Canadian Consulting Engineering Awards 2011

Poirier Sport and Leisure Complex

Submitted by:

The AME Consulting Group Ltd.

&

IMEC Mechanical Ltd.

ASSOCIATION OF CONSULTING ENGINEERING COMPANIES | CANADA

ASSOCIATION DES FIRMES D'INGÉNIEURS-CONSEILS | CANADA

CANADIAN CONSULTING engineer

PROJECT HIGHLIGHTS

Poirier Sport and Leisure Complex

The Poirier Sport and Leisure Complex ("Poirier Complex") is the single largest capital facility project in the City of Coquitlam, BC. The $62 million, 13,200 M2 project was completed 10 months ahead of schedule, several million dollars under budget, and was open to the public in September 2010. The project is part new construction and part renovation. The completed facility has a 2,000 seat main arena, an NHL regulation size recreation rink with 400 seats, a hybrid curling/ice rink with year round ice, multi-purpose rooms, offices, server room, a commercial kitchen and viewing areas. IMEC Mechanical ("IMEC") was chosen to provide design build mechanical services for the facility. IMEC retained The AME Consulting Group ("AME") to provide the design services for this project.

The Poirier Complex has an important mandate to achieve energy savings, reduce GHG emissions, and ensure future sustainability. The Client had previously explored the possibilities of a district heating system and requested that IMEC review an earlier study and offer advice for available energy reduction opportunities. Rather than district heating, IMEC offered the alternative of district thermal energy sharing. After a thorough review, this recommendation was unanimously supported.

IMEC introduced a new energy exchange system which we call "Thermenex". Thermenex (an acronym for Thermal Energy Exchange) is a system developed by Jeff Weston P. Eng., a Principal at IMEC, for large commercial and industrial applications. Thermenex greatly reduces energy use and Greenhouse Gas Emissions at a capital cost that is typically much lower than other green technologies. Thermenex minimizes the creation of heat and maximizes the reuse of thermal energy for both heating and cooling. This provides the Poirier Complex with what we firmly believe is the most sustainable system available. After an analysis, the mechanical system scope was expanded to provide energy sharing with the recently completed Aquatic Centre attached to the Poirer Complex, as well as the nearby Library which was scheduled for renewal.

Thermenex is a pipe with a thermal gradient (one end hot the other end cold) with control valves that functions as a hub for the efficient management of heat. In the case of the Poirier Complex, the pipe was "folded" to create 4 pipes running together, all with different temperature characteristics. The core principle for Thermenex is the recognition that cooling is simply the removal of heat. Thermenex maximizes the effectiveness of that heat. It is a custom built thermal heat exchange hub that dynamically manages the movement of heat to where it is required.

An important feature of this energy exchange system is that it is programmed to maximize efficiency based on the changing building needs, rather than having to rely on the selected design parameters. The building demands choose the set-points. The Poirier Complex is an ideal example of the benefits of Thermenex. The only boilers in the entire facility and the library are the existing units in the recently completed aquatic centre. No new boilers were added or required and the majority of the building's heat comes from the ice plant and the building exhaust. The 2 existing Library boilers were removed. During summer months, it is anticipated that all the pool heating will come from the thermal energy exchanged from the cooling loads of the facility. Monitoring of the existing boilers indicates that they are using less fuel now than they were before the renovation, while serving an additional 15,500 M2 (including the renovated Library) of very well used public facilities.

Poirier Sport and Leisure Complex

The entire facility is now served by a unique Domestic Hot Water system. This system has three stages of heat. The excess building heat is the first stage either directly or through a heat reclaim chiller depending on demand. The existing aquatic centre had a solar DHW system that now functions as second stage heat or if capacity is available can provide final DHW heating. The existing boilers provide the final stage of heat if required.

A new 170 ton heat recovery chiller provides cooling for the ventilation systems and reclaims any low grade thermal energy from all the cooling systems, the ground and the building exhaust. The library, located 200 metres from the main complex, has been added to the facility's Thermenex system so that excess heat from the library can be used to heat the pool facility, and when the library requires heat, it extracts thermal energy from the main complex.

This project provided many unique challenges. One of the design challenges was timing the waste heat availability from the ice plant with the timing of the demand for heat in the pools. An 80 ton geo-exchange field was installed to function as short term thermal storage for rejected heat. (This field also provided a temporary source of heat rejection for the Library before the main facility was completed.) If there is not enough demand for heat being produced within the complex, it is stored in the ground. Once the system demands more heat than available, this heat is recaptured.

