As a Level 1 trauma center that serves a 46-county area the size of Ohio, Dell Children’s Medical Center of Central Texas must have the capacity to treat children in all weather and emergency conditions—including triple-digit summer heat waves. To meet both grid independence and sustainability goals, the hospital partnered with Austin Energy to build an on-site combined cooling and heating power plant.

While all hospitals are required to have emergency backup power for life-safety systems, often the backup power is not sufficient to run building ventilation or cooling systems. Dell’s natural gas-fired combustion turbine is designed to provide 100% of the hospital’s energy needs and is unaffected by an electrical grid shutdown. The plant’s power production is about twice as efficient as a coal-fired power plant.

Sustainability and environmental stewardship priorities are reflected throughout the LEED Platinum hospital, which was built on a brownfield site located within blocks of downtown Austin. The hospital is designed to provide 100% of its energy needs through its own power plant, creating a healthy environment for patients and staff.

The hospital building team sought LEED certification not only for the environmental benefits, but also to create a healthy environment for patients and staff.

Costs and Benefits
The hospital partnered with Austin Energy to build a site combined cooling and heating power plant. To meet both grid independence and sustainability goals, the hospital partnered in all weather and emergency conditions—including triple-digit summer heat waves. To meet both grid independence and sustainability goals, the hospital partnered with Austin Energy to build an on-site combined cooling and heating power plant. The price premium for the hospital’s sustainable features was about 3%—4%. However, even with the premium, the hospital was constructed for approximately $257,612, which was in the typical cost range for hospitals in the Texas region during its construction. Its cost is comparable to a similarly sized hospital without sustainable features that Seton constructed and opened a year later.

Many of the benefits from a sustainable hospital are intangible, but some result in financial savings. Lower staff turnover and patient satisfaction help to improve the financial success of the hospital. For example, the national average nursing turnover rate ranges from 10%—15%, and new hospitals may experience up to 30% turnover the first year; Dell’s first-year rate was 2.4%. Training a new nurse can cost approximately $70,000, so a low turnover rate can make a big difference in the financial well-being of a hospital.

The average patient length of stay has dropped, from 4.76 days at the hospital’s former location in 2007 to 4.13 days at its new facility in 2010. This drop is even more significant given the new hospital’s expanded services and broader service area, which are drawing higher acuity patients who require a higher level of care.

Sustainable Design
Many of the materials used in the hospital were selected for their reduced impact on the environment. The building team also evaluated life-cycle costs and primarily selected sustainable features with a return on investment period of eight years or less. Other practices, such as recycling construction waste and encouraging use of alternate forms of transportation also contribute to the hospital’s sustainability.

These materials and practices include:
• A construction waste management program that sent more than 4,000 tons of construction debris to recycling facilities and diverted 34,000 tons from landfills, accounting for 92% of the construction waste;
• Reused railroad ties used as structural steel;
• Structural system concrete containing 30% fly ash in lieu of Portland cement, which emits significant amounts of carbon dioxide when manufactured;
• Locally fabricated metal shingle wall panels, chosen for their high recycled content and durability;
• Permanent drives and paved surfaces that are constructed from concrete to reduce the heat island effect;
• An ENERGY STAR high-albedo thermoplastic polyolefin (TPO) roof membrane.

The hospital building team sought LEED certification not only for the environmental benefits, but also to create a healthy environment for patients and staff.

W i n t e r  2 0 1 1
H I G H  P E R F O R M I N G  B U I L D I N G S
C O M M I T M E N T  T O  E N E R G Y  S A V I N G S
B U I L D I N G A T  A  G L A N C E

Name: Dell Children’s Medical Center of Central Texas
Location: Austin, Texas
Owner: Seton Family of Hospitals
Principal Use: Children’s acute care hospital
Includes: 176 licensed beds, pediatric intensive care unit, intermediate care unit, neonatal intensive care unit, oncology, respiratory, surgery, general nursing units, Level 1 trauma designated emergency department, imaging department, 24/7 laboratory, pharmacy, kitchen/dining area, rehabilitation therapy department with therapy pool
Employees/Occupants: 1,100 employees
Gross Square Footage: $15,940
Total Cost: $130,000,000
Cost Per Square Foot: $157
Substantial Completion/Occupancy: July 1, 2007
Occupancy: 95%
Distinctions/Awards: LEED Platinum/NC v. 2.1, featured in DOE EnergySmart Hospitals 2009 documentary video, American Society of Healthcare Engineers Energy Efficiency Commitment (E2C) 2009 Recognition

