When the commercial bank CSOB decided to consolidate its Headquarters offices, which were scattered across several buildings in downtown Prague, it constructed one of the largest office buildings in the Czech Republic. The bank building, which houses approximately 2,400 employees, is notable not only for its size, but also for its energy-efficient design features and the sustainable strategies used during its construction.

The green roof of the CSOB Headquarters in Prague reduces storm water runoff, heat loss and heat gain.

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**CSOB HEADQUARTERS**

The CSOB Headquarters facility was designed and built to provide a work environment with good indoor air quality, natural light, and occupant comfort and control. Its energy performance of 52 kBtu/ft²/year achieves 18.8% in energy cost savings compared to the ASHRAE Standard 90.1-2004 baseline.

The approximately 900,000 gross ft² building combines a host of passive energy design strategies, including extensive daylighting, east-west site orientation and shading, without sacrificing occupant comfort. Employees have local control of lighting, HVAC settings and operable windows. But the building control system ensures energy efficiency by automatically shutting off an area’s heating or cooling when a window is opened and returning thermostat settings to automatic setpoints after business hours.

In an effort to ensure that the building’s energy-efficient features were used as designed, building managers provided employee

**PERFORMANCE DATA 06/2007 TO 05/2008**

<table>
<thead>
<tr>
<th>Total Energy Use</th>
<th>52 kBtu/ft²</th>
</tr>
</thead>
<tbody>
<tr>
<td>Electricity</td>
<td>44.1 kBtu/ft²</td>
</tr>
<tr>
<td>Natural Gas</td>
<td>7.95 kBtu/ft²</td>
</tr>
</tbody>
</table>

**Energy Intensive Submeter Electrical Data**

- **Kitchen:** 2.5 kBtu/gross ft²
- **Server Cooling:** 3.91 kBtu/gross ft²
- **Computer Servers:** 9.54 kBtu/gross ft²

**Energy Costs**

- **$1.55/ft² ($1.41/ft² electric, $0.14/ft² gas)**

**Energy Cost Savings**

18.8% Compared to ASHRAE Standard 90.1-2004, 42% Compared to Typical U.S. Commercial Office (90 kBtu/ft²)
training before the move to explain the building operation system and local controls. Employee surveys have helped ensure that the building operates as it is intended to perform.

The building offers a variety of amenities such as an on-site doctor, cafés, a convenience store, a cafeteria, breakout spaces for informal gatherings and meetings, interior and exterior gardens, and water features. Public/shared/nonwork spaces and amenities comprise approximately 36% of the net built area. Each floor has floor-to-ceiling glazing with direct views of the city, hills and the planted green roofs, which are accessible to all employees and comprise 34% of the total roof area. Tanks in the basement store rainwater, which is used to irrigate the green roof, indoor gardens, plants covering façades and the surrounding landscaping.
The building team incorporated sustainable principles throughout construction. The building was constructed on a previously contaminated site that was first remediated. Waste was separated and recycled during construction. Thirteen thousand cubic yards of concrete were salvaged from the previous development and reused in the new construction, while approximately 90% of the total waste was diverted from a landfill. Recycled materials were used for vibration insulation, drainage layers of the roofing and growing media. More than 40% of all construction materials were from within 500 miles of the site.

### Active Design Strategies

**Heating System**

The heating system uses three high-efficiency gas condensing boilers, achieving an annual efficiency of approximately 92%, distributing hot water to the fresh air air-handling units (AHUs) and fan coils. The hot water distribution system is a variable speed, low-temperature hydronic system with 140°F flow and 104°F return.

**Thermal Mass**

Encased within the building envelope is a significant amount of thermal mass. This material provides additional buffering of temperatures during winter and summer peaks. The building also has an active external venetian blind shading system, automatically controlled on the east, south and west façades. This prevents glare and minimizes unwanted solar gains. The exposed thermal mass provides additional buffering of temperatures during winter and summer peaks.

### Passive Design Strategies

The climate in Prague is driven by heating (3,542 heating degree days), with moderate summertime temperatures (only 1,029 cooling degree days) and low humidity. The building's environmental strategy uses optimized orientation, high performance building fabric, natural ventilation via operable windows, advanced HVAC and lighting controls, and an automated external shading system.

The building's long façades face north and south, minimizing east and west exposure. This reduces cooling loads and provides passive solar gains when beneficial during winter months. The 70% glazing ratio is significantly above the Standard 90.1-2004 baseline, but double-pane units are argon filled with a low-e coating to minimize heat loss.

