A RATIONAL APPROACH TO LARGE BUILDING DECARBONIZATION:

Lessons from New York's Empire Building Challenge

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In the last half-decade, we've witnessed a radical transformation of mainstream narratives around climate crisis mitigation and adaptation, economy-wide decarbonization initiatives, changes in low carbon technology readiness, and policy action at various levels of government. There is now broad agreement and recognition that removing fossil fuels from buildings through electrification is required to achieve emissions reductions necessary to significantly impact climate change and meet overall international goals. As such, replicable strategies to decarbonize large and complex commercial and residential buildings are now a major priority among policymakers, government agencies, and industry experts, particularly in New York. In 2019, the State of New York enacted the Climate Leadership and Community Protection Act (Climate Act) putting the State's economy on a path to carbon neutrality by mid-century. The same year, New York City enacted the Climate Mobilization Act, including the building emissions and performance standard commonly referred to as NYC Local Law 97 (LL97) to mandate significant carbon emissions reductions from the buildings sector, which dominates total carbon emissions in the city and is responsible for one third of the economy-wide greenhouse gas emissions in New York State.

This shift in policy on decarbonization has been met with both optimism and skepticism. Optimistic stakeholders explain the benefits of electrification on greenhouse gas emissions, local air quality, opportunities for jobs creation, and better temperature and indoor air quality control. Skeptics call into question the "Electrify Everything" narrative and say this mild-climate California approach is not adaptable to the cold climate of the Northeast.

Through a thoughtful and rational approach, building owners can successfully transition their assets to low or zero carbon operations before self-determined timeframes or regulatory deadlines. Resource Efficient Electrification (REE) combined with an integrated design approach is focused on making incremental changes and enabling steps over time to achieve deep decarbonization without the need to rely on silver bullet solutions. As is evidenced by the recent wildfires on the West Coast, severe flooding in New York from recent increased rainfall, and catastrophic flooding in Europe, climate change is here and doing nothing to address it is not an option.

The Empire Building Challenge

In partnership with the New York State Energy Research and Development Authority (NYSERDA), some leading real estate development companies are tackling these complex issues head-on. The industry and its ecosystem of consulting engineers is discovering a framework for decarbonization tailored specifically to large buildings in cold climates. In the United States, New York is at the forefront of this school of thought. NYSERDA launched the $50 million Empire Building Challenge (EBC), a public-private partnership to spur economic growth in New York by developing solutions to decarbonize skyscrapers and tall multifamily buildings in conjunction with some of the world's largest real estate holders, manufacturers, technology experts, and entrepreneurs. This first-of-its-kind program in the United States addresses high-rise buildings, a difficult building typology to decarbonize, as part of New York State's comprehensive effort to make low-carbon solutions for tall buildings widely available and deliver cost-efficient and replicable decarbonization solutions.

Ten real estate partners made commitments to reach carbon neutrality in at least one of their properties by 2035, representing 52 million square feet of real estate. These commitments include some of the most iconic buildings in the New York City skyline and the potential to scale across entire property portfolios. The 130 million square feet of EBC Partner portfolio buildings is as much real estate as is contained in some mid-sized American cities. The decarbonization investments of the partners alone are expected to total up to $300 million and create up to 2,600 jobs in the clean energy economy.[1] For more information on the Empire Building Challenge, please visit the NYSERDA website.[2]

Decarbonizing Cold Climate Buildings Requires a Novel Approach

The real estate industry and the industries in its sphere of influence are awakening to the realization that fossil fuel-powered equipment has a limited future in buildings. As asset managers, sustainability managers, and their consultants pursue decarbonization plans, they often stumble over what we refer to as decarbonization "blind spots," or a linear mindset that can delay needed action and progress such as:

