SHORT FORM

CHAPTER/REGIONAL TECHNOLOGY AWARD - SHORT FORM

1. Category - Check one and indicate New, Existing, or Existing Building Commissioning (EBCx)

☐ Commercial Buildings	☐ New	☐ Existing or	☐ EBCx
Institutional Buildings:			
■ Educational Facilities	☐ New	■ Existing or	☐ EBCx
☐ Other Institutional	☐ New	☐ Existing or	☐ EBCx
☐ Health Care Facilities	☐ New	☐ Existing or	☐ EBCx
☐ Industrial Facilities or Processes	☐ New	☐ Existing or	☐ EBCx
☐ Public Assembly	☐ New	☐ Existing or	☐ EBCx
☐ Residential (Single and Multi-Family)			

2. Name of building or project: Cunningham Hall at Illinois Tech

City/State: Chicago/IL

3. Project Description: Adaptive reuse of existing apartment building into an undergraduate dorm

Project Study/Design Period: 2/1/2019 (Begin date (mm/yyyy)) to 12/1/2019 (End date (mm/yyyy))

Percent Occupancy at time of submission: 100%

4. Entrant (ASHRAE member with significant role in project):

a. Name: Anand (Last) Sachin (First) (Middle)

Membership Number: 5184161

Chapter: Illinois

Region: VI

b. Address (including country): 303 W. Erie Street, Suite 510

Chicago (City) IL (State) 60654 (Zip) USA (Country)

c. Telephone: (O) 312.847.1057 d. Email: sanand@dbhms.com

e. Member's Role in Project: Principal in Charge

f. Member's Signature: [signature]

5. Engineer of Record: dbHMS

By affixing my signature above, I certify that the information contained in this application is accurate to the best of my knowledge. In addition, I certify that I have discussed this entry with the owner and have received permission from the owner to submit this project to the ASHRAE Technology Awards Competition.

ILLINOIS INSTUITUTE OF TECHNOLOGY

Cunningham Hall

The Illinois Institute of Technology redeveloped Cunningham Hall as a university dormitory on its Mies Campus on the near South Side of Chicago. The project revitalized the previous apartment building's legacy for today's way of life. The building incorporates new high-performance systems and adapts the original floor plan to today's students' needs while respecting its post-war heritage. The project needed to perform at a level comparable with today's certified green buildings, incorporating an energy efficiency goal to perform at least five percent (5%) better than code, while providing best-in-class indoor air.

The City of Chicago ventilation code and the legacy of the building's original designer, Mies van der Rohe, presented the most significant challenges to meeting the ambitious goals. Initially used to house staff, faculty, and married students after the increase in enrollment after World War II, the project's eight-foot (8 ft.) floor-to-floor heights and sixty percent (60%) window-to-wall ratio exemplified Mies' "less is more" philosophy. Finished in 1955, the 74,000-gross square-foot the university decommissioned the building in 2007. With no leeway to lower the existing window-to-wall ratio, or to address the significant thermal bridges in the concrete structure, the design team prioritized respecting the existing building boundaries and minimizing additional exterior elements or spaces to accommodate the new uses. Additionally, the university selected a mix of standard dormitory floors having shared bathrooms with apartment floors to provide a mix of housing. This added a level of complexity as the ventilation system had to have the flexibility to serve two different floor plates.

ENERGY EFFICIENCY

We implemented a decoupled system to maximize energy and space efficiency. The building has variable refrigerant flow (VRF) units with two dedicated outdoor air systems (DOAS). This approach requires minimal footprint for vertical ventilation risers, no footprint for refrigerant piping (as it will be routed inside the new partition walls between rooms), and allows for smaller overhead ductwork in the dorms to maximize existing floor-to-floor heights.. The system delivers ventilation directly into each dormitory or apartment, exhausts air through the central restrooms at each end of the building, and then recovers energy at the DOAS with enthalpy, fixed-plate heat exchangers. Two DOAS allowed for better duct distribution, smaller chases, and shorter ducts lengths. With the decrease in external static pressure, the AHU fans can run at a lower break horsepower, which translates into lower fan energy consumption when compared against a single central DOAS. Given the layout of the building, and the challenge to minimizing footprint for mechanical equipment, the design employed heat-pump style VRF instead of heat-recovery style.

We created an Energy Model using EnergyPlus 8.9 to perform load calculations and compare the proposed design's energy performance against an ANSI/ASHRAE/IESNA Standard 90.1-2016 baseline building. Table 1 shows the energy use of the proposed building operating at 20% less than the baseline building, all while doubling the occupancy of the building and adding air conditioning to allow for year-round use.

