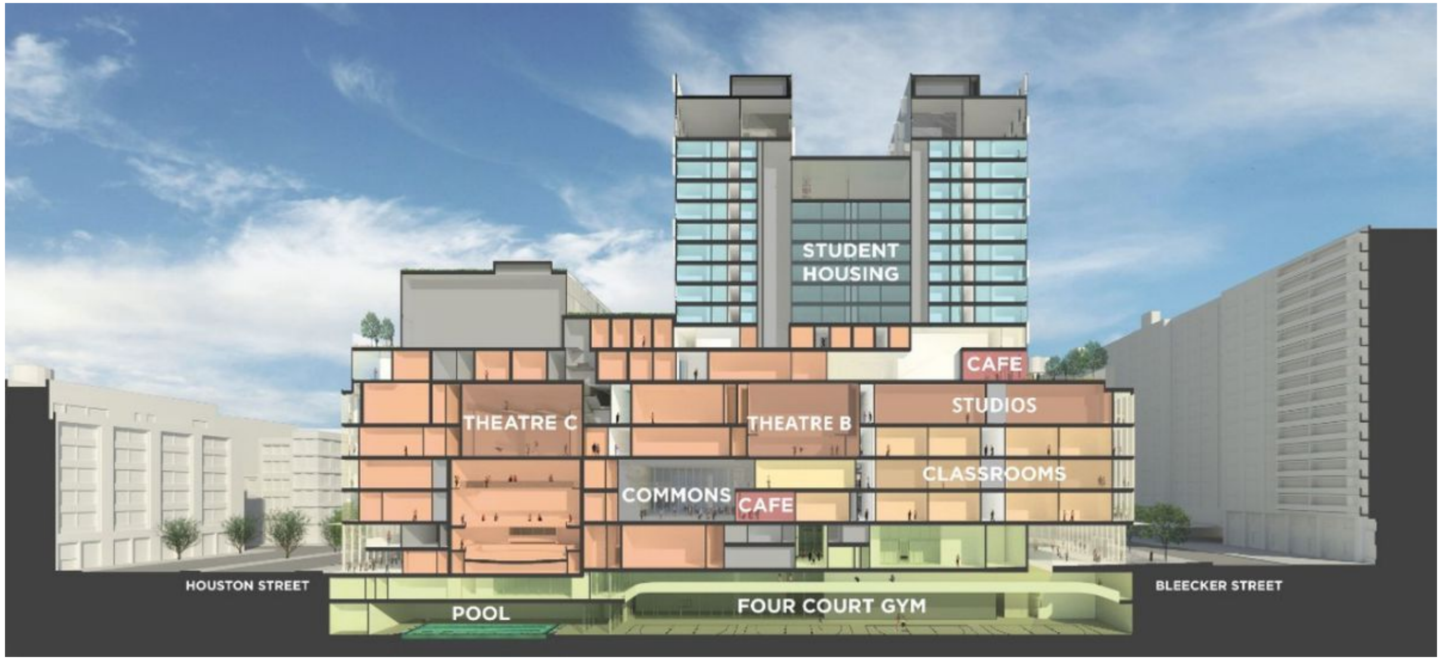


IMAGE COURTESY OF DAVIS BRODY BOND ARCHITECTS

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

