STEAM TO HOT WATER FINANCING

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Introduction

The UC Davis campus is served by a district cooling and steam heating system. However, 30-50% of heating energy is wasted and the system requires major upgrades to remain functional. Conversion to a hot water heating system with heat recovery chillers would: reduce operating costs; avoid unnecessary capital expenditure; decrease losses to 5-10%; save significant energy; reduce carbon and other emissions; and enable additional improvements. The conversion is necessary for UC Davis to meet its climate action goals.

We developed a financial model and investigated methods of financing the conversion, which is etimated to cost \$111M to \$164M in capital expenditure (compared to \$98.5M to maintain the current system).

Phasing Scenario

Two phasing scenarios were analyzed:

- Scenario I --- 10 years for full implementation.
- Scenario II --- shorten implementation time to 4 years.

Figure 1. The percentage of total conversion for different scenarios

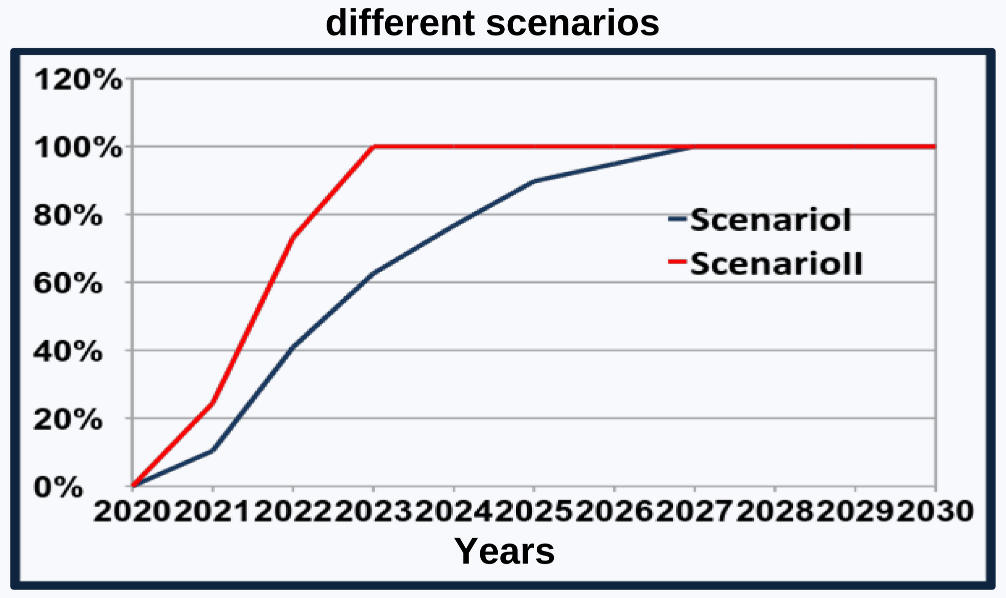
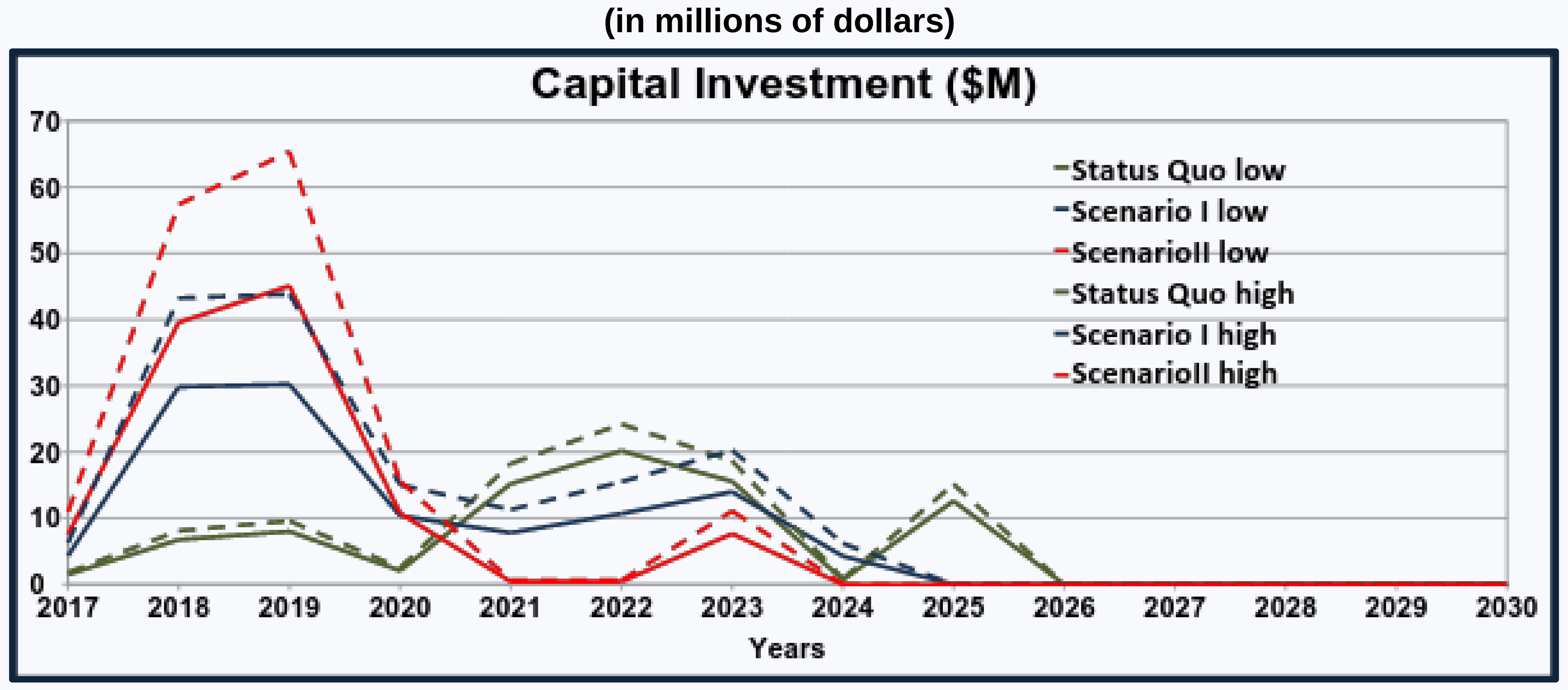


