Virgil
Why did you all decide to make the Net-Zero Energy Warehouse?

Victor
The primary goal of the facility was to accommodate and consolidate all the NIEHS warehouse operations that previously occurred at three separate locations in the area not even all on the NIEHS RTP campus. The Net-Zero Energy Warehouse consolidated operations that occurred at the Module-E Loading Dock marshalling area, the Building 104 Warehouse, and the Davis Dr. lease warehouse.

Administrative support personnel were physically separated. This decreased productivity and coordination and increased supervision requirements. The consolidated NZE Warehouse location included the added benefit of decreasing delivery traffic onto the main campus through the NIEHS main gate with a separate designated entrance for all deliveries that could be scanned and ensured safe before they were brought on the main campus.

Virgil
Alright, yeah! I see that it's very useful; bringing all these separate things together and making an efficient building that makes *processes* more efficient. That's pretty good.

Victor
Yep.

Virgil
Could you give us a brief history highlighting some of the key points in this warehouse's total development?

Victor
Sure! 2010 was really when the idea started. There was a feasibility study commissioned by NIH and conducted by the Metropolitan Architects and Planners (MAP). They investigated the viability of, at that time, constructing a combined warehouse and receiving facility for both NIEHS and EPA in the area [where] we now have the Net-Zero Energy Warehouse on the north end of the RTP campus.

In 2012, that preliminary program was updated and modified by set associates to include a program of requirements and 35% leveled bridging documents with contributions from Flad Architects, Stewart Engineering and Mulford Cost Management. In 2015, HHS provided Nonrecurring Expenses Fund (NEF) funding for the project, and we solicited a design-build contractor to construct the Net-Zero Energy Warehouse.

We made a contract award in August of that year, and design efforts began in earnest by November. In 2016, our civil design documents were complete, and we began site work in March. The building design documents were completed by October and the building was occupiable by July of 2017. That's when we received our Certificate of Occupancy.

Virgil
Ok, so that's *seven years* [as a] timespan. This is a pretty intensive project here!

Victor
Yeah, from initiation, in terms of a thought, to actual physical construction completion, it took seven years, most of which was waiting for funding!

Virgil
(laughter) Oh man, a tale as old as time! Well then, could you go over some of the core features that make up this warehouse? [You've] talked about all the cool benefits. We see it needed a lot of funding [and] time to put together. How does this warehouse operate? What [are] some of its core features?

Victor
Are you referring to construction features?

Virgil
Construction features and operation features. What helps it be efficient? What helps it carry out all the tasks that you described earlier [for which] it was put together to consolidate?

Victor
OK, sure. From a construction standpoint, it was a LEED Platinum-Certified facility. That was a large hallmark and proud achievement for the project and for the building itself. As a result of that, it has your hands-free bathroom fixtures! That was really leading the curve in terms of touch-free experiences. COVID really highlighted that being a necessary attribute of facilities to maintain a healthy environment. We already had that, so there weren't any modifications required at the Net-Zero Energy Warehouse.

Lighting inside of the facility is unique. We incorporate Solatube tubular skylights as well as barrel vault skylights [and] lots of windows surrounding the open office area. [We've also] integrated occupancy sensors, and photocells with all the lighting fixtures to maintain preset lighting levels. We have daylight harvesting across pretty much every fixture within the facility. Areas that were internal to the building all have some sort of skylight, whether it's the Solatube or the barrel-style skylights.

From an HVAC perspective, which helps with operations, we have a 4-pipe variable refrigerant flow (VRF) heating and cooling system for all the administrative areas. That provides us simultaneous heating and cooling capability, meaning that you can have one office on the interior that needs to be heated while exterior office, maybe they'll have more sun exposure and more radiant heat from the outside, can be cooled. That refrigerant flows bidirectionally. It is sent from a combiner location and pipe to the individual air handlers inside of every office. So, there's a combined condenser unit outside of the building, then each individual office in multiple areas inside the open office area have their own air handler system. That way they can operate to provide occupant comfort at a local level while maintaining energy efficiency.

Within the warehouse['s] larger area, we have infrared natural gas heaters that were used to provide occupant heating, to avoid having to heat the entire space. We wanted to be able to directionally provide heat in the areas where it was necessary. We also have [an] energy recovery ventilator for providing fresh air and recovered energy savings for all the spaces that are serviced by the heat pumps. That helps us have the most energy-sensitive and efficient heating and cooling system for the areas that are cooled to occupant levels throughout the summer and the wintertime frames.