Table 1: Predicted Energy Performance Relative to ASHRAE 90.1-2016 Baseline

Energy	Energy Model	Baseline
Electricity Consumption	986,571 kWh	822,726 kWh
Natural Gas Consumption	2,973,465 kBtu	5,117,930 kBtu
Total Consumption	**6,340 MMBH**	**7,925 MMBH**

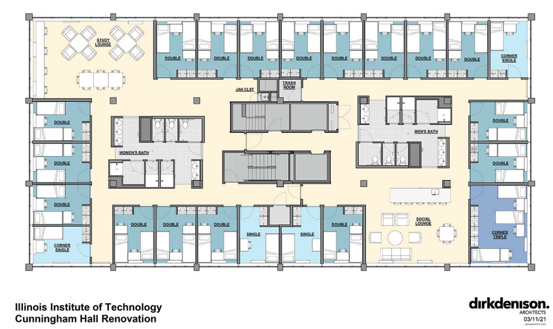
INDOOR AIR QUALITY

Ventilation rate procedure calculations were used to maintain minimum outdoor air requirements. The ventilation requirements for the dormitories are constant, and as such, it is only necessary to furnish both air handling units with airflow measuring stations at the system level. Each unit is ducted directly to the DOAS and is equipped with a balancing damper, ensuring an appropriate amount of outdoor air being delivered.

Under the applicable Chicago ventilation code, this project would not require ventilation in the dormitories, and instead, only needs air to make-up for applicable exhaust requirements. This would result in the residential spaces using operable windows to meet City requirements, which when combined with the attention to tightening the envelope, means little to know fresh air in winter. Recognizing the inadequacy, the design team worked with the client to go above the applicable jurisdiction by meeting the requirements of ANSI/ASHRAE Standard 62.1-2013 and incorporating direct ventilation to the dormitory rooms and common areas balanced out by continuous exhaust from the bathrooms run through an ERV.

BUILDING ENVELOPE

The original building concrete superstructure created significant thermal bridging offset with radiant heating in the floor slabs. A parametric analysis on the building envelope optimized the improvements to the knee-wall and windows that would best improve total building performance. The analysis showed that the bridging condition significantly overshadowed any improvements to the rest of the envelope. Therefore, the team decided to maximize the thermal resistance within each of the areas of the envelope improved and focus the remaining resources into upgrading the space conditioning and ventilation systems.



INNOVATION

The optimization strategy for the project maximized the energy efficiency, indoor air quality, and thermal comfort all within the constraints of the historical preservation requirements. Following this collaborative process resulted in a project that uses 20% less energy than a code-minimum building, even when accounting for the energy challenges presented by a Miesian building. Working in a dynamic, integrative fashion with the architect allowed for the incorporation of direct-ducted ventilation within the physical constraints of the space as well as the budgetary restrictions.

OPERATION & MAINTENANCE

Universities thrive on longevity and resilience in their HVAC systems. Although VRF systems do not have the nominal longevity of a water-cooled chiller, once the refrigerant lines are set, the maintenance predominantly occurs only at the condensing or terminal unit. The design located the condensing units in close proximity, making major equipment maintenance easy to perform without entering the occupants' living space. The system's modularity and the small-sized components allow for easier replacement if needed without the need for cranes or difficult logistics, while the internal compressor redundancy within the condensing units provides a measure of redundancy that allows the facilities team a cushion of time to affect repairs.

COST EFFECTIVENESS

In addition to the operational energy savings and ease of maintenance, the system applied exceeded the overall performance requirements while remaining within budget and significantly lower than other, traditional dormitory solutions.

ENVIRONMENTAL IMPACT

The design creates an integrated and functional space for students to live in, with reduced environmental impact through lower energy consumption, health benefits due to increased indoor air quality and additional control. Because of the electrification of the heating system, the overall carbon impact of the building remains nearly equal to that of a baseline building (Table 2).

Table 2: CO2 Reduction from ASHRAE 90.1-2016 Baseline

Energy	Energy Model	Baseline	Reduction
LBs CO2 Emitted*	1,867,126	1,865,642	-1,483
Estimated Building Energy Intensity (kBtu/sf)	92	115	23
*1.54 lbs CO2/ kWh and 116.97 lbs CO2/MMBtu- EPA 2009			