Figure 2. The capital investment varying with years for different scenarios (in millions of dollars)



Financial Model

Figure 3. Estimated cashflow for existing steam system

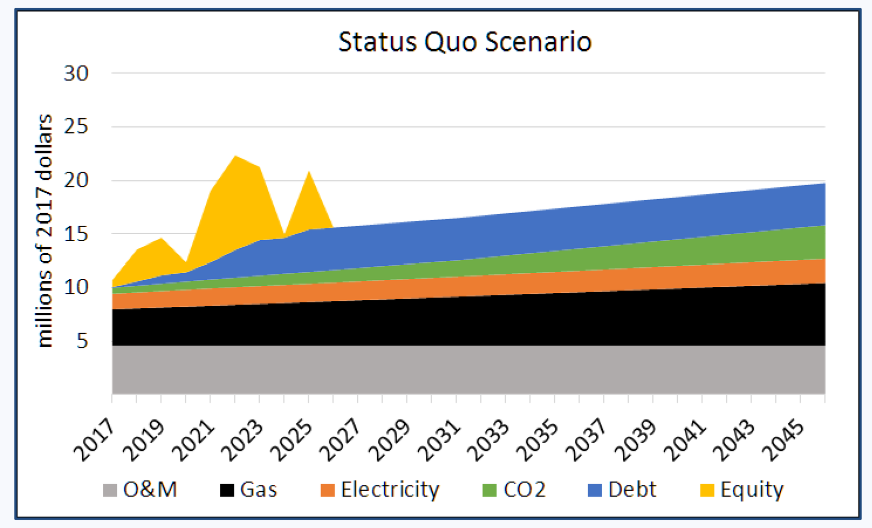


Figure 4. Estimated cashflow for hot water system with heat recovery chillers