This article was published in High Performing Buildings, Winter 2011. Copyright 2011 American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. Posted at www.hbpmagazine.org. This article may not be copied and/or distributed electronically or in paper form without permission of ASHRAE. For more information about High Performing Buildings, visit www.hbpmagazine.org.
The six internal courtyards provide daylight, fresh air, views and access to nature. These connections to the outdoors contribute to a healing environment that improves patient outcomes, and plays a role in improving productivity and recruiting and retaining doctors and nursing staff.

**Daylighting.** The six internal courtyards provide daylight, fresh air, views and access to nature. These connections to the outdoors contribute to a healing environment that improves patient outcomes, and plays a role in improving productivity and recruiting and retaining doctors and nursing staff.

<table>
<thead>
<tr>
<th>Courtyard</th>
<th>Imaging</th>
<th>Specialty Care Clinic</th>
<th>Food and Retail Restaurant</th>
<th>Intensive Care</th>
<th>Surgery</th>
<th>Intermediate Care Nursing Units</th>
<th>Pediatric Intensive Care/Nursing Units</th>
<th>Employee Health</th>
<th>Pharmacy</th>
<th>Parking</th>
<th>Services</th>
<th>Security</th>
<th>Sleep Lab</th>
<th>Cardiac Catheterization Lab</th>
<th>Mechanical/Electrical</th>
<th>Shelled</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>6</td>
<td>7</td>
<td>8</td>
<td>9</td>
<td>10</td>
<td>11</td>
<td>12</td>
<td>13</td>
<td>14</td>
<td>15</td>
<td>16</td>
<td>17</td>
</tr>
</tbody>
</table>

**ENERGY AT A GLANCE**

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy Use Intensity (Site)</td>
<td>261 kBtu/ft²</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>3.2 kBtu/ft²</td>
</tr>
<tr>
<td>Electricity</td>
<td>75.5 kBtu/ft²</td>
</tr>
<tr>
<td>Chilled Water</td>
<td>123.6 kBtu/ft²</td>
</tr>
<tr>
<td>Steam</td>
<td>58.8 kBtu/ft²</td>
</tr>
<tr>
<td>Annual Energy Use</td>
<td>470 kBtu/ft²</td>
</tr>
<tr>
<td>Annual Energy Cost Index</td>
<td>$4.90 (includes green power purchase)</td>
</tr>
<tr>
<td>Load Factor</td>
<td>45%</td>
</tr>
<tr>
<td>Savings vs. Standard 90.1-2004</td>
<td>55% (estimated building plus CCHP)</td>
</tr>
<tr>
<td>ENERGY STAR Rating</td>
<td>58 (CCHP efficiency not reflected; 80–85 if CCHP efficiency is included)</td>
</tr>
<tr>
<td>Cooling Degree Days</td>
<td>2,974 avg.; 2009 actual: 3,549</td>
</tr>
<tr>
<td>Heating Degree Days</td>
<td>1,648 avg.; 2009 actual: 1,413</td>
</tr>
</tbody>
</table>

**W A T E R  A T  A  G L A N C E**

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annual Water Use (2009)</td>
<td>25,623,000 gallons (includes irrigation)</td>
</tr>
</tbody>
</table>

**FIGURE 1** FLOOR PLAN: SECOND FLOOR

Managing complex building environments while meeting your energy efficiency targets is no small task. Our EcoStruxure® energy management architecture achieves this elegantly through intelligent integration of building systems on a single IP platform.

