Sustainability in Animal Research Facility Planning and Design: An Interview with JB&B

By Dr. Corinna Beale, DVM, SRS, DACLAM

Article Two of the Sustainable Vivarium Series

Dr. Corinna Beale, a Lab Animal Veterinarian and sustainability advocate, recently met with experts from Jaros, Baum & Bolles (JB&B), an innovative consulting engineering firm with experience in successfully implementing sustainable technology into animal research facility builds. In this interview with Dr. Beale, JB&B team members discuss their insights on the key issues and potential solutions to energy consumption and why they should be considered and adopted in the Lab Animal Community.

Meet the Experts

Anthony M. Montalto – Partner/Leader, Life Science Group at JB&B

Christopher D. Colasanti – Associate Partner/Leader, JB&B Deep Carbon Reduction Group

Brian T. McKinney – Senior Associate, JB&B Deep Carbon Reduction Group

Maxinne R. Leighton – Director of Marketing and Business Development at JB&B

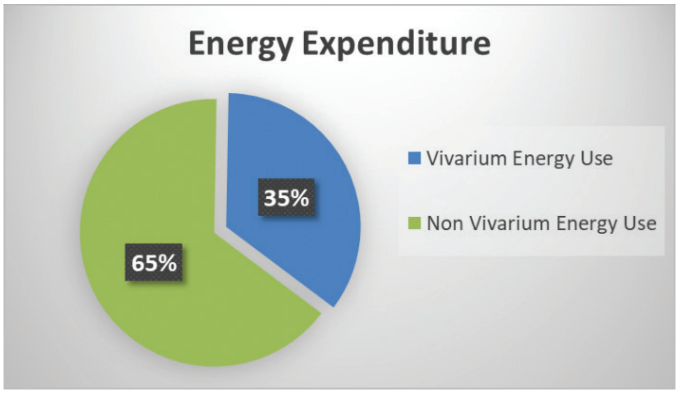
Defining the Problem

CB: Vivariums use a lot of energy, which we know negatively impacts the environment, but just how much more energy do animal research facilities use in comparison to other types of facilities?

JB&B: There's no one-size-fits-all answer to this. Energy, water, and utility consumption can be measured in several different ways that vary significantly from facility to facility. To get an answer to this question, we used a repositioning project of 115,000 sq. ft. of an existing office building into a life sciences facility that included 15,000 sq. ft. of vivarium as a model to illustrate energy consumption. All of the systems being renovated already met current building standards, which makes the starting point of our model project significantly more efficient than a lot of existing facilities that don't meet such standards.

Even with the benefits of modern design, the results depict very high energy consumption by animal facilities. When describing building energy use, we often use a metric called energy use intensity, or EUI, in order to normalize annual energy use by area so that buildings of different sizes can be compared. Using this metric, a typical modern office building may consume between 50 and 65 kBtu/sq. ft.-yr. In comparison, that number was 131 kBtu/sq. ft. annually for the studied project overall and 473 kBtu/sq. ft. annually for the specific vivarium spaces. **That means that according to our model, the vivarium spaces are using 7 to 9 times as much energy as a typical office on a per-square-foot basis.**

Also, Vivariums can have an outsized impact on the energy consumption of any building they're in. In our study, the vivarium consumed 35% of the total energy of



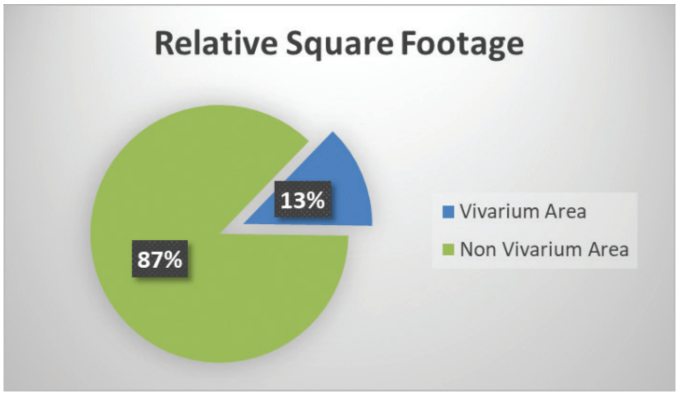


Figure 1: Fraction of energy use and area attributable to vivarium in the studied building

this life science renovation despite making up just 13% of the project floor area.