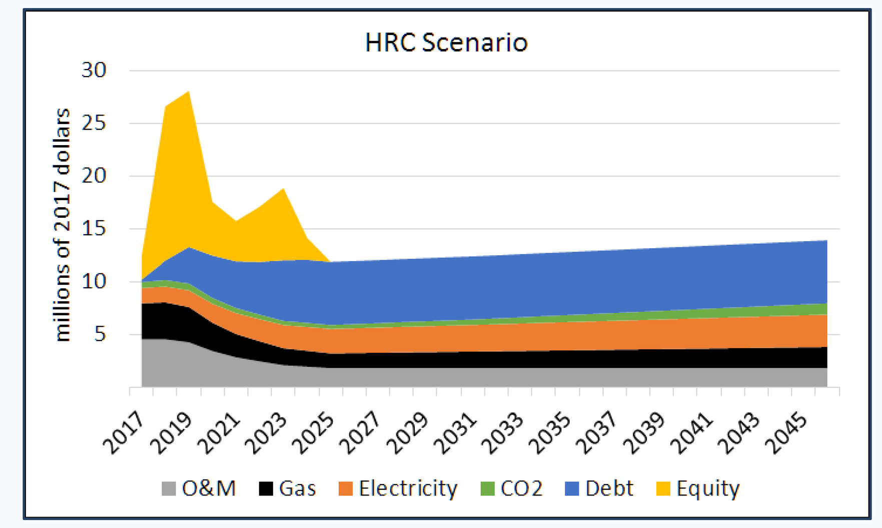


Figure 5. Total cashflow for steam versus hot water with heat recovery chillers

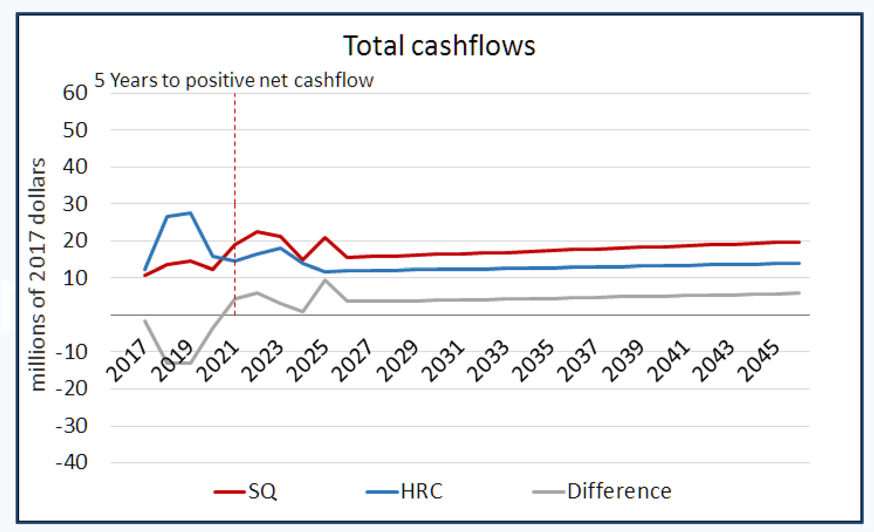


Figure 6. Debt cost versus operational savings from conversion

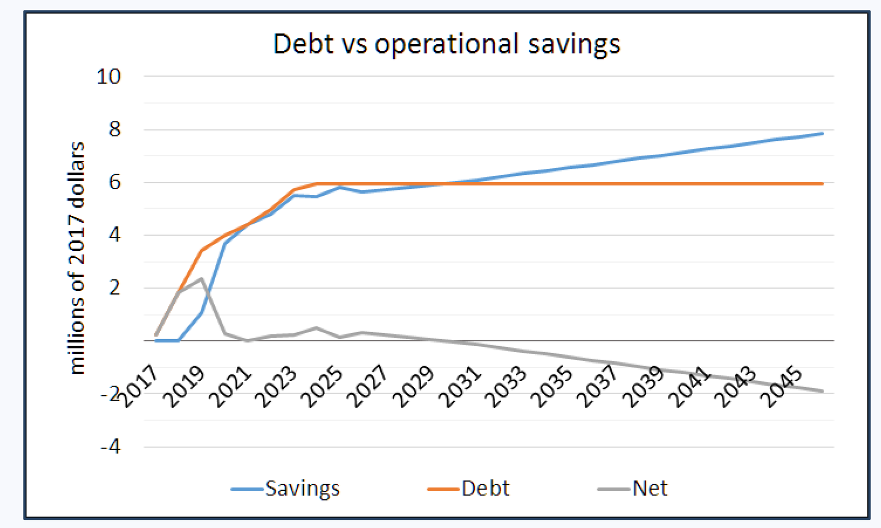
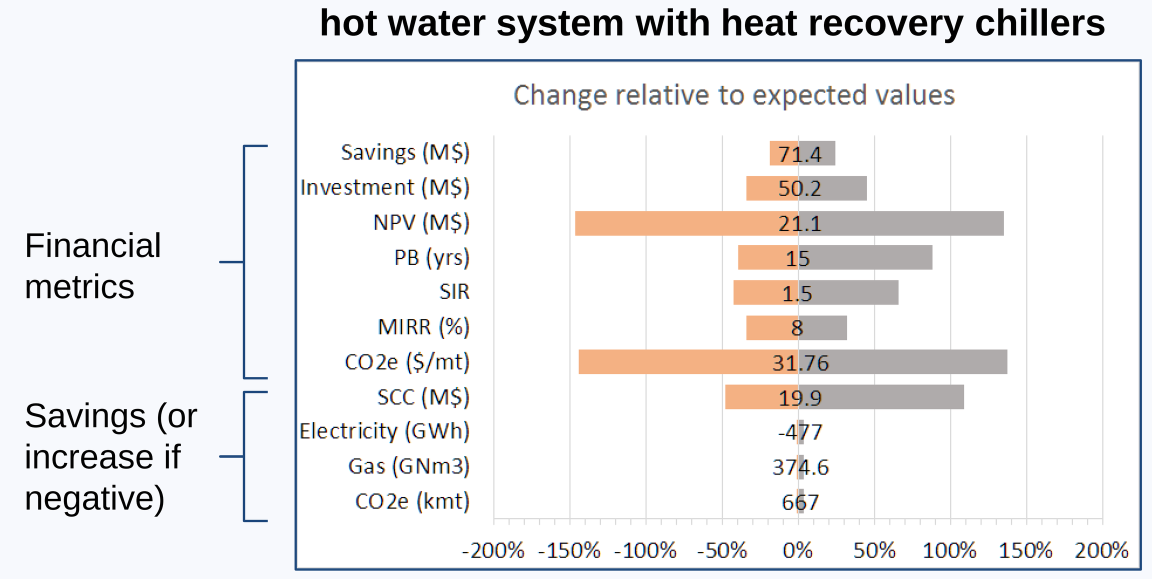