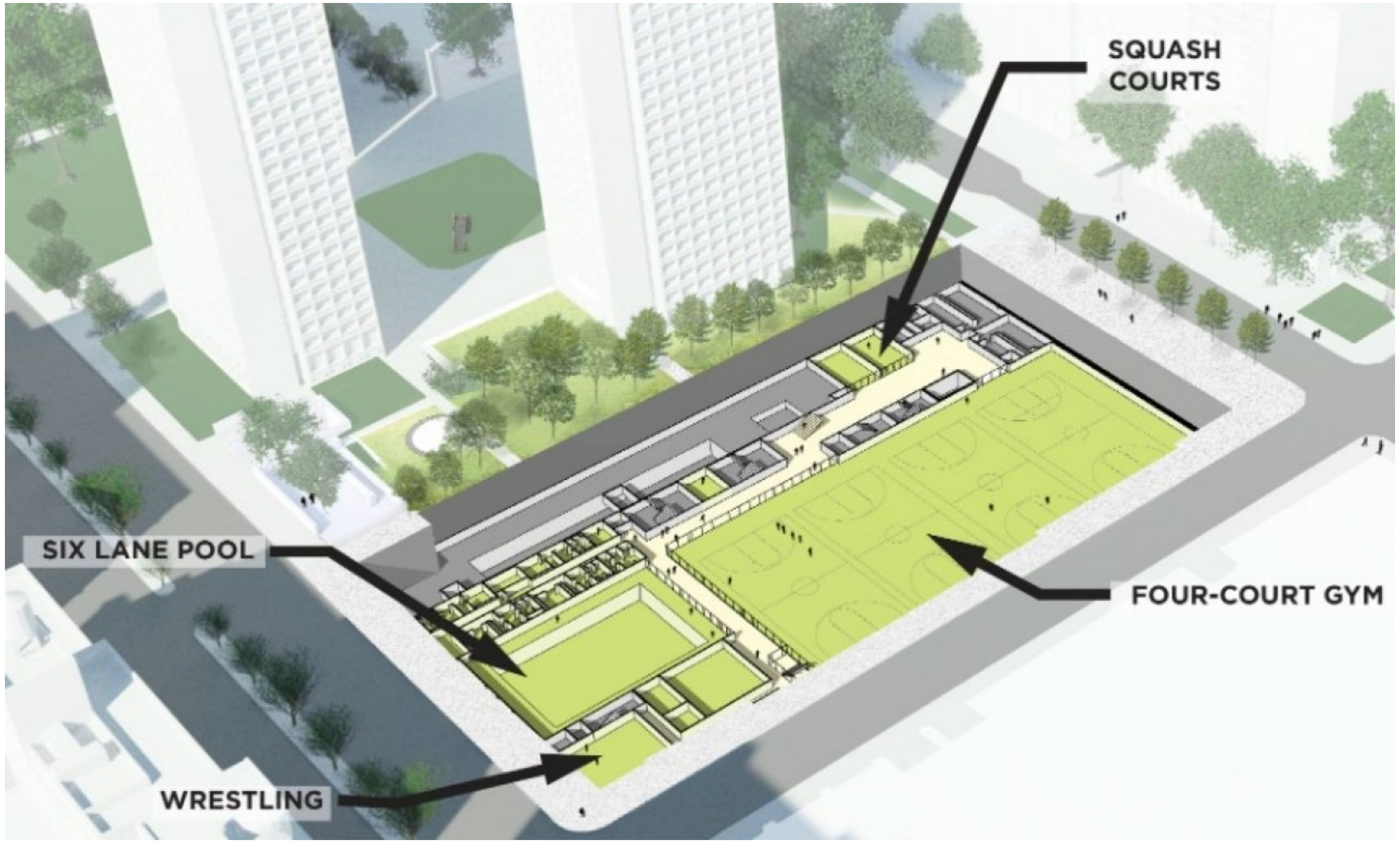


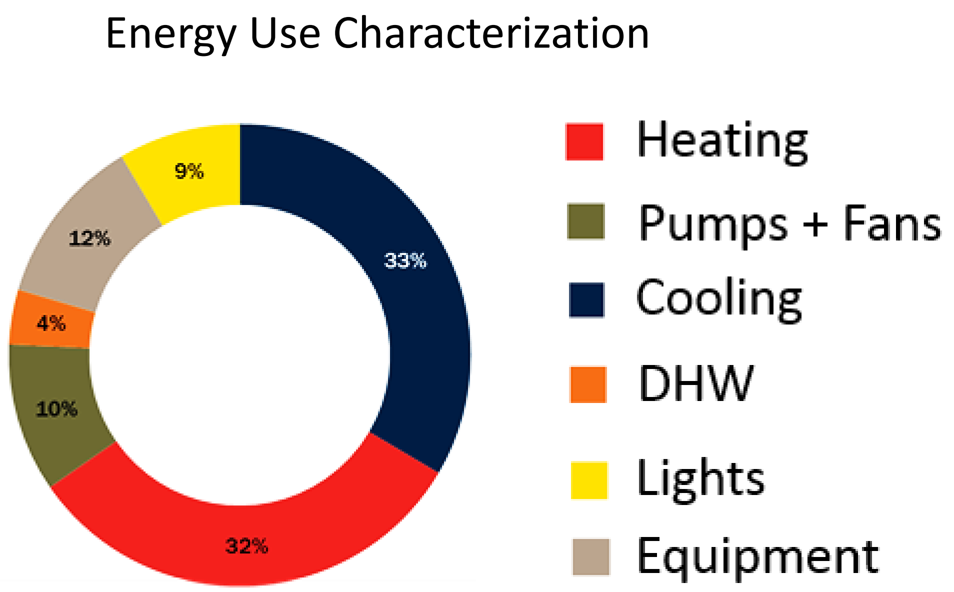
IMAGE COURTESY OF DAVIS BRODY BOND ARCHITECTS