The savings go far beyond buildings

Today, only EcoStruxure energy management architecture by Schneider Electric® delivers up to 30% energy savings, unifying energy-intensive systems like HVAC, access control, video security management, and lighting controls across your entire enterprise. Saving up to 30% of a building’s energy is a great beginning, and thanks to EcoStruxure energy management architecture, the savings don’t have to end there.

Learn about saving energy from the experts!

Download this white paper, a $193 value, for FREE and register to win a Kindle® e-book reader!

Visit www.SElively.com Key Code 97449 Call 800-789-7038

30%* off your building’s energy bill is just the beginning

Imagine what we could do for the rest of your enterprise.

---


---

roofing material. It covers more than 75% of the total roofing area, effectively reducing both the heat island effect and the amount of energy required to cool the building.

- Bus stops, bike racks and preferred parking for carpools, vanpools and alternative fuel vehicles to reduce vehicle traffic to and from the hospital;
- Linoleum and cork natural floor coverings, made from rapidly renewable materials.

**Daylighting.** The six internal courtyards provide daylight to 60% of occupied spaces unrestricted by medical demands and to 35% of diagnostic and treatment spaces. Most areas are no further than 32 ft from a window. Double pane low-e exterior glass maximizes daylight transmittance and minimizes solar heat gain. The floor plan illustrated in Figure 1 shows the hospital’s configuration around courtyards (a sixth courtyard is accessible from the third floor).

The hospital’s lighting design includes more than 10,000 T5 and T8 light fixtures that provide an average of approximately 1 W/ft². Roughly 33% of these fixtures are connected to occupancy sensors. However, critical and patient care areas are not equipped with occupancy sensors. Daylight harvesting controls are installed on fixtures in roof lighting. It covers more than 75% of the total roofing area, effectively reducing both the heat island effect and the amount of energy required to cool the building.

- Bus stops, bike racks and preferred parking for carpools, vanpools and alternative fuel vehicles to reduce vehicle traffic to and from the hospital;
- Linoleum and cork natural floor coverings, made from rapidly renewable materials.
the corridors, open areas and offices next to perimeter glass, or about 3% of the total fixture count.

**Indoor Air Quality.** Interior finish materials such as formaldehyde-free compressed wheatboard casework and low- or no-volatile organic compound content paints and adhesives promote good indoor air quality. These materials can be cleaned with soap and water, eliminating the need for toxic cleaning agents. An abundant amount of outside air coupled with high-efficiency air filtration also helps maintain indoor air quality, which is critical for high quality health care.

**Materials.** Locally and regionally sourced materials such as limestone and red sandstone in addition to other building materials with high recycled content help reduce the carbon footprint of the hospital. The main flooring material used throughout the hospital is limestone, a rapidly renewable material that helps to prevent germ growth. Limestone has a higher first cost than flooring typically used in hospitals, but has a low maintenance cost and excellent life-cycle cost.

**Water.** Low-flow plumbing fixtures and dual-flush toilets help reduce indoor water use by 30%. Water-efficient autoclaves, which sterilize medical equipment with steam, reduce process water use by more than 2 million gallons a year. Outside, native and adapted plants help reduce potable water use. Reclaimed water that is pumped from a nearby water treatment plant provides subsurface irrigation for all landscaping except in the courtyards and a 3-acre healing garden due to infection control precautions.

**Combined Cooling and Heating Power Plant**
The on-site combined cooling and heating power plant (CCHP) is designed to provide 100% of the hospital’s utility requirements for water conservation, low-flow faucets and showerheads; dual-flush toilets, water-efficient autoclaves, xeric landscaping, reclaimed irrigation water from nearby water treatment plant saw an estimated 5.5 million gallons of potable water a year

**Recycled Materials** 21% postconsumer recycled content

**Daylighting** 90% of perimeter rooms having windows and more than 35% of diagnostic and treatment areas have access to daylight

**Individual Controls** 96% individual lighting controls and 65% individual thermal comfort controls

**Vacant CCHP** Provides electricity, chilled water and steam to the hospital

**Renewable Energy** 87% of total electricity consumption is covered by renewable energy purchase (Austin Energy GreenChoice)

**Construction Waste** 93% recycled

**Materials Low-VOC adhesives, sealants, paints and coatings**

**Rapidly Renewable Materials** 2.7% of total materials, including more than 400,000 sq ft of limestone flooring

**Regionally Extracted Materials** 27.4%

Left: The 145 ft tower is designed to serve as a landmark to travelers on Interstate 35, which is less than a mile west of the hospital. The tower’s colored glass is illuminated at night and can be seen from two to three miles north or south on the interstate. The fabric structure on top of the tower resembles a nun’s coattails, representing the Catholic nonprofit organization that runs the hospital.

