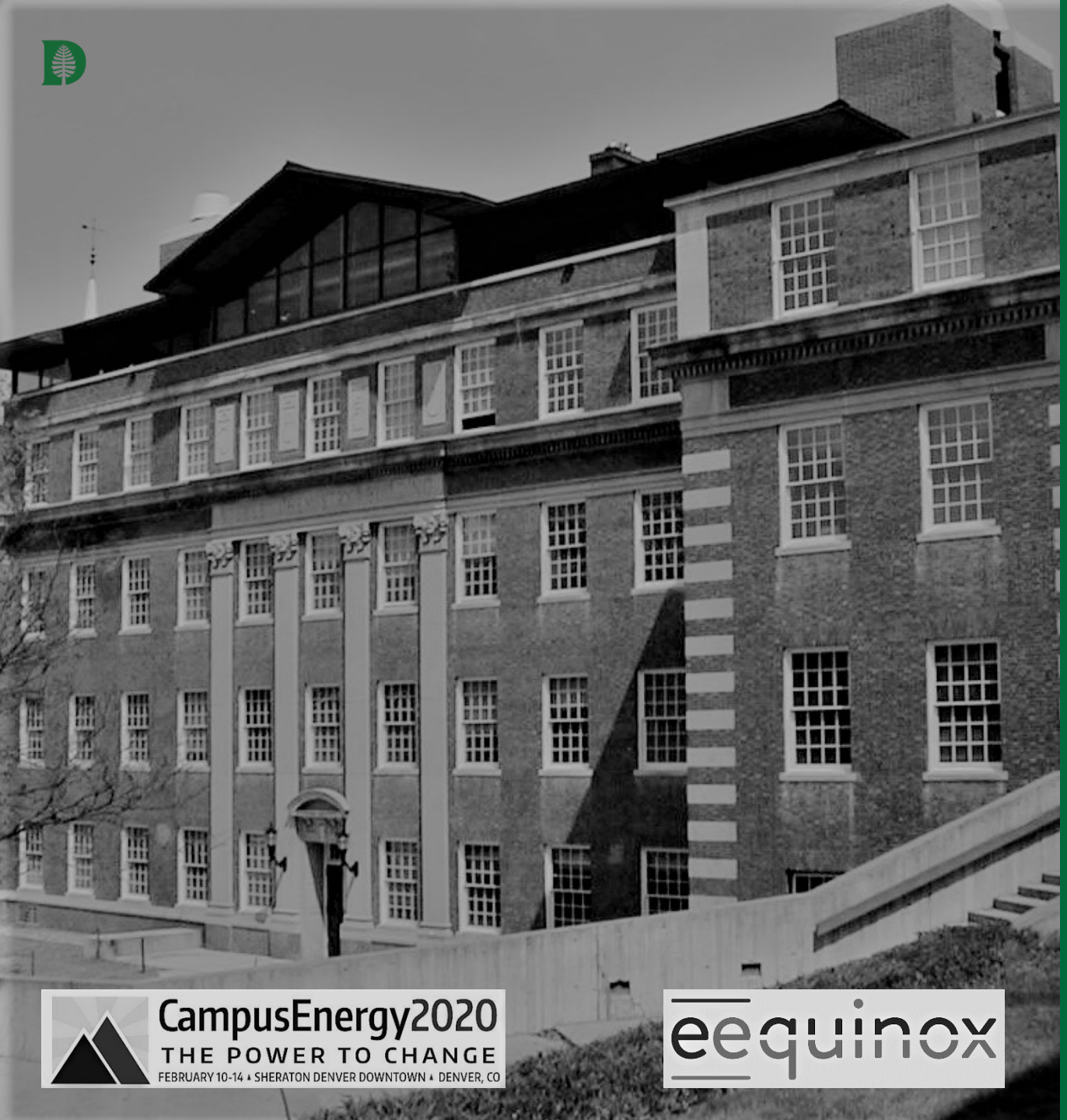

DARTMOUTH

Steele Hall
Energy Retrofit Project

Scott Hening, P.E. LEED BD&C, CEM

Energy Program Manager – FO&M

Dartmouth College

Philippe Gauthier, P.E.

Principal

Eequinox

Steele Hall Description

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Building :

- Built in 1920
- Major renovations in 2000 and 2007
- Earth Sciences, Environmental Studies and Chemistry research labs and offices
- Five floors (including mechanical penthouse)
- 47,495 sq. ft.