There were also significant scheduling challenges with this project. All work needed to be performed while maintaining full recreation programs, which included hockey and lacrosse play-offs and national tournaments. The project required the building of two new rinks, a major renovation to the main arena, the demolition of the old rinks, and finally the construction of the Sports Hall of Fame Atrium Lobby. Two rinks needed to be operational at all times during the construction. An inventive, integrated, three-stage project delivery instituted by TASK Construction Management brought this project in under budget and ahead of schedule.

In order to keep the facility operational during construction, the Thermenex system had to be able to integrate with the existing plant and heating and cooling systems. This involved a very complex series of temporary piping arrangements, control valves, heat exchangers and programming, all the while ensuring that the temporary systems could be integrated into the final design. This proved extremely challenging but in the end was very successful.

Probably the most significant challenge, though, was convincing the City of Coquitlam to take a risk on a new technology with limited proven success on such a large, high profile project. A peer review was conducted and the mechanical design-build contract included a guarantee that if the system did not perform, a plan was in place to convert to a more traditional design, with money held back until the system was functional. Needless to say this was not required.

FULL PROJECT DESCRIPTION

Poirier Sport and Leisure Complex

System Description

Thermenex itself is relatively simple. It is a water filled pipe with one end hotter than the other, a thermal gradient header. When you need heat take it from the part of the pipe with the LOWEST temperature to satisfy the load, change the temperature as much as possible and then return the water to the correct part of the pipe based on the temperature. When you need cooling, take water at the HIGHEST temperature that satisfies the load, add heat to the water and return it to the correct part of the pipe based on temperature. The pipe acts as a hub of thermal energy for all heating and cooling needs of the building. The water can flow in any direction depending on building demand. The key is to design heating systems that use low temperature hot water. (It is much more efficient to make warm water than it is to make hot water, every degree makes a difference.)

The use of a header pipe for all the buildings heating and cooling systems allows the engineer to consider all heating loads as cooling sources and all cooling loads as heat sources. Efficiencies of all systems are maximized by letting the building demand determine the temperature set points. The systems never make water hotter or colder than the building needs. When we let the building determine the temperature rather than predefined peak load conditions, all the energy exchange system efficiencies are maximized for the current conditions.

Mechanical Design Considerations

From a mechanical designers standpoint, to understand Thermenex, it helps to have a fresh mindset. First, the building is not the problem but the solution. Second, there is no such thing as cooling. Instead think of cooling as the removal of heat. Third, avoid design systems based on peak load. Peak load requires the highest hot water temperature for heating and the coldest chilled water temperature for cooling. Making water this hot and this cold all of the time is a waste. Let the building demand determine the HWT and the CHWT. Fourth, do not over control the building air distribution. Giving everyone control of their airflow costs more money and requires more total energy. Providing high filtration requires high fan energy. Fifth, minimize thermal distribution energy costs by using water while maximizing the temperature change using variable speed pumps.

Typical choices for base building mechanical systems that will optimize the application of the Thermenex system include radiant heating and cooling in the slab, chilled beams, induction units, heat pumps and air handling units with heating/cooling/reclaim coils.

The goal is to reuse all the buildings thermal energy before adding any heat from an external source. The target is zero thermal energy waste. Every exhaust system is a great source of heat, but if we wait until we can use ventilation recovery, we waste a large part of available heat. Even if the have an 'efficiency' of 75% that is only under certain conditions, they do not make the best overall use of exhaust heat.

Poirier Sport and Leisure Complex

Technical Innovation Utilizing Thermenex Technology at the City of Coquitlam's Poirier Sport and Leisure Complex

Ice Plants

The ammonia refrigeration system is designed with two heat exchangers to remove high grade heat first and the low grade heat. The high grade heat is used directly at the Hot Water part of Thermenex. The low grade heat is used directly for some loads and also boosted to high grade heat using a heat reclaim chiller.

Aquatic Centre Pool

The pools are heated primarily with the high grade reclaim available in the Thermenex header, the existing boiler now only serves as back-up heat. There is a heat reclaim chiller that boosts waste heat from low grade to high grade.

Poirier Sport and Leisure Complex

Domestic Hot Water (DHW)

The heat reclaimed for the ice plant and excess building heat, becomes Stage 1 preheat for the DHW. Solar panels provide Stage 2 preheat or, when sunny enough, final heating. The existing boilers provide final heating when required.

The load on the DHW system more than doubled yet the boilers do less of the work than before. In addition, the automatic pool make-up water now come from the DHW preheat tanks, further reduces the boiler load.

Ventilation Air

Fresh air is tempered using low grade waste heat before mixing with return air.