**KEY SUSTAINABLE FEATURES**

**Water Conservation** Low-flow faucets and showerheads, dual-flush toilets, water-efficient autoclaves, xeric landscaping, reclaimed irrigation water from nearby water treatment plant saw an estimated 5.5 million gallons of potable water a year

**Recycled Materials** 21% postconsumer recycled content

**Daylighting** 90% of perimeter rooms having windows and more than 35% of diagnostic and treatment areas have access to daylight

**Individual Controls** 96% individual lighting controls and 65% individual thermal comfort controls

**Vacant CCHP** Provides electricity, chilled water and steam to the hospital

**Renewable Energy** 87% of total electricity consumption is covered by renewable energy purchase (Austin Energy GreenChoice)

**Construction Waste** 93% recycled

**Materials Low-VOC adhesives, sealants, paints and coatings**

**Rapidly Renewable Materials** 2.7% of total materials, including more than 400,000 sq ft of limestone flooring

**Regionally Extracted Materials** 27.4%

at least 30 years. The CCHP plant provides reliable electrical power with three levels of redundancy and enhanced power quality, chilled water and steam to the hospital. A hospital is a compatible partner for a CCHP plant due to a steady 24/7 operation and a base load steam requirement. Steam is used by the hospital for sterilization, humidification, space heating and domestic hot water production.

The plant consists of two independent grid feeds, a 4.3 MW natural gas-fired combustion turbine, a 900 ton absorption chiller and a heat recovery heat exchanger that converts the waste heat from the turbine into steam. The steam is sent directly to the hospital and is used to drive the absorption chiller depending on the hospital’s load profile.

At a projected 65% average annual thermal efficiency, the CCHP plant is almost twice as efficient as a comparable coal-fired power plant and has significantly decreased CO₂, NOₓ and SO₂ emissions. The plant is also equipped with a 1500 kW emergency diesel generator for backup power in case both grid feeds and the turbine are lost.

The construction manager estimated that eliminating the need for a central plant (including chillers, boilers, emergency generators and associated equipment) would save $8.5 million. These savings funded many other sustainable features of the hospital. The hospital negotiated a rate structure with Austin Energy that will repay the construction cost of the CCHP plant over the 30-year contract period.

During the first few months of operation the CCHP plant had a catastrophic turbine failure and power delivery problems, which primarily centered around the response of main breakers and the turbine to grid interruptions. After Austin Energy spent considerable efforts and expense to improve the reliability of the plant, the CCHP plant has performed flawlessly for the hospital for more than 11 months. The hospital pays a premium to Austin Energy (AE) to purchase “green” power that is produced from renewable energy sources, which covers approximately 87% of the hospital’s electrical consumption. Combined with the emissions reductions from the CCHP plant, the total atmospheric CO₂ reduction is more than 6,000 tons per year.
Efficiency of On-site Power Production

The site energy use intensity (EUI) for the hospital after three years of operation is 261 kBtu/ft², which is above the 2003 Commercial Buildings Energy Consumption Survey (CBECS) average for inpatient facilities of 249 kBtu/ft². The hospital’s ENERGY STAR rating is 58.

These energy consumption values do not reflect an energy-efficient hospital. However, neither the site EUI nor ENERGY STAR accounts for the efficiencies of the CCHP plant.

If the waste heat use at the CCHP plant could be applied to the source energy consumption, the hospital’s ENERGY STAR rating would be in the range of 80 to 85. ENERGY STAR will not allow the hospital to use the CCHP plant efficiencies because the plant also supplies district chilled water to other buildings in the Mueller development. In addition, since the chilled water and steam are produced at the on-site CCHP plant, the hospital’s site and source energy performance is lower according to EPA calculations for ENERGY STAR than what is reported in the Spray Units.