Project Goals

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Capital renewal

- Replacing failing steam coils in AHUs
- Upgrade aging Laboratory air control system

Hot Water Conversion

- Replace steam coils with hydronic heating coils
- Replace ancillary steam heating equipment with hydronic equipment

Energy Efficiency Measures

- Develop cost effective Energy Efficiency and Carbon Reduction measure

Steele Hall Description

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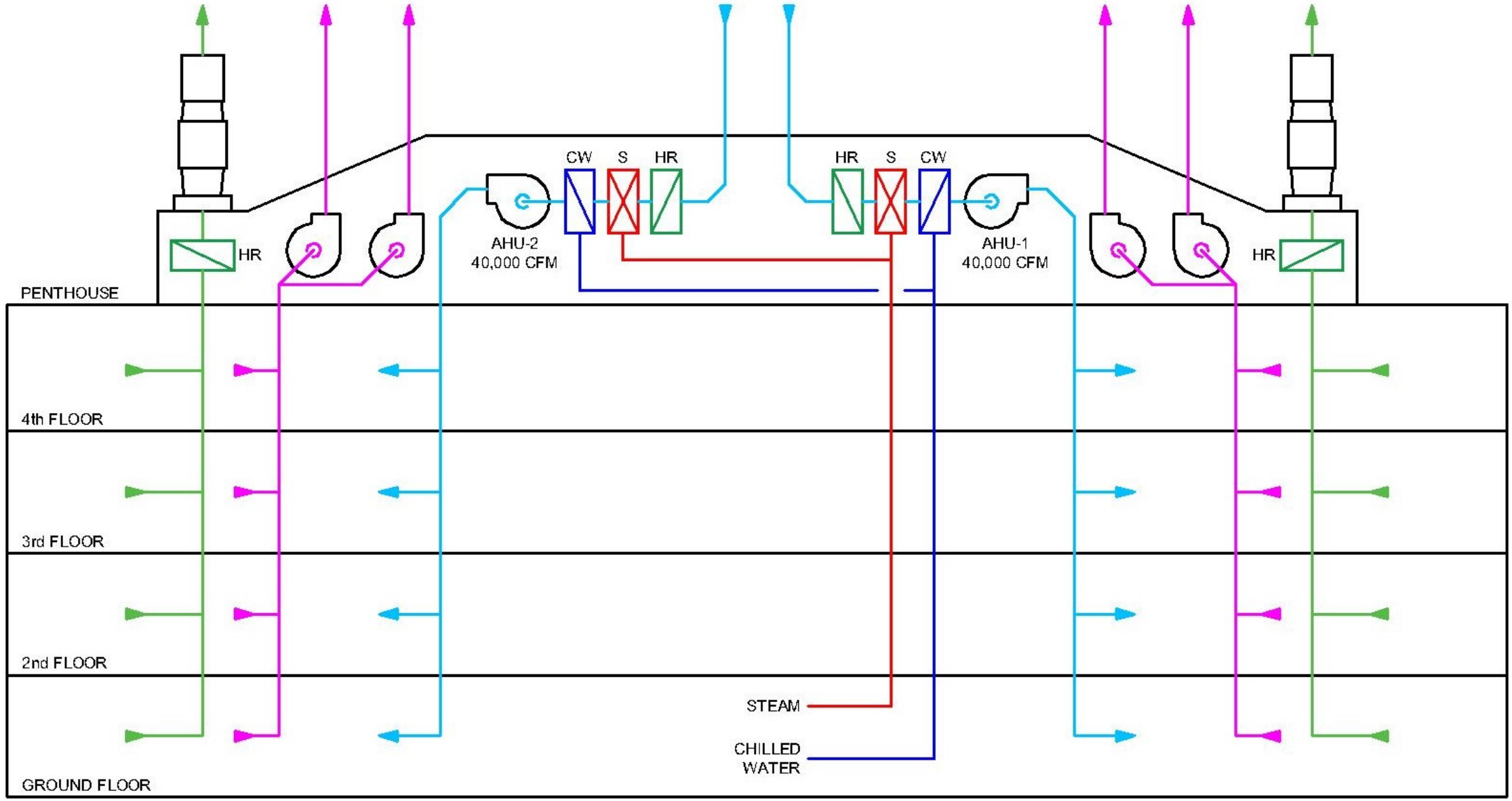
Mechanical Systems Before Project