Rink Dehumidification

A combination of desiccant and refrigeration systems are used for humidity control in the areas, the most efficient models selected based on current conditions. Any reheating needs are fully satisfied with waste heat recovery.

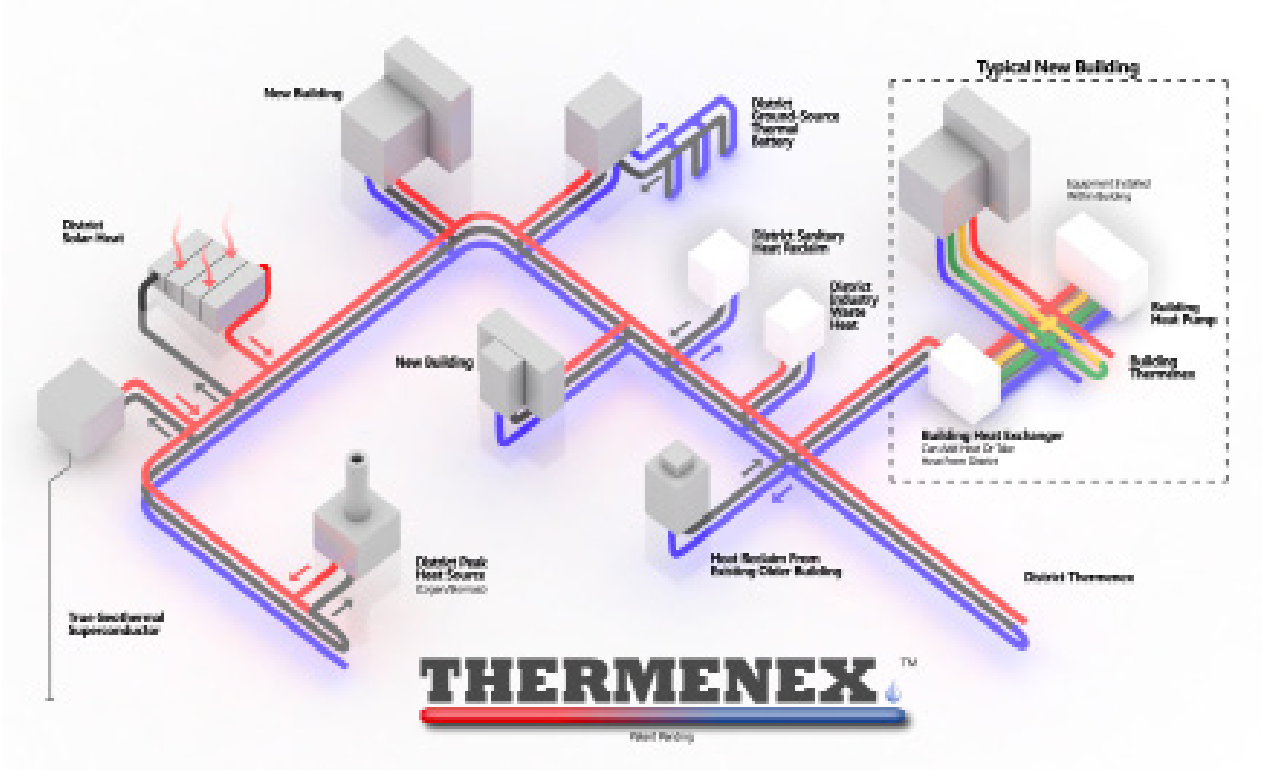
Geo-Exchange Field

The geo-exchange field now serves the entire district in a unique way. It is being used as traditional ground source heating and cooling except it is piped directly to the Thermenex header with no separate geo-thermal heat pump. It is also being used for short term thermal storage to provide load/source balancing of heating demand and supply between ice plant operation and pool heat demand.

Poirier Sport and Leisure Complex

Library

During construction the City requested the team look for opportunities to connect the Thermenex system to the nearby library that was due for renewal. It was quickly determined that there was more than enough heat available from the Thermenex system and the library was connected with no new sources of heating and cooling. This system is now a district energy system with still more capacity for future connections.



Snow Melt Pits

The snow melt pits are connected to the Thermenex header such that they not only use waste heat but they are also used to provide cooling for the building when conditions permit.

