Decarbonizing a 180-Unit Apartment Building in Manhattan

The International Tailoring Company Building (ITCoB) in New York City is an iconic 13-floor, 156,000 sq. ft. building that was originally constructed in 1920 and converted into residential lofts in 1980. With end-of-life equipment and poor occupant comfort, the ITCoB faced challenges shared by many buildings in New York City. Residents were facing upcoming LL97 energy fines and had a D-grade energy rating posted on the front door. The existing HVAC system was a two-pipe hydronic switchover system, which provided heating in the winter and cooling in the summer; the building's gas-fired absorption chillers provided both heating and cooling. During shoulder seasons, the system provided either heating or cooling to the whole building, so some residents were comfortable while others were not. "Our apartments sell as luxury apartments, but not having air conditioning available when your apartment is over 80° F is decidedly unluxurious," pointed out a member of the management team.

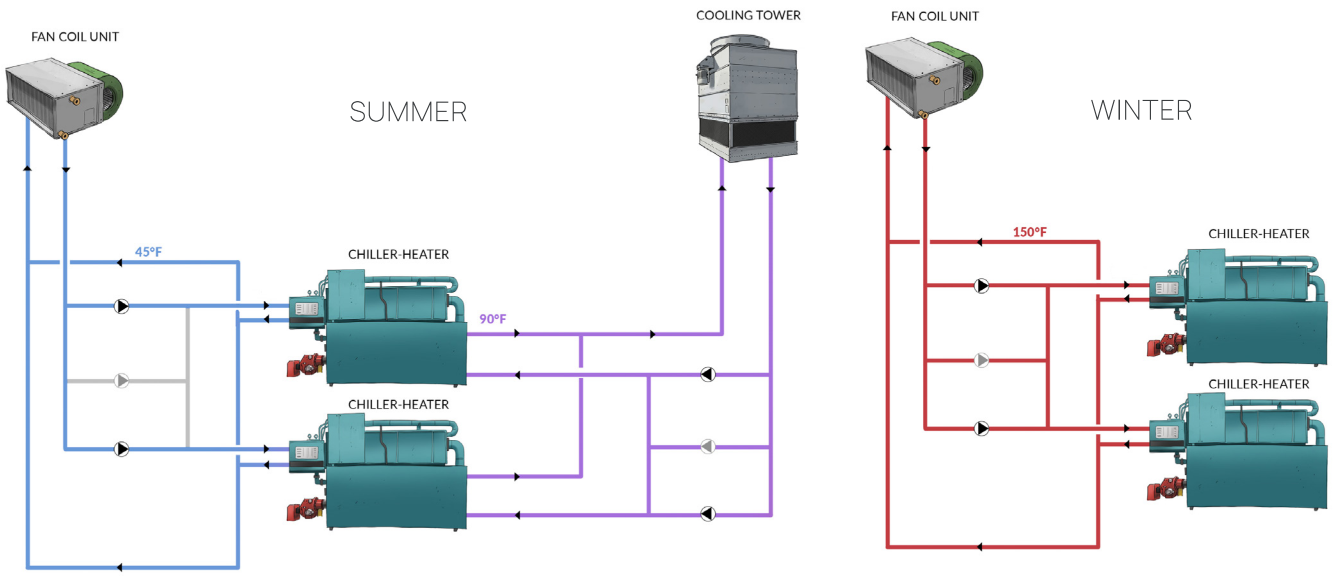
The building management realized that they needed to think outside the box: instead of replacing in-kind -- new equipment doing the same thing -- they needed to re-engineer, modernize, and future-proof their building. This need was compounded by the unreliability of all the aging equipment: emergency outages were going to be inevitable, leaving residents without heating or cooling. Doing nothing was not an option.

An Effective Transition

The first step of the project is to transform the current two-pipe hydronic system into a modern thermal network or tempered loop, in which energy can be transferred between apartments. This was achieved by replacing the legacy fan coil system, which required high water temperatures for heating and low temperatures for cooling, with a hybrid water-source heat pump unit, designed to be able to both heat and cool with water temperatures anywhere between 80F-110F. During the heating mode, these units have a low-temperature hot water coil to provide heat to the apartments; during cooling, the condenser rejects heat to the thermal network.

The next step is to provide a low-carbon heating technology to move away from a natural gas, oil, or district steam-based heating system.

