YOUR GUIDE TO SUSTAINABLE COOLING

BALANCING OCCUPANT COMFORT, SUSTAINABILITY AND COSTS

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Although modern air conditioning systems are less than 100 years old, the concept of cooling interior air has been in existence since ancient times. In Ancient Egypt and Rome, occupants would hang wet cloth and reeds in windows to cool air as it blew into a room, construct homes with windows opposite doorways to create drafts and build aqueducts carrying cold water through the walls of homes to cool spaces.

Not long after the invention of a large air conditioning machine in 1902, smaller window units for residential use boomed in popularity in the 1950s. Then, central cooling gained traction in the 1970s.

Today, a great number of commercial and residential buildings have some form of cooling in place, whether it's window air conditioners or central air systems. The U.S. Department of Energy notes that two thirds of all U.S. homes have air conditioners, which cost homeowners $11 billion each year to power. In many regions, having cool air available at the flip of a switch is essential so that building occupants don't become overheated when they're working, sleeping or relaxing.

Unfortunately, a lot of buildings, both older ones in need of renovation and newer construction projects, may not be providing the most responsive, effective and environmentally-friendly cooling. Thankfully, there are options for sustainable cooling that can meet occupants' comfort needs as well as the needs of developers, architects and engineers, and the planet.

THE SHIFT TOWARDS COOLING

In regions that experience seasonal temperature fluctuations, or those that are warm year round, it's especially important for cooling systems to function properly without putting too much strain on budgets or the environment. Additionally, interior temperature can greatly impact both occupant comfort and productivity.

In southern states, such as Texas, South Carolina and Florida, and areas in the northeast, including New York and Boston, air conditioning is necessary for maintaining occupant comfort. Traditionally, buildings in the Pacific Northwest of North America have not needed cooling due to milder weather conditions. However, this trend is shifting, and cooling is now becoming more popular in these areas. Why? It's actually a result of the improved design of today's new construction projects. Buildings are being constructed with more advanced insulation in order to reduce heat loss during colder times of the day and night and cooler months. However, improved insulation can have a negative effect on comfort in certain scenarios. Buildings with a tighter grip on heat loss can become extremely hot during warmer times of the day and summer months because they are built to prevent heat loss. Air conditioning offsets this imbalance, and is thus becoming more common in markets that previously did not install systems. Developers of both residential and commercial buildings now understand that efficient cooling systems are required in order to secure tenants. What was once an upgrade is now a standard for an increasing number of buildings (see "Wood Innovation Design Centre" sidebar).

In addition to the level of insulation, there are other factors that predict whether cooling will be necessary within a building, including:

- **Occupancy**

In this case, occupancy considers both the people and objects that will emit heating loads and put a strain on indoor comfort. For instance, a floor with 300 employees working in cubicles and a large room to house servers and other equipment will heat up more quickly than a floor of the same size that has just 10 employees and no servers. Total occupancy needs to be factored in when considering the appropriate cooling for the space.

- **Windows**

The number of windows in a building and their placement also affect the demand for cooling. For example, a building with numerous windows facing southeast will bring in a lot of sunlight during the day and create a very large cooling load. Floor-to-ceiling windows and windows without appropriate shades or blinds will bring in more heat than smaller windows. Building occupants won't be comfortable at these elevated temperatures and will have trouble being productive if there is not an effective cooling system in place to lower the temperature.

COOLING CONSIDERATIONS

Developers, architects and engineers must think about numerous cooling considerations when designing a system for a new space or renovating an older building, including:

- **Responsiveness**

As occupancy and the amount of sunlight entering a building change, temperatures can fluctuate quite drastically. Cooling systems need to be extremely responsive in order to offset increasing and decreasing cooling loads throughout the day and night. The system should run only when it's needed in order to maximize comfort and drive down costs and the environmental impact.

- **Cost**

Often, cooling units run continuously, creating a large demand on energy loads. In fact, heating, ventilation and air conditioning (HVAC) systems account for roughly 40 percent of a commercial building's total energy consumption depending on climate and other factors. Thus, it's essential

Prince George, B.C. saw hotter-than-average temperatures in the summer of 2014. Thankfully, the **Wood Innovation Design Centre (WIDC)** had the proper solutions at hand. The seven-story structure, which houses offices and educational programs for the University of Northern British Columbia, showcases B.C.'s reputation and expertise as a leader in wood construction, engineered wood products and design.