The building shell itself was built with high-performance materials to minimize any thermal bridges that might occur. We have continuous insulation effectively around the entire perimeter of the building, from the walls with concrete- or metal-insulated panels around certain portions, to a complete continuous insulation system for the roofing system. That provides us the ability to keep the heat in or out, or keep the cold in or out, depending on what season we're talking about.

Of course, one of the unique construction aspects is the photovoltaics that are on top of the roof. Every available inch that we had, we pretty much covered to be able to meet the net-zero energy criteria; producing more energy than we consume. From an operational perspective, we have some neat pieces of equipment that that are inside the warehouse.

We have two types of X-ray machines, one that can support full palette scanning capabilities. So, you can have a pallet of materials that goes through a large X-ray machine, and they can scan it for anything that may not be desired to come on campus. We have a smaller X-ray machine that's used for mail and smaller packages that may come through.

We then try to be efficient with our cardboard recycling, so we have a compactor. It's located inside, so all our cardboard is compacted. We have all the excess materials that get sent for disposal-surplus purposes is also staged at this warehouse. That was one of the operations that [were] moved over. We [can] package materials into pallets there as well.

We have one of the spinning disks that [are] able to shrink wrap pallets of material down. That's where bulk chairs might get stacked on top of pallets or a series of cabinets that are going to be surplus get stacked together and then shrink wrapped to be sent out. All the interior shelving inside of the warehouse portion is designed to be able to support pallets of material, so it can be efficiently stored and labeled and organized four layers high.

We have high-capacity, 'Home Depot' style storage inside the warehouse itself. We also have an onsite electric lift in case we need to go up and do a quick change to any lighting features or any other equipment that's up in the higher portions of the warehouse. Many of our exhaust fans are mounted with controls that are the next to them and we'll use those lifts. They were all constructed so they would be in the aisles of the warehouse and not overlap with any of the storage areas. So that way everything was maintainable with equipment that could be done so without interrupting operations simultaneously.

Virgil
That is really awesome! You have all the bells and whistles, and it really seems like every centimeter of this place was very well thought out. It's cool to see what a LEED Platinum building is really capable of, and all the thought that goes into it. But, with every modern marvel, there's definitely some difficulties that go behind it. Could you go through a couple of key difficulties that you all experienced in the construction or even the maintenance of this warehouse?

Victor
Sure! [There are] definitely challenges with being able to achieve a net-zero energy facility of any nature. Yeah. The first challenge from a construction standpoint [is ensuring] the selection of materials [is] consistent with the energy model. LEED doesn't necessarily address this, so it's really something that you [must] look at separately. Energy modeling is a part of LEED, but the follow-up to that is making sure that the materials [have] certain energy criteria that is embedded into it, whether it's a U factor or an R factor. [This could be with] the glazing system, the insulative properties of the structure, the CRA rating of the HVAC equipment, the lighting levels, [even] the doors. [It includes] every component in the building.

Those specific factors [must] be compared against the energy model. You would hope that the specifications themselves covered all those salient characteristics and it would be a straightforward

process from just a specification review criterion. But there are modifications being made throughout a design-build type project all the time.

What we would always rely on was backing up to “what did you model for this building”. You can change the specifications how you need to [in order] to facilitate whatever supply chain constraint that you may be faced with right now or whatever increase in cost that you weren't anticipating, but is it equivalent to what you modeled in the energy model? If it's not, provide us an updated energy model so that you're able to substantiate that the PV that's being selected and programmed for the rooftop is going to meet our net-zero energy criteria.

That was always a battle point with the construction team, because subcontractors aren't necessarily looking at that type of information. They're looking at other criteria whenever they're submitting materials to be utilized. The construction team was looking at the criteria in the specifications and sometimes the specifications don't discriminate and give some of those factors as a part of your normal specification that's used for a building. So, we had to take the extra effort to go back and compare to make sure that we had all of our building systems consistent with how they were modeled so that when we actually turned over something, we would have a reasonable expectation that it was going to perform as expected.

The occupied period of time is also significantly important. Models are based on time of use, number of devices that are utilized, certain amount of energy consumed by peripherals, meaning computers, printers, refrigerators, and space heaters. Educating the building occupants on what that limitation was, which might not be what you experienced in the day-to-day inside most of the buildings that NIH. You're not allowed to space heater, personal refrigerator, toaster oven, or other things that people may acquire over time and bring it to their office to make it like home.