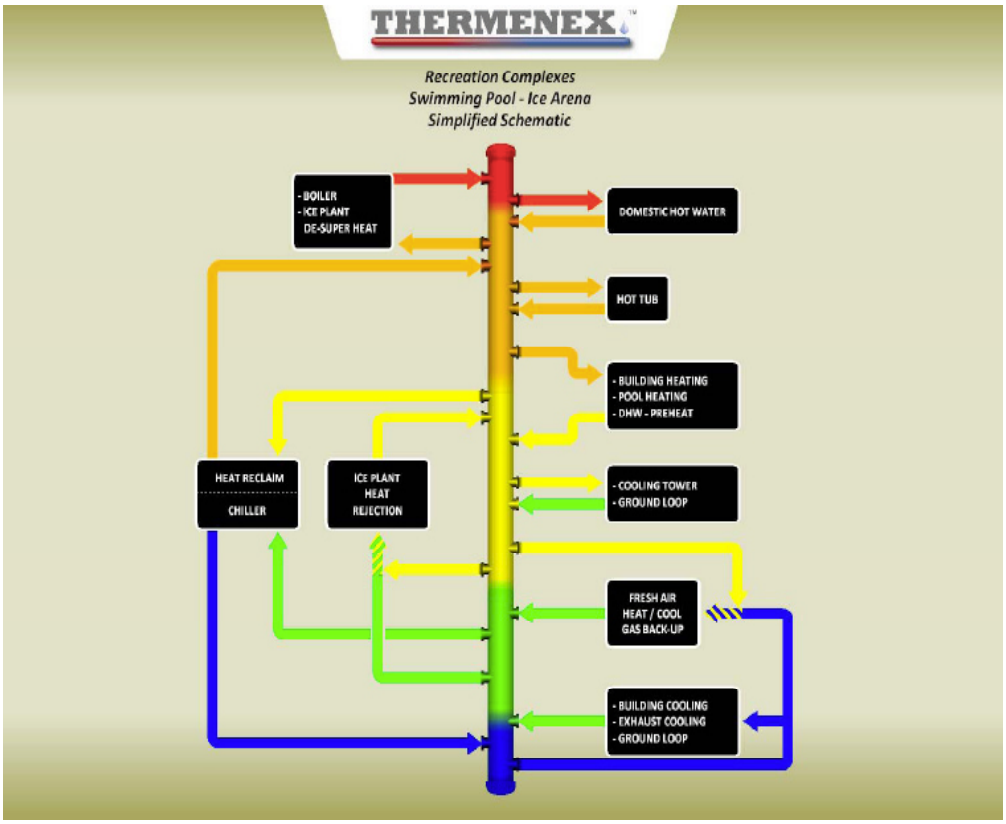
Central Server

Provisions for a large central server room are pre-piped to reclaim the equipment heat.

Poirier Sport and Leisure Complex

Technical Innovation of Thermenex

Thermenex is an innovative use of a water filled pipe that functions as a hub for thermal energy exchange. The pipe is not a loop and has no pumps, it is simply a long length of pipe with a temperature differential from one end to the other. A "Thermal Gradient Header" is the best descriptor. A simple schematic of the Thermenex system appears below:



Rather than simply looking at the ground, as in a ground source system, for energy exchange, the system looks at all potential sources of thermal energy within the system (in essence, the building).
In traditional mechanical system designs, heating, cooling and domestic hot water have been treated as separate systems. With Thermenex they become one system of dynamic thermal energy exchange, or heat transfer from where ever you can get it, to where you need it.
With the Thermenex system, the building heats and cools itself. The heat gain from the external skin can be fully utilized by the system, essentially becoming a solar heat collector. The efficiencies and energy exchange potential is also maximized by designing systems with minimal water flow and maximum change in temperature, which in turn minimizes energy transportation costs. The water can flow in either direction in the header.

Poirier Sport and Leisure Complex

Design Principles

On the surface, Thermenex is simply a different piping system. But at its core, it represents entirely new thinking. The system will change the way Engineers and Architects approach building design and also entire districts and neighborhoods. It challenges current core sustainable concepts and provides the backbone for a mindset shift toward more effective and efficient sustainable buildings.

1. Start with the mindset that the building is your primary source of heat. Thermal energy is a utility to be conserved and reused. Cooling is the removal of heat. Chillers are also sustainable heaters.

2. Differentiate the heating loads into temperature categories, High (DHW), Med (Space Load), and Low (Ventilation Air). Design a variable temperature, low temperature heating system. Base system decisions on heating with the lowest temperature water during non-peak conditions.

3. Design a controlled fresh air supply system that heats and cools the air BEFORE any mixing with return air. (Heating colder air can be done with colder HW, it is more efficient to make colder HW).
4. Design a variable temperature cooling system. (Do not produce water cooler than required to meet the cooling load.)