Really Simple Paybacks

Would building owners get a straightforward answer if they asked for the simple payback of a lobby renovation project? Instead of looking for tangential ways to create value, consulting engineers often use energy savings alone (and some may now include carbon emissions fines savings) to justify investments in energy conservation measures, resulting in unattractive investment economics. An alternate approach would be to conduct scenario analyses including net present value calculations. The lowest net present cost, or negative net present value (NPV), over the decarbonization period will provide deep insight into which energy conservation measures to choose. Return on investment (ROI) and/or internal rate of return (IRR) on the incremental cost of action over a do-nothing baseline will help persuade real estate owners to prioritize these projects. Rather than a simple payback analysis that looks only at the decarbonization path, analysis should focus on comparing a decarbonization path with a "business as usual" path. This approach helps isolate the incremental cost of decarbonization over a business-as-usual approach. Other savings sources like maintenance savings, reduced business interruption, or value at risk can be included. This type of analysis requires completing a Strategic Decarbonization Assessment (SDA), which is based on a discounted cash flow (DCF) analysis over the decarbonization period. The SDA should include the complexities of capital refresh, tenant improvements, and non-energy benefits. Asset investment should be in context of a comprehensive decarbonization roadmap rather than simply reactive maintenance.

Isn't this Plug and Play? Or, Why Can't I Replace My (Oversized) Boiler with an Air Source Heat Pump?

A one-to-one equipment swap with air source heat pumps, which is typically the first full electrification option considered, may not be a realistic decarbonization strategy, particularly for owners of large buildings facing various constraints around thermal distribution systems, outdoor space, tenant disruption, and energy supply. In fact, we are suggesting that you determine the building's need for heat pumps towards the end of the decarbonization road mapping process so these heat pumps can run optimally. Significantly reducing loads, recovering and reusing heat wherever possible by enabling thermal networking, and using a cascading approach to decarbonizing easy-to-electrify loads is likely advantageous. Systems should be optimized to deliver heat or cooling efficiently over the integrated sum of the year's diverse conditions, the vast majority of which are at part-load. Efforts to reduce and shift loads can help reduce peak capacity, and electrification of more difficult peaks may require special consideration within the building's roadmap, taking a rational approach to resilience and accounting for evolving electric grid or thermal network supply conditions. This is the foundation of Resource Efficient Electrification (REE).

Electrify Everything…and Do it Immediately and in One Move!

Perhaps because the electrification movement was born in mild-climate California, the cold-climate, tall-building narrative has for a time been incomplete. Decarbonization skeptics suggest that if it doesn't make sense to electrify everything in one simple move, then it doesn't make sense to electrify anything. Air source heat pumps have improved tremendously and may be a key component of electrification in cold climates, but they are likely only one part of the complete solution set for large and tall buildings. Such buildings must overcome space constraints and distribution challenges to provide comfort at peak load conditions without straining the electric grid or requiring oversized, sticker-shock-inducing equipment capacity.

