CITY OF VANCOUVER | GREENEST CITY

CASE STUDY - VANCOUVER

PARK PLACE

Heat reclaim system expected to reduce steam consumption 80%, GHG emissions 68%

Address	666 Burrard St, Vancouver
Management	QuadReal Property Group
Type of Building	Office
Year of Construction	1984
Number of floors	35
Floor size	703,000 sq ft

Built in 1984, Park Place is a AAA office building in downtown Vancouver. The 703,000 ft^2 property has 35 stories above grade, and six floors below grade making it the largest leasable office space in B.C. The lower level retail mall accommodates a variety of shops, services and restaurants with the majority of the building being dedicated to 2,200 office occupants. Managed by QuadReal Property Group, the building has housed QuadReal's global headquarters since 2017.

RETROFIT MOTIVATIONS

Previous Retrofits

Driven by long-term financial and environmental considerations, the building owners have invested in many successful energy retrofit upgrades over the years. The HVAC system has been upgraded multiple times. Most of the branch ducting was insulated and an Adaptive Frequency Drive (AFD) was added to the main chiller. Controls and variable speed drives were installed on fans and pumps. In addition, motion sensors were added to the lighting controls and all lights on the retail levels and in stairwells were converted to LEDs.

To complement the energy savings, a condenser loop was added to reduce water usage from the heat pump condenser system. Additional water reductions came from washroom faucets that were retrofitted with aerators, and irrigation controls that were installed for outside planters and the lawn area.

From 2007 to 2016, the building's energy consumption was reduced by 25%, mostly stemming from electricity savings, and water consumption decreased by almost 60%. The retrofits led to $317,000 annual energy cost savings.

EXISTING MECHANICAL EQUIPMENT
(Pre Heat Recovery Retrofit)

4 steam/water Heat Exchangers
2 water-cooled centrifugal Chillers
2 Cooling Towers
70 Air Handling Units (AHUs)
2 variable flow Make Up Air Units (MAUs)
45 Heat Pump units and a Condenser Cooling Water System to serve tenant computer and server rooms

2007 – 2016 RETROFIT SAVINGS

Energy (%)	25%
Energy ($)	$317,000
GHG (%)	19%
Water (%)	60%

Heat Recovery Chiller Retrofits

As a responsible leader in the real estate sector, QuadReal is committed to the pursuit of excellence in sustainability across its portfolio through reducing energy, water, waste and greenhouse gas (GHG) emissions. One of QuadReal's goals is to improve and invest in its existing building stock to remain competitive with new commercial properties and provide high quality, comfort and productive environments for tenants.

Energy studies carried out in 2015 proposed adding heat recovery to the make-up air units or a geothermal system for additional energy saving opportunities. Trane, a manufacturer of heating, ventilation and air conditioning (HVAC) systems, knew the building's mechanical systems and configurations well. During a routine visit, Trane representatives suggested heat recovery as an option to reclaim and reuse waste heat for space heating to Park Place's Operations Supervisor. The building's heating and cooling is provided by a hydronic system fueled by steam from the downtown district energy system.

SOLUTION

Trane, along with SES Consulting, a mechanical consultant, were asked to carry out additional analysis for the building and to design the heat reclaim system. SES Consulting proposed two heat recovery chillers (HRCs) that would reject waste energy from cooling systems into the existing heating water system instead of the building's cooling towers. The ability to capture waste heat that was being rejected through water evaporation out of the cooling towers was appealing to QuadReal since it meant not only a major reduction in steam consumption but also a reduction in water usage.

PROJECT PROCESS The design phase of the retrofit project started in 2016. Trane and SES Consulting worked together to verify design details and the feasibility of the heat recovery system. The team developed a sequence of operations to maximize recovered heat and calculated potential energy savings. The two HRCs were installed in the summer of 2017. The project experienced a small delay due to pressure and pump sizing challenges which meant that certain parts had to be reordered. Commissioning of both units is expected to be completed when the heating system resumes in the fall of 2018.

