East Gwillumbury Elementary School Design Charrette

SBC Charrette, October 2nd, 2009

FINAL REPORT

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1.0 Summary and Background

The Conseil Scolaire de District Catholique Centre-Sud Centre Sud (CSDCCS) is planning to build a number of new schools in their district. The East Gwillumbury project is the first that will seek funding through the High Performance New Construction Program The planned building is a 2 storey, building that will hold will hold 319 Students and 26 daycare children. The building will be designed with the possibility to be expanded. There is 12 months planned use - daycare during summer, day camps, scouts, sports teams, etc. but not full capacity (approximately 1/3 of school will be used in summer- the rest will be closed off). The design is based upon a school that has already been built in Whitby, Ontario. The school will use municipal services.

The architect for the project is Mills Architects Inc. while the mechanical and electrical engineering team is from Jain & Associates. In keeping with the philosophy the CSDCCS, there is a desire to ensure that the new building is both highly energy efficient in and demonstrates strong environmental stewardship for this kind of project. As such, the developers set out to identify both the elements of the building that would ensure the lowest possible energy use and "carbon footprint" and the nature of the project that would achieve broader environmental stewardship.

Sustainable Buildings Canada (SBC), in partnership with the High Performance New Construction (HPNC) and the CSDCCS undertook a 1-day design "Charrette" aimed at identifying the various energy and environmental improvements that might be achieved by this project. The Charrette was professionally facilitated by Mike Singleton and engaged a multi-disciplinary group of individuals who explored a variety of ways to improve the environmental performance of the building.

The team also made use of a series of building energy modeling and energy performance models and assessment tools – in particular, the EE4 energy modeling software as used by Jain Sustainability Consultants.

The Report is presented as follows:

Section 2 shows the participants and their expertise.

Section 3 tracks the various discussions throughout the day, including an examination of the various occupant considerations and the potential alternative equipment types and building configurations. It also includes the energy models presented by Jain Sustainability Consultants.

This report has been prepared from the notes, reflecting the various discussions at the Charrette and is reported "as is". No further research has been undertaken related to any of the discussions and SBC makes no warrants regarding the accuracy of any of the information presented herein.

Sustainable Buildings Canada wishes to express our appreciation to all those involved in making this an important event. Thank you to all.

2.0 Participants

Daniel Cayouette, Construction Manager, CSDCCS

Robert Castel, Directeur du Service des ressources matérielles, CSDCCS

Mike Singleton, Facilitator, Sustainable Buildings Canada

Valerie Kindree, Energy Advisor, HPNC

Melanie Bossence, Communication Specialist, HPNC

Judy Zhang, Simulator, Jain Sustainability Consultants

Anish Jain, Jain Sustainability Consultants

Dinesh Jain, Geothermal Expert, Jain & Associates

Juris Zvidris, Architect, Mills Architects

David Mills, Architect, Mills Architects

Paul Leitch, Johnson Controls, Renewable energy Expert

Haidee Lam, Cooper lighting, Lighting Design Expert

3.0 Discussion and Results

The group discussion focused initially on the current design. Detailed site plans and drawings assisted the discussion.

Mills Architects has designed the building to be orientated for the best solar usage. However, rezoning and concerns expressed by the current neighbours have dictated how the building will likely be configured.

Site: The site is a rural corner property, with exclusive estate housing developments nearby. The exterior is intended to fit in with its surroundings. The initial concept included the containment of water on-site and energy performance that significantly exceeds the Ontario Building Code.

Initial concepts designed to address neighbours' concerns include the use of outdoor lighting sensors and quiet A/C systems to be placed on the side of the school that is away from the residential area. There is a large dip at the back of the school and questions remain about whether it is advantageous to use it, or if it would be best to fill it in.

LEED: The CSDCCS has not yet decided if they seek LEED certification. Initial analyses indicate that the building will perform like a LEED building, but the CSDCCS may not be willing to entertain the certification process. The CSDCCS notes that attaining LEED certification will not bring more children to the school or influence any other key factors that are normally considered by the Board. It can also be costly and time consuming.

3.1 Energy Model of Baseline Building Performance and Select Alternatives

In advance of the charrette, Jain Sustainability Consultants prepared both a baseline energy model and a series of the "alternative" models, representing a variety of design and mechanical features of interest to the CSDCCS. It is important tpo note that the baseline performance of the building is already significantly better than the energy requirements of the existing OBC – that is the building as planned by the CSDCCS can be anticipated to out-perform a "reference" building under the requirements of the OBC. Any energy improvements examined as part of the charrette will serve to increase the performance even further.