MIXED-USE SPACE: CLASSROOMS & THEATRES

- Load peaks during the day
- Large swings in occupancy
- CO_2 control

IMAGE COURTESY OF DAVIS BRODY BOND ARCHITECTS

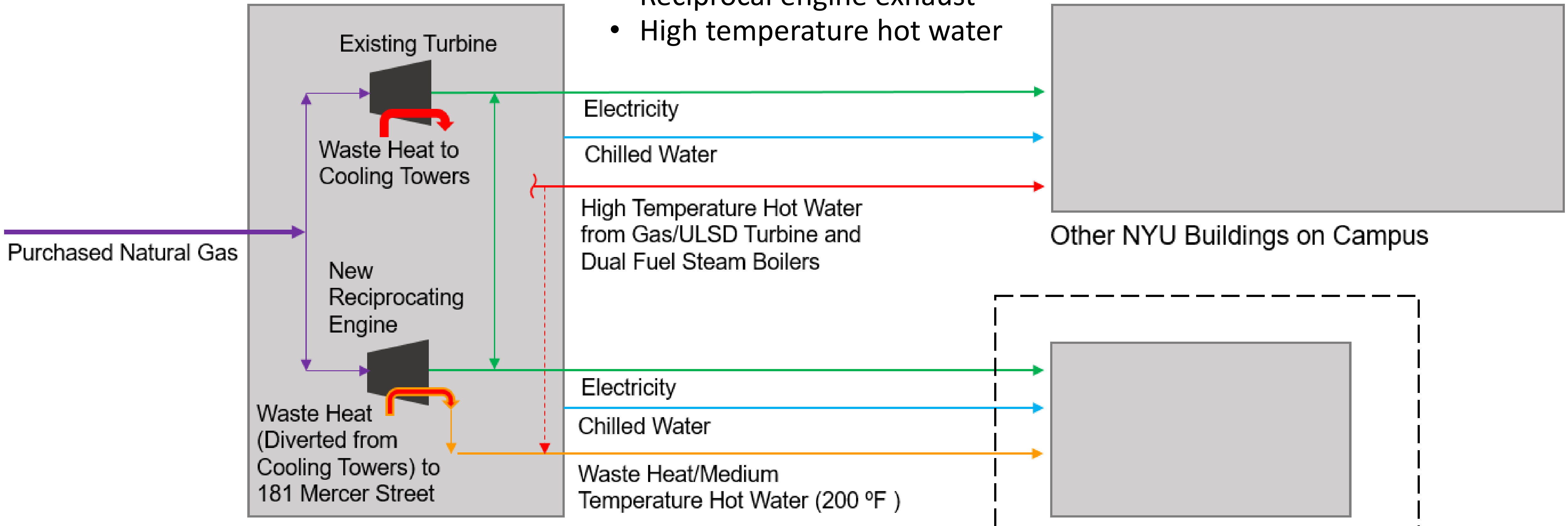
ENERGY USE OVERVIEW



- 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

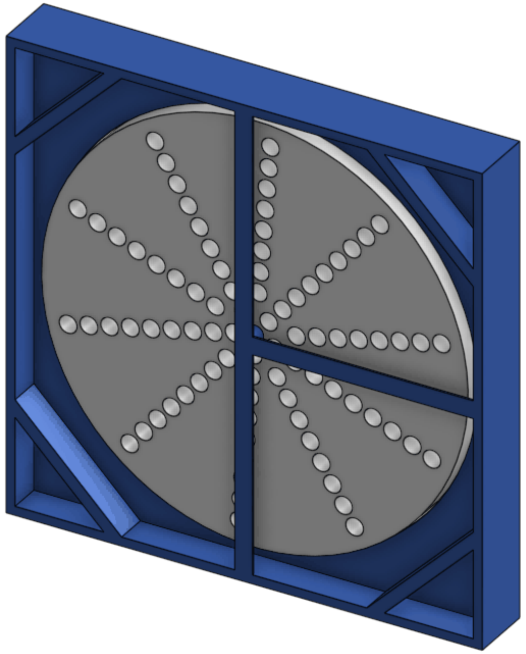
- NYU's tri-generation plant
  - *Decreases greenhouse gas emissions by **23%**[2]
  - *Reduced air pollutants by **68%**[2]
  - Approaches **90% energy efficiency**[2]