The collaboration between several stakeholders during the consultation, design, and implementation phase of the project was essential: SES Consulting provided the schematic of the design and worked closely with Trane, the manufacturer of the equipment, who was responsible for the HRCs' mechanical details and installation. ESC Automation will be working together with SES Consulting to make sure the logic of the building automation system (BAS) will function well.

TECHNICAL DETAILS SES Consulting's design involved both a 250 ton Trane Series R RTWD helical rotary chiller, as well as a smaller 50 ton Multistack unit, model MS050A. Ranging in size from 80 to 250 tons, the Trane equipment operates over a wide range of conditions, temperatures, and under varying loads. It is ideal for both industrial and commercial use. The Multistack HRC can consist of multiple 50 ton modules and reaches slightly higher temperatures than the larger unit. In case multiple modules are stacked, each refrigerant circuit consists of an individual compressor, common dual circuit condenser, dual circuit evaporator, expansion valve, and control system.

TECHNICAL DETAILS

Technology	Heat Recovery Chillers (HRCs)
HRC I Make & Model	Trane, model RTWD Water-cooled Series R Helical Rotary Chiller
HRC II Make & Model	Multistack, model MS050A high temperature
Service provided	Med temp. hydronic space heating
Installation Date	July 2017
Source Temperature	20°C (68°F)
Load Temperature	50°C - 65°C (122°F - 149°F)

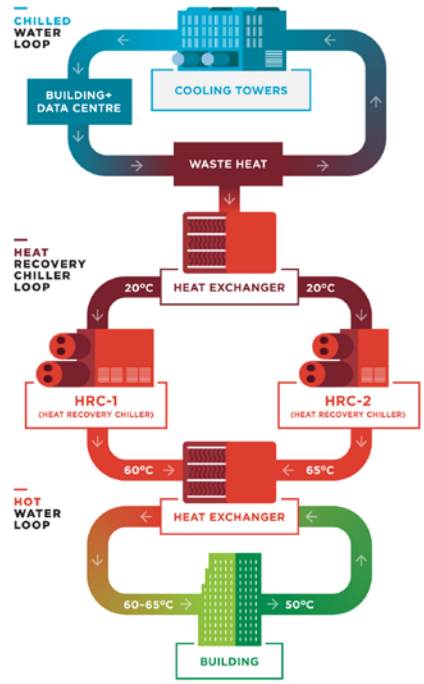
> **"Once the Heat Recovery Chillers are commissioned and running, Park Place will be the first property in our portfolio to achieve 80% GHG emission reduction from its 2007 baseline – this significant improvement is a result of annually set energy reduction targets, new technologies, and operational excellence."**
>
> Jamie Gary-Donald, VP Sustainability, QuadReal Property Group