CB: Wow, I knew it was a lot, but this is astounding. If this were an experimental treatment, these results would qualify for a breakthrough discovery. Unfortunately, the breakthrough here is the knowledge that our facilities are disproportionately contributing to harmful emissions**.** So, what are some of the main contributors that drive this elevated energy consumption?

JB&B: The most significant drivers of the high energy consumption in vivariums are the large airflow rates, which in turn are driven by codes and standards, all of which focus on reducing the concentration of contaminants and odors in the air. While high air changes reduce those concentrations, they have an adverse effect on energy use. All of this air is once-through, meaning that it's pulled directly from the outdoors rather than recirculated within the building. As more outside air is brought into the building, more energy is used to heat, cool, and move that air around the building. With our case study project, the vivarium is divided into two parts: animal holding and non-critical vivarium spaces. Animal holding maintains 15 air changes (ACH) at all times, as recommended by AAALAC International and other industry standards, while the non-critical vivarium spaces maintain 10 ACH at all times.

While airflow rates are the most important drivers of high energy consumption, there are other notable ones. Vivariums are typically used in them. Vivarium spaces often have species-specific humidification requirements.

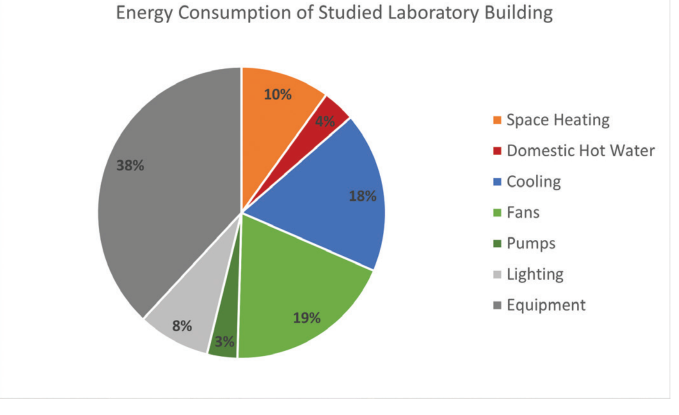


Figure 2: Fraction of energy use attributable to components of the studied HVAC system

Unlike typical office space, in which spaces are usually allowed to become drier over the winter, specific levels of humidity must be maintained for the animals in vivarium spaces to avoid confounding research results.

Finding Solutions

CB: With regulatory requirements trending toward stricter parameters that require more energy, higher energy use in animal facilities may be, to some extent, unavoidable. What are some of the solutions we can implement when renovating an existing animal facility or building a new facility to reduce this trend?

JB&B: The first step toward implementing a sustainable option is to understand the cost-benefit and value proposition to the institution against some of the limitations the solutions might pose. These facilities are critical to research; keeping them online during power outages and equipment failures is paramount, so as not to compromise ongoing and previous research. Each new technology needs not only to be reviewed from an energy conservation standpoint but also from a reliability perspective. The key is realizing that numerous measures must be tested, since many of them may not make it to the final installation. Early on in the design phase, the design team will prepare an exhaustive list of energy conservation measures (ECMs) and will share the results with all of the project's stakeholders. This approach can be applied to new builds and even major renovations for existing animal facilities. The key to retrofitting into existing facilities is to layer in how they're implemented in order to minimize downtime in the facility. The design and construction team needs to plan for a method of procedure to provide a seamless implementation.

For the case study noted above, here's the list of ECMs that were investigated in the early schematic phase of design. Their relative costs and benefits varied.

CB: Given the high energy demands of animal facilities, this appears to be a great opportunity to implement energy savings, but even new builds aren't consistently choosing sustainable options when it comes to decisions on building materials, infrastructure, and design**.** What are some of the common obstacles to implementing a sustainable design, and how do we overcome these?

JB&B: The main reason many of the ECMs are not implemented is the construction cost. A simple cost-benefit analysis showing payback savings over time is one way to ensure that ECMs are implemented in the final build.

Opportunely, these long-term cost savings can be an essential resource for supporting an institution's environmental social governance (ESG) goals as well as understanding how city, state, and federal regulatory compliance is currently evolving and where it might be heading in the future. There's no doubt that the trend in many locales is toward pursuing more stringent energy conservation measures as well as reducing operational carbon emissions from facilities. You can think of cost savings motivation as the carrot and regulatory repercussions as the stick to overcoming sustainability barriers.