- **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

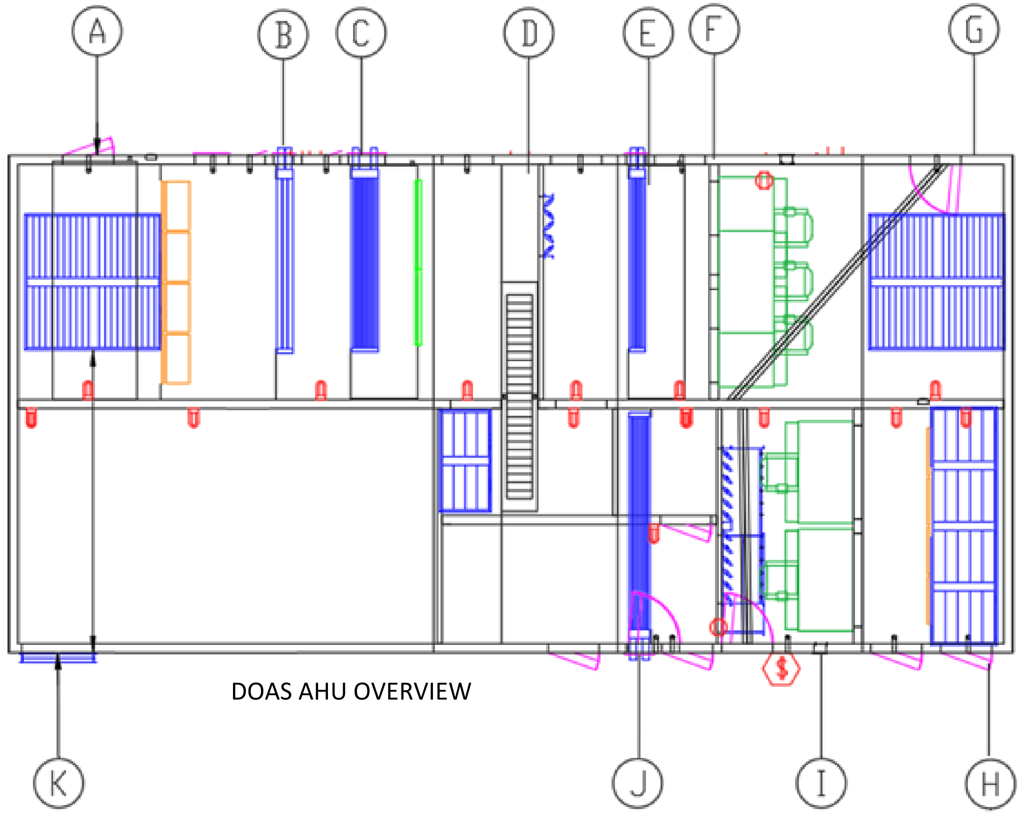


- Equipment:
  - Enthalpy and Mass Energy Recovery Wheel (**ERW**)
  - Active desiccant wheel using waste heat (**ADW**)
  - Glycol run-around coil