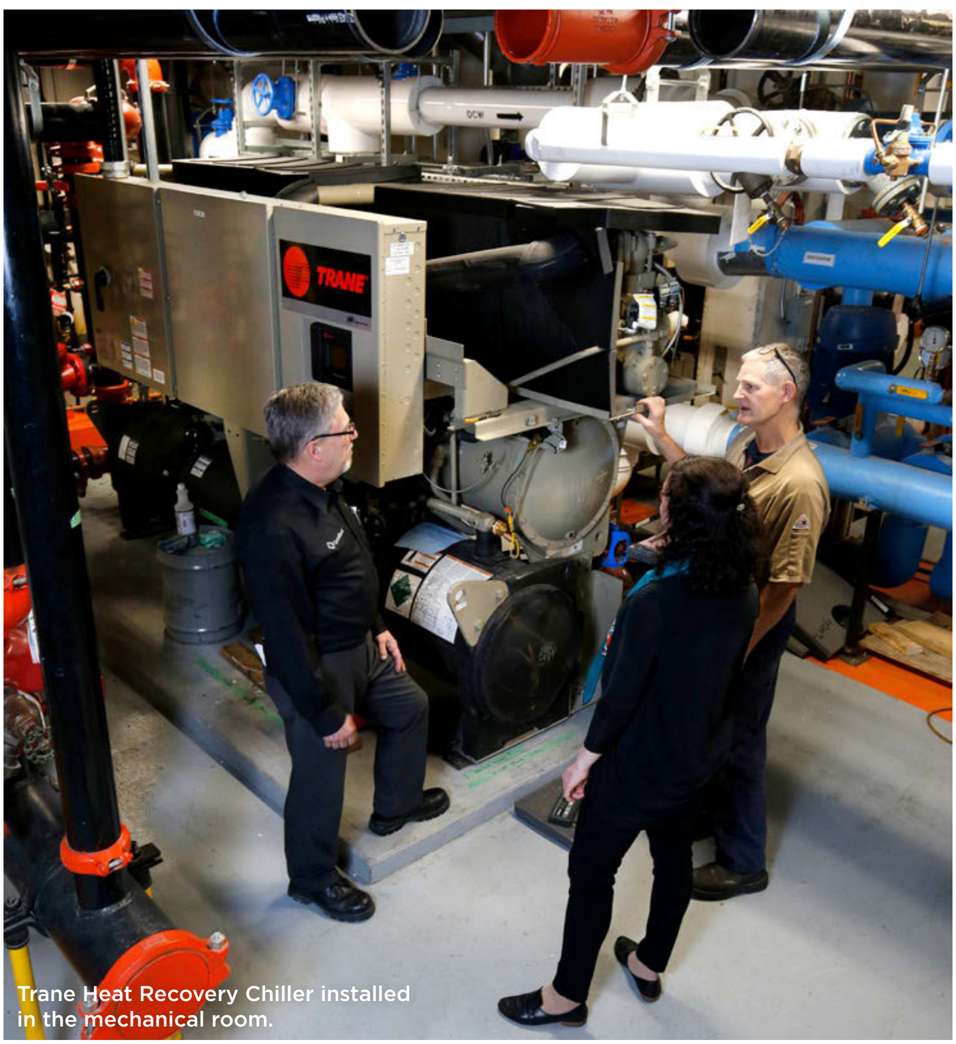
SYSTEM DESIGN At Park Place, the HRC system captures waste heat from cooling systems and lifts the heat rejection temperature to roughly 60°C so that it can be used in existing hot water heating coils located throughout the building. In this way, the chillers are acting as heat pumps to deliver useful heating and cooling water at the same time. The smaller unit takes advantage of the condensing water from the tenant loops which run 24h per day. It is sized to operate at low load conditions, as well as providing higher supply water temperatures up to 65°C. The smaller Multistack unit also provides heating at night time when the bigger equipment is turned off.

On average, it is expected that the entire office building will be heated solely by the HRCs down to 7°C outdoor air temperature. On the coldest days of the year, steam from the district energy system will be used to top-up the necessary heat. In order to maximise energy savings and reduce steam requirements, the scope of the project will also include the addition of CO_2 sensors for demand controlled ventilation on each floor, air flow adjustments to the Variable Air Volume (VAV) system, and heating water temperature optimization to provide sufficient heating to the tenant spaces at lower temperatures. This will be carried out as part of the system commissioning throughout 2018.

QuadReal

PARK PLACE
HEAT RECOVERY SYSTEM





Trane Heat Recovery Chiller installed in the mechanical room.

Multistack Heat Recovery Chiller installed in the mechanical room.

PROJECT IMPLEMENTATION & INSTALLATION CONSIDERATIONS

Despite the Trane RTWD chiller's relatively small size, the biggest obstacle was transporting the unit into Park Place's basement mechanical room. The equipment had to be disassembled to separately bring in the condenser and evaporator. Both parts were delivered through the parkade stair case. A platform had to be built with a block and tackle system to lift the units and lower them down the staircase. As a result, the delivery took an entire day.

The condensing loop tie in was another challenge. Due to the location of the main bypass valve there was very little space and the tie in had to be carefully engineered. The Trane unit's single-and dual-point power electrical connection options generally allow using existing electrical wiring. The Multistack chiller also has a single point power connection and external inputs and outputs to be compatible with all major building management systems.

At Park Place, the launch of the new HRCs has been slightly delayed due to water pressure and pump selection challenges. Drawings had to be revised and different pumps and heat exchangers ordered which are expected to be installed in the summer of 2018. For QuadReal's operations team the main impact from the retrofit will likely be in the fall of 2018 when the HRCs will commence operation and staff will work with SES Consulting, Trane and ESC Automation to fine tune the operations and temperature limits.