### Monthly Energy Use, June 2007—May 2008

<table>
<thead>
<tr>
<th></th>
<th>Electricity Data (kWh)</th>
<th>Gas (therms)</th>
<th>Peak Electric* (W/ft²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>June</td>
<td>959,945</td>
<td>388</td>
<td>3.13</td>
</tr>
<tr>
<td>July</td>
<td>985,165</td>
<td>134</td>
<td>3.45</td>
</tr>
<tr>
<td>August</td>
<td>1,031,078</td>
<td>0</td>
<td>3.04</td>
</tr>
<tr>
<td>September</td>
<td>850,178</td>
<td>26</td>
<td>3.01</td>
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<tr>
<td>October</td>
<td>904,535</td>
<td>772</td>
<td>2.88</td>
</tr>
<tr>
<td>November</td>
<td>954,953</td>
<td>6,458</td>
<td>2.60</td>
</tr>
<tr>
<td>December</td>
<td>934,300</td>
<td>13,948</td>
<td>2.64</td>
</tr>
<tr>
<td>January</td>
<td>1,021,806</td>
<td>17,645</td>
<td>2.77</td>
</tr>
<tr>
<td>February</td>
<td>953,578</td>
<td>12,950</td>
<td>3.12</td>
</tr>
<tr>
<td>March</td>
<td>987,292</td>
<td>11,698</td>
<td>2.83</td>
</tr>
<tr>
<td>April</td>
<td>947,067</td>
<td>5,305</td>
<td>3.06</td>
</tr>
<tr>
<td>May</td>
<td>945,825</td>
<td>1,180</td>
<td>3.32</td>
</tr>
<tr>
<td>Total</td>
<td>11,465,724 kWh</td>
<td>70,502 therms</td>
<td>3.45 W/ft² Peak</td>
</tr>
</tbody>
</table>

*Based on gross building area.

### Submeter Data

Submeter data is available for the energy-intensive data servers, server cooling, convenience store and kitchen facilities. Computer servers and server cooling consume 31% of the building energy. This equipment also provides services for other buildings within the Czech Republic, with 30% serving external needs. The servers provide basic computer services for the Headquarters along with meeting the needs of more energy-intensive trading floors.

The kitchen, servers and server cooling are atypical services for a commercial office and add significantly to the energy use intensity of the building. The total energy consumption should be considered in conjunction with the following data.

- **Submeter 1**, Kitchen Facilities: 648,708 kWh, 2.5 kBtu/gross ft²·yr
- **Submeter 2**, Convenience Store: 50,079 kWh, 0.19 kBtu/gross ft²·yr
- **Submeter 3**, Server Cooling: 1,014,923 kWh, 3.91 kBtu/gross ft²·yr
- **Submeter 4**, Computer Servers: 2,583,980 kWh, 9.94 kBtu/gross ft²·yr

Energy consumption is quoted over the same time period (06/2007 to 05/2008), with energy intensity based on the total building gross square footage.
Weather compensation drops the flow temperature in response to the external air temperature, improving the system efficiency. This provides significant savings in heating and pumping energy. The heating system has an installed capacity of 15 Btu/ft².

**HVAC System**

The HVAC system uses a combination displacement system with perimeter fan coils for space heating and cooling. The displacement system uses a year-round supply air temperature of 66.2°F. The air returns through the large atria with heat recovery in the AHUs. The displacement system air volume is varied between a minimum in winter and peak in summer, with increased volumes when free cooling is available.

The fan coils provide the required heating and cooling, and local adjustable thermostats control 1,076 ft² zones. This hybrid system reduces installed fan power compared to a conventional fan coil or variable-air-volume (VAV) solution, with the perimeter units cycling only when required for space conditioning.

All meeting rooms have local fan coils for space conditioning and adjustable VAV boxes on the floor diffusers to provide a variable fresh air rate with manual speed control. Meeting room controls all default to off after two hours.

Operable windows within the building are linked to the HVAC controls. This system provides free cooling when conditions permit and prevents heating or cooling when the windows are open.

Light wells provide natural lighting to interior offices, while active shading systems prevent glare.

Lighting and Controls

The lighting strategy consists of task lights, which are combination up and downlights, and are programmed according to their location within the building. Every two desks share one set of task lights. An external weather station adjusts each light fixture.

**Cooling System**

The building uses air-cooled chillers, which supply chilled water to the AHUs and the perimeter fan coils. A separate circuit is provided for the servers with a free cooling chiller. The main chillers only operate when the air temperature rises above 64.4°F, while the displacement ventilation system and natural ventilation meet cooling needs below this temperature.