Figure 1: existing system



One of the secrets of implementing heat pumps is knowing that the lower the temperature they have to heat to, the more efficient they can be. The difference can be quite stark. In fact, a heat pump can consume twice as much electricity (and therefore $$$) to produce the same amount of heat at 150F compared to 110F. The new thermal network substantially reduced the temperature, which opened the door for very efficient and cost-effective air-to-water heat pumps to be located on the roof.

This design process was not all smooth sailing. The building needed to stay within its existing electrical infrastructure, and the footprint for air-source heat pumps was limited. Thankfully, the thermal network allows a flexible approach as different technologies can be integrated to provide low-temperature heating. The air-to-water heat pump system was maximized within the constraints of the building, and highly efficient condensing boilers were integrated to provide supplemental heat to reach the design-condition heating load.

It is worth noting that heat pumps have an inherent “Goldilocks” zone. They work very effectively above 35F, but below that, performance decreases because defrost cycles are required to keep ice from forming on the heat exchanger. In the design, the condensing boilers not only help on the coldest days, but they have the added benefit of providing significant resiliency in case of extreme cold weather or equipment failure. At the ITCoB, the building’s natural gas consumption will be reduced by over 80%, with about a third of the design heating load provided by the heat pumps. While the design condition heat load can be quite substantial and thus can be perceived as a significant barrier to electrification of heating, in reality substantial decarbonization can be achieved even with one-third of design capacity coming from a clean heating technology.

Figure 2:
Design Heat Load compared with Air-Source Heat Pump outputs

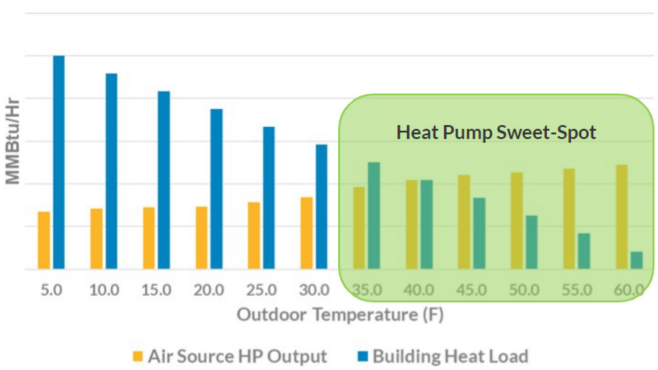
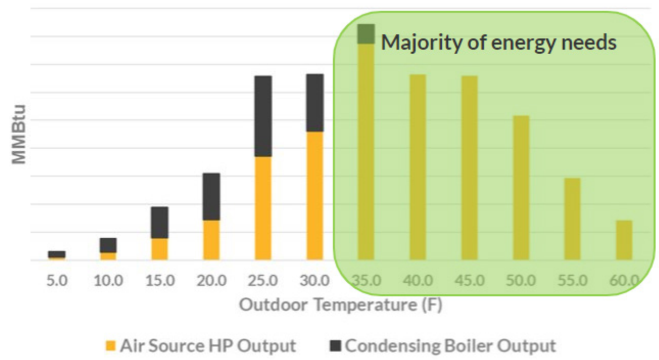