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

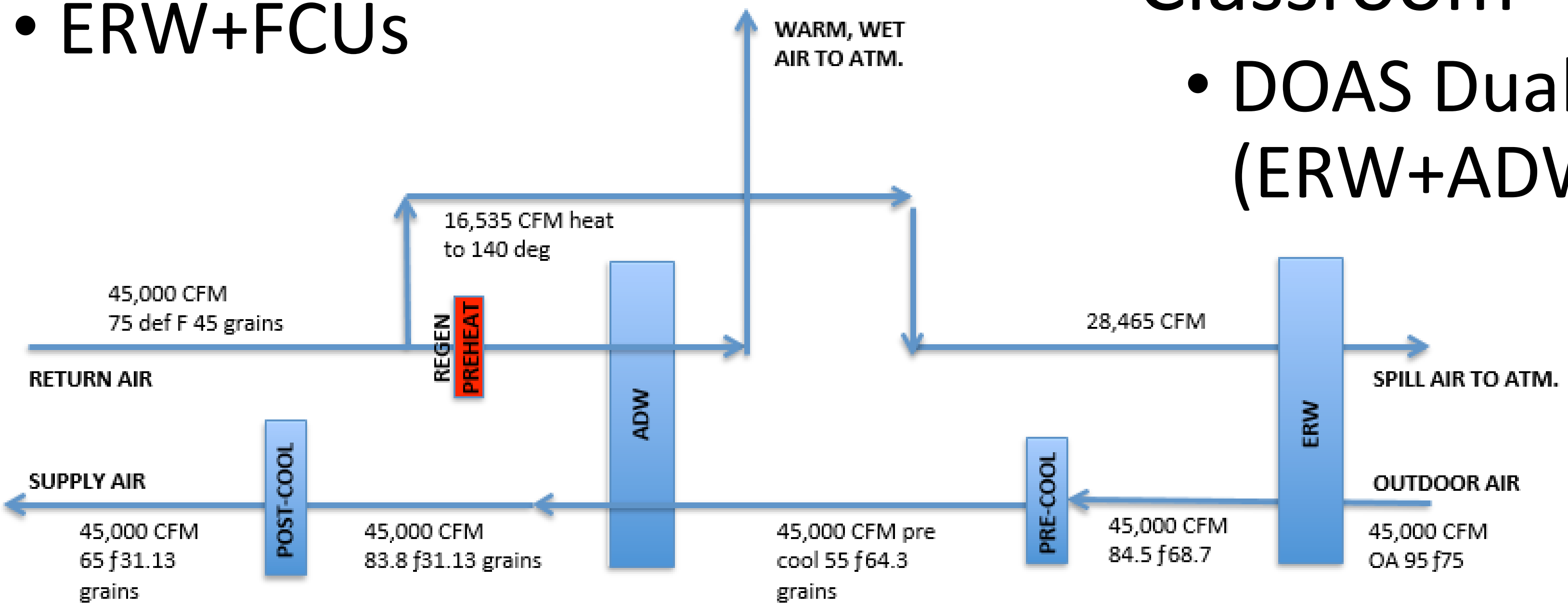
A=Supply Inlet B=Preheat Coil C=Precool Coil
D=ADW E=Post-Cool Coil F=Supply Fans
G=Supply Outlet H=Regen Inlet I=Return Fan
J=Regen Coil K=Regen Outlet



DOAS AHU OVERVIEW

SYSTEM SELECTION

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



SYSTEM ADVANTAGES

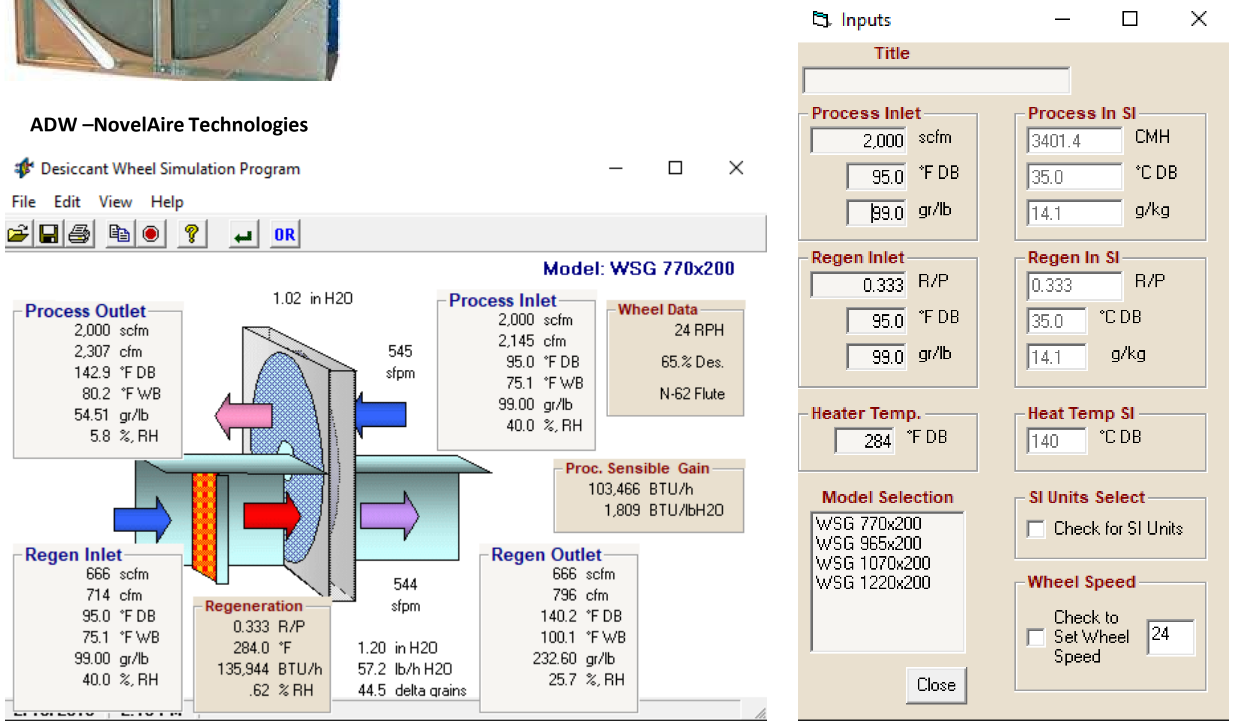
- Enthalpy and mass energy recovery wheel
  - Significantly **reduce preheat load**
  - Free **humidification** in Winter
  - **Decreases precool** load