Another critical obstacle that needs to be overcome is bridging the gap between the design team and the facility operators. The operators need to be involved with the project design at the very inception of the project so that they can understand the various ECMs and offer feedback on the pros and cons of each. Breaking down

Energy Conservation Measures (ECM)				
ECM		Implementation Method	Energy Reduction	Relative Implementation Cost
1	Animal Holding with 6 - 10 ACH	The use of ventilated cages in animal holding facilities allows for a reduction in the overall amount of air delivered to the space from 15 ACH to 10 ACH.	Significant reductions in heating, cooling, and fan energy.	$
3	Non-critical vivarium space with 6 ACH	The airflow rate in non-critical vivarium spaces, such as storage or supply areas, is reduced from 10 ACH to	Similar to ECM 1, this saves on heating, cooling, and fan energy beacause airflow rate through this air handling unit is the main driver of high energy use in this space.	$
4	Aircuity	This provides active feedback by sensing contaminants in the exhaust air in order to increase or reduce air change rate within the space based on real-time air quality feedback.	Maximizes reductions in heating, cooling, and fan energy while ensuring quality of air.	$$$
5	Konvecta heat recovery	This form of heat recovery provides a boost to the dehumidification ability of the system.	Reduces the amount of heat lost to reheat.	$$
6	Steam heat recovery for sterilization	Steam condensate is recovered from the sterilization process, and the heat in that condensate is used to preheat incoming water.	Increases the efficiency of the sterilization system.	$$
7	DOAS with local recirculation boxes	Air handler flow rate is reduced by local DOAS boxes with enhanced filtration capabilities that run at 9 ACH in the animal holding and 4 ACH in the non-critical spaces to achieve a resulting 15 ACH and 10 ACH required in these spaces.	Reduced energy consumption by running high air changes locally so that pressure drops in the main air handling system are minimized and reduces outside air rate, which contributes to lower heating and cooling energy.	$$$
8	Occupancy sensors for setback	The non-critical spaces are able to set back to 4 ACH during unoccupied hours.	Reduces heating, cooling and fan energy during unoccupied hours.	$

barriers and socializing all considerations is critical to the success of the project. The last thing the project team wants to see is that operators override various ECMs because they don't meet the needs of the facility, and there's concern about maintaining stable environments within the facility. One example would be if the amount of supply and exhaust air provided to the animal holding spaces is lowered to a point that the odors within the space are not palatable for the operators.

CB: Since we all share this planet, any successful approach will require a coordinated effort across different industries, cultures, and governments. In the U.S., there have been multiple efforts to reduce energy consumption nationally, including President Biden's bold commitment to ensure that the U.S. achieves a 100% clean energy economy and reaches net-zero emissions no later than 2050. How does this, and other changes in regulations, affect how we build vivariums?

JB&B: That's a great question, and the landscape is changing every day. We're seeing new regulations springing up all over the country; all focused on energy use in the built environment. Where we typically only had to think about meeting local Energy Codes, we now have to think about numerous other aspects of energy performance throughout the life of a building. Just recently, in cities such as New York and Boston, we've seen new regulations that limit the number of carbon emissions an existing building can produce, with potential financial penalties if the building exceeds its allotted carbon. The financial penalties from these new laws are front and center in every conversation about how to build out new vivarium spaces and are having the effect of driving more efficient solutions than would have been considered even a couple of years ago.

On a broader scale, we're seeing state governments committing to "greening" their electricity grids at a rapid pace. States are planning to phase out their fossil fuel-burning power plants and replace them with sustainable alternatives such as solar, wind, and hydropower. By greening the grid, it allows buildings to source carbon-free electricity from the grid as well as to implement alternative solutions (heat pumps, for example) that can heat and cool buildings using only electricity. This has resulted in reducing carbon emissions at the building level and helping buildings meet stringent carbon reduction goals. It all circles back to taking the time and effort to investigate possible energy conservation measures at the start of the project in the context of the specific project and location to implement the most sustainable measures.

Where We Go From Here

Now more than ever, we need to consider every design element and its concomitant energy use implications in order to meet more stringent Energy Codes and reduce our global impact. To successfully achieve proper functioning *and* sustainability, vivarium users and operators in concert with design professionals, need to be aligned with the goals and objectives of these facilities. It is unarguably daunting, but new innovations and our deliberate strategic collaboration with industry partners and experts such as JB&B provide good reason to think that sustainable animal facilities are something we CAN achieve. When not every project can get the green light, choosing your animal facility for sustainable change is a great place to start because the reduced carbon impact from these changes is predictably significant.

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