- Two 40,000 CFM, 100% OA AHUs
- AHUs equipped with run-around heat recovery, steam and CHW coils
- Two main exhaust systems of three 20,000 CFM fans c/w heat recovery coils
- Two exhaust systems of two 4,500 CFM fans w/o heat recovery
- Separate hot water heating network for air reheat and perimeter radiation
- Campus Steam and CHW networks utilization

Steele Hall Description



Steele Hall Description

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Yearly Energy Usage

- Electricity : 1,500,000 kWh
- Steam : 10,756,000 lbs
- Campus CHW : 400,000 ton-hour
- EUI : 362 kBTU/sq. ft. (106 ekWh/sq.ft.)
- Energy cost : $430,000
- GHG emission : 1,920 MTCDE

Energy Efficiency Measures Description

DARTMOUTH

Laboratories ventilation air reduction

- Laboratory Ventilation Risk Assessment realization

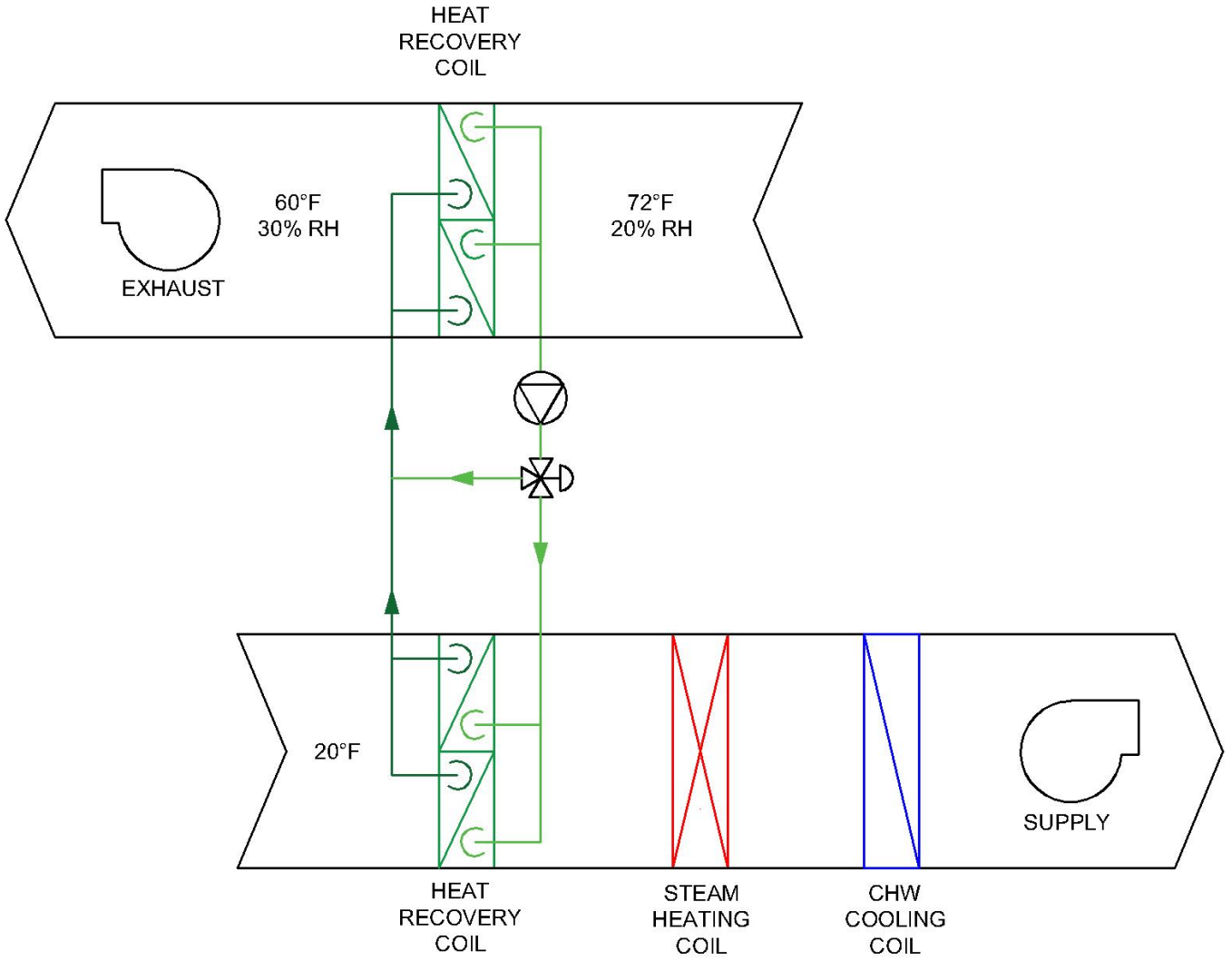
AIRFLOWS	BEFORE	AFTER	REDUCTION
Average supply/exhaust CFM	48,000	37,000	23%