ERW -ThermoTech

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

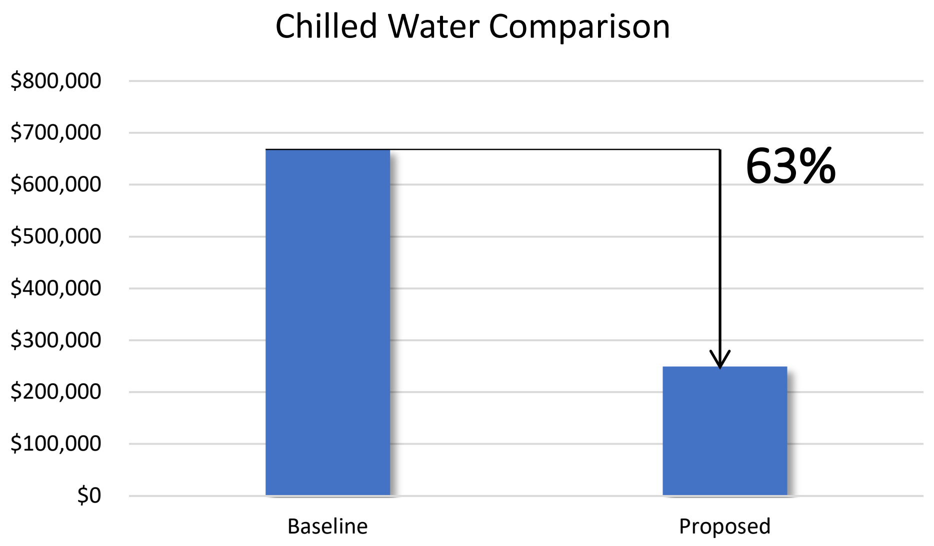
NEW SYSTEM PERFORMANCE

- **25% energy savings** over NYCECC
- **40% energy-cost reduction** compared to baseline using LEED v4 New Construction[3]

4	Purchased Energy Rates							
Fuel	Utility Rate Provider/Rate Structure (i.e ConEd)	Virtual Utility Rate ($/unit)	Baseline Design Total Charge ($)	Virtual Utility Rate ($/unit)	Proposed Design Total Charge ($)	Supporting Doc. Location	Model Output Report	
Electric	Trigen Plant - Elec	$0.14	$ 956,953.62	$0.13	$ 848,374.00	Utility Rates Presentation	ES-D, NYU Water Cooled Chiller	
Gas	Nat Gas	$0.63	$ 14,874.00	$0.63	$ 14,874.00	NYU Gas Rate Derivation	ES-D	
Steam	District Hot Water	1.215	$ 310,278.50	1.059	$ 304,670.00	Utility Rates Presentation	ES-D	
Other:	District Chilled Water	19.16	$ 668,399.00	9.33	$ 249,605.49	COST SAVINGS	COMPLIES?	
TOTAL			$ 1,950,505.12		$ 1,417,523.49	$ 532,981.63	COMPLIES	