Figure 7. Sensitivity analysis for conversion to hot water system with heat recovery chillers



NPV	Net Present Value
PB	Discounted payback
SIR	Savings to investment ratio
MIRR	Modified internal rate of return
CO2e	Direct cost of carbon
SCC	Net social cost of carbon
Nm3	Normal meter cubed
kmt	Thousand metric tons

System	Status Quo (SQ) vs. HRC HW, 30% losses in steam system.
Cashflows	O+M, gas, electricity, incentives, carbon emissions, debt, and capital.
Assumptions	2017 base, 30 year, 60/40 debt/equity, 6% debt and discount rate.
Model	Middle estimate for cost, price escalation, and schedule.
Sensitivity	Low / mid / high price escalation and cost, moderate / fast schedule.

Financial Options

The project will likely require varied financing. Below are several financing approaches.

Public-Private Joint Venture

Joint venture between a public entity and a new private corporation. The public entity pays for services operated and provided by the joint venture, which gains access to capital while using a utility revenue model, with variable energy fee and fixed capacity charge.

Case Study: Toronto needed capital to improve its water supply, providing an opportunity to enhance its district heating and cooling system. Enwave was formed by Toronto and the Ontario Municipal Employees Retirement System. Enwave used the free cashflow of its revenue stream, its asset value, and EBITDA to value the corporation and raise capital. It undertook a \$200-\$250M project, reinvested margins, and was eventually purchased for \$475M.

Energy Savings Performance Contracts (ESPCs)

ESCO (Energy Service Company) installs system and guarantees energy savings to the customer. Infrastructure improvements are owned by the customer and installed with little upfront cost (Kim et al. 2013).

Case Study: Energy efficiency upgrades at Oregon State University's Hatfield Marine Science Center cost over \$300,000 but provided annual energy savings of over \$15,000. University paid with energy savings, which were guaranteed in ESPC by partner (Oregon Department of Energy 2004).

Energy Services Agreements (ESAs) and Managed Energy Services Agreements (MESAs)

Project developer arranges for installation by an ESCO and coordinates capital investment. The developer owns, operates, and maintains equipment during the term of the ESA. Customer pays for energy saved as a service. In a MESA, a project developer owns the energy efficiency equipment and serves as liaison between the customer and the utility. MESAs can have varying arrangements for how energy savings can accrue to the customer. Developers are incentivized to maximize energy savings (Kim et al. 2013).

Case Study: Drexel University upgraded fume hood controls and replaced a central chiller plant through MESA with SCIenergy, Mitsui USA, the Pennsylvania State Treasury, Blue Hill Partners and others. Project cost \$6.5 million and allows upgrades to be paid through savings on university utility bills (SCIEnergy 2016).

Student Fees and Revolving Loan Funds

Student fees are a powerful source of funds that empowers students to fund major, campus-wide, projects and fund revolving loan funds where a portion of savings from projects are reinvested into the fund (Campus InPower 2009).

Case Study: UCB's Green Initiative Fund charges \$5 per student, per semester, for 10 years. The student government fund raises \$200,000 per year to fund efficiency projects (Campus InPower 2009).

Conclusion

Project appears **financially viable and environmentally beneficial**

- Positive return on investment (NPV \$21.1M, SIR 1.5, MIRR 8%)
- Savings sufficient to cover debt payments (@40-60% debt)
- Reduced carbon emissions (667 kmt)

Recommendations

1. Perform engineering and financial analysis for entire campus, and investigate additional measures including: solar hot water, thermal storage, optimizations, building efficiency upgrades, operational improvements.
2. Further explore financing options and structures

References

1. Campus Heating & Cooling Systems Energy Planning, BMcD Engineering Company, FVB Energy, 2014; 2. Energy Planning at UC Davis, Chris Agerfeld Svenning, 2015; 3. Hot Water Conversion White Paper, Joshua Morejohn, 2016.