

The courthouse's energy performance has improved most years since it opened in 2002. The savings have allowed Ada County to recoup the incremental costs of the courthouse's sustainable and energy-efficient systems in two years.

Building management has used the ENERGY STAR application as a framework to evaluate energy performance each year. The Courthouse's rating has improved from 76 in 2004 to 84 in 2009. The courthouse received LEED Silver certification for Existing Buildings in 2005.

Ada County's administrative offices previously operated out of a 60-year-old courthouse building and two other leased buildings. When the chillers failed at times in the former courthouse, indoor temperatures could vary by as much as 10°F in various areas of the building. Building management had to manually maintain the heating or cooling load.

In addition to facility and security problems with the old courthouse, the county's growth also helped spur the decision to consolidate all departments into a single highly efficient building. A public/private

BUILDING AT A GLANCE

Name Ada County Courthouse and Administration Building

Location Boise, Idaho

Owner Ada County

Principal Use Courthouse

Includes Courtrooms, inmate holding area, office space, meeting rooms, parking area

Employees/Occupants 502 employees, more than 56,000 visitors per month

Gross Square Footage 356,300

Total Cost \$45 million

Cost Per Square Foot \$126

Substantial Completion/Occupancy January 2002

Occupancy 100%

Distinctions/Awards LEED-EB (pilot) Silver 2005, LEED-CI Certified 2006, ENERGY STAR

Maintaining Efficiency

BY DAVE LOGAN AND SELENA O'NEAL

The Ada County Courthouse and Administration Building demonstrates that even a new building that is designed for efficiency and sustainability can improve its performance through constant monitoring, adjustments, maintenance and annual evaluation of systems.

The Ada County Courthouse and Administration Building in Boise, Idaho, includes street-level retail and restaurant spaces as well as courtrooms, offices and a detention area. A fifth-floor colonnade area (above the main entrance) provides an outdoor break space for the courtrooms.

partnership was developed with Civic Partners, Capital City Development Corporation, and Ada County to construct a sustainable structure incorporating the latest in energy-efficient design that would be cost effective to operate and maintain.

The resulting building demonstrates how the combination of sustainable design, user interface and automated building systems produce a structure that allows the operator to continually

A large south-facing window fills the lobby with natural light. The facility is built on an east-west axis, with most offices facing north or south.

refine and monitor energy use and occupant comfort.

The five-story multi-purpose facility includes offices, meeting rooms and courtrooms. A 30,000 ft² basement area contains inmate holding cells, a mailroom, offices and a small parking area.

The building's energy-efficient systems include a geothermal heating system, multi-staged chillers, variable drive pumps and motors, and fresh air economizers, all controlled by a direct digital control (DDC) system.

ENERGY AT A GLANCE

Energy Use Intensity (Site) 64 kBtu/ft²
 Natural Gas 3 kBtu/ft²
 Electricity 48 kBtu/ft²
 Geothermal 13 kBtu/ft²

Annual Source Energy 176 kBtu/ft²

Annual Energy Cost Index (ECI) \$0.93/ft²·yr

Peak Load 1450 kW (2009)

Base Load 935 kW (2009)

Load Factor 47.6% (2009)

ENERGY STAR Rating 84 (2009), 85 (2008), 85 (2007), 83 (2006), 75 (2005), 76 (2004)

Insulated ductwork, insulated water lines, low-E (emissivity) glass, energy-efficient lighting and window tinting also contribute to energy savings. Clerestory windows allow daylight to penetrate into the core areas of the building.

Sustainable Practices

Commissioning reduced start-up problems and helped make the building fully functional on opening day, which was critical since court dates are scheduled up to a year in advance. The commissioning authority also developed an integrated training schedule for facility staff that included specific training objectives and key items for each piece of equipment.

Good operation and management practices have kept the building operating as designed. Building management performs scheduled preventative maintenance of its electrical and mechanical systems. Ada County also contracts with the manufacturers of its systems for annual maintenance.



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The courtrooms incorporate integrated audiovisual systems that are used to present evidence during trials.

Ada County aims to maintain health and safety by using cleaning and operating practices that minimize the impact on the building occupants, the workers who maintain the building, and the environment. For example, maintenance staff uses cleaning products with low levels of volatile organic compounds.

Janitor closets and high-volume copying, faxing and printing areas have separate exhaust and air supply systems to contain odors and chemicals. At high-volume building entrances, grills, grates and mats help prevent dirt, dust and pollen from entering the building.