Many of the proposed design improvements, including those related to day lighting and renewable energy need to be further examined and modelled outside the EE4 software. The baseline energy model highlights are shown in Figure 1 below.

Figure 1. Baseline Energy Model

As shown, a number of end uses are excluded from the modelling. These include elevators, exterior lighting, process loads, plug loads etc. This represents a limitation of the EE4 modelling platfor. Further analyses of these loads – in particular, plug load is recommended.

Figure 2. Baseline Energy Model (cont'd)

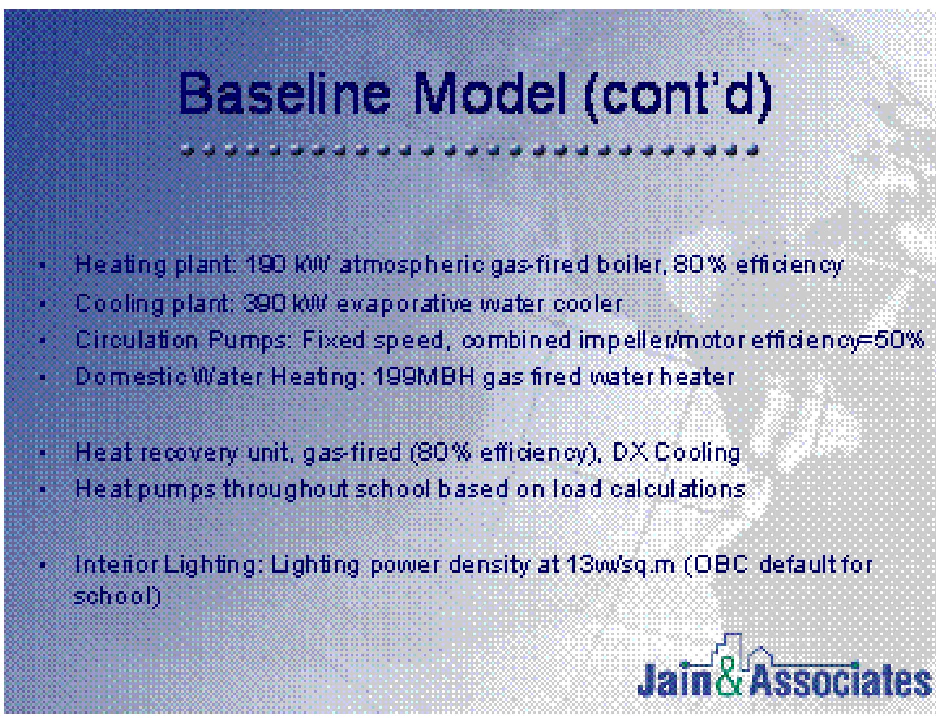
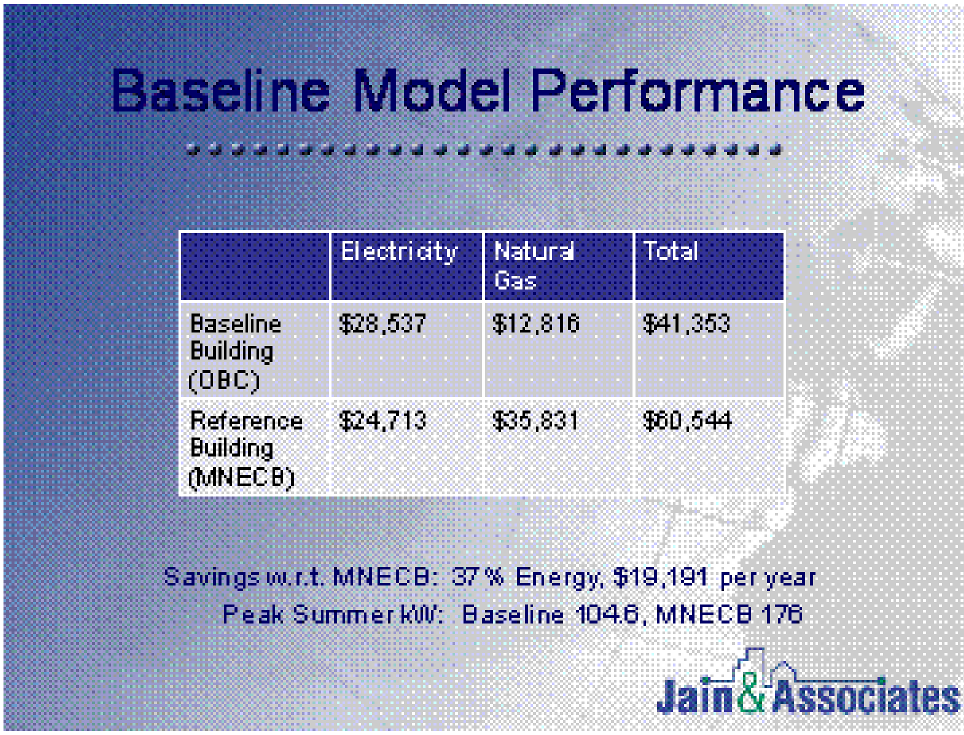