To cultivate an ideal learning environment, designers needed a heating and cooling system that could perform at a low noise level. They also required a solution that could provide comfortable temperatures, eliminating cold draughts in the winter and providing relief during hotter months. Additionally, they wanted a solution that offered a high heating capacity at low water heating temperatures.

To meet these needs, developers installed 200 continuous Jaga Clima Canal Hybrid heating and cooling units along the perimeters of each floor. To keep in line with the WIDC's all-wood structure, the units feature natural beech wood grilles. The units are powered by hundreds of small low voltage DC fans, quietly providing the heating and cooling needed for the space.

Built into raised window sills, the space-saving design of the Clima Canal Hybrid allows for added seating or workspace for students. Operating at low water temperatures, the Clima Canal Hybrid units are able to react quickly to temperature changes, enabling occupants to stay comfortable regardless of internal or external heat loads, all while using less energy.

that the solutions selected to control the indoor climate are efficient. If they aren't, they'll have to work harder to lower temperatures, all while increasing costs for building owners and occupants.

- **Environmental impact**

Cooling places extra strain on the power grid and our natural resources. In fact, the manufacturing process, leakage, service during the lifetime of the equipment and disposal of the equipment produce harmful greenhouse gas (GHG) emissions. The Environmental Protection Agency (EPA) states that residential and commercial buildings can improve energy efficiency with more efficient HVAC. With many of today's new construction and renovation projects aiming for green certifications, such as Leadership in Energy and Environmental Design (LEED), reducing the environmental impact of cooling systems is essential (see "Edith Green–Wendell Wyatt Federal Building" sidebar).

- **Placement**

The location of cooling units is extremely important because poor placement can have an impact on effectiveness as well as ease of maintenance. For instance, consider a ducted fan coil system placed within interior closets. It would be difficult for maintenance personnel to access the ducts to clean them and fix other issues. However, if duct filters are not cleaned out on a regular basis, efficiency will suffer. A cooling system recessed into the ceiling of the bedroom and living area would provide more effective cooling because it counters hot air along the perimeter and is easier to access and maintain.

ALTERNATIVE OPTIONS

A lot of buildings use forced air, or ducted cooling, systems consisting of a four-pipe fan coil to push cold air throughout main areas. Although these fan coils can circulate air through the ducts quite effectively, the entire system requires extensive construction and space for ductwork, making it more obtrusive than other options. This system will also be noisier than alternatives.

Another common option for cooling is to use heat pumps, which pull heat out of the interior air to reduce the temperature within a room. However, heat pumps rely on electricity, causing utility bills to rise. Heat pumps require a compressor in every room that will require cooling.

Still other properties are using radiant cooling systems installed in floors or ceilings to maintain appropriate temperatures. However, these systems are only effective to a certain point because the chilled water can't get too cold (below 55° F or 12° C) or it will develop condensation. In fact, the Vancouver Olympic Village (athlete housing) had this experience, which meant that the system had to be turned off during hot summer days and couldn't provide cooling relief for occupants. Overall, these systems are likely not the most ideal solution for providing high levels of cooling.
The U.S. Department of Energy claims that homeowners can reduce air conditioning energy use by 20 to 50 percent by switching to high-efficiency air conditioners and taking other actions to reduce home cooling costs. Commercial buildings can also realize cost savings with more efficient systems. This is why many developers and architects are turning to hydronic systems that cool without the use of an individual compressor in every room.

With hydronic systems, chilled water is piped to the units and an ultra-efficient tangential fan with an EC motor pushes the cooler air into the space.

There are two options for hydronic systems:

- A total cooling system runs chilled water throughout the unit at a lower temperature than the dew point. To cool a room, it removes humidity from the air and collects it in the form of water. Units recessed into ceilings will use a gravity drain connected to a pipe to hold this excess moisture. Units that are not recessed use a condensation pump installed next to the fan coil to manage the moisture so that puddles or stains don't develop.

- A sensible/passive cooling system lowers a room's temperature through natural convection, dispensing cold air through the unit's heat exchanger. The unit uses chilled water above the dew point to refresh the room, but doesn't provide any dehumidification. Therefore, it is an ideal cooling solution for dryer climates such as Alberta or New Mexico where there is no or only a

The Edith Green – Wendell Wyatt Federal Building is an 18-story high rise building located in downtown Portland, Oregon. The building, named after two members of the U.S. House of Representatives, was originally constructed in the 1970s.