Energy Efficiency Measures Description

DARTMOUTH

Existing heat recovery run-around system optimization – Initial arrangement

Average efficiency ± 23%

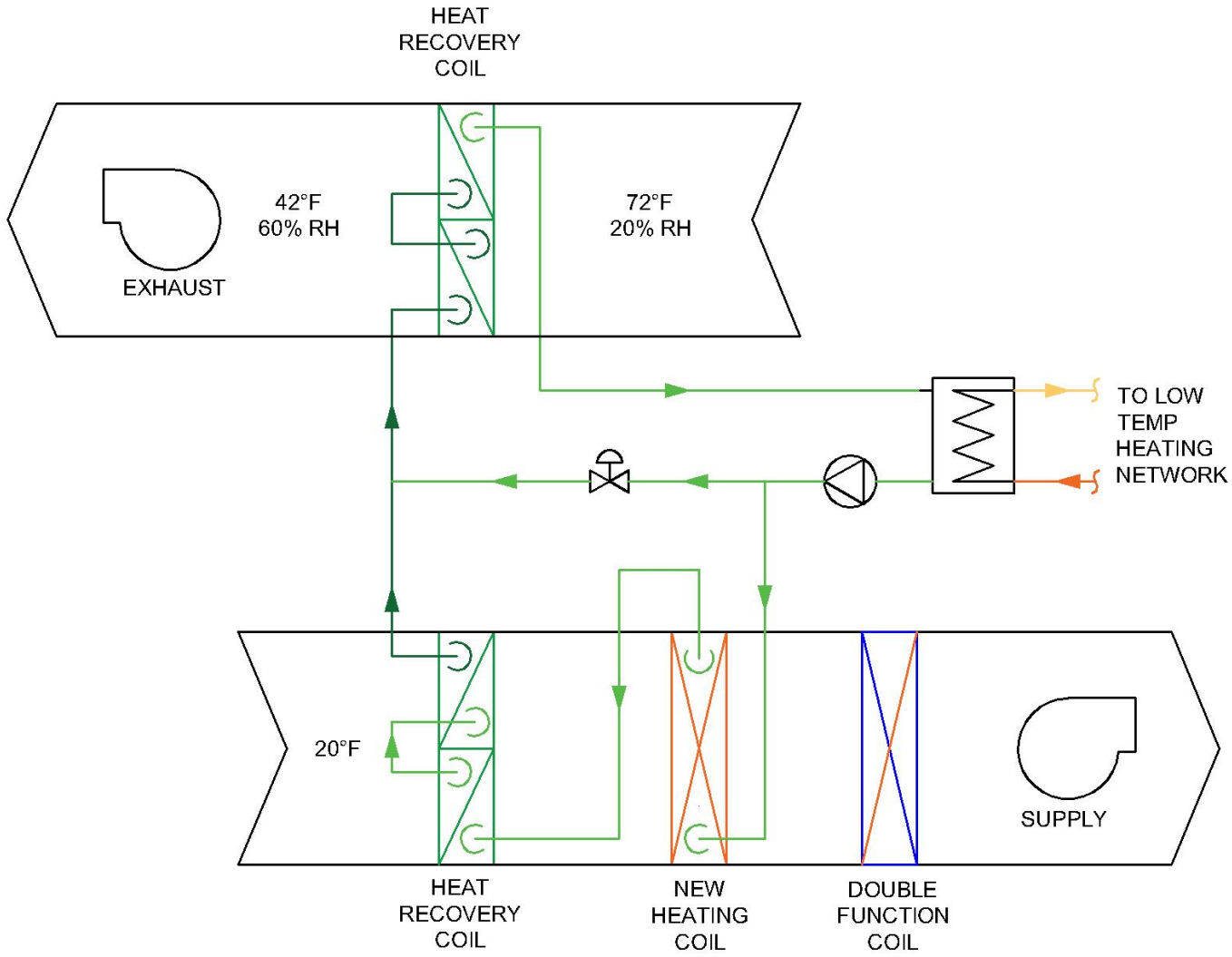


Energy Efficiency Measures Description

