
CampusEnergy2021
BRIDGE TO THE FUTURE
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WORKSHOPS | Thermal Distribution: March 2 | Microgrid: March 16

Western University's New Vision of District Energy to Mitigate Climate Change

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Q&A Will Not Be Answered Live

Please submit questions in the Q&A box.
The presenters will respond to questions off-line.

Presentation's Agenda

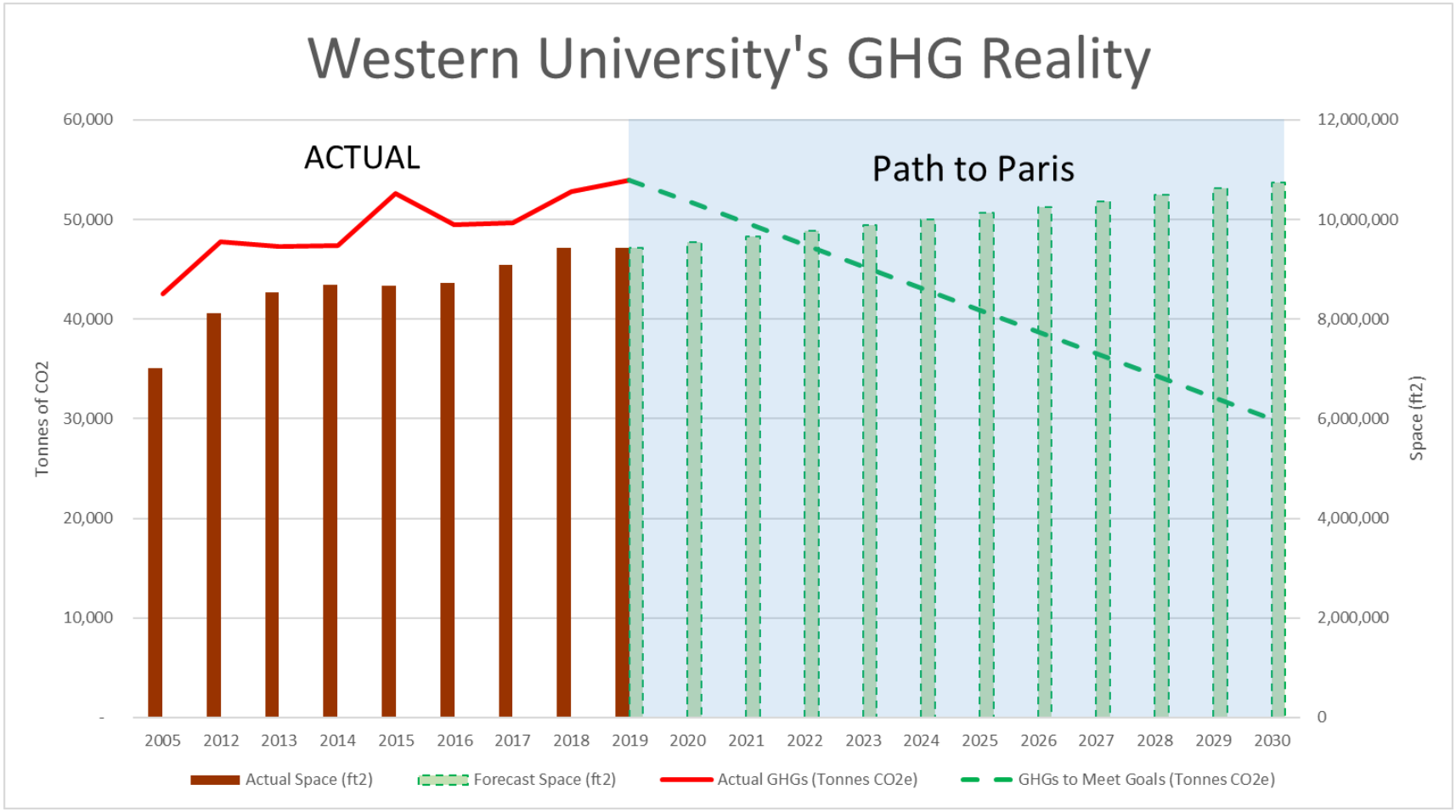
1. Western University and GHG Reduction Commitments
2. Description of the district energy network before modifications
3. Transition to the future district system
4. Description of projects underway in buildings
5. New buildings design
6. Conclusion

Western University and GHG Reduction Commitments

Western University

- Located in London, Ontario, Canada.
- Research university with 9,400,000 sq. ft. of building space across 82 buildings on main campus.
- Building uses: teaching and research, including laboratories, medical and dental clinics, student residences, academic offices, administration, libraries, student services, and athletics and recreation, including a pool and ice rink.

