KEMA

memo

To:	James Jordan, AIA, LEED AP Partner, AI3 Architects	Date:	April 15, 2011
From:	Jim Leahy, PE, LEED AP		
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Subject:	Preliminary Energy Efficiency Narrative East Bridgewater Jr./Sr. HS		

As a Model High School project, the East Bridgewater Junior/Senior High School design will be based on the design of the Whitman-Hanson Regional High School in principle, but a number of modifications are being made to account for latest changes to the Massachusetts building energy code and the owner's preferences for an energy efficient building.

The energy efficiency goals of the project include:

- Receive 5 points for the LEED Energy and Atmosphere credit 1. This means that the project goal is to improve the proposed school building performance so it offers at least 20% energy cost savings as compared to a "baseline" building that meets the minimum requirements of ASHRAE 90.1-2007 Appendix G.
- Install a 75 kW photovoltaic system to generate electricity on site
- Provide optimized building performance while managing and maintaining the building construction costs within the project budget
- Participate in the energy efficiency incentive program offered by local electric and gas company (National Grid and Bay State Gas) to help offset some of the incremental construction costs associated with more energy efficient building equipment and systems

To help achieve these energy efficiency objectives the design team has done the following:

- Instituted an integrated design process in which the design team members collaborate early in the design process

- The project architect, AI3 Architects, LLC, retained the services of KEMA Services, Inc. (KEMA) for energy and daylight modeling. KEMA is an energy consulting firm specializing in building energy modeling, energy efficiency studies, and sustainable building development. KEMA is developing an energy use simulation model for the East Bridgewater Jr./Sr. High School building. Various design alternatives are being tested for their energy efficiency and cost-effectiveness.

- A Comprehensive Design Approach study for the project is being prepared that will be submitted to the utility companies to serve as the basis for the determination of the monetary incentive by the utility.

While an energy and design analysis of the East Bridgewater Jr./Sr. High School is currently underway, an initial list of the design features/measures for consideration in the project is provided below. The measures are grouped into categories and include items that may already be planned for the project as part of the Model High School plan or may be considered as new "enhancements" for this project. The list provides a fairly comprehensive understanding of the systems and strategies; however, some of the items listed here may not be applicable, feasible, or desirable for various reasons. Measures may also still be added at a later time as more detailed design information becomes available. The building energy model is being used to assess the individual impact on the overall energy consumption of the building and the potential cost-effectiveness of the measures.

Energy Efficiency Measures

Building envelope

1. Roof insulation exceeding baseline. This project will use continuous insulation (c.i.) applied entirely above the roof deck. 4.5" of continuous roof insulation (extruded polystyrene) is planned for the project at this time. That offers —R-23 c.i. as compared to the minimum R-20 c.i. required by the code.

2. Optimized windows. The objective is to select windows that offer favorable combination of glass and frame properties for good thermal and solar control; that would include low overall U-value, low solar heat gain coefficient (SHGC) - at least for south facing windows, and high visible light transmittance (VT). The project is expected to use windows that will have low-e coating on the 2nd surface and insulating properties for optimal thermal performance including:

- Overall U-value for the entire window assemblies:
  - Single hung windows: 0.51
  - Fixed windows: 0.45
  - Storefront windows: 0.42
  - Curtain wall: 0.43
- SHGC of —0.37
- VT is of — 0.7

Electric systems

3. Optimized lighting system for entire building resulting in as low as economically possible average lighting power density (LPD) for the building. This measure focuses on selection of energy efficient lighting fixtures, lamps, and ballasts, and a lighting system layout that offers low LPD while allowing for good quality and the appropriate amount of light level in the spaces. Currently a building-wide average value of 1.0 W/sf or below is targeted.

4. Maximized daylight harvesting, sensors & controls. The design is expected to include daylight harvesting, sensors and controls in classrooms, the cafeteria, and the gymnasium (track area). Other spaces where daylight harvesting will also be considered include any spaces with significant access to daylight —library, lobbies, corridors, etc; the light control method can range from on/off through step dimming to continuous dimming depending on preference and how visually critical tasks will be typically performed in a particular space. For spaces such as corridors, lobbies, and vestibules a simple on/off switch based on available daylight could be considered. Dimmable ballast will be used in all fixtures that will be expected to use continuous dimming for a light output control method.

5. Occupancy sensors for lighting system control. Occupancy sensors for lighting control are expected to be used extensively in the East Bridgewater Jr./Sr. High School project. At the very least, they will be used in classrooms, offices, storage rooms, etc. Additional spaces where the occupancy sensors might be use in the East Bridgewater Jr./Sr. High School include spaces such as:

   - Boys and girls lockers
   - PE Alternatives/Training

- Band classroom
- Choral classroom
- Gymnasium
- Cafeteria

For these spaces, using occupancy sensors in addition to "regular" light switches is considered. Sensors with a large coverage area or multiple sensors will need to be considered for these spaces because of their size.

For spaces equipped with occupancy sensors that have access to daylight, the design team is considering using sensors that turn lights off when space is unoccupied but do not automatically turn light on when space becomes occupied. If desired, the occupant turns lights on.