DARTMOUTH

Existing heat recovery run-around system optimization – New arrangement

Average efficiency ± 58%

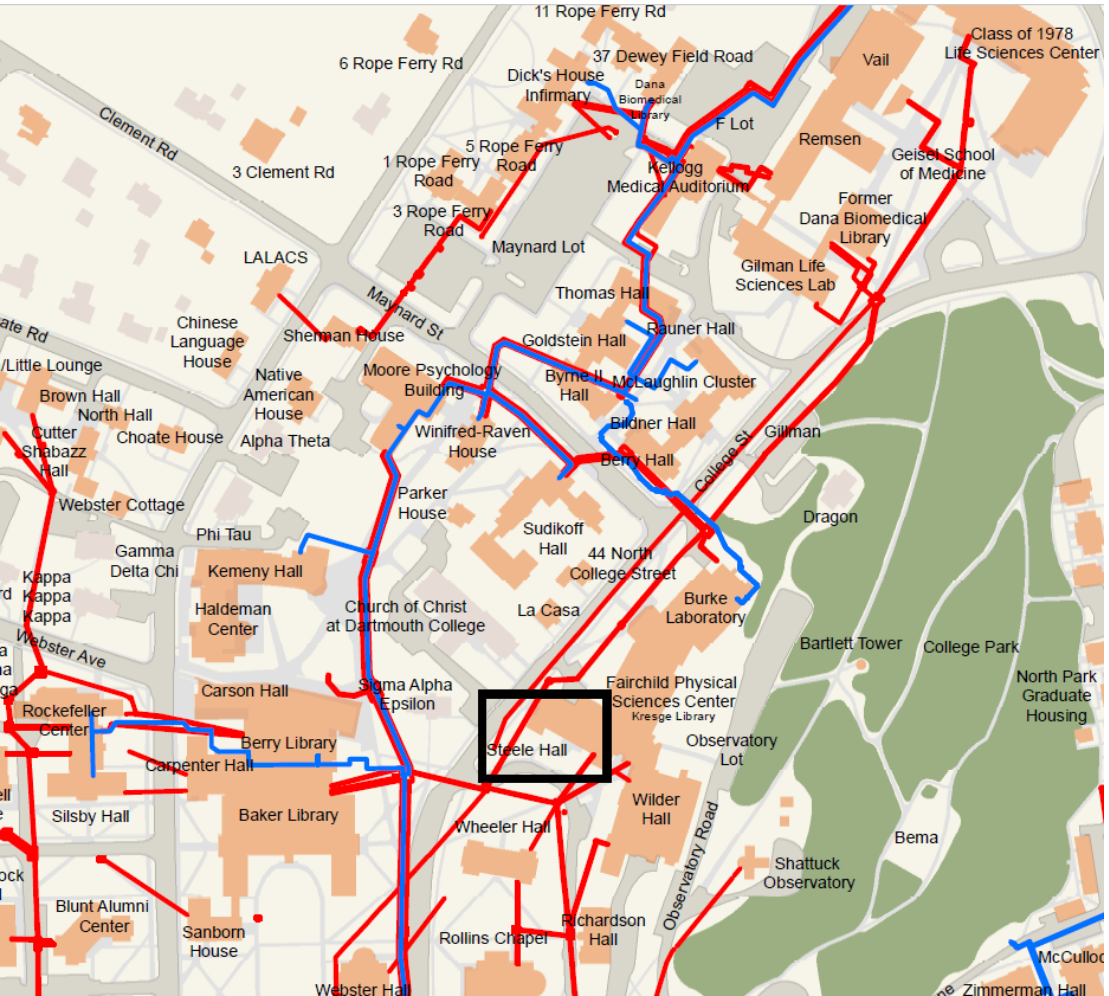


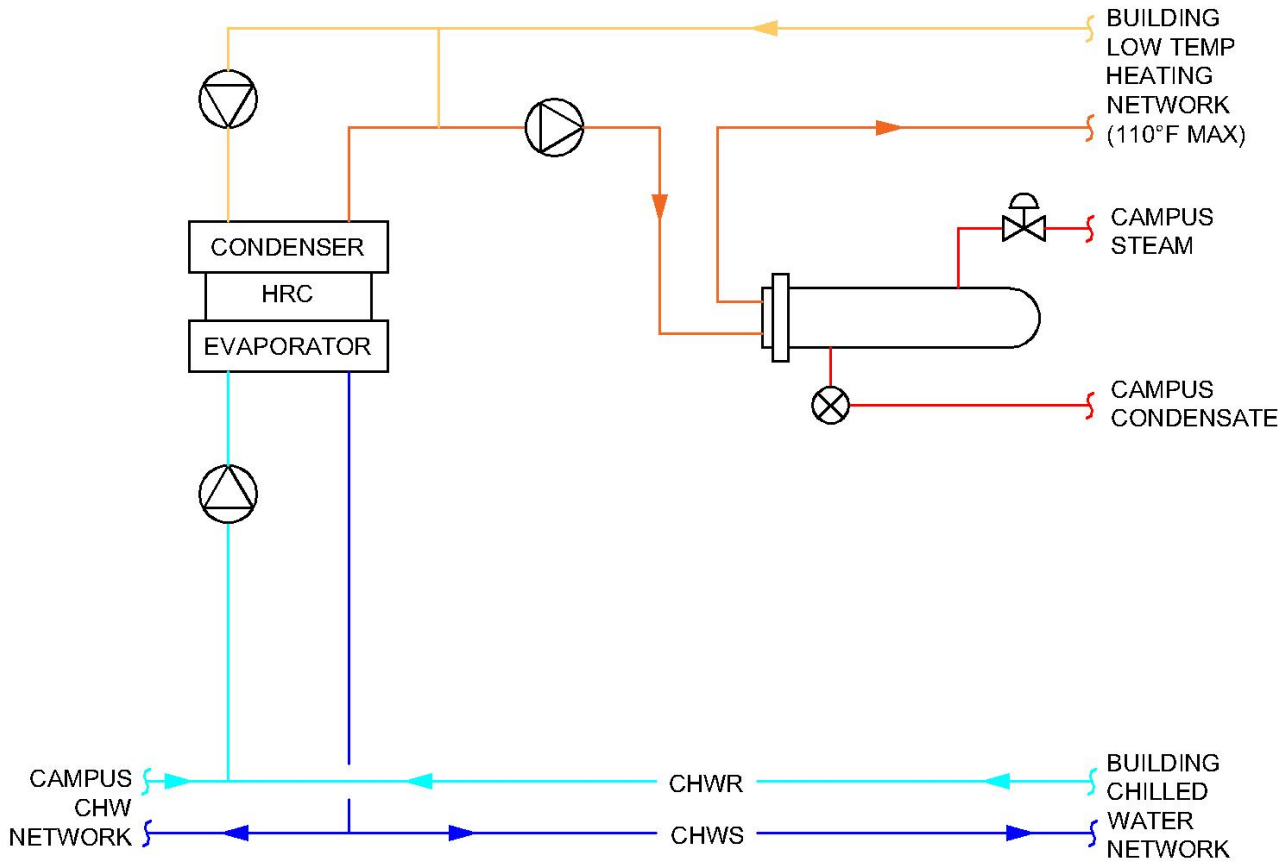
Energy Efficiency Measures Description