That was a training effort, to make sure that they understood that there was a consequence and that we were trying to have a holistic goal of being net zero energy. Their contribution was maintaining [this goal]. You're cutting your computer off and not leaving it on overnight. You're not bringing in a mini fridge [for] your own personal Coke products [instead of] putting them into the building supply break room. Those types of things were very important.

[We’re] trying to be realistic with temperature requirements in the space. Some of the areas were open office environments and not everyone appreciates the 72-degree day. Some people may think that's cool, [others] may think that's warm. Trying to say: it's OK to put on a jacket or a sweater. It's OK to have to wear that inside because your partner on the other side is warm-natured, right? We're trying to keep it reasonable year-round for everyone.

Some areas were easier to accommodate because there were certain individuals that may prefer it to be [cooler] in the wintertime, ironically. They were in an interior space of the building, and that could be accommodated without an impact to the energy model, right? If you're keeping it cooler in the wintertime [and] warmer during the summertime, those are more efficient operating parameters.

Those were OK, but situations where it was going to be contrary to that, we had to help inform and educate the facility. Believe it or not, not bringing extra -80C freezers and just plugging them in because they were surplus. As you can appreciate, those are energy hogs! So, we didn't have any -40s and -80s programmed into our energy model. When we noticed that some of our trending was going the opposite

direction of what we expected, we did a walk through the facility and found that we had some of those types of equipment that were being utilized and that drastically affected our ability to meet the net-zero energy goals.

Occupant participation is *critical* to success in one of these types of facilities. It can't be done without a group effort. From the construction component all the way to how you're going to use the facility, [it] has to be consistent with how it was planned to be performed. Otherwise you're going to start deviating.

Virgil
That is very, very interesting. I feel like often, when we hear about these cool engineering projects, the only thing we think about [is] the engineering side and we don't think about like the communications, the behavioral aspects, the accountability, not only in the construction but the operation. It's interesting to see how that comes to play in such a meticulous manner. Literally having a personal space heater could mean the difference between we meet our goals and we don't. It's pretty cool that you guys track down to that level!

Victor
Yeah!

Virgil
That's neat that you're paying attention so closely.

Victor
We put together an occupant guide to help facilitate the communications in the training. We went over that with the building occupants before they occupied the facility. Then we came to find out they had a contract change and a big personnel change so we ended up doing it again. It became a learning opportunity to where this needs to be a continuous training situation, because people come and go. They need to understand what type of facility they're working in, what their contributions are, and how that can positively or negatively impact our goals overall.

Virgil
That's interesting. We see here how such an efficient building needs all this precision and jumping over hurdles and facing challenges. What's the opposite side? What are the benefits and positive impacts from this Net-Zero Energy Warehouse? Why are we putting all this attention, time, and precision into it?

Victor
Well, it has the benefits of having lower ongoing utility costs. On an annual basis, the only electric cost that we have paid for that facility have been the standard electrical standby charges and the basic facility charges. The utility charges [the electrical standby charge] to have a transformer outside to be able to utilize energy from the grid if it were necessary.

Per our billing statements over the lifetime of this building, the 12-month usage has been ‘not applicable’. It’s been zero! (laughter) You can look at any billing statement from the time that we turned over and accepted it. We have never consumed enough energy to qualify towards being billed. During the wintertime when we have shorter days and higher energy consumption, we've been utilizing our credits from the summertime. It's always offset on an annual basis.

Another positive aspect of this facility that the occupants can say they're a part of is: they're living and operating in a the first LEED Platinum and net-zero energy building in the HHS portfolio. That's a pretty proud thing to be able to say. Obviously, the next one won't be able to say that, but it's nice to be first sometimes and be able to say you are.

For the facility itself, it [provides] more efficient and secure operations for deliveries to NIEHS. They're able to be done in a space that is easily maintained and very efficient. From an operating perspective, it was a net savings to the Institute who has to pay for a lease facility that was separate [from] what we have currently now. The operating expenses were higher because you had more people that were spaced out in different areas.

