The New Low Hanging Fruit

Reducing PUE by making power from chiller waste heat.

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HAYZEL

ABSTRACT

This presentation details the innovation and expected impact of Hayzel's Liquid-Vapor Expander (LVE) technology. The LVE is a two-phase turbine generator that improves chiller efficiency and generates carbon-free electricity. Demonstrated in collaboration with the NREL/Wells Fargo IN2 program and Digital Realty, **a prototype is being deployed on an 800-ton water-cooled chiller at a California data center** to validate its impact on energy savings, carbon reduction, and reliability. Initial models suggest a 10% improvement in the chiller's coefficient of performance (COP) and a reduction of over 121,000 kWh per year. Air-cooled chillers, more often used in data centers, can improve their COP by over 20%.

INTRODUCTION

A chiller absorbs and transfers heat from inside a data center to a fluid compound known as a refrigerant (e.g. R134a, R1234ze). Heated refrigerant is pressurized and transferred outdoors, where it cools close to ambient temperature with outdoor air. **However, some latent heat from the building remains available in the refrigerant for the final expansion step.** Expansion reduces pressure from the partially cooled refrigerant. Since pressure and temperature are directly correlated according to basic laws of thermodynamics, refrigerant temperature is also simultaneously reduced. To finish the cycle, low temperature refrigerant then transfers this temperature reduction to water sent back to cool the data center in air handlers or DLC.

INNOVATION

Many expansion devices can be used for pressure reduction; however, expansion valves are most commonly used in chillers today. **The LVE can be used in lieu of an expansion valve to perform the same pressure reduction**, but also delivers additional benefits, increasing cooling capacity and generating carbon-free electricity.

IMPACT

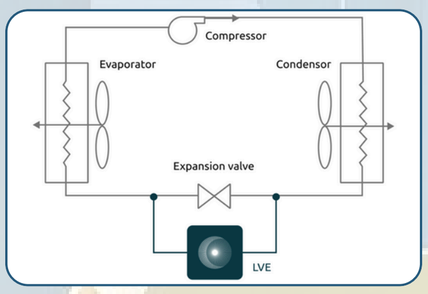
The LVE associated with this project will be reducing the full refrigerant flow from an 800 ton water-cooled chiller from 9.3 bar to 3.2. This LVE design can make 33.4kW electrical power at 480V, plus remove 35.5 kW of wasted heat from the refrigerant. Initial data modeling indicates that **an LVE can improve chiller efficiency by 10%, translating into an estimated energy savings of 121,000 kWh annually**. This reduction results in a projected simple payback of 2.6 years, considering installation costs and energy savings, not including readily available incentives. Environmental benefits include an estimated reduction of 33 tons of CO_2 emissions per year.

CALL TO ACTION

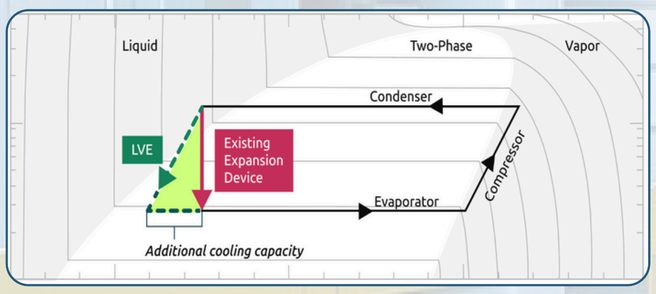
Twenty percent of energy demand in Ireland today is from data centers. Forty percent of data center power is for cooling alone. With the rise of AI, data center power demand will double by 2030, exacerbating an already warming planet. **The need for increase in cooling efficiency is a burning priority for data centers.** If successful, broader deployment of LVE technology could begin within two years, significantly contributing to energy efficiency and carbon reduction efforts.

CONCLUSION

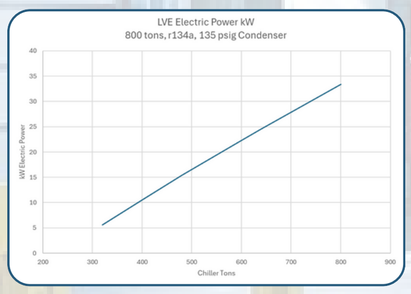
The LVE represents a breakthrough in sustainable cooling. **By enhancing cooling efficiency and generating carbon-free electricity, this innovation will support DLC advancement and redefine cooling strategies in high-density IT environments**. The LVE demonstration will validate its benefits and scalability for future deployments.



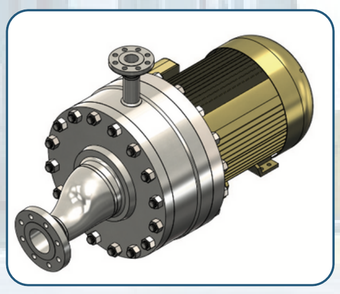
Chiller PFD with LVE bypass



LVE Value Creation



LVE Simulated performance curve



40 KW LVE—Data Center Demonstration

We would like to recognize the contributions of colleagues at Digital Realty, NREL, Wells Fargo, and the tireless efforts of the Hayzel engineering team for making this innovation possible.

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