Figure 3. Baseline Model Performance



A series of alternative designs were also prepared by Jain Sustainability Consultants. These are shown in Figures 4 through 10.

Figure 4. Alternative 1. Condensing Boilers

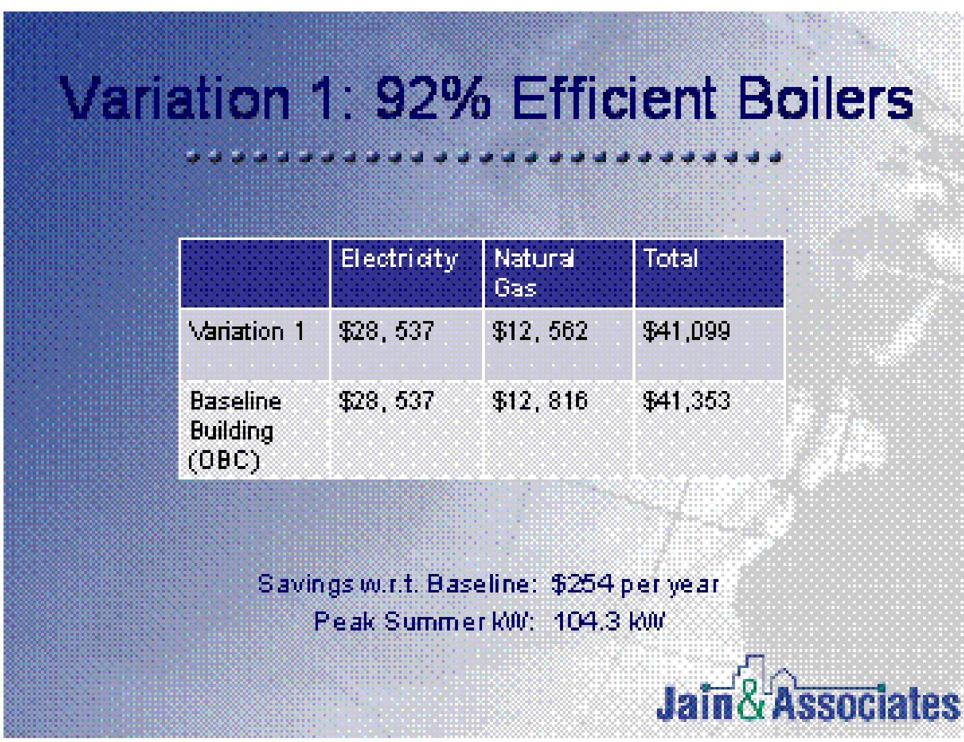


Figure 5. Alternative 2. Variable Frequency Drives on Circulation Pumps

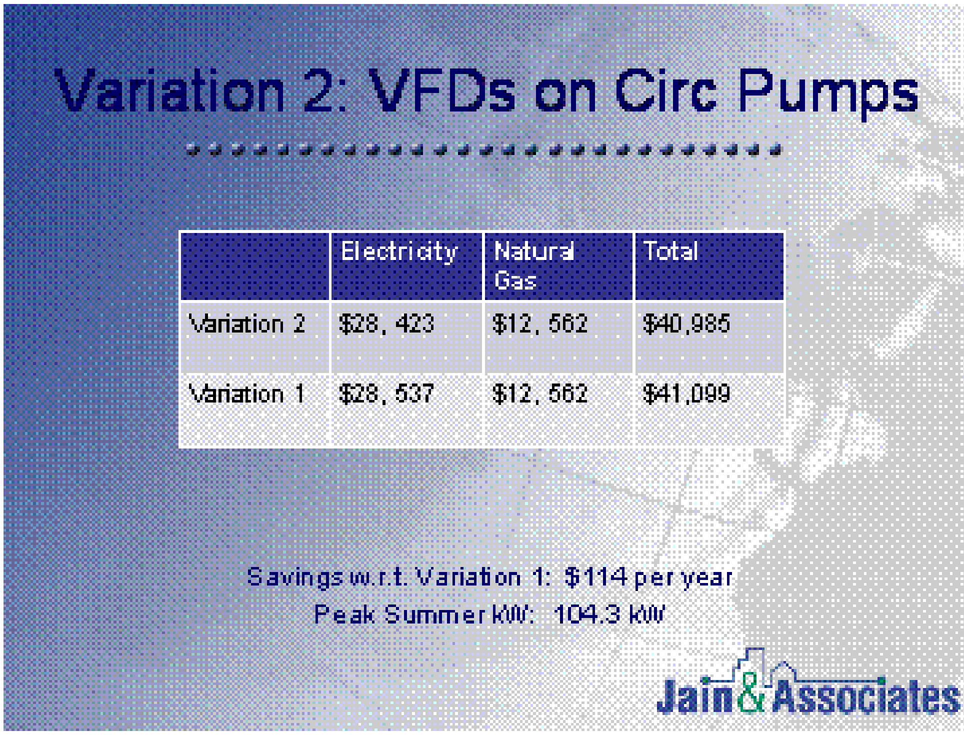