Western University's GHG Reduction Commitments



Description of the District Energy System Before Modifications

District Energy System-Before

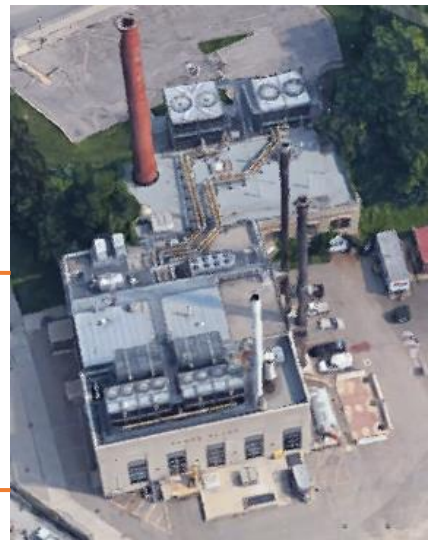
Steam Plant

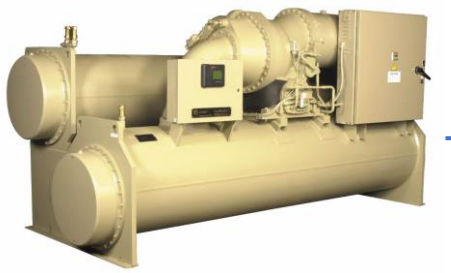
Buildings on North Side

+/- 50 buildings

Buildings on South Side

100 PSIG Steam





42°F chilled water

42°F chilled water

North Chilled Water Plant

South Chilled Water Plant

District Energy System-Before

- 1st generation district: 100 PSIG steam distribution network. Condensate is returned to the steam plant.
- Hot water for heating and domestic hot water is produced in buildings using steam to water heat exchangers.
- Steam is also used for humidification.
- 50 buildings are supplied in steam, as well as an adjacent hospital, which is the sole client of Western.
- Chilled water plants and network were added in the 1970's. A total of 11,000 tons of refrigeration is installed in both chilled water plants. Chilled water is supplied to 45 buildings.

District Energy System-Before

- In buildings, heating water at an average of 180°F with steam-to-water heat exchangers.
- Heat recovery strategies such as energy recovery wheels, run-around loops and economizers are used in many buildings.
- Humidification is done using steam, minimum set point in winter in buildings is +/-30% RH.
- Chilled water is used directly in cooling coils. Design of coils uses 45°F to 55°F chilled water.

Issues with the District System

- Aging infrastructure: piping, insulation, cooling towers, chillers.
- Capacity limit in the chilled water plants and new buildings being added.
- Cost of peak electricity demand: represents 50% of total electricity bill.
- High GHG emissions due to heating demand.
- High capital costs for replacement and expansion.

Transition to the Future District System

Options Considered

- Replacement of steam boilers by hot water boilers.
- Cogeneration for electricity reduction.
- Heat recovery on steam boiler exhaust.
- Centralized and local heat pumps.
- Geothermal.
- New chilled water plant for expansion of campus.

Step One-Chilled Water Plants Optimization

- South Chilled Water Plant was optimized in 2019 : reduction of peak electric demand of 1,000 kW and 3,500,000 kWh. Pumping strategy modifications, increase of chilled water temperature difference and flow modulation allowed to “free” 1,000 tons of capacity.

- Installation of a pumping station between both plants to allow operating both chilled water networks as one network. The station allows sending 1,000 tons for one plant to another.

- North Chiller Plant optimization underway: projected reductions of peak electric demand of 600 kW and 1,700,000 kWh.

- Connection of local satellite chillers to the network to add capacity and resiliency. This strategy will avoid building and addition plant for future expansions.