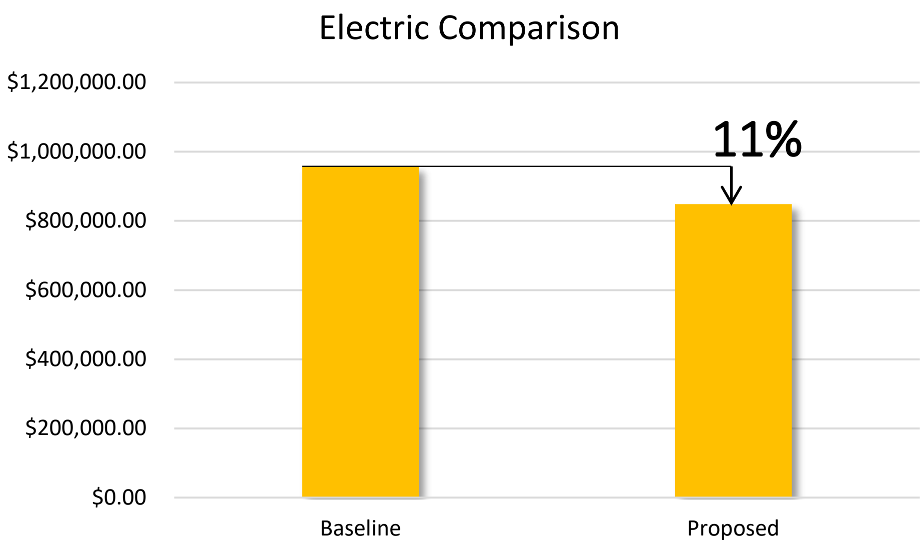
CHILLED WATER: ANNUAL SAVINGS

- Chilled water savings:
  - ERW reduces precool load
  - Increased ΔT lowers flow rate, decreasing pumping energy at campus level plant



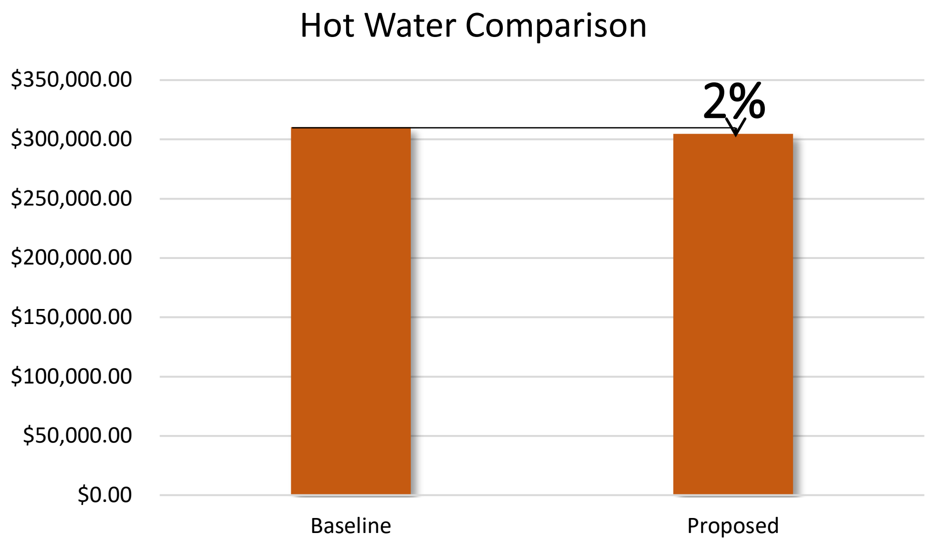
ELECTRICITY: ANNUAL SAVINGS

- Electricity savings:
  - **Decreased fan energy** using FPUs for sensible loads



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 ΔT to plant equipment
  - Lower pump flow
  - Higher equipment efficiency
- Active desiccant wheel regeneration provided by reciprocating engine heat throughout year

WORKS CITED

[1] *Building Energy Codes Program*, U.S. Department of Energy, 2015.

[2] *NYU Switches on Green CoGen Plant and Powers Up for the Sustainable Future*, NYU, 2011.

[3] LEED v4 Edition, USGBC, 2013.

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[5] *Thermal Environmental Conditions for Human Occupancy*, ASHRAE 55, 2017.

[6] *Healthcare Facilities Resources*, ASHRAE 170, 2008.

[7] *ECC Compliance Utility Rates,* Presentation to D.O.B., BR+A, 2018.

Thank you

105 Madison Ave, 10th Floor
New York, NY 10016
www.brplusa.com

Andrew Kozak, PE, AEE Fellow
Principal, Director of Mechanical Engineering
646.205.7207
AKozak@brplusa.com

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