5. Design for all building exhaust to be cooled, this reclaims the heat out of the exhaust and makes it available for total building heating. Avoid ventilation recovery units that only temper outside air supply, they underutilize thermal energy recovery and are only effective during a small period of the heating season.

6. Building general exhaust to have air quality sensors, if the air is good quality, return it instead of exhausting it. This minimizes the energy required to condition OSA and prevents over ventilating at minimal cost. Perhaps during peak loads, we allow short durations of lower air quality to save energy.

7. Glazing is the worst building envelope material. Concentrate the building glazing to face the winter or morning sun, the cooling of this solar gain becomes heat for the rest of the building.

8. 'Free' cool ONLY when the total building cooling demand exceeds the building's heating demand, most free cooling systems operate when the building needs heat, they are heat wasting systems. Opening a window to let out heat means you cannot recover that heat.

9. Peak heating and cooling loads rarely occur. Focus design decisions for off peak efficiency.

10. Fossil fuel for heating should only be used to satisfy the peak heating demand or final domestic water heating load.

11. Base system selection on using the least amount of energy. Be careful not to chose systems that "save" the most energy. How much you "save" is not relevant, how little energy you use is critical.

THERMENEX™

A Patent Pending Thermal Energy Exchange System

IMEC

AME Group
Consulting Professional Engineers

Canadian Consulting Engineering Awards 2011

Capital Costs of Thermenex

By following some basic design principles, the installation of a Thermenex system can actually reduce capital costs versus a traditional mechanical system. Designers can optimize a building for Thermenex by recognizing that there are only three areas in buildings that require heat:

- Outside Air – Typically the amount of fresh air is highly controlled with heated/treated air simply being exhausted to the outside. Rather than focusing on monitoring and controlling intake air, simply focus on not exhausting good quality heated air. If the air is poor quality reclaim all waste heat and utilize it where it is required.

- Building envelope heat losses - minimize the amount of glazing as much as possible or alternatively maximize its efficiency and U-value. Glazing has the worst U-value of any external envelope assembly.

- Domestic hot water – rather than a typical boiler or plate heat exchanger, consider a water-to-water heat pump which has the potential to cool your building in the process of producing domestic hot water.

For cooling:

- Minimize peak solar gain with external shading or optimize glazing orientation.
- Use all possible cooling loads as heat sources.
- Use all possible heat loads as cooling sources.
- Reduce lighting levels and turn them off.

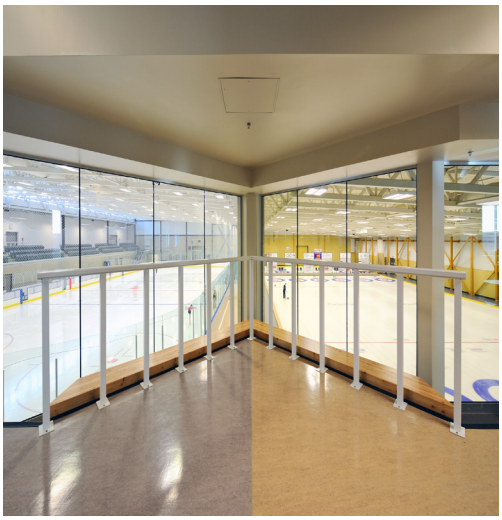
For ventilation:

- Use a constant volume, displacement style system.

Poirier Sport and Leisure Complex

External View of the Renovated Poirier Facility

During Construction



External View of Curling Rink and Ice Arena

Letters of Recommendation

May 3, 2011

To: Whom it may concern:

TASK Construction Management has recently had the pleasure of working with IMEC Mechanical on an extremely challenging project - the City of Coquitlam's Poirier Sport and Leisure Complex.

This project, a combination of renewal/renovation and new construction mandated that all construction activity not impact any of the facility's existing programs. As a result, IMEC was faced with the challenges of incorporating their new heating and cooling installation with existing mechanical systems that required upgrades, while providing services to a facility featuring a swimming pool, three sheets of ice, workout rooms, cafeteria/restaurant facilities as well as common rooms.

IMEC did an exceptional job, as every schedule phase was seamlessly met. In fact, IMEC took the time to understand the operational requirements so well, they proactively stayed ahead of schedule by anticipating the needs of the project team.

As a result the completed installation was done within budget and ahead of schedule. Even better - the City is currently on track to save 56% in operating costs for heating and cooling of the facility.

I fully support IMEC's application for a Canadian Consulting Engineering Award. I can honestly say their efforts and dedication to quality work make them suitable candidates in our eyes.