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2009 ENERGY USE

2009	Electricity kWh	Electricity Cost	Natural Gas Therms	Natural Gas Cost	Geothermal kGallons	Geothermal Cost	2009 Heating Degree Days	2009 Cooling Degree Days	2002-08 Avg. HDD	2002-08 Avg. CDD
Jan	393,848	\$17,828	521	\$542	2,184	\$8,064	1037	0	1007	0
Feb	363,231	\$17,997	387	\$408	1,792	\$6,620	779	0	812	0
Mar	409,402	\$20,129	418	\$443	1,427	\$5,323	716	0	624	0
Apr	419,814	\$20,117	436	\$472	936	\$3,659	430	7	426	1
May	447,331	\$21,311	498	\$539	833	\$3,260	187	87	199	50
Jun	460,743	\$29,114	518	\$560	1,054	\$4,120	24	114	55	175
Jul	507,434	\$31,681	615	\$663	863	\$3,373	0	428	0	446
Aug	459,462	\$28,850	581	\$627	223	\$889	14	338	5	323
Sep	433,340	\$24,346	554	\$584	169	\$673	40	214	88	96
Oct	389,011	\$21,998	475	\$421	492	\$1,941	505	0	370	10
Nov	361,645	\$20,316	986	\$801	910	\$3,523	701	0	734	0
Dec	396,944	\$21,455	2,952	\$2,320	1,398	\$5,174	1,179	0	958	0
Total	5,042,205	\$275,142	8,941	\$8,380	12,281	\$46,619	5,612	1,188		



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ONGOING COMMISSIONING

Although the Courthouse had received an ENERGY STAR in 2004 and was an energy-efficient building, the county noticed energy consumption was steadily increasing since occupancy in 2002 and decided to take a closer look.

A commissioning agent (CxA) met with the county's energy specialist, facility manager, and internal HVAC technician in 2005. The CxA provided recommendations such as moving the outdoor air temperature sensor from a location that received direct sunlight to eliminate unnecessary chiller starts.

Another recommendation concerned the electrical rooms, which are small spaces, but required constant cooling. The electrical rooms were using the VAV boxes connected to the building's large air handlers to provide cooling. Individual exhaust fans were added to each electrical room to prevent these constant cooling loads from driving the need for the large air-handling units.

The CxA tested a sample number of VAV boxes and decided that a rebalancing of the entire building was necessary. The CxA provided county staff with the tools

and training to do the rebalancing in-house, resulting in savings for the county and a better educated operations and maintenance staff.

The recommissioning project resulted in an ENERGY STAR rating that increased from 75 in 2005 to 83 in 2006. Electricity costs decreased by \$28,905 from 2005 to 2006 and geothermal costs decreased by \$12,610 for a total annual savings of \$41,515.

The biggest lesson learned is that with today's complicated building systems, many factors drive energy consumption. Maintaining efficiency requires ongoing monitoring and adjusting.

The facility manager and HVAC technician work closely with the controls company to seasonally adjust the programming and temperature settings. We meet a few times a year with our electric utility representative to look at data such as monthly electric consumption and load factors. A mechanical engineer independently verifies the energy data and takes readings for the ENERGY STAR application each year.

The building team selected revolving doors for the lobby entrance instead of a vestibule. The revolving doors condense the entry space and reduce the amount of outdoor air that enters the lobby.

Other sustainable practices and designs include:

- Low-flow water fixtures. Water closets use 1.6 gallons per flush and urinals use one gallon per flush.
- Exterior lighting designed to reduce light pollution.
- A storm water management program that collects, filters and directs storm water to a nearby pond.
- A recycling program. Recycling bins are placed at desks and in common areas to encourage recycling.
- Reuse of centrally located site to reduce urban sprawl. The former rail yard was designated as a brownfield.
- No CFC-based refrigerants are used in the main HVAC system.

BUILDING ENVELOPE

Roof

Type Metal deck on steel beams, rigid insulations, single ply EPDM (ethylene propylene diene monomer) membrane ballasted with rounded riverbed gravel
Overall R-value R-30

Walls

Type Nonload-bearing 6 in. steel studs with brick and stone veneer, GFRC (glass fiber reinforced concrete) with sandstone accents; EIFS (exterior insulation finish system) used on the penthouse and fifth floor
Overall R-value R-19
Glazing percentage 30 (approximately)

Basement/Foundation

Basement wall type Concrete
Slab edge, basement wall insulation R-value R-5 per in. – 2 in. rigid insulation

Windows

Type Aluminum frame with anodized finish, PPG Solex low emissivity
U-value 29
Solar Heat Gain Coefficient (SHGC) 36
Visual Transmittance 60%

Location

Latitude 43.6°
Orientation Front of building faces south

HVAC

The HVAC system is operated by a DDC system. The building is primarily a heat source, so some level of cooling is always needed. The system is designed to provide constant 55°F air. The setpoints and offsets are adjustable and can be set at the local control or from the building automation system (BAS).