District Energy System-Before

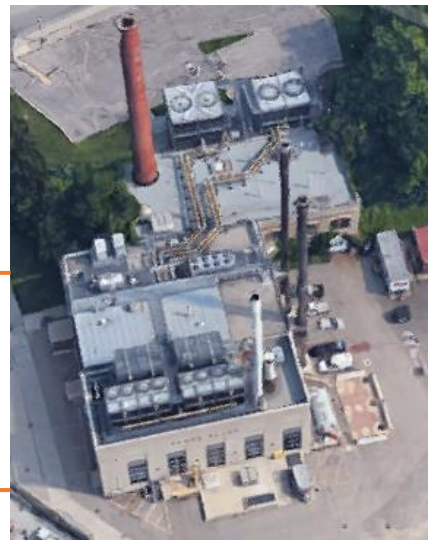
Connection of satellite chillers on the main network

Buildings on North Side

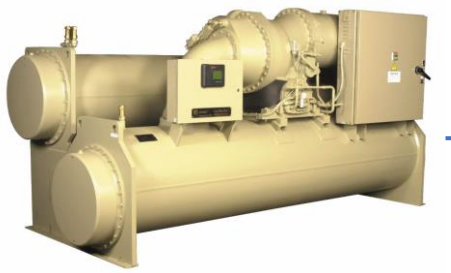
+/- 50 buildings

Buildings on South Side

Steam Plant

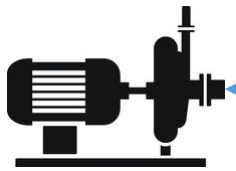


100 PSIG Steam



42°F chilled water

North Chilled Water Plant



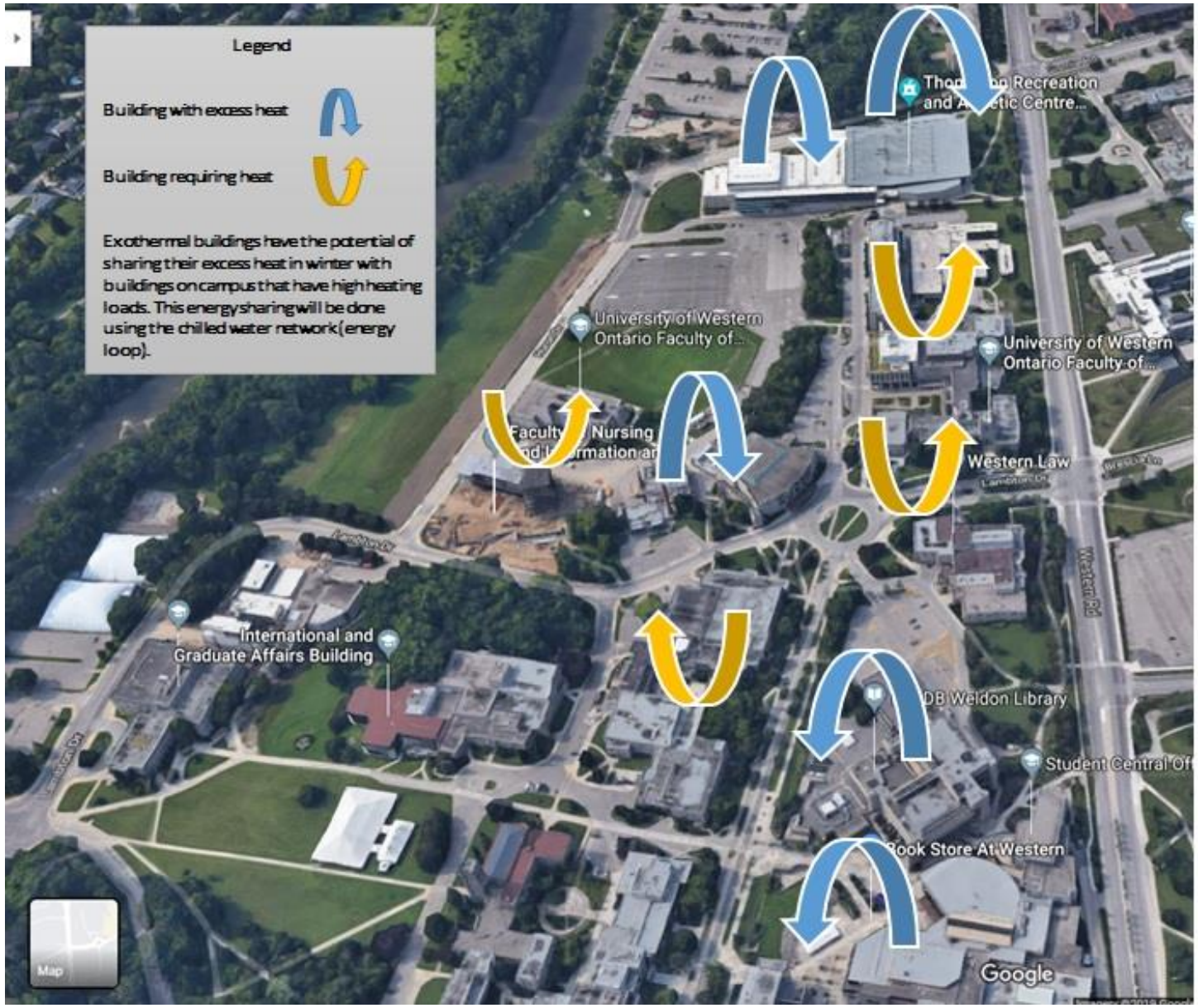
New Pumping Station

42°F chilled water

South Chilled Water Plant

Step Two-Conversion to Low Temperature Heating Water

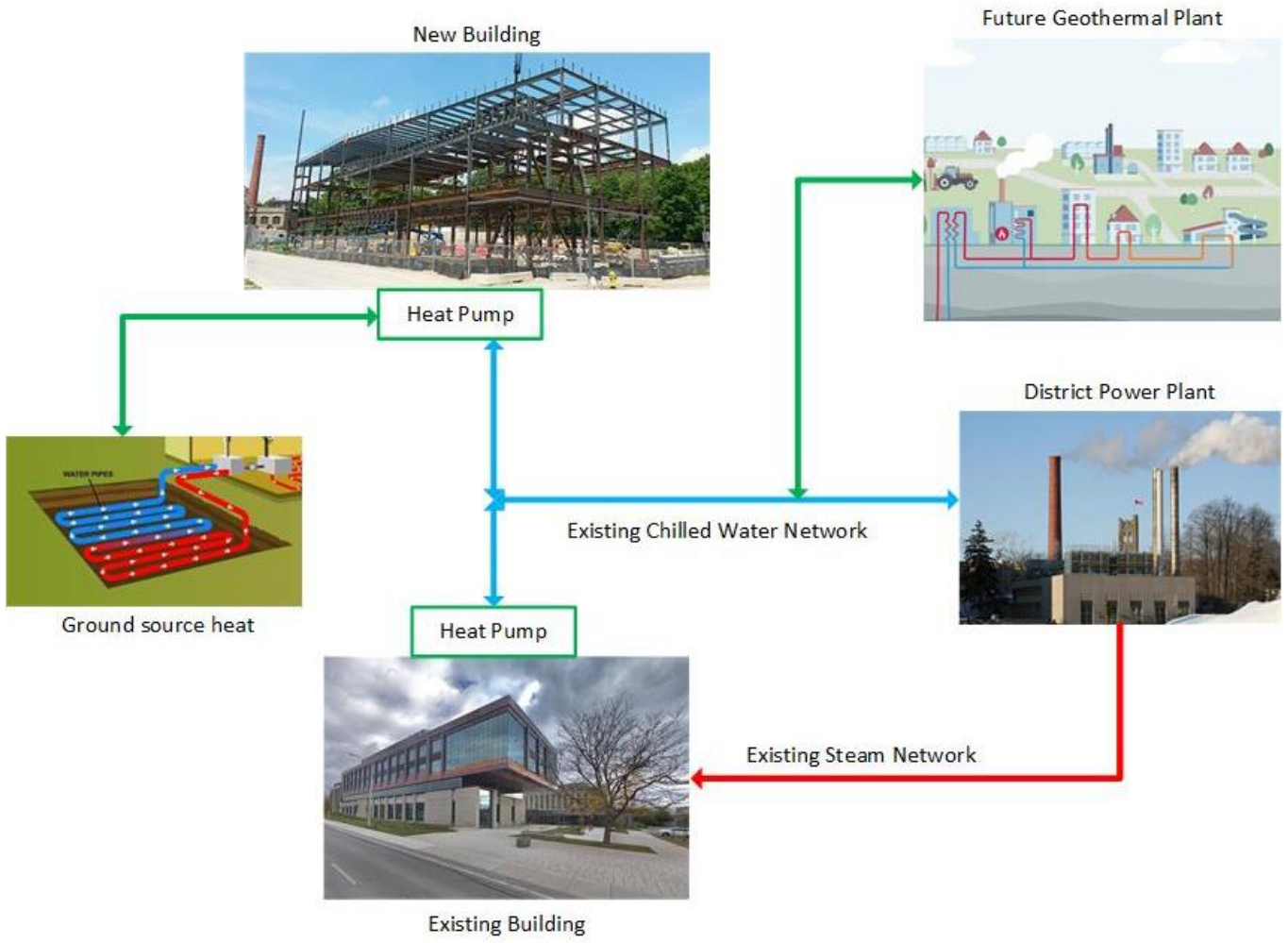
- Convert each buildings using steam to low temperature heating water: 45°C (113°F and lower).
- Production of low temperature heating water by local heat pumps using the chilled water network as an energy source.
- Inject heat from renewable sources into chilled water network anywhere on campus: heat from process, flue gas heat recovery, internal heat gains, geothermal.
- Convert steam humidifier systems in buildings to high-pressure water systems.
- Existing steam infrastructure used as back-up and peak heating only.