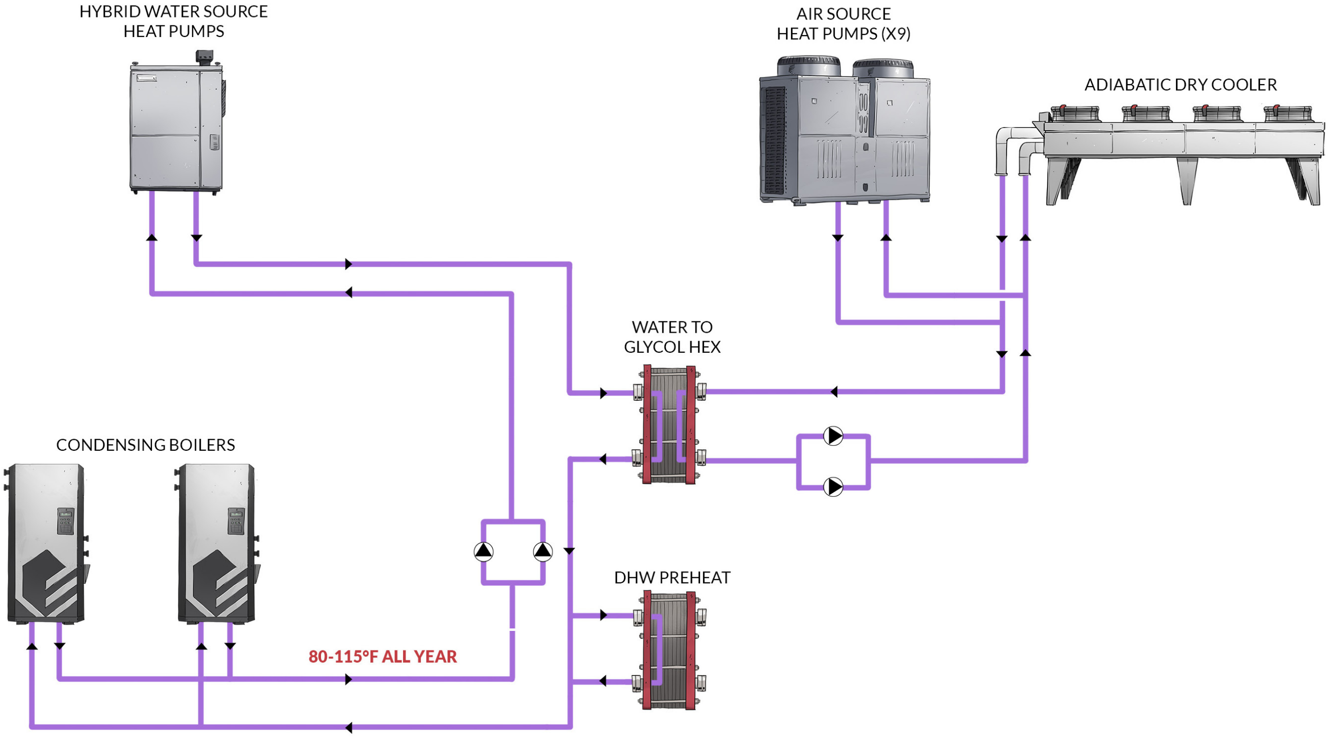
Figure 3:
Annual energy consumption for each temperature range



Figures 2 & 3 highlight this disparity between design heat load vs actual energy consumption.

The large cooling tower that occupied a lot of rooftop space and accounted for significant operating costs, due to water treatment associated with an open-loop system, is being replaced with a much more compact closed-loop adiabatic dry cooler. This system not only creates more space for the air-to-water-source heat pumps, but it also slashes water consumption and chemical treatment, ever-rising and often forgotten costs for cooling buildings. The thermal network was also expanded to include pre-heating the domestic hot water, both to maximize the air-source heat pump usage and to reclaim what would otherwise be waste heat in the summer, further reducing the building's carbon footprint.

Figure 4: New low carbon thermal network



Efficiency in Action

- **In the winter,** heat pumps on the roof will pull heat from the air into the thermal network. On very cold days, the heat pumps will be supplemented by the condensing boiler, which, given the low temperature of the thermal network, will operate with efficiencies approaching 96.5%.
- **In the summer,** waste heat will heat the domestic hot water, with any excess heat being rejected into the air by the adiabatic coolers on the roof.
- **In shoulder seasons,** one warm apartment's air-conditioning waste heat may actually end up heating someone else's cold apartment, with no use of the central plant equipment except to pump water through the thermal network.

Designing electrification of heating around a modern low-temperature thermal network opens the door to this combination of heat pumps and condensing boiler, a design in which each system is designed according to its inherent strengths; this is like the way hybrid cars maximize both the electric drive and internal combustion engine to save fuel. This approach allows the ITCoB to remain within its existing electrical and space infrastructure, saving significant money without creating a new electrical demand on the NYC grid. It will bring the building's energy grade up to a high B, even possibly an A depending on other efficiency initiatives in the building. More importantly, the building will fully align with New York State's and NYC's vision to drastically cut carbon emissions; LL97 fines will be eliminated, and the ITCoB will be significantly below even its 2050 carbon limit once the electrical grid is decarbonized.

At Ecosystem, we believe everything can and should be more efficient. This holds true for buildings, energy systems, the project delivery approach, and the collaboration with our clients. This is the foundation our business is built on.

We are equally committed to the energy transition and making progress toward an environmentally responsible energy future. As an integrated engineering and construction company specializing in energy projects, we have a dedicated role to play helping our clients along the path to carbon neutrality. Our holistic approach to projects in the built environment, combined with our proven expertise in delivering meaningful energy savings, sets us apart and enables us to develop measurable and achievable decarbonization programs.

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