Geothermal Heating. The geothermal system in Boise was developed in the early 1900s using the valley's natural hot springs and abundant water supply. It is now administered by the

Boise Public Works Department and is the largest direct use geothermal system in the U.S., supplying energy-efficient heat to more than 55 businesses (3.75 million ft²) in the downtown area. The system pumps 190 million gallons of water per year.

Direct use systems such as Boise's not only provide heat to buildings, but also provide hot water for recreation (hot springs resorts), greenhouses (heating), and aquaculture (raising warm-water fish and aquatic plants).

Geothermal systems benefit from economies of scale. This technique, also used in Reykjavik, Iceland, and Klamath Falls, Ore., is known as district heating.

When the new courthouse building was planned, it made sense to include the geothermal system in the design. The line was close and only needed to be extended onto the site. It provides an estimated 23 million gallons per year of municipal hot ground water, which is the primary source of heating for the entire building, and provides approximately 17% of the building's annual energy needs.

The water comes to the building at 170°F and is returned back to the aquifer at about 130°F. A heat exchanger transfers the heat from the geothermal water to a sealed hot water system that circulates the heated water to terminal fan boxes to provide heat to mix with the 55°F air.

A boiler heating system serves as a back-up to the geothermal system. Most geothermal outages are short term, however, other outages can result from a piping failure or other accidental damage to the geothermal line.



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The limestone and brick façades take cues from the surrounding buildings in Boise. The limestone echoes the façade of the former courthouse, while the brick blends with other buildings in the area.

In December 2009, the geothermal system could not sufficiently heat the building due to unusually cold weather. Boise had 1,179 heating degree days this month, exceeding the previous seven-year average by 221 days, or 19%. For the first time in the building's history, the geothermal system and boilers ran simultaneously.

Boilers and Hot Water Pumps.

Two 152 hp natural gas backup boilers provide a minimum of 2.46 MMBtu and a maximum of 6.36

Ada County, Idaho, encompasses 1,055 square miles including Boise, the state's capital, largest city and commerce hub.

BUILDING TEAM

Building Owner/Representative
Dave Logan, Director of Ada County Operations

Architect
Lombard Conrad Architects, Boise

General Contractor
Morrison-Knudsen, Boise

Mechanical Engineer
Engineering Incorporated, Boise

MMBtu. In the event of a geothermal system failure as indicated by a low temperature on the hydronic heating supply water, the lead boiler and circulation pump are energized in response to a call for heating.

When a boiler is called for, the boiler's respective secondary pump is

enabled. In the event of a boiler failure or if the lead boiler is unable to maintain the setpoint, the lag boiler and circulation pump start. The lead/lag boilers are rotated every week.

The primary hot water pumps share a variable-frequency drive with automatic pump changeover panel. On a call for heat, the lead hot water pump variable-frequency drive is started. Natural gas heats the domestic hot water. A storage tank allows for the use of smaller burners.

Cooling System. The cooling system consists primarily of two 400-ton rotary liquid chillers, chilled water pumps and a cross-flow cooling tower. It cools water and circulates it through coils in the air handlers, which allow supply air to

pass through the chillers and circulate 55°F air through the building's ventilation system.

The BAS monitors the chiller's run status. The chilled water system is enabled whenever the outdoor air temperature rises above the supply air setpoint. If the lead chiller is unable to handle the building load, the second chiller is started.

If the lead chiller fails or is unable to maintain the chilled water supply temperature to within 2°F of the setpoint for 10 minutes, the lag chiller automatically starts and an alarm is sent to the operator's workstation. The lead/lag chillers are automatically rotated every week.

A public information desk is located inside the lobby entrance. After jurors go through security, they receive instructions regarding the location of their courtroom.



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The County Commission room is located off of the main lobby on the ground floor. The room includes more public seating than the former courthouse. An open space in the rear of the room provides space for overflow crowds.

Two chilled water circulating pumps have variable-frequency drives controlled by discharge air temperature on the VAV air-handling units. Minimum pump speed is limited to 30% of rated pump speed.

One of the two circulating pumps is selected as the lead pump. The lag pump remains off unless the lead pump fails. If the lead pump fails, the lag pump automatically starts and an alarm is sent to the operator's workstation. The lead/lag pumps rotate every week.



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The clerk's office is located off the main lobby on the ground floor to make it easily accessible to the public. Offices use energy-efficient electronic ballasts and T-8 lamps.

KEY SUSTAINABLE FEATURES

Water Low-flow water fixtures, storm water management system

Site Former rail yard was designated as a brownfield

Lighting Daylighting, T-8 lamps

Individual controls Comfort, lighting

Geothermal Heating Provides 17% of building's annual energy needs



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Air Handlers, Ventilation. Two air handlers, which are controlled by the BAS, circulate conditioned 55°F air throughout the building. Each air handler has two 125 hp turbine supply fans and two 60 hp return air fans. Each fan is controlled by a variable-frequency drive.

