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Energy Efficiency Pilot Projects in Jaipur: Testing the Energy Conservation Building Code

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March 2014

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Energy Efficiency Pilot Projects in Jaipur: Testing the Energy Conservation Building Code

The Malaviya National Institute of Technology (MNIT) in Jaipur, India is constructing two new buildings on its campus that allow it to test implementation of the Energy Conservation Building Code (ECBC), which Rajasthan made mandatory in 2011. PNNL has been working with MNIT to document progress on ECBC implementation in these buildings. Table 1 below shows highlights of the buildings:

Building/Characteristic	**Design Centre**	**Lecture and Theatre Complex**
Project description	Additional two floors to expand an existing building; the building will provide training space for ECBC and green building stakeholders	A large, new building complex with multiple lecture halls, classrooms and multipurpose meeting space. The core building is 5 stories, linked to a theatre/multipurpose complex.
Anticipated savings	Approximately 20% because of ECBC measures, plus an additional 20% above code because of additional measures and solar PV	Not yet simulated, but estimate 20+%
Technologies deployed or planned	***Envelope*** -Roof insulation (Owens Corning XPS and some fiberglass) -Wall insulation (BASF XPS, sandwiched between the wall layers) -Double-glazed windows with St. Gobain glass and Fenesta frames -Vertical fence shading design ***HVAC and PV*** -Daikin VRV heat pump air conditioners -DRI heat recovery (Dessicant Rotors International) -Fiberglass duct insulation -150 kW rooftop solar PV ***Lighting*** -LED lighting (not yet	***Envelope*** -Building oriented for low heat gain -Windows face shaded spaces; few windows on south facing wall -Shading -XPS insulation in roof and walls (planned, will procure in April-May 2014) -Double-glazed windows (planned, procure in April-May) -Insulation sandwiched in wall layers (primarily for earthquake resistance, already installed) ***HVAC and PV*** -Natural ventilation in corridors and other common spaces -HVAC (plan variable air

	procured) ***Controls*** -Building Management System (not yet procured, options may include Honeywell, Schneider or Lutron)	volume AC with heat recovery and controls, will procure in March-April; UT has helped with design) -Solar PV on roof (not yet defined) ***Lighting*** -Not yet defined, likely LED -Natural day lighting through shaded spaces ***Controls*** -Building Management System integrated for HVAC and lighting (UT has also helped with design)
Status of pilot	Building should be complete by April 2014. Lighting is the major remaining item for ECBC compliance to be procured. Once the building is finished and occupied, MNIT will conduct final, as-built simulation of the building to estimate savings. MNIT will also monitor the building's energy use to compare it with the estimates. Typically, it takes one year of measurement to present measured results.	Building construction has begun; completion expected in approximately 18 months. Design incorporates green building features associated with the building footprint (orientation, shading, natural ventilation and day light). Once the HVAC is procured, MNIT will conduct initial building energy simulation of the building design to show to anticipated energy savings.

Key lessons learned to date:

- Buildings can save significant energy with ECBC implementation.
- Procurements in public buildings like those on MNIT's campus can be complex. MNIT found that not all the materials and equipment it needed for ECBC compliance were available on the list of approved products for government procurements. The Central Public Works Department maintains this list, which is known as the"Schedule of Rates". This slowed down the procurement of LED lighting in the Design Centre. It also affected other procurements for ECBC materials, which in some cases lowered the efficiency of the building. MNIT compensated for this by adding 150 kW of solar PV. The Bureau of Energy Efficiency has since worked with the Central Public Works Department to update the Schedule of Rates. However, public buildings must still show lowest first cost, which is a challenge for many efficiency measures which typically have low life cycle costs, but slightly higher first costs.

- MNIT conducted significant analysis to build the business case for purchasing materials and equipment that helped with ECBC compliance. This information will be helpful to other public facilities.
- Manufacturers may overstate energy performance of the materials and equipment. MNIT noticed this when they conducted their own simulation of the windows they planned to install. A robust system to test, rate and label products will make ECBC implementation easier.
- MNIT was able to use eQuest, a building energy simulation program, to assess whether the planned design met ECBC requirements. It would be very helpful to have robust, easy-to-use compliance software. This requires improving the functionality of ECOnirman.
- All central government public buildings must now meet ECBC requirements because they must have a green building certification. Public buildings do not need to receive construction or occupancy permits from the local government, but rather, they receive this approval from the central or state public works departments. Strengthening the capacity of these public works departments to implement ECBC in all their buildings will help build momentum to mainstream ECBC implementation.
- Due to the ease of interpreting prescriptive requirements, CPWD and other government organizations prefer the prescriptive method of compliance. MNIT, on the other hand, has preferred the whole building method. Due to this, some requirements in the MNIT pilot buildings were more stringent than ECBC prescriptive values to compensate for other components. This made the procurement process significantly lengthier. One such case has been lighting, in which the lighting power density chosen is much lower than ECBC requirements, thus raising the level of specifications of lighting fixtures and controllers.

The sections below on the Design Centre and the Lecture and Theatre Complex provide photos of the two pilot buildings from February 2014, highlighting energy efficiency and renewable energy measures, and the status of construction.

The Design Centre, MNIT Campus

Figure 1. Front entrance to the original building

Figure 2. Ceiling insulation

Figure 3. Ceiling insulation and wiring for LEDs

Figure 4. Ceiling insulation, wiring for LEDs and natural day light

Figure 5. Duct and ceiling insulation

Figure 6. Ceiling insulation

Figure 7. Ceiling insulation

Figure 8. Meeting space

Figure 9. Double-glazed window, St. Gobain glass and Fenesta frame

Figure 10. 150 kW of rooftop solar PV

Figure 11. Rooftop PV and VRV air conditioning system

Figure 12. Solar PV

Figure 13. Solar PV and VRV air conditioning units

The Lecture and Theatre Complex (under construction at MNIT's campus)

Figure 14. Main entrance. Day lighting, shading and natural ventilation.

Figure 15. Light, insulating concrete building material

Figure 16. Foundation of the new complex

Figure 17. Front entrance highlighting shading and open air flow

Figure 18. Limited windows on south facing wall, natural ventilation in corridors

Figure 19. Windows facing shaded spaces

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