Figure 6. Alternative 3. Variable Frequency Drives on Circulation Pumps

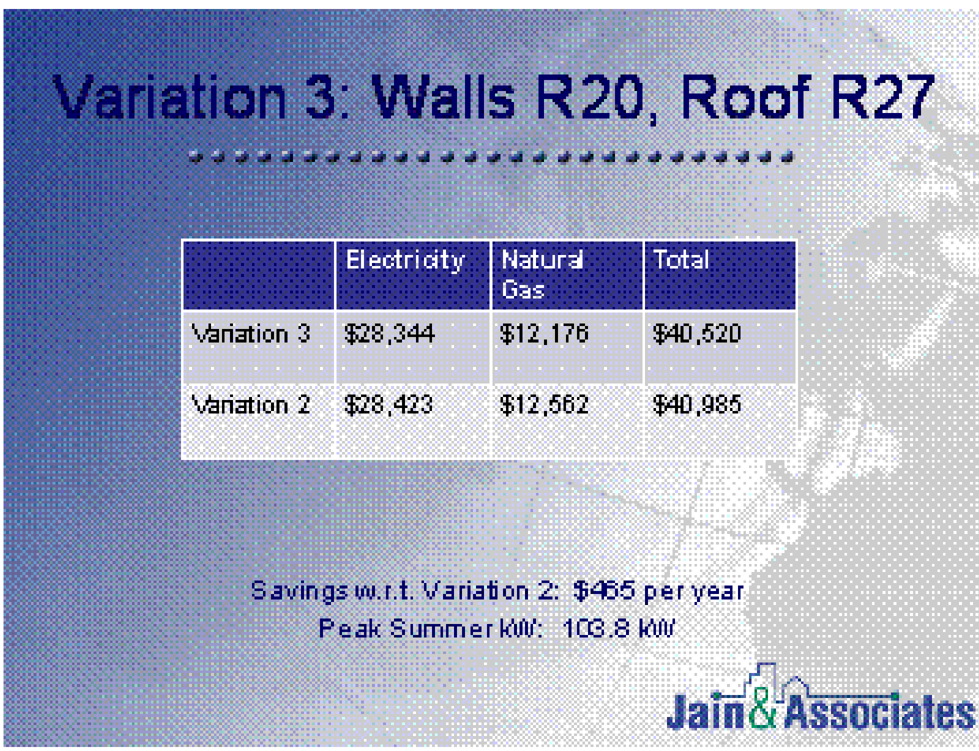


Figure 7. Alternative 4. Low E Glazing

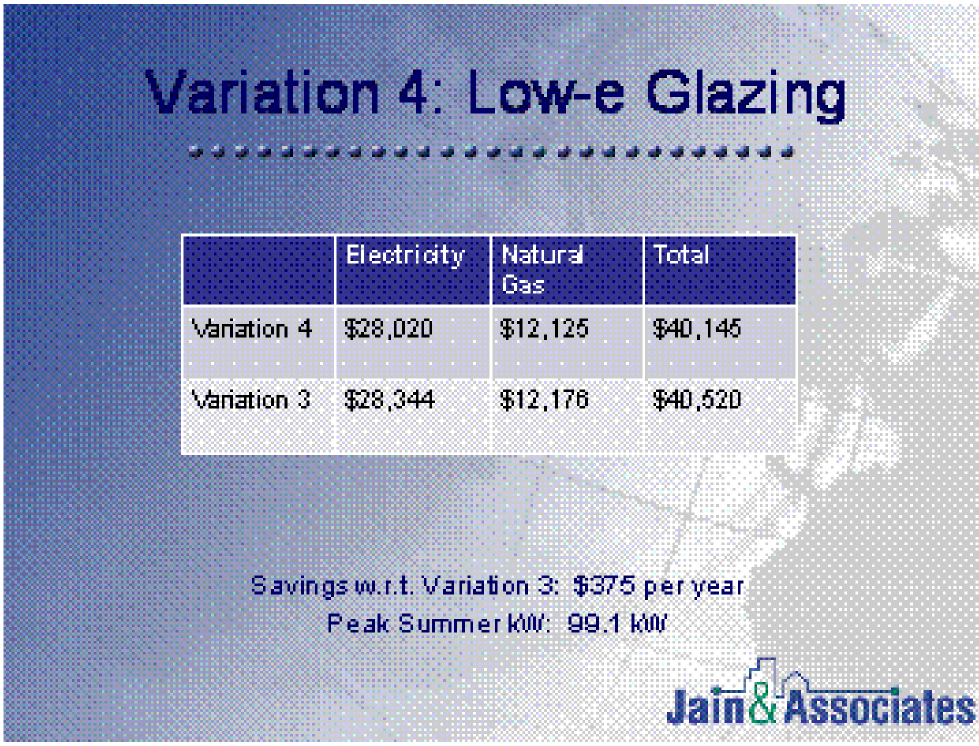