The unit produces up to 300,000 cfm for an air change occurring as

LESSONS LEARNED

Training operations staff to manage the direct digital control system, which is programmed and operated by the building automation system, has proved challenging due to the complexity of the systems and how they interact with each other. A document that summarizes the building's operating systems helps orient new building staff.

Ada County hosts an annual energy plan meeting and invites building professionals from the local community such as architects, engineers, commissioning agents, and utility representatives to review and comment on the energy plan for the courthouse and all county facilities.

An indoor air quality plan that sets policy for dealing with occupant temperature complaints can help quickly identify and address potential problems with the heating or cooling system.

Communicate building operations strategies and changes to building occupants. Examples include the provisions of an indoor air quality plan, recycling opportunities, or changes, such as adjustments to thermostat settings. Then, publicize progress towards meeting goals, such as the amount of trash that is recycled and diverted from landfills.

When occupants understand the broader goals, they help meet those goals by turning off unnecessary lights and keeping the building clean.

The Ada County Courthouse has demonstrated energy efficiency, cost savings and the benefits of indoor air quality. The building has become a benchmark in the community and serves an example for other projects.

often as every 10 minutes. Indoor air quality is maintained per ASHRAE Standard 62.1.

The air exchange is maintained via fan-powered terminal VAV boxes to provide a constant air change. The VAV boxes provide individual zone temperature control using a sensor in the space that controls the valve on the heating coil to provide heat and vary the damper on the VAV portion to provide cooling.

The damper opens for cooling and closes to 10% when heating or the temperature is met. When heating, the return air is mixed and a hot water coil is energized with hot water. Fresh air is introduced via the supply dampers and excess return air is expelled automatically via the exhaust dampers by the BAS. Ceiling diffusers are strategically located to maximize comfort and minimize condensation on the windows.

Normal occupancy of the building is 2,000 people daily. At a rate of 15 cfm per person, the building needs 30,000 cfm to meet indoor air quality standards. The system is capable of producing 300,000 cfm, and minimal flows are typically set at 10% of the system's capacity.

Controls, BAS

The building's DDC system is programmed and operated by the BAS installed on a dedicated PC. The BAS operates the heating and cooling system.

The program operates on a range of options, from 100% economizer to provide a full supply of fresh air, down to 10% fresh air mixed with the air being returned from within the building. It controls the cooling chilled water system, the boilers'

reset schedules on the heating loop, and the start/stopping of pumps for both heating and cooling systems.

It also controls static pressure in the air-handling system using the variable-frequency drives on the supply and return fans in the main air-handling system. Cooling coils and outdoor air economizers are controlled through the DDC system as well. The DDC system adjusts the night setback (55°F) and setup functions of the facility.

The local thermostat control is generally adjustable from 68°F to 74°F. A two-degree offset is programmed to permit a separation of heating and cooling functions. When local ambient factors make an area too warm or too cold, the local control can be adjusted to allow a wider range of temperature settings for more heating and/or cooling control.

Competing settings on adjacent controls can cause the two terminal fan boxes to "fight" (one unit heats while the adjacent unit cools), it may be necessary to reduce or eliminate the local control.

Lighting

The building primarily uses energy-efficient T-8 lamps. Daylighting maximizes the use of natural light and minimizes the need for artificial light.

Interior lights are subdivided and controlled by standard wall switches. This low-cost, low-tech design allows users to control specific zones and individual office spaces, minimizing use during unoccupied or low occupancy periods.

Individual task lights in offices are used to provide small areas of high-intensity light for specific tasks in place of overlighting the general



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The building team designed the courtrooms with input from Ada County judges. Some judges requested windows while others preferred spaces without windows. The view from this courtroom looks west toward the state Capitol dome.

work area. Meeting rooms, courtrooms, conference rooms, common areas and hearing rooms have dimming and dual switching to allow lights to be used only as needed.

Custodians shut off lights after cleaning an area. Security staff shut off lobby area lights at night. Exterior lighting sensors automatically turn off the fixtures during daylight hours.

Conclusion

The constant monitoring and attention of the courthouse by facilities and maintenance staff contribute to the success of the building. Understanding how to manage the

building systems correctly and efficiently, and spotting and repairing problems in the systems before they become bigger issues have made these systems successful.

Strategies such as building orientation, consolidation and efficiency in planning of departments, HVAC controls and high performance exterior materials combine to produce an efficient and durable building that will continue to perform into the future. ●

ABOUT THE AUTHORS

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