Taking Advantage of Energy Sharing Using the Chilled Water Network

- Building with excess heat can send energy to buildings requiring heat.
- Other energy sources can be connected to the Energy Network, such as flue gas heat recovery, geothermal or process heat.

District Energy Vision



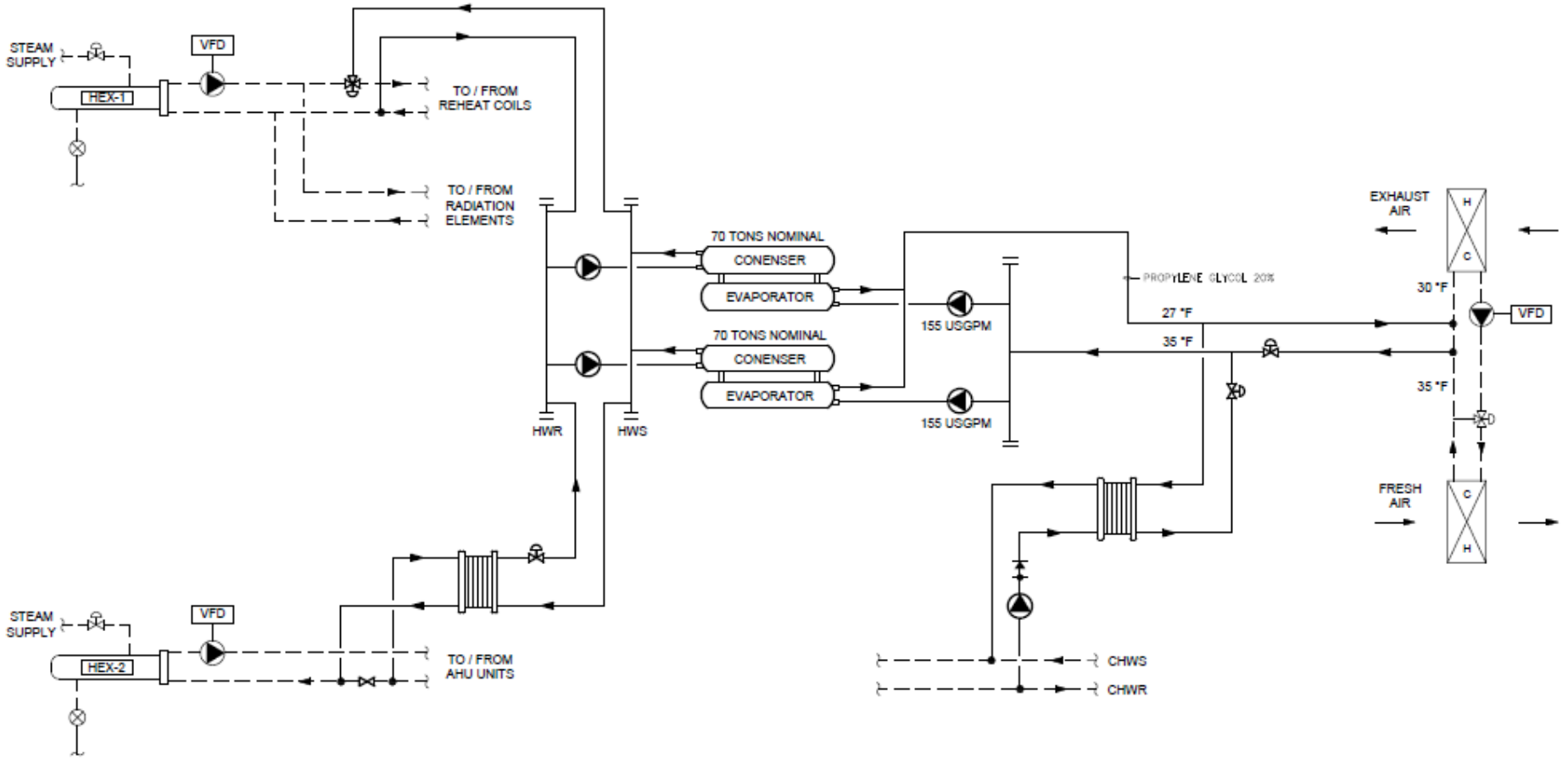
- Currently, two existing buildings were converted, resulting in a reduction of +/- 14,000,000 lbs of steam and 1,000 tonnes of CO2 yearly.
- A flue gas heat recovery unit was installed on one boiler in the steam plant. This unit will allow injecting energy in the energy loop and reduce steam consumption by +/- 45,000,000 lbs of steam and GHG emissions by 3,000 tonnes.
- Two buildings are currently being converted, projected results are reductions of 19,500,000 lbs of steam and 1,300 tonnes of CO2.
- One new research building on campus will use low temperature heating water with heat pumps and innovative heat recovery solutions and will avoid 10,000,000 lbs of steam and 700 tonnes of CO2 per year.
- One new building will aim zero carbon for heating and be coupled with geothermal energy.