Figure 8. Alternative 5. Occupancy Sensors

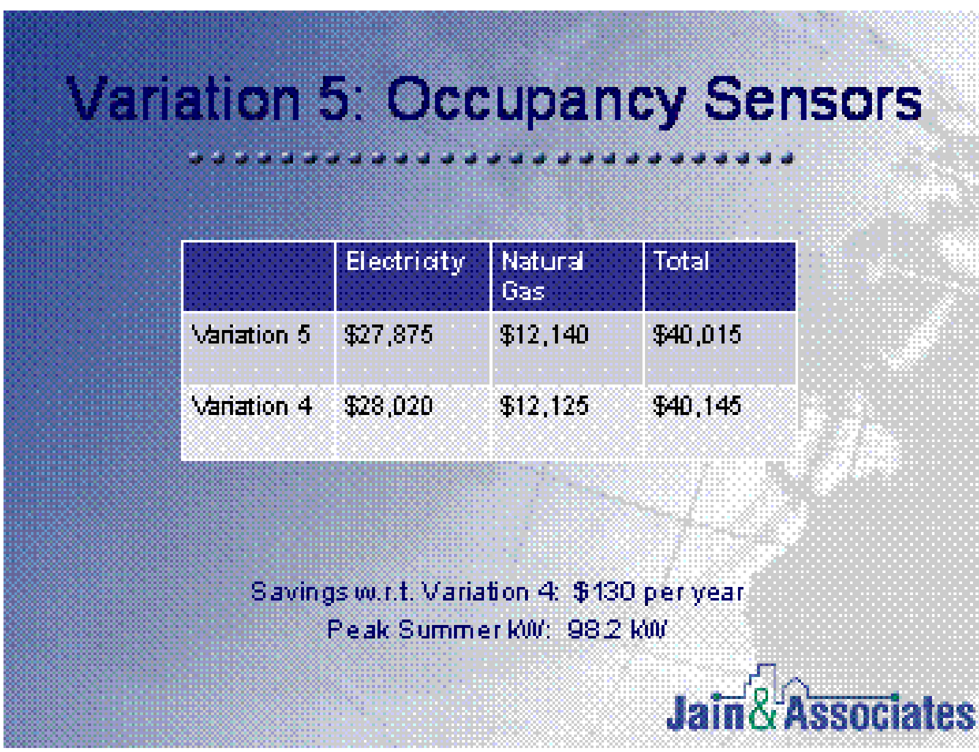


Figure 9. Alternative 5. Day light Sensors

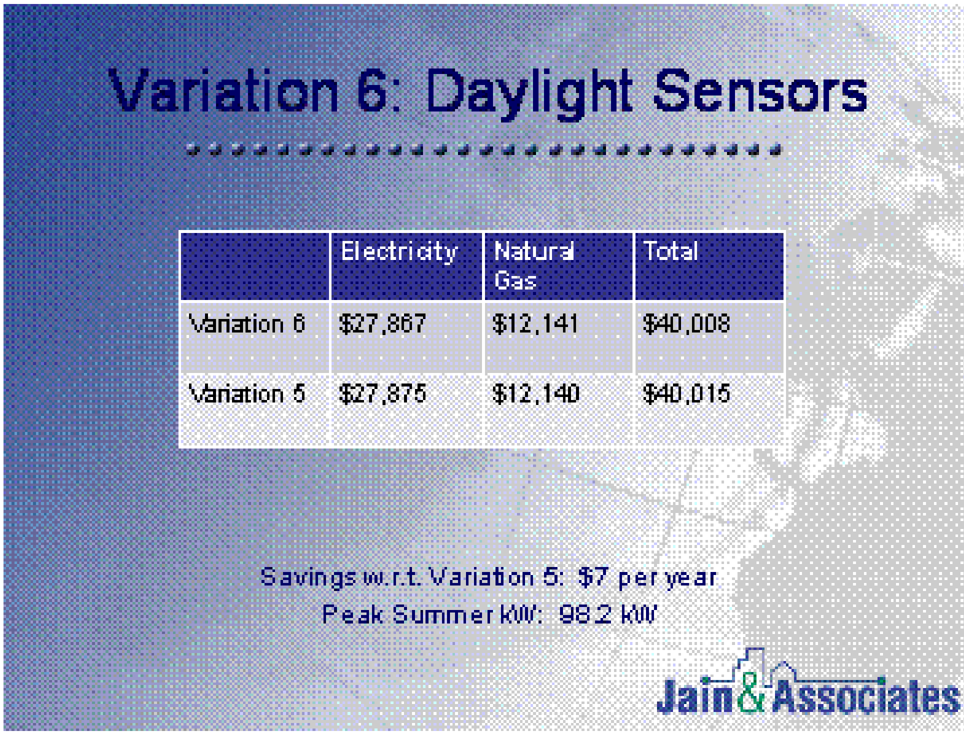
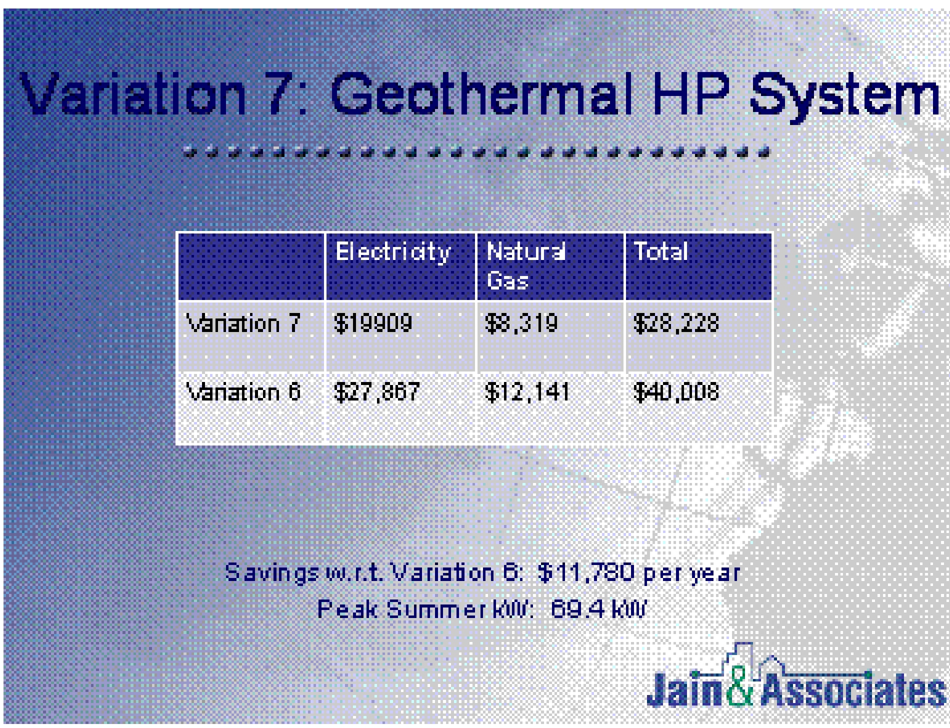


