Wildfire Smoke Impacts on Residential IAQ

I read March's *ASHRAE Journal* column, "Wildfire Smoke Impacts on Residential IAQ" with great interest, as I'm a resident of Fairbanks, Alaska, which is subject to significant wildfire pollution.

Interestingly, our local hospital is considered one of the worst spaces during a high smoke event. Our hospital has many 100% outside air spaces. While the MERV 14 filtration can greatly reduce $PM_{2.5}$, it does nothing for the volatile components, which gives the perception of high smoke. Buildings that can operate at minimum outside air quantities are perceived as much better. Chemical reduction filters have been discussed, but so far nothing has been proven to improve conditions.

During one of our higher smoke events, one where ash was visibly falling out of the air, our east-facing home could be completely closed down without overheating. I worry about our new south-facing home.

To me, HEPA filtration is the answer for residences. I doubt anyone would invest in mechanical cooling simply to mitigate the rare smoke event.

Robin J. Rader, P.E., Member ASHRAE, Fairbanks, Alaska

The Authors Respond

Thank you for your interest in this important topic. The focus of this column is residences, but ASHRAE is working to provide guidance for commercial buildings, including hospitals, through the development of Guideline 44P, *Protecting Building Occupants from Smoke During Wildfire and Prescribed Burn Events*. We agree with you regarding HEPA filtration in residential buildings during high smoke events. Multiple studies (including our example presented in the column) found that portable air cleaners with HEPA filtration were successful in reducing the indoor/outdoor ratio of $PM_{2.5}$ during fire events. For many, wildfires coincide with hot weather, and many households run cooling systems, which may increase outdoor air intake into their homes. For those situations, a combination of high MERV filtration and portable air cleaning may provide a solution during highly polluted days.

Chrissi Antonopoulos, Student Member ASHRAE; Steven Emmerich, Fellow ASHRAE; Brett Singer, Member ASHRAE; Rick Karg, Life Member ASHRAE

A Fistful of Dollars

Andy Pearson, Ph.D., P.E.'s, column "A Fistful of Dollars" in the March *ASHRAE Journal* correctly identifies both the reasons and the solution for commodified or "vocational professional" wages. The true worth of a job well done is not appreciated because owner benefits are uncertain.

The full efficiency benefits of our energy-efficient equipment are often never realized because of poor operations. Oversized and uncommissioned equipment result in low-efficiency operations. The fragmented nature of our industry, with split engineering consultant-contractor-owner incentives, makes first costs the only reliable metric.

To the question raised in the column on what a potential new business model for solving this issue could look like: A New Business Model: "As-A-Service."

Servitisation or as-a-service business models sell products as a service for creating additional value or new offerings. This business model helps asset owners avoid up-front costs and pays the service provider from efficiency cost savings if they materialize. The predictable pay-as-you-go payments can be accommodated in owner operating budgets, preferably from the operating cost savings of energy efficiency.

Erin McConahey's May 2020 *ASHRAE Journal* column "Counting Carbons and Circular Diets" gave an example of "Cooling-as-a-Service." The client specifies the temperature and flow required and is charged a fixed ongoing $/refrigeration ton hour subscription fee. There are no up-front fees to the owner, resolving the problem of short term-oriented low-bid service providers. The as-a-service provider supplies the capital equipment, the managerial and technical human resources for operations, maintenance and equipment disposal.

This shared risk, reward model incentivizes high efficiency, reliable and safe services as a critical differentiator. Maintenance and ongoing artificial intelligence-based commissioning allow the as-a-service provider to minimize operating costs, in particular energy use.

Engineering and technical skills can be monetized through their direct profit margin impact, like the compensation models for technology workers. Modular systems match supply to demand and eliminate the issue of oversized equipment. The as-a-service provider is

also better placed to participate in demand-response type programs and increase regulator efficiency. The owner could also benefit from freed up space, not having to pay for redundant equipment.

Other examples of this business model are the Lighting as a Service installation at Amsterdam Schiphol airport and SunEdison's solar power purchase agreements.

This business model has environmental benefits. Operating emissions of energy consumption are reduced because of higher operating efficiency. Additionally, embodied carbon and material waste is reduced because the vendor is incentivized to install extended product-life, modular equipment, which can be reused elsewhere after the contract has ended. Human-made "stuff" now exceeds the 1.1 terratones of natural biomass on earth, so these considerations are key to solving the constraints of finite natural resources for a growing population.

The bigger point is that first cost-focused transactional relationships are no longer fit for current economic and ecological considerations. HVAC&R professionals need to evolve business models in view of the economic conditions of record debt levels and inflationary pressures on profit margins.

Some of the inflationary pressures would result from the energy transition work of the HVAC&R industry. The Basel Agency for Sustainable Energy, a Swiss nonprofit partner of United Nations Environment, explicitly identifies as-a-service businesses to be "a major contributor to systemic efficiency approach to decarbonization."

The ability to attract top technical talent to work on decarbonization solutions is crucial. So yes, the industry needs to carefully ensure that the technical workforce stakeholder shares the financial benefits of the energy transition, which are estimated be as high as $4.5 trillion. I look forward to your and *ASHRAE Journal* readers' critiques, and to continue this discussion.

Shahid Naeem, P.Eng., Member ASHRAE, Milton, ON, Canada

The Author Responds

Thank you for raising the question of provision of cooling as a service, and for the reference to Erin McConahey's column. This is a topic we have discussed in-house quite regularly. As you point out, there are many attractions, but in general we find our customers are not sufficiently dissatisfied with the current position and so are unwilling to implement a radical departure from the procedure that in their minds "works well enough."

In the next breath they will bemoan their high electricity bill or yet another machine breakdown, but fail to connect this poor performance with the way they have set up the maintenance contracts.

From our side there is a significant risk in placing expensive equipment on site—possibly in a fairly inaccessible location such as a rooftop or basement plant room—and then being unable to recover the asset without significant capital cost when the supply agreement comes to an end. This doesn't mean that it's a bad idea but needs to be carefully planned with a robust exit strategy. We have made significant progress toward the use of packaged machine rooms—a concept that has been around since at least the 1980s—where the whole container of equipment can be lifted and removed at the end of the contract, whether that is at full term or it is terminated early.

This topic is also relevant to the *ASHRAE Journal* Podcast number 11 which was aired last month (https://tinyurl.com/dpsnnwjv). It addresses one of the key stumbling blocks in the concept you outline— quantifying the savings made. More importantly, it also considers the benefit of quick reaction when performance starts to deteriorate, a point most people are unwilling to consider and which didn't feature in your analysis.

For example if a subtle degradation of performance of your plant increases the energy use by 5% and your bill for a year is $100,000, then this change will cost you $5,000 every year if it goes unnoticed and uncorrected. If you can be alerted to it after a week and can take corrective action then it only cost you $100—a "savings" of $4,900 in the first year alone.

This never gets counted as a savings because the $5,000 wasn't spent, but it helps explain why some systems' energy performance is so much worse than others—it is the accumulation of lots of these small "off-design" elements each making a contribution to overall poor performance.

In conclusion, I am not sure the world is ready for "cooling as a service," but technology is getting us closer to that point than we have ever been before.

Andy Pearson, Ph.D., C.Eng., Fellow ASHRAE, Glasgow, UK