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**Lighting and Controls**

The lighting strategy consists of task lights, which are combination up and downlights, and are programmed according to their location within the building. Every two desks share one set of task lights. An external weather station adjusts each light fixture.
according to its position in the building and the available natural light. Users also may vary the light level by ±15% at their computer stations. Circulation spaces have T8 fixtures with two light levels. The available natural daylight results in the use of few lights during the day in atria spaces, perimeter office zones and perimeter kitchenettes. Even in interior circulation zones, lighting is dimmed at 50%. A combination of automatic and manual controls made this reduction in artificial lighting possible.

Zoning and Controls
The control system, which is centrally monitored by building staff, gives local control to building occupants. Each meeting room and HVAC zone provides temperature, air flow and fan coil data, and operable window status back to the central control room to allow troubleshooting of complaints. The control system also monitors all boilers, chillers and AHUs to ensure optimum performance. The control system also gives users local control over their lighting and HVAC setpoints. The central controls typically operate on default setpoints, turning lights and the HVAC system off two hours after regular hours and within meeting rooms at all times. Cooling setpoints also increase from 73°F to 80°F as the external air temperature increases from 77°F to 89.6°F. Operable windows in meeting rooms are fitted with sensors, which turn off the displacement system and perimeter fan coils when opened.
LEED Avisos

We found that, for LEED, the most part, is adaptable to international projects such as this one. The most challenging category is materials since an inherent conflict exists in selecting local versus selecting materials that are certified by U.S.-centric organizations, such as Green Label Plus Program. Attempts to request equivalency based on VOC concentrations were unsuccessful.

Skanska’s construction and environmental policies, the stringent local building environmental regulations and European union directives on issues such as VOC limits resulted in the easy achievement of many LEED credits.

Employee Feedback

To prepare its employees, who were accustomed to individual offices, for a new open plan work environment, training sessions and meetings were held for a year prior to the move. Employee surveys helped the operations staff better understand how to operate and interact with the space and HVAC system controls.

An ongoing employee feedback system records and addresses suggestions and complaints. Complaints such as others not turning computers and lights off highlight opportunities for improvement. This provides an effective means of communicating operation and maintenance issues.

Lighting and HVAC System Controls

The controls system monitors all of the thermostat zones, the status of fresh air, HVAC systems and operable windows. Building occupants have local control of HVAC systems, HVAC system setpoints and fresh air for meeting rooms. This setup has succeeded in troubleshooting complaints, improving occupant satisfaction and ensuring maximum energy efficiency and occupant satisfaction.

Heating System Performance

Compared to many U.S. buildings, the heating energy consumption at 7.95 kBtu/ft² is particularly low given the high annual heating demand with 3,542 heating degree days. Incorporating heat recovery on outdoor air systems, low flow, temperatures with high-efficiency gas condensing boilers, and weather compensation and effective controls has resulted in energy savings of 30% compared to the ASHRAE baseline (as defined by Standard 90.1-2004, Appendix G) of kW with reheat and 80% efficient boilers.

Lessons Learned

Energy-Efficient Design Measures

• Passive cooling via natural ventilation.
• Displacement ventilation with perimeter fan coils for heating and cooling. Central AHUs include heat recovery and free cooling with outside air when conditions permit.
• Automatic external shading with venetian blinds.
• Central atria and light wells provide natural light deep into open plan offices. These zones are less closely controlled using return air from the offices for space conditioning.
• Low-power density lighting with daylight dimming is adjustable for every two people. Common area lighting has dual light levels and the atrium lighting is off during daylight hours.
• Controls turn lighting and HVAC systems off after 6 p.m. Small control zones of 1,076 ft² permit after-hours occupancy with unnecessary space conditioning. Other Green Features

Transportation

The building is located within the city limits and is accessible by buses and the subway. It is built over a subway line with a station entrance within 100 ft of the building entrance. Building users have access to 190 bike stalls and 37 showers. Twenty-six spaces have been reserved for fuel-efficient vehicles and 20 spaces for carpools.

Indoor Air Quality

Natural ventilation, low-VOC paints and coatings, adhesives and sealants, and extensive placement of plants help promote the building’s indoor air quality. Ventilation systems provide 30% more air than required under ASHRAE Standard 62.1-2004, with boosted ventilation rates possible in meeting rooms through local VAV boxes on the fresh air system. Daylighting reaches 95% of spaces and HVAC systems provide local control of thermostatic setpoints.

Water Usage

Use of dual-flush toilets and low-flow fittings resulted in water savings of 22% compared to U.S. buildings. In addition, native vegetation and a rainwater catchment system have minimized irrigation needs.

Balancing Comfort, Efficiency

The CSOB Headquarters is the first building in the Czech Republic to achieve LEED certification. Its incorporation of sustainable principles and designs demonstrates that even a building that houses a small city can achieve significant energy savings while maintaining occupant comfort.

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