Between 2009 and 2013, the building underwent a $139 million renovation aimed at improving efficiency and sustainability. The project was designed to achieve a LEED Platinum rating, the highest designation from the U.S. Green Building Council. The work involved both interior and exterior enhancements, including new heating and cooling solutions and solar panels on a tilted roof.
Project managers selected Jaga's Clima Canal Hybrid heating and cooling units to be recessed along the perimeter of the floors to discretely provide efficient outputs. The units fit seamlessly into the newly modernized space, saving space while using less energy. They are also extremely quiet due to their low voltage fans.

Today, the building is listed as a LEED Platinum facility for incorporating sustainable design and technology that helps reduce water, energy, pollution and waste. The successful renovation offers inspiration for other older buildings that are considering retrofitting to meet new environmental standards and goals.

small risk of condensation in the air. If there is a risk of condensation, it's important to have a secondary system that can remove the water from the air. Passive cooling can also be accomplished through radiation by using chilled beams or radiant floors, but this can increase the risk of condensation.

Hydronic units substantially reduce the amount of electrical energy used by the system- by as much as 90 percent compared to forced air systems. They are also smaller and quieter. Additionally, hydronic systems can work in conjunction with renewable energy sources, such as geothermal or solar technology, especially in the heating seasons, making them an ideal solution for projects focused on energy efficiency.

Hydronic solutions are ideal because they enable cooling along the perimeter, such as near windows where heat tries to enter the space. However, because hydronic cooling solutions with EC motor fans are extremely powerful, they don't necessarily need to be placed on a perimeter wall. Units can be placed on an adjacent wall and still effectively push cool air across the space. In addition to walls, the units can be recessed within floors and recessed or placed on ceilings, providing flexibility to developers, architects and engineers (see "TELUS garden offices" sidebar). Being able to install them discretely in ceilings is an advantage because the cool air sinks and distributes throughout the room.

IMPRESSIVE BENEFITS

Hydronic cooling solutions offer many benefits, including:

1. **Extra space.** Forced air systems require extensive ductwork throughout the building, which takes up a lot of valuable space. Hydronic systems are easy to install, cost effective and are only needed at the perimeter of the room. These systems allow buildings to eliminate hard-to-maintain ductwork, freeing up extra ceiling space--up to one additional foot per floor. This gives architects and engineers the opportunity to add additional floors or penthouse suites in high-rise projects, allowing developers to generate additional and unanticipated revenue from extra suites within the same vertical footprint. In many cities where office space and residential rent comes at a high price, building owners can expect to take in tens of thousands of extra dollars for these extra suites.

2. **Noise reduction.** Many of today's heating and cooling systems generate a loud buzzing noise, which can be distracting to workers and building occupants. The American National Standards Institute (ANSI) standards (512.60.2002) require fan coil equipment to maintain hourly averages below 35dBa. Hydronic systems greatly exceed this standard, running below 29dBa (comparable to the sound of a desktop computer fan), helping reduce noise levels and maintain peace and productivity.

3. **Improved comfort.** Engineers should look for a system that can be equipped with individual climate control units, so that building occupants can set the unit to their preferred temperature rather than the property manager controlling the temperature for every unit on a floor with a single thermostat. This allows for more personalized temperature control within an occupant's space. (see "MC2 Residential Towers" sidebar).

4. **Better indoor air quality.** Ductwork within a building can be a magnet for bacteria and dust if filters are not regularly cleaned and maintained. Hydronic heating systems do not require filters. Although it may seem like these systems will become easily clogged, because they circulate room air, not ducted air, there is less dust present. Plus, there are hydronic systems that coat coils in epoxy so that they don't attract dust. Thus, hydronic systems help promote healthy, clean indoor air by eliminating opportunities for materials to collect in a building's ventilation system. To clean them, maintenance personnel can simply vacuum the top of the grille once or twice per year without removing any other parts.

5. **Lower total cost of ownership.** EC motors used with hydronic systems are extremely efficient and long-lasting, helping to lower electricity and maintenance costs. Additionally, because the units do not trap dust and materials like ducted systems, costly maintenance can be avoided. Largely constructed from renewable resources such as aluminum, hydronic systems reduce the overall heating and cooling costs over the lifespan of the building.

For too long, the argument against hydronic systems was that they didn't offer true cooling capabilities. However, today's options can offer cooling and are able to work in conjunction with renewable energy sources. These solutions keep occupants productive and comfortable during times of extreme heat and humidity. Hydronic systems also substantially reduce the carbon footprint of new and retrofit residential and commercial buildings. There's no noisy compressor, no high utility bills, no unsightly, large air conditioning box taking up window space, just discrete and comfortable cooling!"