DARTMOUTH

Heat recovery chillers addition

- Using the Campus chilled water network as an energy source



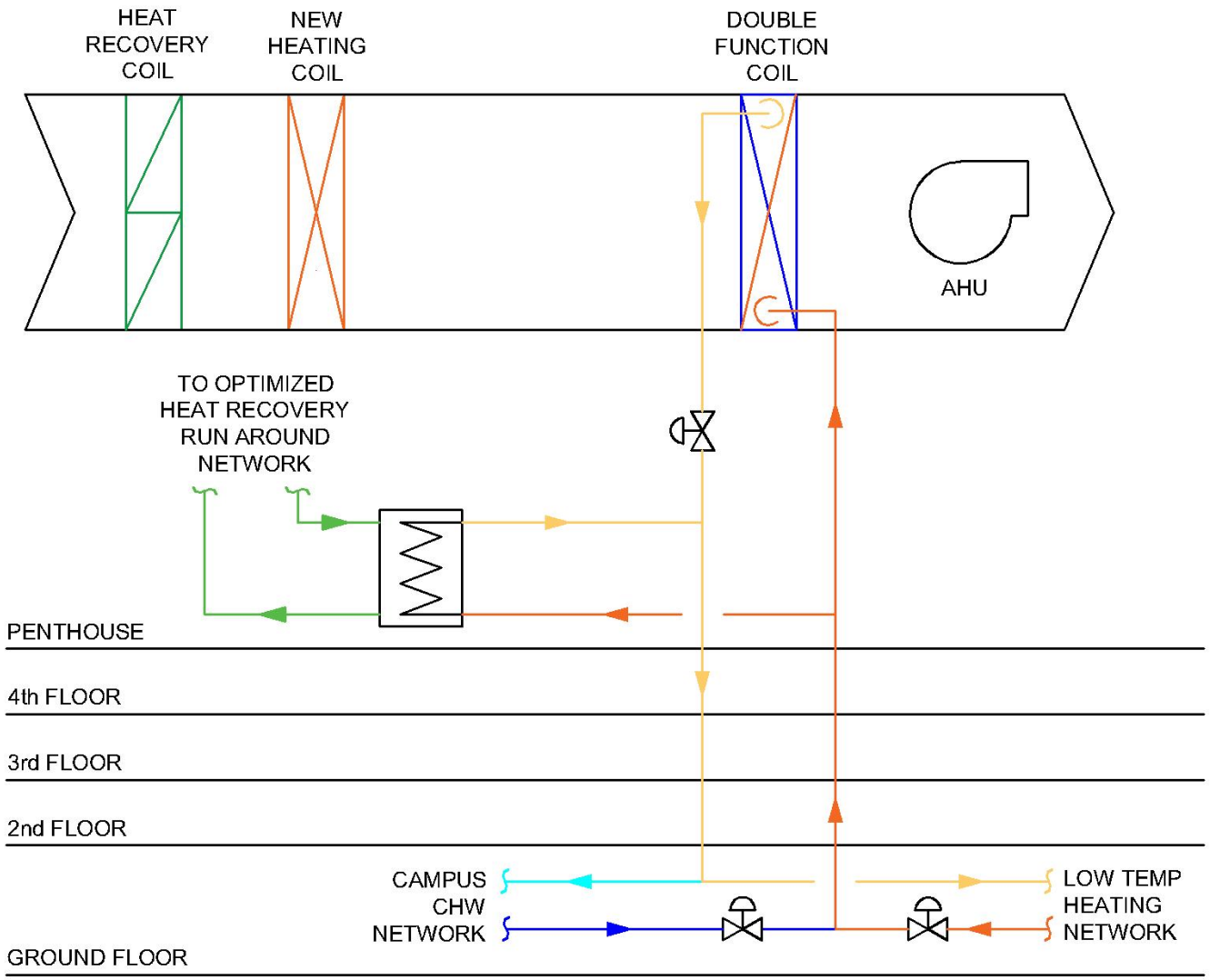


Energy Efficiency Measures Description

DARTMOUTH

Low temperature heating network deployment

- Replace existing VAV reheat coils selected at 110°F supply water temperature
- Use existing AHUs chilled water coils as double function coils for heating purpose using 110°F supply water temperature