Sincerely,

John Bowser

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Poirier Sport and Leisure Complex

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Building Success with Recreation Facilities and Operations

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May 2, 2011

To whom it may concern:

Re: Canadian Consulting Engineering Awards 2011

I am pleased to provide a letter in support of AME Consulting and IMEC Mechanical being considered for the above award.

As the Owner's Representative and Project Manager for the Poirier Precinct Renewal Project (a combination of arena renewal, library renovation, Centennial Room renovation and joining the existing pool to the adjacent facilities with a cost in excess of 100 million dollars), I witnessed first hand the ability, dedication and professionalism of IMEC in its role as Design Builder.

The Poirier Sport and Leisure Complex and the surrounding facilities provided the Project Team with numerous challenges from a mechanical perspective. The requirements were daunting in that the vast majority of existing mechanical systems required renewal while significant portions of the buildings were required to remain operational over the life of the project.

IMEC began by introducing an innovative energy saving solution, "Thermenex" to the project, in addition to being able to meet and exceed the operational requirements of this vital City recreation facility. IMEC fully understood the operational needs during the renewal of mechanical systems and were always ahead of the game in anticipating the City's needs and those of the Construction team. Every problem was resolved quickly and professionally. IMEC's understanding of the work, its rapport with trades, the Design Team and the Project and Construction Managers was exemplary.

I have the highest regard for IMEC. Ian Hall and Jeff Weston and their staff continually perform well above average and the firm is innovative, professional, knowledgeable and accountable. For example when presenting the new energy saving program (Thermenex) to the City, IMEC guaranteed that if the system did not perform to expectations, IMEC would convert the entire system back to conventional methodology, *at their cost*. Now that truly is 'putting your money where your mouth is'.

The Canadian Consulting Engineering Award is a prestigious one that in my view, IMEC is worthy of and I urge you to give favourable consideration to naming AME Consulting and IMEC Mechanical as this year's recipient of the award.

Yours truly

Brian Storrier
Principal

:s

HVAC(R)EVOLUTION

IMEC Mechanical Ltd and the Thermenex System

As the world strives to reduce energy consumption and Greenhouse gas emissions in building mechanical systems, alternative energy systems like geo-exchange and municipal wastewater heat recovery are gaining attention.

These systems extract heat by cooling. Cooling is simply the removal of heat. Geo-exchange and wastewater heat recovery both use heat pumps to get the job done. The process is similar to your refrigerator, which cools food by removing heat and then expelling it out of the back of the fridge.

Heating and cooling systems for buildings have been designed independently of each other and optimized to maximize efficiency at peak loads. Until now, engineers reduced the capacity of heating equipment by installing ventilation recovery (VR) units that recover heat from exhaust. We also 'free cool' any load that occurs when it's cold outside, and finally we look for opportunities for heat reclaim within the building.

But it turns out there are very few such opportunities. Why? Because we don't run the cooling system when it's cold outside, therefore there's nothing operating from which to take heat. We assume we've optimized the energy from exhaust because we have an efficient VR unit. But in reality, because VR is efficient only during peak heating, most of the time thermal energy is being…well…exhausted.

There's a different and more effective way to approach these issues. If we simply treat the building as a thermal resource, a typical commercial building can provide about 75% of its heating needs by reclaiming its own inherent thermal energy—by cooling itself. We need to stop free-cooling and using ventilation recovery units, which don't take full advantage of a building's own thermal energy during heating.

Thermenex is a system that optimizes thermal energy exchange for buildings. Rather than looking for heat reclaim as an afterthought to building design, heat reclaim becomes the driving concept for design. Anytime something needs heat, it gets it by cooling—just like that heat emerging from the back of your refrigerator. Anytime something needs cooling, it provides heat. With Thermenex, the building heats and cools itself by moving the heat from where you don't want it to where you need it.

Not only does Thermenex maximize the quantity of heat reclaim, it also maximizes efficiency…think about refrigeration again. Your refrigerator is more efficient than your freezer. That is because it's easier to take heat from something that's warmer. Your refrigerator is also more efficient if it's in a cold room, because a cold room can more easily accommodate the heat. This concept is extremely important! The temperature difference determines the efficiency of the process: therefore, the warmer the thing you cool and the cooler the thing you warm, the more efficient the entire process will be.

With that in mind, let's focus on the heating demands of a building.

