Net Zero Energy / Carbon: Feasibility and Challenges in Connecticut

By Ken Lambert, CSI

It would be hard to work in the AEC community for a week and not hear or read something about net zero. That could be net zero energy, or perhaps the related subject of net zero carbon emissions. Many people outside of the design and building field have also prioritized these goals, from politicians to young students.

Of course, working or living in a building that does not release any carbon emissions is a very worthwhile goal. This is evident across the nation. Architecture 2030 seeks a 50%-65% reduction in carbon emissions by 2030. SE2050, representing structural engineers, has similar goals.

In Connecticut, per the 2018 Governor's Council on the subject, the state is seeking a 45% reduction in greenhouse gasses (GHG) by 2030 – just 9 years away. Their goal is an 80% reduction by 2050.

Declaring something and implementing it are two different things, and today in 2021 the state, and the AEC industry in general, is in the first phase of achieving the ambitious goal. Though there is much written about net zero and there are several similar groups which are rating and advocating for green building practices, the truth is that- so far in Connecticut- we have very little building stock that is clearly in the net zero/ net zero ready realm:

- # of LEED Platinum buildings completed in CT, under LEED v4.1 or v4: (3)*
- # of Passive House Certified buildings completed in CT: (3)*
- (*All as of June 7, 2021. None listed are larger than 3,500 SF-GLA.)

Architects are keenly aware that the devil is in the details, and they also need to help decipher what the additional upfront building costs might be per specific building project to achieve net zero or at least be "net zero ready".

There are two issues as we look towards 2030: existing buildings, and new construction. In many ways, creating a net zero building from the ground up is much easier than retrofitting an existing building, which many times could be 40-60 years old (or older). One reason why it is more feasible is because we have already

analyzed and learned from existing building inventory and its energy usage, and we can incorporate that knowledge into our pending designs.

Is net zero attainable for our existing building stock?

"The vast majority of existing buildings and new buildings into the foreseeable future will not be candidates for ZNE," according to Incremental façade retrofits: Curtainwall technology as a strategy to step existing buildings toward zero net energy (Patterson, Vaglio, Noble – 2013). While this statement is now 8 years old and we have been designing and building more energy-efficient buildings since, it is still worth taking note of.

Patterson (et al) in their paper were talking primarily about glass curtainwall facades, and their opinion that in general, for many "glass towers" it is not practical, or financially viable, to retrofit the exterior walls on these buildings to attain a better effective R-value.

That said, moving forward, it would be wise to strategically consider a building's Window-Wall-Ratio (WWR), as the WWR is one of the key criteria in a building's energy usage.

The US Department of Energy (DOE) has much to say about this very topic, via its 2015 report Building Energy Asset Score: Program Overview & Technical Protocol. The report looks at 18 different building types and analyzes the relative importance of different criteria on building energy usage.

While interior lighting power density ranks near the top, a building's WWR is in the top 4 criteria in 61% of all building types.

In urban areas, it is common to see 15+ story buildings, with a significant percent of their facades as glazing, vs. an opaque wall surface. How can this be designed, exactly, and still result in a net zero structure?

One recent example, which will be completed by 2023, is the Boston University Center for Computing and Data Sciences, which aims to be LEED Platinum with net zero carbon emissions. It is an attractive and unique 19-story building with a significant portion of its exterior walls as glass curtainwall.

If this is a potential model for net zero for a (relatively) tall glass structure, how exactly are they doing it?

All glass is triple glazing

- Incorporating fixed exterior louvers on the entirety of the facades, which limit the SHG
- Using geothermal as one of the fuel sources; had to drill 1,500 feet down to access
- Heat pumps planned as primary heating mechanism
- Using on-campus (but not at building site) solar panels to supplement power needs
- Using an offsite, out-of-state long-term wind power purchasing plan to supplement power needs

As referenced above, energy efficiency is certainly not all about glazing or the WWR. There are many factors at play, and architects and owners need to weigh the benefits and costs, both upfront and ongoing, of each.

One such benefit sometimes overlooked is that of thermal mass. According to ArchitectMagazine.com (May 2009), "The thermal behavior of a material is a function of its density, thermal conductivity and specific heat capacity. Thermal mass is an attribute that represents the best combination of these three properties for absorbing, storing and slowly releasing heat." Masonry and tile products naturally exhibit significant thermal mass, which can be taken advantage of whether we are designing an exterior wall or an interior ceramic tile floor layout.

What about building height, as it pertains to energy efficiency and net zero? Are we entering an era where we will not see many new 20, 30, or 60 story buildings?

Ann Edminster (The New Carbon Architecture) states that the most energy-efficient building height is between 6 and 12 stories.

Similarly, per a report by Adrian Smith + Gordon Gill Architecture, the ideal building height for energy efficiency is 4-story within a courtyard layout.

In cities, with higher land values, it often is not financially viable to build "just" a 4-story building. So, when a developer or company wants to build a 30-story building downtown, yet it must be net zero, how does that work, assuming there are added construction costs?

Voters, politicians, and city commissions are already beginning to grapple with this dilemma. Many have already started or are considering funding building energy upgrade grants or zero-interest loan programs with public monies.

Another key point regarding green building is how long will the building remain before it likely will be torn down? In order to reduce demolition and landfill needs, designers need to carefully consider the life expectancy of common building materials. According to the "Recommended guidelines for building component lifespans in whole building life cycle assessment" by the Carbon Leadership Forum (2018), these are the likely lifespans of common exterior envelope elements:

- Precast Concrete Panels: 30+ years
- Metal Curtainwall: 30+ years
- Glass Curtainwall: 30+ years
- Brick / Stone / Concrete Block: 50+ years

These are the key concerns, and opportunities, that the industry is grappling with in 2021 and likely well into the future. The decisions, including State Energy Codes/ Addenda as well as municipal bylaws, that we enact now will have far-reaching repercussions. Architects, engineers, contractors, and manufacturers need to work with those in public service and in finance to best meet the needs of Connecticut and the nation.

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