DPS Better Engineered Solutions

Sustainability vs. Schedule—The Unapparent Opportunity in Novel Therapy Facilities

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FIVE STRATEGIES TO OPTIMIZE ENERGY PERFORMANCE IN NOVEL THERAPY FACILITIES

Business drivers such as speed to market are critical factors that influence the trajectory of emerging companies in the novel therapies market. The ability to produce life-saving medicines and therapies carries an inherent urgency. The influence of delivering a facility quickly impacts many decisions throughout constructing a manufacturing facility. One unfortunate casualty of a hyper-focus on schedule can often be sustainability, which is perceived to carry a premium of time or upfront capital for the sake of improving operating costs and reducing environmental impact. This contradiction places design teams in a difficult situation. As consulting engineers, we serve our clients' best interests and strive to do so with sustainability in mind. It is futile to argue the relative importance of speed-to-market of a life-saving drug vs. long-term sustainability of a facility. However, delivering on a tight schedule does not mean we have to ignore energy performance.

The following five basic strategies can help reduce the footprint of cutting-edge novel therapy manufacturing facilities without compromising on safety or speed:

1 Maximize Heat Recovery Effectiveness

Manufacturing facilities face a contradiction between indoor air quality and energy consumption. For example, gene therapy facilities that leverage viruses in the process may require single-pass air in Grade C cleanrooms to ensure personnel safety and mitigate cross-contamination. Airside heat recovery is mandated by state-enforced International Energy Conservation Code (IECC) for most systems like this. However, the effectiveness of the most common form of recovery (run-around loop) can be poor. Fixed plate air-to-air energy recovery systems, or heat pipe technology, combine the safety of completely isolated air streams while improving performance over run-around loops.

Heat recovery can also be employed when heating and cooling synergy exists in the load profiles. Even in warm climates, many manufacturing operations require reheat energy year-round, setting up a heat sink for this use. Identifying sources and sinks for recovered energy can reduce the net energy consumption of a site on a meaningful scale.

2 Eliminate Plant Steam (if possible)

There is no doubt that steam is a highly efficient medium to transfer heat. However, answering the fundamental question of its necessity is essential to avoid unnecessary energy use. As an illustration, generating saturated steam at 90 psig requires that water be heated to 331° F. Many process applications require this high temperature for sterilization (i.e., autoclaves), but most HVAC applications do not.

For HVAC, steam is often used to generate 180 °F water for a hydronic heating application, or 140°F domestic hot water. Said plainly, in using steam to heat a building via a hydronic system you are heating water to 331 °F to heat water to 180 °F. Using steam directly to heat air through steam coils heats water above boiling to heat air to 90 °F.

HVAC heating needs can be met with low-temperature hot water systems, which allow for high efficiency condensing hydronic boilers, or even water to water heat pumps.

3 Collaborate to Challenge Legacy/Prescriptive Criteria

The importance of optimizing a facility's energy performance requires alignment of the entire design team, and only when each is informed by the other can the maximum impact be achieved. It is imperative the team challenges legacy or prescriptive criteria such as fixed air change rates for a given class space—and even the need for single-pass air to recognize potential energy savings if the opportunity exists. As new methods for manufacturing novel therapies are introduced, the tendency is to be risk-averse and conservative due to the unknowns in new endeavors, which is justifiable. But as processing technology advances and the risks are understood, the HVAC approach must also evolve.

A significant topic of debate is the definition of cleanroom air change rate criteria, which has an incredible impact on a facility's energy consumption. Arriving at the best solution involves an early collaboration of the process, HVAC, and owner-side stakeholders to ensure the process needs are met in a robust way. It is common to find that legacy air change rates are higher than required and better risk-based methods of designing to clean classifications exist.

The single most important factor in sizing mechanical utilities for novel therapy facilities is the amount of outside air that must be cooled and dehumidified, or heated by the HVAC systems. For example, in the Philadelphia area, a single-pass HVAC system requires 3.5 times the cooling capacity as a recirculating system with 20% outside air. Many applications necessitate single-pass air due to personnel or product risk. Still, the impact on the mechanical systems makes it worthwhile to challenge this requirement to ensure the energy cost is justified. If segregation of suites is the driving factor, separate air handling systems may be a better choice than a typical single-pass AHU.

In many cases, there are acceptable strategies to minimize facility energy consumption without introducing additional risk. Working with an experienced, cross-disciplinary team focused on the same goals can lead to significant upfront and life cycle cost savings in a building's infrastructure.

4 Lower Pressure Drop

Energy codes in the United States fall short of those enforced in Europe on maximum system fan power. Europe's eco-design legislation already requires that new air handling systems adhere to much stricter maximum fan power limits than IECC or ASHRAE 90.1. A simple way to summarize the impact on air handling unit (AHU) design is to look at maximum face velocity at the cooling coil, which is typically a key parameter used by many engineers to select AHUs. Purely considering the air handler's first costs, cooling coil velocities usually fall in the 450 – 500 fpm range. Since 2018, non-residential AHUs in Europe have been limited to 1.6 m/s (~315 fpm) at the cooling coil, resulting in significantly less internal pressure drop. Limiting velocity at the most critical component (cooling coil) also reduces pressure drop across heating coils and filters, adding up to meaningful fan power savings. With critical HVAC systems operating more than 8,000 hours per year, the impact on life cycle cost is significant.

Air handlers sized this way have a larger cross-section (and footprint) but smaller fans. There is certainly a premium for larger AHUs and coils. However, it is important to consider that the initial investment in an air handling unit typically represents a low single-digit percentage of the lifecycle cost of that AHU.

5 Variable Air Volume Laboratories

Laboratories supporting manufacturing operations can be just as energy-intensive as clean space. One advantage afforded by being a non-production area is the ability to apply variable airflow. In laboratories, varying airflows can easily be used to save energy while maintaining appropriate directional airflow. Strategies also exist for unoccupied setback and dynamic reset of air change rates which can further reduce the energy consumption of the non-production HVAC systems.

IT'S TIME TO INVEST IN ENERGY PERFORMANCE IN YOUR FACILITY

Incorporating the above strategies requires an awareness of the key issues at an early enough phase of a project to influence its trajectory without adding significant delivery time or even cost to your overall project.