Example of Projects in Existing Buildings

Research Laboratory Deep Energy Retrofit

- 100% fresh air building. Currently consumes 19,000,000 lbs of steam and has a peak electricity demand of +/-800 kW.
- Measures that will be implemented: heat recovery chillers, air change per hour optimization in spaces, pumping and ventilation improvements.
- Measures will reduce peak demand by 450 kW and 2,000,000 kWh (50% reduction).
- Measures will reduce steam demand by 13,000,000 lbs per year (68% reduction) and 900 tons of C02 per year (75% reduction).

Project Schematic



Western Recreation Center Deep Energy Retrofit

- Six gymnasiums, one fitness center, squash courts, multi-purpose gym rooms and Olympic size pool.
- Fourteen AHU's.
- Supplied in chilled water and steam from campus district energy system.
- Current energy consumption : 4,900,000 kWh/year and 8,900,000 lbs of steam per year.
- Measures will reduce peak demand by 180 kW and 1,000,000 kWh, which represents 20% of current consumption.
- Measures will reduce steam demand by 6,500,000 lbs per year (74% reduction) and 480 tons of C02 per year (60% reduction).

GHG Reduction Total projected for 2022

- Both these projects are projected to reduce GHG emissions by +/- 1,280 tons, which is +/- 10% of the 2030 reduction goal.
- To reach the 2030 goal, more buildings per year will have to undergo a deep energy retrofit.
- When most buildings are retrofitted, then the central plant can undergo an energy conversion for back-up and peak heating production.

New Building Designs

New Buildings Design

- New buildings have to adapt to the new district system and not the other way around.
- Design briefs are submitted by Western to design teams. These guidelines state, among others, the cooling and heating coils temperature designs, heat pumps specifications, heat recovery options.
- New buildings cannot rely on steam for their heating demand. Heat recovery is prioritized and steam is for peak and back-up purposes.

Closing Remarks

Conclusion

- Building-level deep energy retrofits provide real GHG reductions, but are insufficient to meet Paris Accord goals. System solutions are necessary.
- Maximize utility of existing infrastructure as much as possible.
- New space must be zero carbon.
- Alternative and renewable energy sources will be required to meet goals.

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