Project's Results

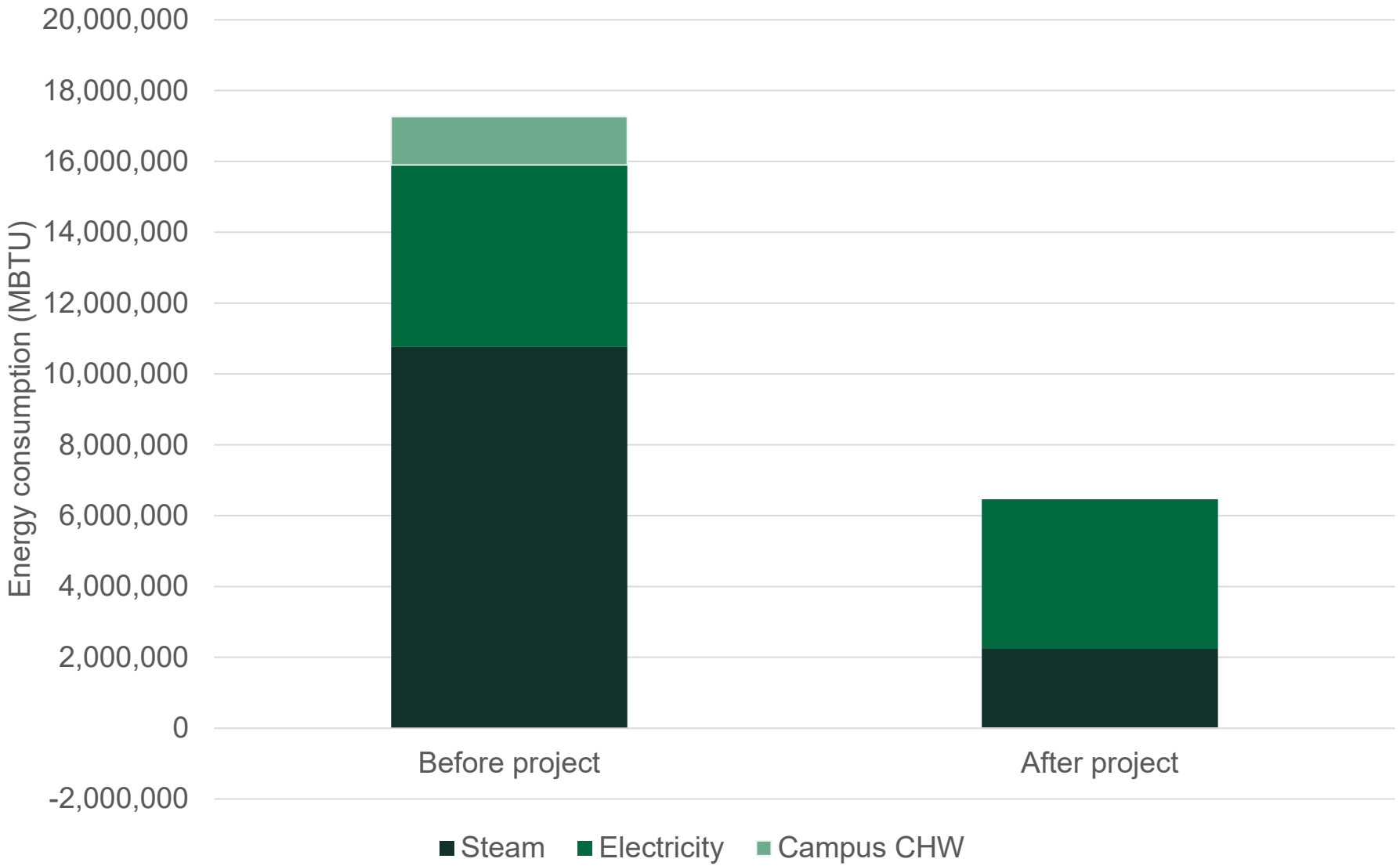
DARTMOUTH

ENERGY	BEFORE	AFTER	SAVINGS	SAVINGS %
STEAM (lbs)	10,756,000	1,995,000	8,761,000*	81%
ELECTRICITY (kWh)	1,500,000	1,309,000	191,000	17%
CAMPUS CHW (ton-hour)	400,000	-6,100	406,100	102%
EUI (kBTU/sq ft)	357	134	223	62%
GHG emission (MTCDE)	1, 900	595	1,305	69%
ENERGY COST ($)	$430,000	$190,000	$240,000	56%

*Equates to over 100,000 gallons of #6 fuel oil saved at the central boiler plant

Project's Results

DARTMOUTH



Lessons Learned

DARTMOUTH

Place for improvement

- Low temperature heating elements : 2 rows VS 4 rows reheat coils

Successful achievement

- Realize most of the building heating through air and minimize peripheral heating through radiators
- Cost effective heat recovery chiller capacity selection
- Thorough controls commissioning sessions and operational follow-up lead to a stable and efficient systems operation

QUESTIONS ?

Thank you !

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