AUSTIN EXTREME SUMMER WEATHER

The ASHRAE 1% occurrence design temperature for Austin is 97.5°F with a mean coincident wet bulb of 74.5°F (2000 ASHRAE Handbook—Fundamentals, Chap. 14, Climatic Design Information). The following highlights from the National Weather Service indicate the extreme summer weather conditions experienced during 2008 and 2009:

• June 2008 was the warmest June on record with an average monthly temperature of 87.4°F. The historical average monthly temperature for June is 81.5°F. In addition, June 2008 holds the record for the number of triple-digit days at 20.

• The average monthly temperature of 86.6°F in June 2009 made it the second warmest on record.

• The period between June 22 and July 21, 2009, was the warmest 30-day period on record with an average temperature of 89.7°F. The historical average monthly temperature for July is 84.9°F.

• July 2009 also set a new record for the highest average maximum temperature of 100°F, breaking the old record of 101.7°F set in 1923.

• Twenty-six days of triple-digit temperatures during July of 2009 missed the record of 101.7°F set in 1923.

Despite the extreme summer heat during 2008 and 2009, the overall energy performance for the hospital was within 5% of the modeling projections as shown in Table 1 (Page 44). The total cooling degree days during this period exceeded the average weather data used for the modeling by 20%.

CONSTRUCTION AND WARRANTY PHASE ISSUES

Commissioning continued for several months after the hospital opened due to an accelerated construction schedule mandated by the owner. Issues that were discovered and resolved during commissioning are summarized below.

The electrical harness cables of the combination media—electrically enhanced ionization air filters failed and were replaced by the manufacturer numerous times. Improperly sized outdoor air unit steam preheat coils were discovered and replaced during functional testing.

Fire shutdown of the OAUs was a common occurrence during cold, dry weather. Humidification steam that was not completely absorbed by the airstream triggered smoke detectors, which shut down the OAUs. New drain pans were added and drain piping modifications had to be made to the OAU heat pipe spray assemblies because the spray units could be placed in operation near the end of the warranty period. Additional problems with clogging of the heat pipes continue to plague these units and compromise energy savings potential.

Numerous BAS issues were addressed, including airflow monitor and VAV box airflow calibration, improper selection of domestic water and steam flow meters, surgery unit fan coil sequencing and economizer sequencing.

The daylight harvesting system has never functioned properly. Resolution of this issue is still ongoing due to inadequate design support and backfit and controller failures.

An undetected horizontal water cross connection was discovered during hardness testing of the water. The problem persisted until the domestic hot water return piping was routed back through the water softeners. The cross connection was never found. This issue caused scaling and capacity problems with the clean steam humidifier heat exchangers fed by soft water.

Construction and Warranty Phase Issues

In addition to deficiencies at the end of the warranty period, many items were not resolved during commissioning near the end of the warranty period. Commissioning continued for several months after the hospital opened due to an accelerated construction schedule mandated by the owner. Issues that were discovered and resolved during commissioning are summarized below.

The electrical harness cables of the combination media—electrically enhanced ionization air filters failed and were replaced by the manufacturer numerous times. Improperly sized outdoor air unit steam preheat coils were discovered and replaced during functional testing.

Fire shutdown of the OAUs was a common occurrence during cold, dry weather. Humidification steam that was not completely absorbed by the airstream triggered smoke detectors, which shut down the OAUs. New drain pans were added and drain piping modifications had to be made to the OAU heat pipe spray assemblies because the spray units could be placed in operation near the end of the warranty period. Additional problems with clogging of the heat pipes continue to plague these units and compromise energy savings potential.

Numerous BAS issues were addressed, including airflow monitor and VAV box airflow calibration, improper selection of domestic water and steam flow meters, surgery unit fan coil sequencing and economizer sequencing.

The daylight harvesting system has never functioned properly. Resolution of this issue is still ongoing due to inadequate design support and backfit and controller failures.