Buildings heat and cool themselves

Langara College,
First Thermenex Installation, Zero GHG

Coquitlam's Poirier Sport and Leisure Centre, District Thermenex Installation

Improve the efficiency of ANY building

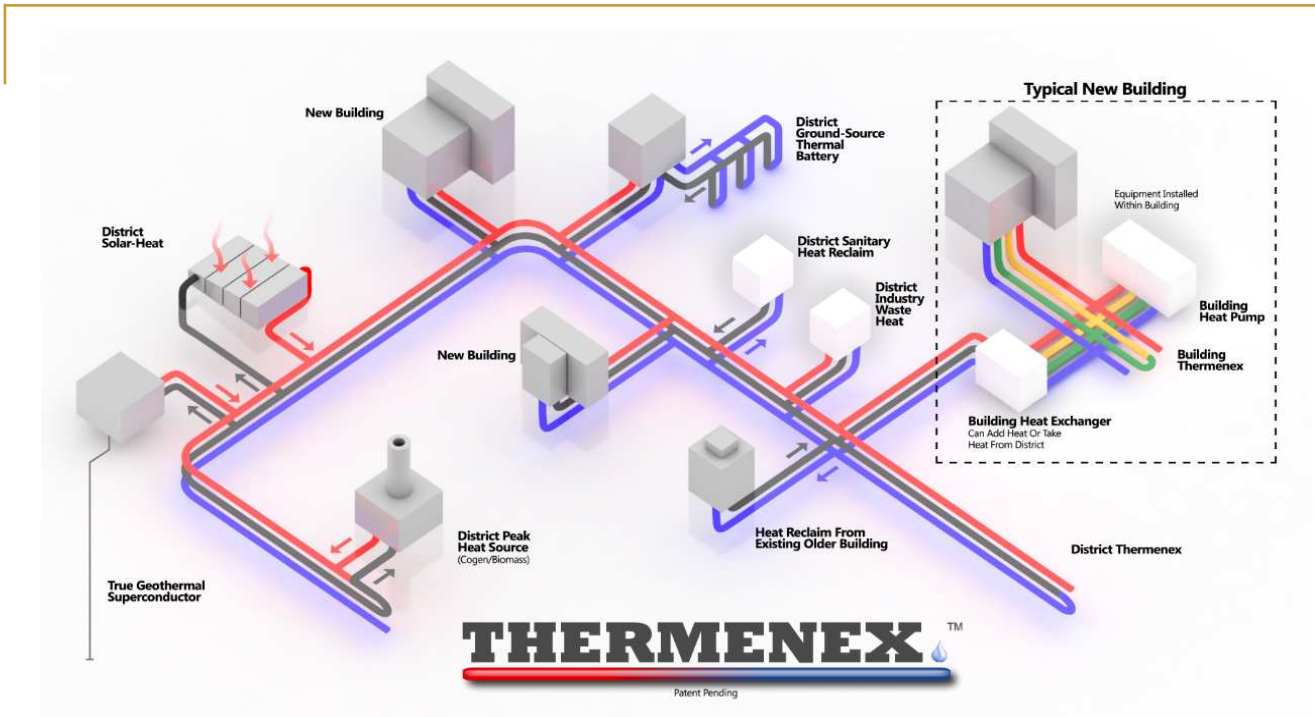
We only heat three things: Domestic Hot Water (DHW), building envelope losses, and ventilation of outside air (OSA). These can all be heated with different grades of heat. DHW requires the highest grade of heat, but it can be preheated with low grade heat. Envelope losses typically require a medium grade of heat at peak winter months but can often be satisfied during off peak with a low grade heat. Tempering OSA can be satisfied with the lowest grade of heat.

This is where Thermenex shines: we only make heat at the grade required, based on building demand. Since we do not make water any hotter than required to satisfy the load, we minimize the input energy. This makes Thermenex about twice as efficient as geo-exchange. Plus any time you need cooling, the heating is free. BTW, if you think about it, your building outfitted with Thermenex also becomes a solar collector.

Now here's the best part: Thermenex, when considered during design development, is typically less expensive than any other sustainable building design and, using the system will improve the efficiency of ANY building. No matter how 'green' your current concept is, Thermenex will make it greener. It will even improve large 'passive' buildings. Unless you are designing a tent or an igloo, Thermenex increases the sustainability of the building.

