

The three methods used to reduce the purchased energy use of the ISTB 3 Building are:

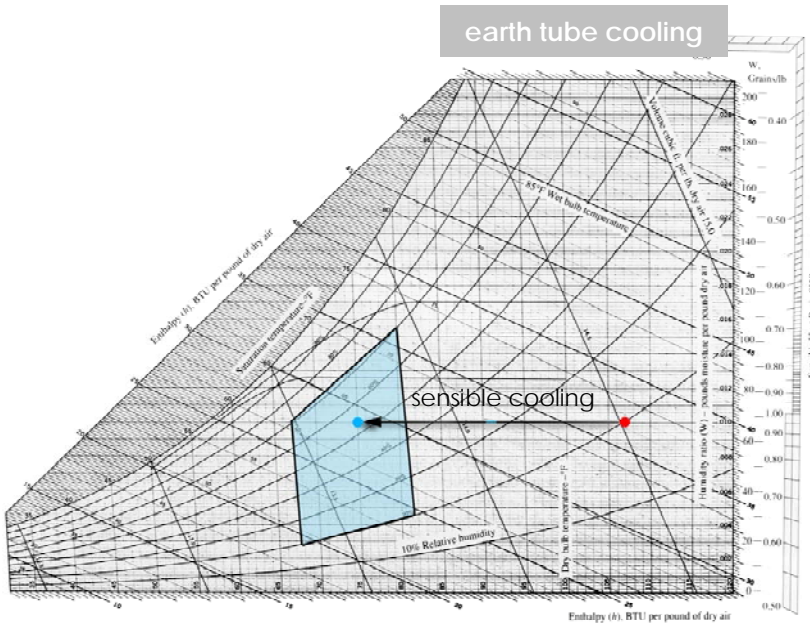
- Reduce the existing load
- Improve efficiency of equipment
- Use on-site renewable energy

1. The reduction of the existing load was accomplished by the addition of earth tubes. The earth tubes cool the outside air before it is taken into the makeup air handler. Since, the laboratories require 100% outside air, there was a large heat gain from the hot outside air.

2. To improve the efficiency of the central plant, one of the existing 250-ton chillers was replaced with a 150-ton adsorption chiller. This was possible by using the earth tubes to reduce the chiller load. The adsorption chiller uses approximately 2% of the energy of the York chiller. Solar collectors are placed on the roof for the adsorption chiller.

3. To further reduce the purchased energy demand, photovoltaic modules are placed on the roof in order to power the new adsorption chiller. The photovoltaics will provide 100% of the power required by the adsorption chiller, 4500kWh/year.

1 Earth Tube Cooling for Laboratories	
AVERAGE ANNUAL GROUND TEMPERATURE (T_g) =	68 °F
AVERAGE AMPLITUDE OF GROUND TEMPERATURE (A_{tg}) =	18 °F
AMPLITUDE CORRECTION FACTOR (CF) =	14'
DESIGN DEPTH OF EARTH TUBES (DD) =	10'
LATE SUMMER GROUND TEMP (T_{sg})= $T_g + A_{tg} \times \{1-(DD/CF)\}$ =	24.6 °F
INDOOR DESIGN TEMPERATURE (T_{in}) =	75.0 °F
TEMPERATURE DIFFERENCE (ΔT) = $T_{in} - T_{sg}$	50.4 °F
CONDUCTIVITY OF SOIL (C) =(drysoil, $k = 0.25$ Btu/hft°F) =	0.11
TUBE AREA (A) (Assume 20" dia. Tube) = $(2 \times 3.14 \times r)/12$ " =	5.23
LONGTERM COOLING RATE (Btu/hft) = $\Delta T \times C \times A$ =	29
HEAT GAIN FROM VENTILATION (Btu/hrft ²)=	5.32
FLOOR AREA OF LABORATORIES (ft ²)=	4356
TOTAL COOLING NEED FROM TUBES (Btu/hr) =	23174
OUTSIDE AIR DESIGN TEMPERATURE (T_{out}) =	107 °F
ADJUSTMENT FOR HOT AIR (T_{out}/T_{in}) =	1.43
ADJUSTED COOLING NEED FROM TUBES =	33061
EARTH TUBE LENGTH (ft) = cooling need/cooling rate=	1140



2 Adsorption Chiller	
EXISTING YORK CHILLER LOAD =	250 TON
ESTIMATED EARTH TUBES REDUCTION =	100 TON
NEW CHILLER LOAD SIZE NEEDED =	150 TON
ANNUAL ELECTRIC CONSUMPT. OF YORK CHILLER (kWh)=	263,520
ANNUAL ELECTRIC CONSUMPT. OF ADSORPTION CHILLER=	4,500
ANNUAL ELECTRIC SAVINGS FROM ADSORPTION CHILLER=	259,020
ANNAUL % ELECTRIC SAVINGS FROM ADSORPTION CHILLER=	98%
Solar Collector Modules	
ADSORPTION CHILLER =	150 TON
SOLAR COLLECTOR AREA NEEDED (90 sqft/ton)=	13500 sqft
3 PV Modules for Adsorption Chiller	
ANNUAL ELECTRIC CONSUMPTION OF ADSORPTION CHILLER=	4500 kWh
DESIGN PHOTOVOLTAIC MODULE OUTPUT (8.63 ft ²)=	40 W
ANNUAL SUN HOURS (6 per day x 365 days)=	2190 hrs
TOTAL PV MODULES NEEDED =	51
TOTAL PV AREA NEEDED =	440 sqft