ECONOMIC ANALYSIS

Combined, both HRCs capital cost was $797,000 with the tenant loop adding another $103,500. Total installation costs amounted to $1,084,500.

The project is estimated to reduce Park Place's annual steam consumption by 80% (8700 GJ). Electricity use is expected to slightly increase by 6% (536k kWh). Combined, this leads to estimated annual energy cost savings of $104,000 – resulting in a simple payback on investment of 10.4 years.

Important drivers of the project were also the 68% reduction in annual GHG emissions and 4% lower water consumption.

When the anticipated savings from the HRC retrofits are combined with previous energy retrofits that were completed between 2007 to 2016, expected savings are considerable: Park Place's GHG emissions are anticipated to decline by 80% and the building's water consumption is estimated to be reduced by 64% compared to the 2007 baseline.

COSTS

Equipment Costs	$797,000
Tenant Loop	$103,500
Installation Costs (controls, recommissioning)	$184,000
Total Installation Costs	**$1,084,500**

ESTIMATED POST-RETROFIT ANNUAL SAVINGS

$	**$104,000**	**VS 2016**	
Steam (GJ)	8,700	Steam (%)	80%
Electricity (kWh)	(536,000)	Electricity (%)	(-6%)
Water (m3)	2,250	GHG (%)	68%
GHG (t CO2e)	600	Water (%)	4%
Simple Payback (years)	10.4	**VS 2007**	
Measure Life (years)	24	GHG (%)	80%
		Water (%)	64%

ANNUAL SAVINGS

80% STEAM

64% WATER

80% GHG EMISSIONS

APPLICABILITY For commercial buildings, this type of heat recovery solution could be widely adopted. The business case will be best in facilities that have year-round cooling needs, such as large office buildings, shopping malls, and ice arenas. Many commercial office and recreational facilities fit in this category.

Medium grade heat from hot water can be used for many purposes in the building or for process applications. In particular, hot water can be used for heating the building, heating service water or as part of a manufacturing or industrial process. For space heating applications, a hydronic heating system is required.

Most heat recovery chillers have smaller dimensions and the same electrical service capacity as the chillers they replace, meaning that space can usually be identified in existing mechanical rooms.

Very large efficiency gains and reduction in greenhouse gas emissions can be achieved using heat recovery chillers.

LIMITATIONS A comprehensive energy audit is required, which investigates the current state of the entire mechanical system. While new heat recovery equipment might appear to be a relatively straight forward plug-in solution on the surface, without careful engineering of the heat distribution systems and controls, it is unlikely to be successful.

Depending on the mechanical system configuration, piping and control changes might be required for the installation of heat recovery equipment. This would add to the installation costs.

In commercial buildings that don't have a process load from a data centre or another simultaneous cooling and heating load, the business case for an HRC is likely to be not as favourable.

FOR MORE INFORMATION, PLEASE CONTACT:

QuadReal Property Group
sustainability@quadreal.com

SES Consulting
info@sesconsulting.com

City of Vancouver
green.buildings@vancouver.ca

DESIGN CONSIDERATIONS For heat recovery systems in buildings a very efficient compressor is not necessarily required. When abundant waste heat is available, a really efficient compressor on the chiller will recover more source heat with a lower electrical cost. Equipment selection should carefully consider the maximum heating water temperature required so the heat recovery process can be used as much as possible. Different chillers generate less waste heat, meaning the system would need to rely more heavily on the top-up natural gas boiler or steam system, reducing energy savings.

Building height should be factored into equipment selection so that pumps, piping, and chiller bundles are selected for the appropriate operating pressures.

Conducting air-sealing to reduce leakage, prior to the mechanical system retrofit, can result in even greater energy savings, and reduce the system design temperatures.

"Operating temperatures are really critical to make sure the system performance is achieved. Using this heat recovery technology combined with advanced control strategies transforms the building with an ultra low carbon solution hyper efficient heating system. Detailed commissioning will need to be provided to ensure the back-up steam system doesn't get used very often." Scott Sinclair, President & CEO, SES Consulting