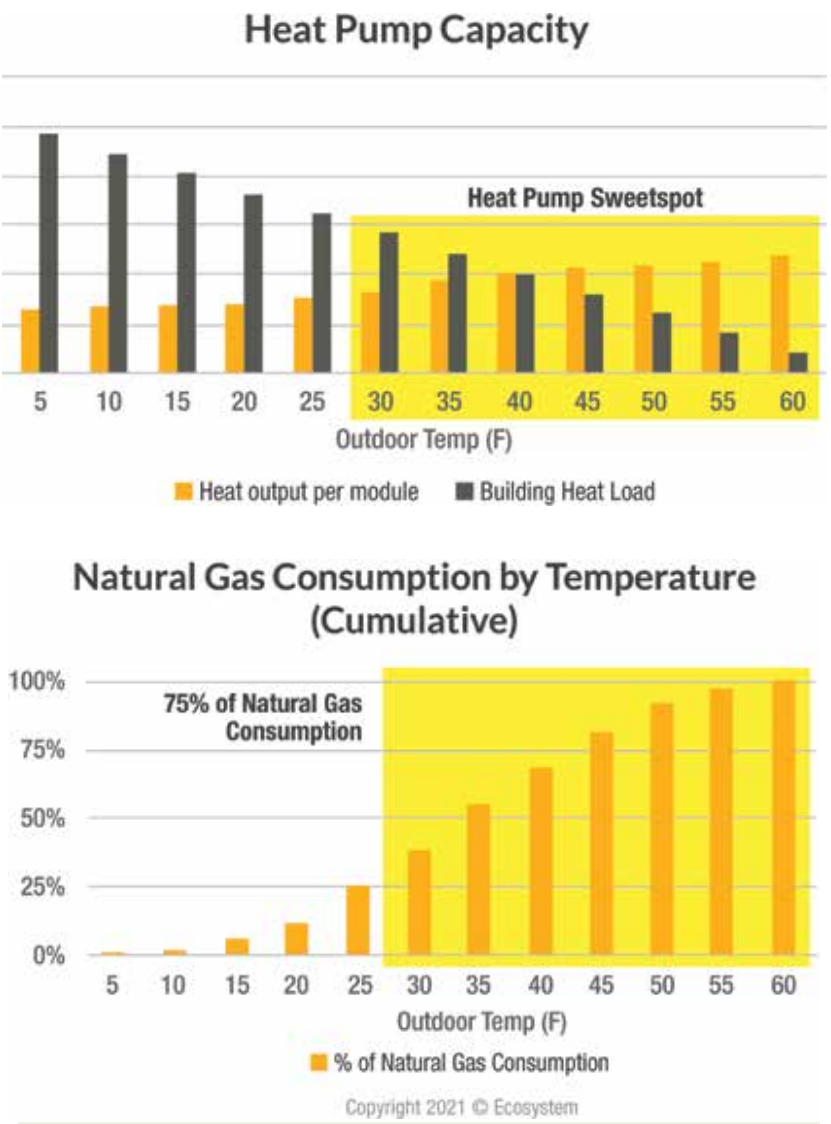

Image credit: Ecosystem Energy

Figure 1. Electrification is currently most feasible to cover loads occurring during relatively mild outdoor temperatures, and these are typically the vast majority of loads (75%+).

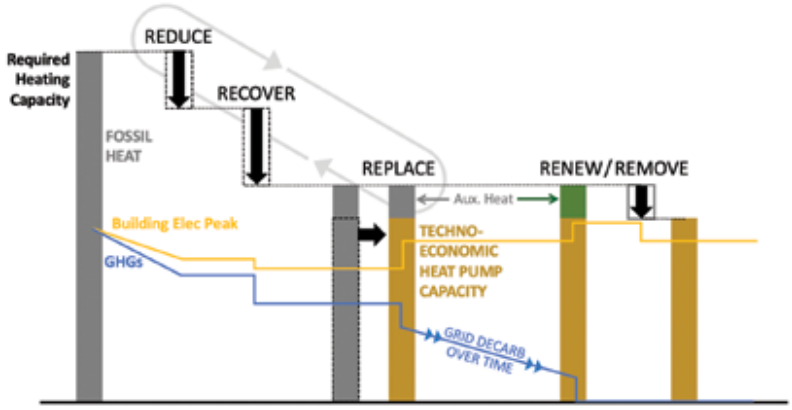

Image credit: RMI, NYSERDA

Figure 2. The "Five Rs" of Resource Efficient Electrification.

A more suitable chant for Northeast electrification cheerleaders should be "Electrify Everything . . . Efficiently." Engineers should model building energy consumption data across granular temperature bins (see Figure 1) and plan for electrification with "easy" loads like domestic hot water, then mild temperature loads (typically representing 80 percent-plus of total loads), and finally, for the extremes. This is the cascade approach, with an end-state goal of phasing out gas-fired boilers and steam radiators as technology solutions emerge to address resilient functionality during extreme conditions. Despite global average temperatures increasing, cold snaps may become more extreme thanks to a collapsing winter Polar Vortex.

But Technology is Changing So Fast, Isn't Something Better Going to Come Along?

Yes, but it is imperative that we start decarbonization efforts now. There are plenty of technology-neutral enabling steps to take prior to committing to a particular low carbon retrofit technology. Asset and sustainability managers should also recognize equipment doesn't last forever. Reducing loads, enabling thermal recovery, sharing and networking, and implementing grid interactivity measures are all priority measures that might take place prior to electrifying heat sources. Consultants must also determine the value of inaction and the value at risk if a building owner decides to do nothing. Balancing this risk with technological innovation on a time axis is a delicate analysis, and impossible to conduct without a Strategic Decarbonization Assessment. When in doubt, look to leverage your existing infrastructure like using chilled water loops for heating, replacing partial loads. Electrifying perimeter heating used during extreme temperatures may be a later priority or off the critical path on a strategic decarbonization roadmap. Look to the case studies emerging out of the Empire Building Challenge for more information on this strategy.