Figure 10. Alternative 5. Geothermal Heat Pump System



The team noted the criticality of the installation (or not) of a central air conditioning system. This choice affects related choices with respect to the heating system. In particular, the use of geothermal is only “worth it” if there is central air conditioning. Similarly, thermal heating (e.g. in floor radiant heating) will likely be precluded if central air conditioning is selected.

As indicated, the reference building is already relatively efficient. As a result. the improvements related to condensing heating, high performance windows and VFDs are relatively small, reflecting the higher baseline. It can also be expected that with the higher baseline, improvements in energy efficiency may come at a higher cost.

3.2 Other Technologies for Consideration

With a series of alternative models in place, the team then examined a number of other technologies and measures that CSDCCS wishes to examine further.

Lighting

Starting point – typical classroom: recessed 2x4 T8s and Ceiling heights: 9 ft. with some possibility of direct/indirect lighting. Indirect fixtures allow for lower lumens and resulting lower electricity use. Lighting can also be more uniform if it is directed to the ceiling and lower levels (as low as 30 ft candles) is possible.

Day lighting controls and dimmers represent excellent opportunities, particularly for intermittent use areas. There is also the Possibility of using lighting tubes - 10-21” in diameter r- looks like a fixture. Collects on light from the roof and has a 94-98% light transfer (30ft max). Light sensors would turn off lights if Lighting tubes are giving off light. Occupancy sensor controls can also be used effectively in a number of spaces – particularly stairwells. CSDCCS notes that currently at many schools, the custodial staff leave all the lights on in the evening even if they are only working in one area. Jain did examine day lighting controls in the class room context and found that the payback was failrly long – about 15 years. More detailed analyses need to be done on specific parts of the school.

Another effective approach is the creation of “lighting zones” within a room by the window for example, the lights would turn off depending on day lighting. Closer to corridors, lights may be on more often. There can be multiple lighting zones which can be controlled independently.

There has been significant discussion in the industry regarding the use of T-5 systems. A blanket statement is not possible and T-5s are not always more efficient that T-8s. T-5s can be appealing for situations where there is not a lot of space for the lights.

LED lights do represent the future however their colour rendering and efficacy factors are not well enough developed to consider for use in a school. They may have application in outdoor setting, such as for security or parking lot lighting.

Selection of the lighting type will have a direct affect on maintenance issues and can have less obvious affects on issues relate to health, hyperactivity in children etc. It is critical that the

CSDCCS carefully consider all the various issues. Other considerations such as widespread application of natural light married to the appropriate shading also need examination. A lighting designer can help in this and energy modelling will bring more robust results, including cost effectiveness.

Controls

A standard installation in new school includes some basic capabilities:

- enable/disable,
- monitor temps,
- reduce point count,
- alternating boilers
- Energy regulation- supply water temperature.

It was recommended that the building should have more than basic controls and more modification capability, reflecting multiple uses, zones and technologies. These days, all loads can be intelligently controlled and given that the project is still in the design stage, a robust system can easily be accommodated.

Most heat pumps now have a built in loop temperatures, status on all heat pumps, enable and disable, outdoor temp, lighting zoning.

Renewable Energy – Solar, Geothermal and Wind Power

The CSDCCS is very interested in examining a variety of renewable options – in particular solar (both thermal and photovoltaic) and geothermal (heat pumps). As noted earlier, the decision to air condition the building (or not) is critical for the heat pump decision.