Obviously, you have a much more controllable situation with every delivery from mail to large packages coming into a centralized location. They can be physically scanned and ensured that if someone rolled into the campus with an 18-wheeler filled with explosives, it's not going to damage our critical research facilities. It would be a bad situation, but it would not impact our ability to continue to operate. It would be a much smaller impact overall from a consequence perspective. Hopefully something like that would never happen and because of the security that they have to go through to get to the building, I wouldn't expect it ever to happen. But it's much safer for all the occupants at NIEHS as a result.

Virgil
I see. That's good! Again, that is another thing where you look at these green fixtures and things, [and] it's cool to hear the actual energy reduction and cost savings, but you never think about efficiency going over into the security sector as well. These are some neat points and I thank you for bringing them up!

Moving forward into the future, we have these executive orders that are requiring a lot of these energy reductions and the whole general trend is trying to go towards net-zero buildings to save costs, improve efficiency, and reduce greenhouse gas emissions. What are your thoughts on the future of net-zero buildings as it relates to NIH?

Victor
Well, NIH has a huge energy budget with uncontrollable costs, right? Some of the cost for energy are consumed by research, and they're not fixtures, there's not any green methods that are substitutes at this time. That's going to be a huge challenge for NIH, to be able to meet that requirement.

It's going to probably lead towards purchasing power to offset the consumption, on the main campus at the very least. [This would include] solar, wind, or other types [of electricity sources] that don't have the carbon impacts. We can certainly make a big impact by improving the types of facilities we build, ensuring that we're selecting the most energy efficient equipment that's possible, and selecting and designing buildings that are oriented properly. [We would] be able to improve upon the radiant qualities that happen naturally in the environment.

[Also, we'd] put the additional effort into building our structures so that they have the energy efficiency they need from a thermal conductivity perspective to minimize the sizing of equipment that we have to utilize. Animals require certain temperatures that can't be fluctuated. They don't have nearly as much flexibility as we humans do! In some cases it may be [that] we have to take a different approach on what we consider to be comfortable as well. If we're really going to be serious about net-zero, we're going to have to be a little bit uncomfortable.

It's going to be a situation where, as I was describing earlier, the people who operate and occupy the facility are going to have to [own] the perspective that they're making an impact to the success of NIH as a whole [in] meeting its energy goals. If we do that, we can certainly come a long way. But when you're operating hospitals and labs, there's certain things that require a large use of energy that we don't have a lot of control over.

But we can do smart things in our construction to help reduce it substantially. With employing those technologies and those efficiencies, we can make big strides. We can get there; it's just going to take some time and social engineering to make it important.

Virgil
Absolutely, well said. This has been very enlightening! At the end here, I always add one more question. I go into these with a certain perspective as an environmental engineer in DEP. [But,] there might be some aspects about the project or topic as a whole that I don't know about. So, I just don't know to ask about it to begin with. Is there anything else on this topic at all that I might not have asked that you'd like to share?

Victor
Well, the project was constructed in the area of campus that's segregated. Most folks who watch or listen to this interview and hear about it are not going to be familiar with the RTP campus. This specific area is segregated. It's on the very northern portion. It's not connected by any internal roads, so it's truly an isolated facility that now has the capability to basically island itself and operate in the event that we have a situation that impacts our power usage on campus. [This is] because of the photovoltaics, having backup energy from generators that are necessary for safety purposes, and the efficiency that was put into it.

Because this facility is not connected to the same grid per se as the main campus, we don't have the same reliability with the service that we receive for the warehouse as we do our main campus. As a result, that added benefit of it being a net-zero energy building makes it where we can actually continue to operate whenever we have electrical outages. [These] are more prevalent and routine because we're now being fed off the residential local commercial grid as opposed to the industrial grid that the NIEHS main campus is fed off of.

The windy days where a tree limb may fall has no effect on main campus. Everything's underground distribution and we're receiving power from the high voltage system. We're now being affected by the lower voltage residential small poles that are used to distribute energy in the Durham area. That's something that is unique: now we're able to continue to operate and be resilient because of the energy savings and the expectations of the project.

That was kind of an added benefit now, that was not necessarily considered on the front end. It would be cost prohibitive to connect to the grid that we service the main NIEHS campus from versus now with the use of solar and backup generation, we can now be resilient to the same level as the main campus, which is pretty cool.

Virgil
[I] feel like this whole thing is pretty cool! Good way to describe it. Thank you so much for your time and insights on this project.

Victor
Absolutely. Well, I'm glad I could help.