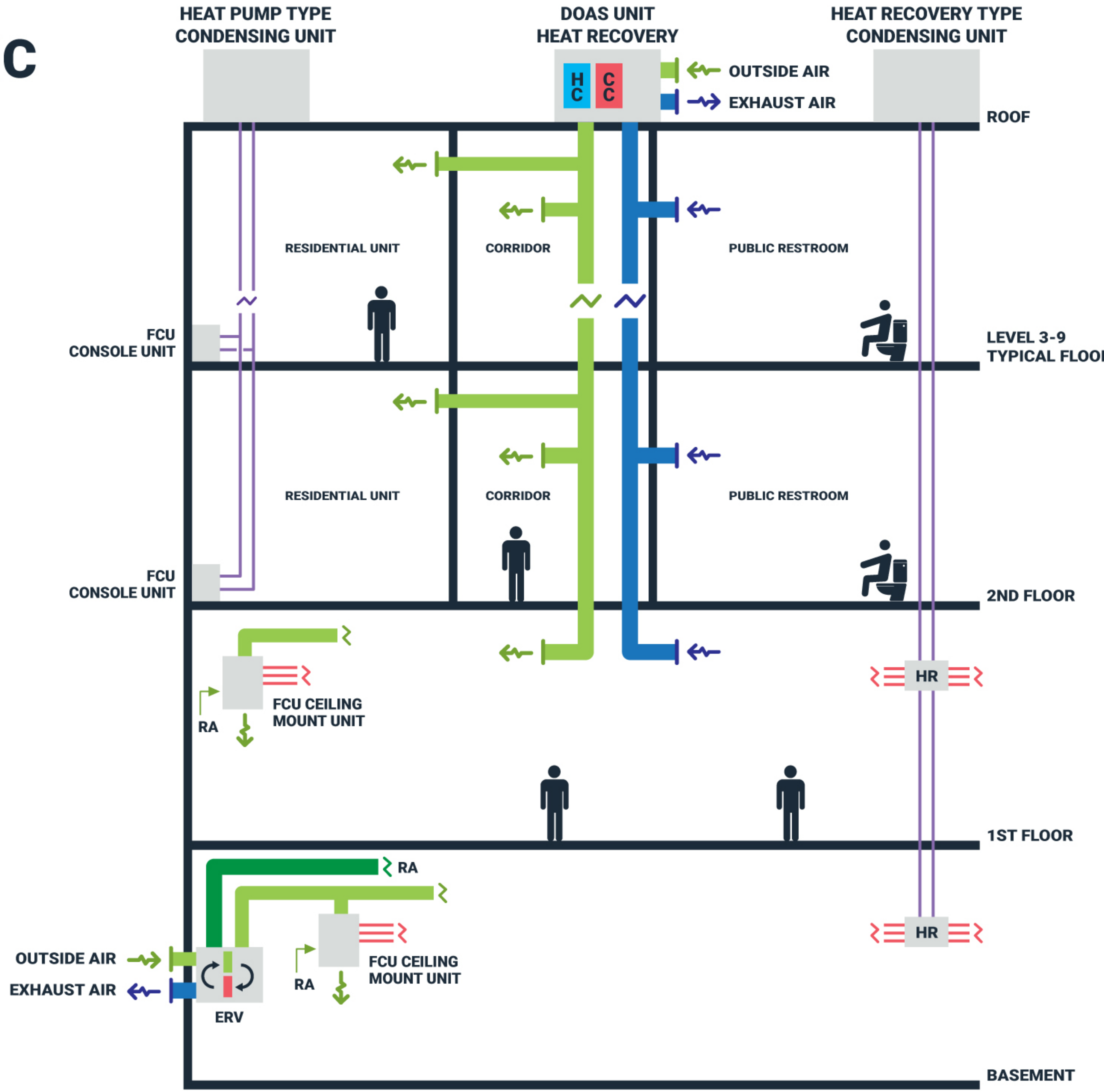
This comes from the embodied carbon in the local utility grid. With both the State of Illinois and ComEd working on cleaning the regional grid, and Illinois Tech constantly improving their microgrid, the decarbonization of the grid that will occur within the life of the building will result in a drastically lower carbon footprint for the building compared with a baseline (Table 3).

Table 3: CO2 Reduction from ASHRAE 90.1-2016 Baseline with Clean Grid

Energy	Energy Model	Baseline	Reduction
LBs CO2 Emitted*	347,806.20	598,644.27	250,838.07
Estimated Building Energy Intensity (kBtu/sf)	92	115	23
*1.54 lbs CO2/ kWh and 116.97 lbs CO2/MMBtu- EPA 2009			

In addition, locating the hot water heaters in the penthouse allows for a straightforward retrofit to electric, heat-pump style heaters down the road which will not only lower the EUI, but allow the building to easily adapt to carbon neutral.

SCHEMATIC



HEAT PUMP TYPE
CONDENSING UNIT
DOAS UNIT
HEAT RECOVERY
HC
CC
OUTSIDE AIR
EXHAUST AIR
HEAT RECOVERY TYPE
CONDENSING UNIT
ROOF
RESIDENTIAL UNIT
CORRIDOR
PUBLIC RESTROOM
FCU
CONSOLE UNIT
LEVEL 3-9
TYPICAL FLOOR
RESIDENTIAL UNIT
CORRIDOR
PUBLIC RESTROOM
FCU
CONSOLE UNIT
2ND FLOOR
FCU CEILING
MOUNT UNIT
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