Solar PV

With the assistance of the architects and a variety of drawings, the team identified the potential for using the roof for a combination of light tubes and solar p.v. array. This would require a 20 degree slop on the gymnasium roof. The p.v. array would then be flush with the roof and the light pipes would be interspersed among the arrays (it is noted that for code reasons, all equipment must be at least 6 ft from the roof edge.

In this configuration, the light tubes would be above washrooms and the mechanical room on upper floor. No lighting tubes would be located over stage the stage. There are closing flaps for over lighting tubes, if necessary.

As prices come down and with the application of the Feed-in-tariff program (.802/kW.h). solar p.v. is becoming relative cost effective – payback of 5-6 years. Schools are a good application because at the time that the PVs create the most electricity (summer) is also the time when the schools do notneed it.

OPA will buy electricity –FIT (fee and tariff program)- contract for 20 years. Rates are differentiated by technology and location.

Micro fit is for smaller- 10kW or less mounted on a roof will be paid at 80.2 cents per kWh for 20 years. You also relinquish the Greenhouse credits for the 20 years.

Orientation for this building roof is good. Pitched roof of 20 degrees over gym and cafeteria. PVs would sit flat on that roof. Approx 400 sq m is available on that roof. 10 kW requires aprroximately 294 sq m. The library can also have a few or some on racks along with light tubes.

Snow accumulation on panels can be an issue. However, just slight showing can warm panel and snow flows off. Can affect performance but in winter the sun is low on the horizon anyway, so you're not losing much. Generally it should not be a barrier

As long as there is proper ventilation under panels, the roof life is extended as it's not open to elements.

A system of this size will generate around 12,000 kW.h per year, with degradation of .5-1% per year.

PVs now come with 12 and 25 yr warranties. If the system degrades by more than 5% in 12 years, it is replaced. At 25 years it must still retain 80% or it is replaced. These warranties eliminate much of the long term risk.

Costs: a typical buy value is around $10/W. $8-10/W, installed so a 10 kW system at $10/w = $100,000 (approx). The exact cost will depend on manufacturer/installation. Given the FIT program, the payback could be anticipated to be approximately 10 years.

The Local distribution (Power Stream) will determine specific requirements for hook-up to the grid etc. There are no safety issues - If transformer turns off, no power. If it stops seeing power from the grid, it won't feed back.

There are ESCO type financial models available where the CSDCCS would enter into a power purchase agreement. Company takes all revenue - pays for itself over 12-15 years.

<u>Geothermal heat pump Systems:</u>

The team started with an examination of a revision to Alternative 7:

Savings versus Variation 6: $11,780 per year

Peak Summer kW 69.4kw

Payback is 10-12 years.

Heat pumps bring additional benefits, including:

- Maintenance costs are lower than boilers (boilers require annual maintenance).

- Boiler / cooling tower lifespan is 20-25 years. GSHPs last longer and are easier to maintain and operate.

- Mechanical room size can be reduced with GSHP.

- Geothermal system - 80 tons of cooling - 15 ft of drilling- $300,000 on drilling and approximately $200,000 for mechanical room - a difference of approximately $100,000. Payback of 8-9 years.   Mechanical room required 100 sq ft. Lifespan of ground loop is approx 50 yrs.

- Possible to use smaller pumps for areas open in summer.

- The heating is instantaneous – the school will warm quickly in the morning.

- There is a solid history of application of heat pumps in Ontario and a number of Boards are using these systems - Dufferin School Board uses has been using heat pumps for 20 years and are very pleased with the results. Hamilton also uses heat pumps exclusively.

<u>Wind Power</u>

The team briefly discussed the application of a wind turbine system – either in a field or integrated with the building (vertical axis unit), however the concept was largely rejected because of concerns about the wind regime and the focus on solar p.v. as a better alternative.

<u>Other</u>

The day concluded with a discussion of the various incentives that might be available. There are a variety of potential incentives to explore including the HPNC program, where incentive money is available based upon summer peak kW reduction and OPA's Feed-in-Tariff program focusing on renewable energy. It is important to note however that these 2 programs are exclusionary. An application under one program precludes an application under the other. CSDCCS is advised to carefully consider which program will provide the greater funding before going forward.

The team also noted that there may be other funding available such as through the Renewable Energy Funding for Schools Initiative or other programs and that there may be opportunities to finance a solar p.v. installation through the application of the ESCO financing model . CSDCCS is also advised to explore all potential funding opportunities.