6. Parking/grounds lighting. Energy efficient lighting is considered for the parking and grounds lighting.

HVAC and DHW systems

7. Optimized variable-air-volume (VAV) rooftop units. The HVAC for the classrooms, library, and administration areas will be served by rooftop VAV units. The units provide variable air flow to the spaces depending on the occupants needs. The benefits of these units include:

    - Save on energy costs by slowing the speeds of the fans to provide only the minimum airflow required to each space
    - Provides occupancy-based (or CO2-based) supply of ventilation air to VAV boxes
    - VAV terminal boxes are controlled by occupancy sensors as well as thermostats, which will provide exceptional operational flexibility by allowing unoccupied spaces to be in a stand-by mode or “off” during the normal occupied mode of the day.

8. Demand Controlled Ventilation for the gymnasium and cafeteria. The gymnasium and cafeteria HVAC needs will each be served by one rooftop air handling unit with demand controlled ventilation (DCV) capability. DCV systems provide energy efficiency benefits by:

    - Slowing down the supply/return fans (100% to - 70% of design supply air flow) during occupied mode when there is no significant heating or ventilation needs in the space.

- Use high quality CO2-based demand controlled ventilation for the control of outside air dampers for these units as required by the building code.

The DCV strategy will dictate that most of the time the units will be in a recirculation mode. Furthermore, the auto-temp control system will control the units to three distinctly separate modes; “normal daytime use”, “event or game” mode and “assembly” mode. With these options, the outside air quantity can be controlled to reflect the actual occupancy of the space.

9. Variable flow, variable temperature system and enhanced controls for single zone units serving the auditorium and stage. The system will be designed with the following parameters:

   - The auditorium, stage & cafeteria system will operate at variable supply air flow (the supply air flow will vary from 100% to 70% or less of the design supply air flow) and variable discharge temperature based on the space temperature.
   - As required by the building code, a CO2-based demand controlled ventilation system is planned.

10. The HVAC units will have enthalpy economizers installed for increased energy efficiency. An enthalpy economizer cycle reduces the mechanical cooling load when the outdoor air enthalpy is less than the enthalpy of the return air.

11. Enhanced kitchen hood controls such as Intelli-hood system from Melink Corp. This measure would provide kitchen hood controls to reduce hood exhaust and fresh air make-up when cooking equipment served by the hoods is not in use. By slowing down the fans and reducing the amount of exhausted air (and heated make-up air) when possible, a decrease in heating and fan energy can be attained.

12. Water-cooled chilled water plant is considered for the project. Also considered are the following "enhancements" to the water-cooled plant:

   - A high efficiency VFD chiller with good full load and excellent part load performance.
   - Air cooled chiller with VFD’s on compressors will be provided. The chiller will have an IPLV (EER) of 18.5

- Aggressive CW temperature setpoint reset based on the chiller plant load and ambient conditions. This must be coordinated with the chiller manufacturer's recommendations and chiller limits.

- Variable/primary pumping strategy to be employed for the CHW loop.

13. Hot water (HW) system enhancement. High efficiency condensing boilers are planned for this project. The HW system will also be designed for a lower temperature - design HW temperature of I50F and have aggressive resets based on outside air temperature. This will allow for more efficient operation of the condensing boilers planned for the project.

14. Considerations are given to designing all HVAC systems for reasonably low pressure drops to reduce fan & pump power and energy.

15. All motors 1 hp and larger that operate on regular basis will be premium efficiency; motors for emergency equipment or infrequently operating equipment (for example smoke evacuation fans etc) will not have any significant impact on energy efficiency.

16. Enhancements for the domestic water heating:

    - High efficiency condensing domestic water heating units are planned.

    - Insulating jackets with high insulation values (R-14 or higher) are considered for the hot water tanks.

17. Small solar water heater to supplement the main domestic water heating system is considered. This system is very small in size and intended mainly for demonstrational/teaching purposes. It is expected to have negligible impact on the building energy consumption.

18. High efficiency appliances and kitchen equipment. The Energy Star rated equipment was considered by the design team in the selection of the kitchen appliances and the following Energy Start equipment is currently specified for the project: reach-in refrigerators, a ware washer, and hot food holding cabinets. The Energy Star rating is used to recognize energy efficient appliances, lighting, boilers, and other energy consuming equipment and systems.

Renewable Energy Technologies for Active Power Generation

Photovoltaic System (PV) — the project plans to include an installation of a PV system with a total capacity of approximately 75 kW-dc. At this time it is planned that the system will consist of Solyndra PV modules. Solyndra PV panels utilize unique cylindrical modules which capture sunlight across a 360-degree photovoltaic surface and convert direct, diffuse and reflected sunlight into electricity. The modules will be installed on the gymnasium roof. At this early stage of the PV system design, it is estimated that the system could generate approximately 93,000 kWh/year of electricity. This amounts to approximately 2.5% of the baseline building electric energy consumption. The system would be tied to the utility grid and any excess power generated at the site will be sold back to the utility. An interactive touch screen display kiosk is expected to be provided in a prominent location on the site to increase the promotional and educational benefits of the system. The kiosk will allow students and visitors to monitor system performance in real time, or easily review historical performance. Performance data includes power/cumulative energy production, pollution reduction (including attributable greenhouse gas emissions), and weather conditions. The same information might also be available on the school's website on the Internet. The building electric meter could also be tied into the kiosk data base so students and visitors can not only observe how much energy is generated on site, but also how much is consumed and how energy conscious behavior can affect such consumption.