The TELUS garden offices in downtown Vancouver is a 22-story office tower that is home to TELUS' national headquarters, Amazon Canada's offices and a variety of other businesses. With sustainability as a critical design aspect and floor-to-ceiling glazing throughout, the developers needed a heating and cooling system to meet a high level of energy-efficiency. They also required a solution that could work with the onsite district energy system—meaning it must function at low heating water temperatures and high chilled water temperatures. Lastly, they wanted a solution that was compact in size but could still promote lasting comfort for building occupants in the varying Vancouver climate.

To meet these needs, more than 1,900 of Jaga's Clima Canal Hybrid heating and cooling units were installed into a raised floor around the perimeter of the offices. This means there is no obstruction of the panoramic views of Vancouver. The space-saving design of the Clima Canal Hybrid also allows for additional furniture or conference room seating in offices.

The units work perfectly in conjunction with the onsite district energy system, and will help the building reduce energy demand by an estimated 80 percent.

The Clima Canal Hybrid units feature a continuous aluminum grille with six millimeters of open spacing to prevent even the slimmest high heels from getting caught. Since the unit operates at low water temperatures, it is able to react quickly to temperature changes, allowing office occupants to remain comfortable regardless of internal or external heating and cooling loads.

Vancouver's **MC2 Residential Towers**, consisting of one and two-bedroom units, showcase an innovative design and layout, and offer residents views of downtown Vancouver, the North Shore Mountains and the water. Designed by noted architect James Cheng and interior design firm Trepp Design, the project reveals modern design with exceptional function, exceeding LEED Gold standards.

To heat and cool residences, architects and developers wanted a dynamic solution that worked in small spaces. With units averaging 400-800 square feet, developers required a system that was minimally invasive and enabled residents to maximize the space for living. It would also need to provide controls for individual zones and work in conjunction with an ultra-efficient air-to-water heat pump.

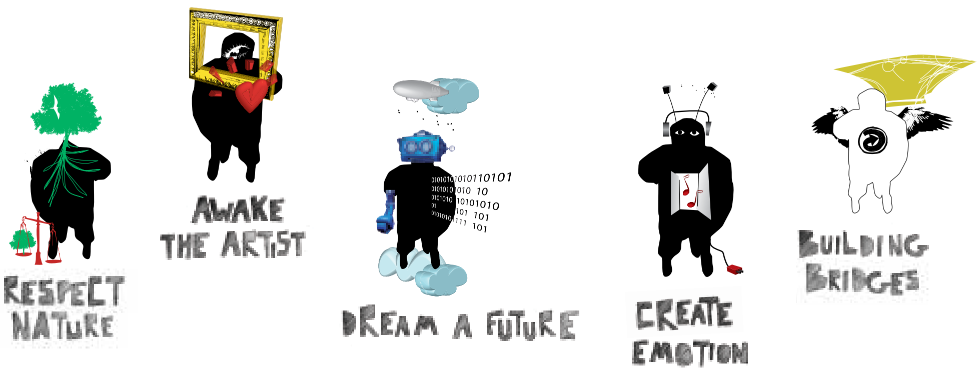
In the design, architects separated units into two zones – a living room and bedroom zone. The system uses motion-activated thermostats, creating an energy-efficient living environment with custom climate control based on the residents' lifestyle and preferences.
To provide a unique solution that enhanced the desired interior aesthetic, Jaga customized a casing for its convectors to match interior colors and styles. Jaga's Briza convectors, which measure just 4.5 inches, were built into the wall beneath bedroom windows, providing a sleek yet functional heating and cooling solution.
Jaga Micro Canals were installed in each living space. As Jaga's shallowest trench heating solution, the Micro Canal is placed along the perimeter of floors.

In addition to the convectors' compact size, efficiency and style, developers selected the units because they were quiet. The minimal noise allows residents to enjoy the sounds of the local environment without interruption or incessant buzzing from the heating and cooling system.

ABOUT JAGA CANADA CLIMATE SYSTEMS INC.

For more than 50 years, Jaga has led the world in hybrid heating and cooling concepts, innovation and art. Jaga manufactures award-winning, energy-saving heating solutions, such as its Low-H_2O radiator systems, which contain only 10 percent of the water content from a panel radiator with identical output. The radiators also operate at lower water temperatures, making them much safer than traditional radiators.

Jaga's products have been used in many notable projects in North America, including the Evergreen Brickworks Building in Toronto, the World Trade Center Museum in New York and the Cite Verte project in Montreal. As the demand for comfortable, energy-efficient products increases, more architects, engineers and contractors are turning to its stylish and energy-efficient solutions.



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