You may be wondering in detail how Thermenex works. For that information, please contact IMEC Mechanical at info@imecmechanical.com or info@thermenex.com

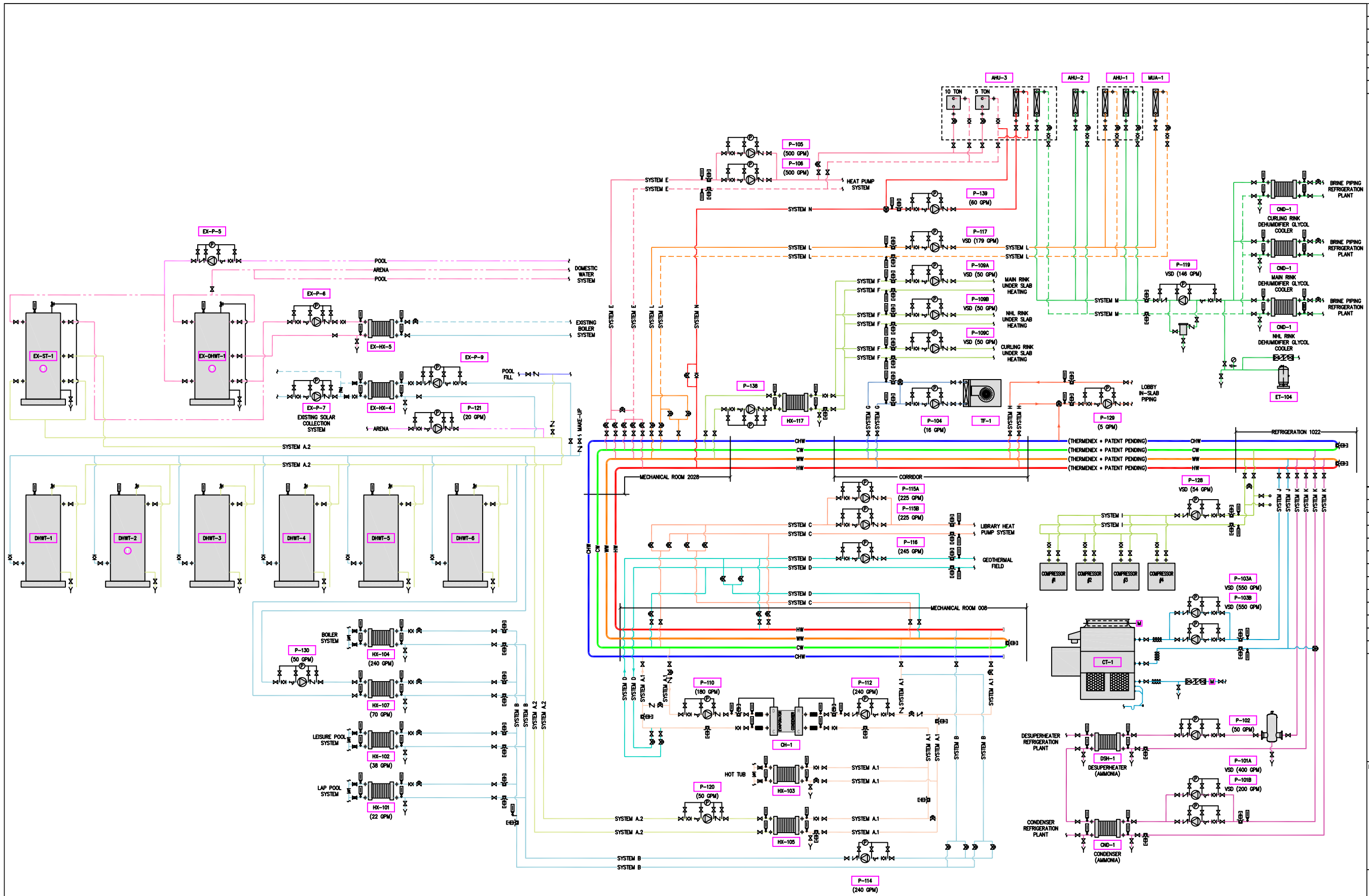
District Thermenex



The Author

Jeff Weston, P.Eng., a Mechanical Engineer with a passion for building, invented the revolutionary Thermenex system. By studying physics and engineering, Jeff has acquired a strong scientific background.

In 1995, Jeff partnered with Ian Hall to start IMEC Mechanical, a mechanical contracting firm. They built their reputation by making improvements on traditional HVAC design and methodology, tackling a wide range of technically challenging projects. They have installed Thermenex in three buildings to date.



ISSUED FOR:

DATE	DESCRIPTION
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THERMENEX TM

AME Group
Consulting Professional Engineers

REVISIONS:

NO.	DATE	DESCRIPTION
1	MAR.30.11	UPDATED

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PROJECT:

CITY OF COQUITLAM

POIRIER SPORT & LEISURE COMPLEX

633 POIRIER STREET

DRAWING TITLE:

AS-BUILT HVAC SCHEMATIC

DRAWN:	RH	DRAWING N°:	MSK
SCALE:	NTS		
JOB N°:	08-026		
DATE:	SEPT.20.10	REV. N°:	1