But My Tenants Don't Think This is a Priority

The question a sustainability or energy manager should be asking is: What other tangential benefits can be had from pursuing decarbonization early? For example, more and more Class A tenants are demanding environmental action from landlords to comply with shareholder environmental, social, and corporate governance (ESG) requirements. Accelerating façade improvements may reduce invasive and expensive maintenance later. Indoor air quality, improved comfort, and operability are emerging priorities among all tenant types.

Electricity Produces Emissions

If the electricity is driving heat pumps, particularly during mild annual part-load conditions, emissions are likely lower even today. States are legislating net zero emissions electricity, including New York's mandate as part of the Climate Act. Modeling total emissions over time using declining electric grid carbon emissions coefficients across multiple decarbonization scenarios is an important task. Phasing in electrification over time and in a strategic way is the only pathway to eliminating on-site emissions.

It's Too Disruptive and Expensive to Decarbonize a Building All at Once

Not necessarily, and it doesn't mean a building owner should abandon all attempts to decarbonize or plan for ongoing work to achieve carbon neutrality over time. Phased, incremental implementation of low carbon retrofits across a continuum is critical to reaching building operations carbon neutrality in cold climates. Avoid the all-or-nothing approach and evaluate the cost effectiveness of phasing and maintaining technology optionality and the risk mitigation benefits these efforts might deliver. It's important to remember decarbonization efforts fall on a decision-making tree that evolves as time elapses and technology, policy, or other conditions change; each branch of the decision-making tree is a new decision point. Sustainability and asset managers should plan these branch points over the decarbonization period.

Resource Efficient Electrification (REE) for Cold Climates

The Resource Efficient Electrification (REE) method of building decarbonization incorporates strategic capital planning, an integrated design process, and an incremental, network-oriented approach to deliver building heating, cooling, and ventilation which:

- requires limited or no combustion,
- enables carbon neutrality,
- is highly efficient at low design temperatures and during extreme weather,
- is highly resilient, demand conscious, and energy grid interactive,
- reduces thermal waste by capturing as many on-site or nearby thermal flows as possible, and
- incorporates realistic and flexible implementation strategies by optimizing and scheduling low carbon retrofits phase-in.

Figure 2 above illustrates a conceptual framework for accomplishing these objectives and overcoming the mindset challenges or "blind spots" described above. Specific measures and sequencing will be highly bespoke for a given building, but engineers and their owner clients can use this

bucketed "RRRR/R" framework to place actionable projects in context of an overarching decarbonization roadmap:

- Reduce loads, for example, with envelope improvements and advanced controls. Reduce the use of steam-fed radiators and forced air by moving to hydronic and/or distributed systems. Reduce supply temperatures to ranges of optimal heat pump performance.
- Recover, and store where necessary, heat otherwise wasted from economizers, simultaneous heating and cooling on thermal networks, correlated heating and cooling within daily load profiles, or other creative and opportunistic heat sources.
- Replace fossil combustion equipment with the appropriate heat pump technology(ies), to the degree techno-economically feasible, with emphasis on efficiently meeting the bulk of the building's annual load. Give separate consideration to meeting extreme conditions and retaining resilience.
- Renew auxiliary heat supply to meet the most challenging load conditions as the need is fully understood and technically, economically and environmentally resilient.

-or-

- Remove redundant fossil heat capacity proven to be no longer necessary.

Conclusion

Decarbonization blind spots are sabotaging the decision-making process for real estate companies and holding back progress on meeting climate goals and regulatory compliance. By adopting an incremental methodology and integrated design process combined with strategic capital planning, building owners can build a clear path toward carbon neutral operations. The Resource Efficient Electrification (REE) approach enables an understanding of the most economically and technically efficient scenarios to realize decarbonization of the built environment. Through the Empire Building Challenge, NYSERDA, its real estate partners and their consulting engineers are pioneering this approach, accelerating necessary change in the building sector and its supporting industries. EBC building partner case studies and deeper findings are forthcoming and are expected to transform the way owners of large buildings and their consultants approach decarbonization, creating a broader market for low carbon retrofit solution providers and manufacturers. These efforts, among others, will continue to cement New York as the primary hub and marketplace for low carbon retrofit technology in North America.

ENDNOTES

1. *www.urbangreencouncil.org/content/news/recovery-through-retrofits*

2. *www.nyserda.ny.gov/All-Programs/Programs/Empire-Building-Challenge*

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