An undetected horizontal water cross connection was discovered during hardness testing of the water. The problem persisted until the domestic hot water return piping was routed back through the water softeners. The cross connection was never found. This issue caused scaling and capacity problems with the clean steam humidifier heat exchangers fed by soft water.
Recent Performance

4 Energy-efficiency strategies include:

- Daylight harvesting controls;
- High-efficiency lighting;
- Dedicated outdoor air units;
- Low pressure drop electrically enhanced ionization filtration on patient care air-handling units.

The HVAC design consists of 21 distributed air-handling units and six dedicated outdoor air units (DOAUs) served by variable speed chilled water pumps. The “right-sized” variable speed air-handling units serve departments and smoke zones.

The associated air-distribution systems were designed with more than 700 variable air volume (VAV) systems were designed with more than 700 variable air volume (VAV) air-handling units serving the hospital. The OAUs provide pretreated (maximum 56°F/minimum 42°F dew point) outdoor air units, and each consists of a refrigerant heat pipe with a spray water assembly on the building exhaust entering air side. General exhaust throughout the hospital is collected and ducted back to the OAUs. The OAUs provide pretreated (maximum 56°F/minimum 42°F dew point) outside air to 20 of the 21 distributed air-handling units serving the hospital.

Overcoming Performance Challenges

Chilled water consumption for the first three months of the hospital’s operation exceeded design estimates by 75%. Steam consumption followed a similar trend.

After two months of commissioning, performance improved, but it was still far from expectations. Various control strategies and set-point adjustments during the next few months also improved energy performance. Some of those adjustments included:

- Reevaluating all rooms and areas for air change rates and minimum VAV flow setpoints. Approximately 10% of the total minimum volume was trimmed, reducing the chilled water demand by roughly 140 tons;
- Implementing cold deck temperature reset based on outdoor air

Table 1: Cooling Degree Days, Energy Use Versus Design 2008–2009

<table>
<thead>
<tr>
<th>Total CDD Compared to Average</th>
<th>Energy Use Versus Design Prediction</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Chilled Water Use</td>
</tr>
<tr>
<td>20%</td>
<td>9%</td>
</tr>
</tbody>
</table>

The hospital’s cooling loads exceeded the modeled predictions during much of 2008 and 2009. Some reasons for the variances include the failure of evaporative spray pumps on five outdoor air units, the addition of a new air-handling unit in 2009 to serve an operating room addition and hotter than normal weather both summers.
temperature, resulting in significant cost and thermal energy savings; and
• Implementing continuous outside air tracking and setpoint adjustments to optimize the outside air supplied to the various areas of the hospital based on the required percentage of outside air to supply air. In no case is the minimum air change rate or outside air volume ever allowed to decrease below what is required by code or ASHRAE Standard 62.1-2001 and to maintain positive space pressurization.

The hospital’s energy performance tracked closer to the modeled predictions in 2009 and 2010, as shown in Figure 2 (Page 44).

### Chilled Water Use

Figure 3 (Page 45) shows the hospital’s chilled water consumption history from 2001—2009 compared with the design model. The actual hourly chilled water peak loads in both years are close to projections with a few exceptions when the load exceeded 1,200 tons in 2009. The higher loads in 2009 can be partly explained by the failure of all of the evaporative spray pumps on the fire outdoor air units. Another contributing factor was the addition of a 10,000 cfm air-handling unit in June 2009 to serve a 6,500 ft² operating room addition.

Actual minimum loads are well above the projected minimum loads throughout the summers of both years. One reason for this discrepancy involves modeling based on setting back or turning off many of the air-handling units on nights or weekends. However, the units cannot be operated in this manner because one or two areas or rooms in the air-handling unit distribution zone must be kept cool 24/7 due to their functions. The above average hot weather is the most apparent cause for the significant variances between actual and projected peak, minimum and monthly loads during the 2008 and 2009 summer months.

### Conclusion

Despite initial operating issues, Dell Children’s Medical Center demonstrates that sustainable design reaps both financial benefits and intangible benefits for building users. Continued monitoring and evaluation of the building system will help ensure that building systems perform at their optimal levels, providing a healthy and sustainable environment.

To comment on this article, go to www.HPBmagazine.org.

---

**LEGS ONS L E A R N E D**

The building design engineer and energy modeler must coordinate throughout the design phase to ensure that the building performance meets its metrics. This project’s designer and energy modeler were in different cities; their communication and coordination was not as timely or efficient as it could have been, resulting in some lost opportunities. In addition, the energy modeling did not begin as early in the process as it should have, and making up for lost time is always difficult, especially for complex projects.

The HVAC/control system design must comprehensively implement the energy conservation strategies used for the energy modeling. The lack of communication between the designer and energy modeler during the design phase resulted in the initial omission of some minor but important energy conservation control strategies. These elements were incorporated later during the commissioning/warranty phase.

Thorough submittal review is required to ensure that the design intent is met and that even obvious things do not fall through the cracks. For this project, weekly submittal and shop drawing review meetings were held with the contractor, engineer and commissioning agent well before the beginning of the MEP construction to ensure that all coordination details as possible were worked out early to minimize installation and field issues.

The construction manager/general contractor should give priority to completing all commissioning prior to occupancy during the development of the construction schedule. In a hospital numerous code-required smoke compartments and fire and smoke protection systems must be tested and commissioned prior to opening.

For this project, owner changes and a number of other design and construction related issues left barely enough time in the construction schedule to fully commission the critical life safety systems before opening. Many of the air-handling/distribution systems as well as other electrical, special systems and plumbing systems had to be commissioned post-occupancy, which was inefficient, cumbersome and time consuming for all parties.

Conduct post-commissioning after occupancy. The typical commissioning effort does not follow up on unresolved issues after occupancy to ensure that they are properly addressed or repaired. For this project, outstanding construction and warranty issues were followed through to closure, with the exception of a few items as noted in Construction and Warranty Phase Issues (Page 42). Post-commissioning also allows for verifications and modifications to weather-sensitive setpoints and sequences of operation as well as building occupancy-related nuances.

Energy management requires operations staff training beyond operations and maintenance training. Unless the operations staff has significant experience with only the type of BAS, but also with the operational sequences, staff will only gain a general understanding of the various systems during a few hours of training by the contractor.

In the case of this project, daily interaction between the owner’s facilities engineer and the operations staff resulted in the discovery of BAS sequence of operations and control logic issues that went undetected during commissioning and were subsequently corrected.

---

**DCV – With Ultimate Performance**

**TRU E  G R E E N  S O L U T I O N S**

**Demand Controlled Ventilation for Dryers, Bathrooms and Kitchens**

Quiet, extremely reliable, no condensation problems, no motor hunting—just an easy-to-install and listed system with the best and most reliable components that provide the best demand control.

**Power, Reliability and Easy Access**

- Direct-drive, Variable speed, No belts, easy to maintain, Redundant, Ultrasafe
- Fan Engineers
- Bury & Partners, Austin, Texas
- Landscape Architect: TBI, Austin, Texas
- LEED Consultant: Gail Vittor, Center for Maximum Potential Building Systems, Austin, Texas

**Intelligence**

- Fully integrated pressure control, 10% turndown, Interlocks, and alarms, BAS compatibility
- Unmatched accuracy, Dualmeasures testing, Safety monitoring and interlocks

**Safely and Accuracy**

- Unmatched accuracy, Dualmeasures testing, Safety monitoring and interlocks
- Fully integrated pressure control, 10% turndown, Interlocks, and alarms, BAS compatibility
- LEED Consultant: Gail Vittor, Center for Maximum Potential Building Systems, Austin, Texas

**The only system on the market with a complex listing and fully compliant with NFPA 95, FGC and B1C with visible/audible alarm and interlock, Includes EXHAUSTO’s standard Performance Guarantee and documented savings, engineering and field commissioning.**

---

**ABOUT THE AUTHOR**

Philip S. Rizer, PE, Member ASHRAE, LEED AP is a network engineer/senior project manager at Seton Family of Hospitals in Austin, Texas.