



Deep Energy Retrofit of Brown University's Heating System ON PATH TO CARBON NEUTRALITY



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Agenda



Background

Current
project

2017-2020

Carbon
neutrality

2020-2040



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Background

The background features a solid yellow field. In the lower-left and bottom-right areas, there are decorative elements consisting of multiple overlapping, wavy lines. These lines are filled with a pattern of small white dots, creating a textured, mesh-like appearance that flows across the bottom of the slide.



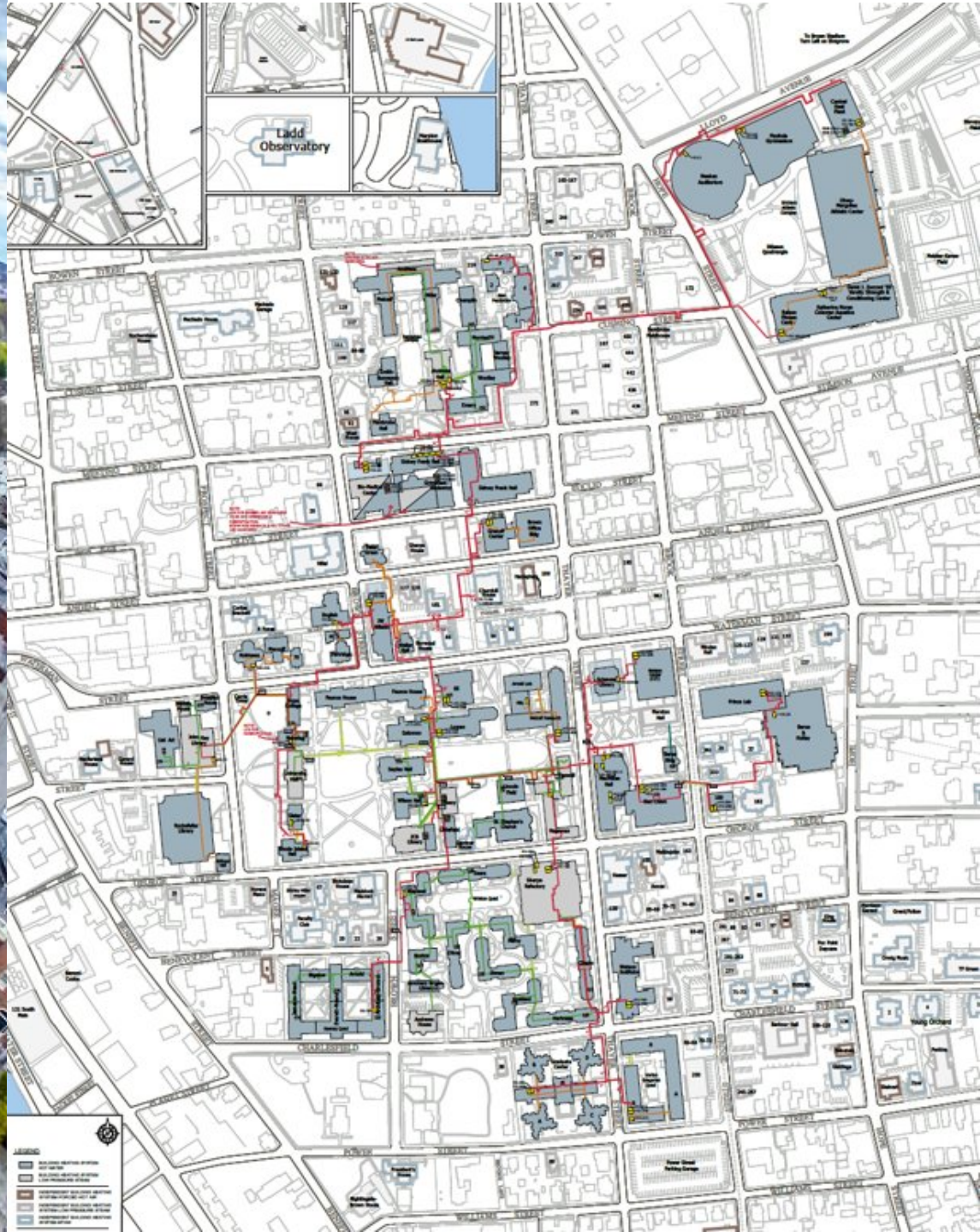
BROWN UNIVERSITY PROVIDENCE, RI

FOUNDED
1764

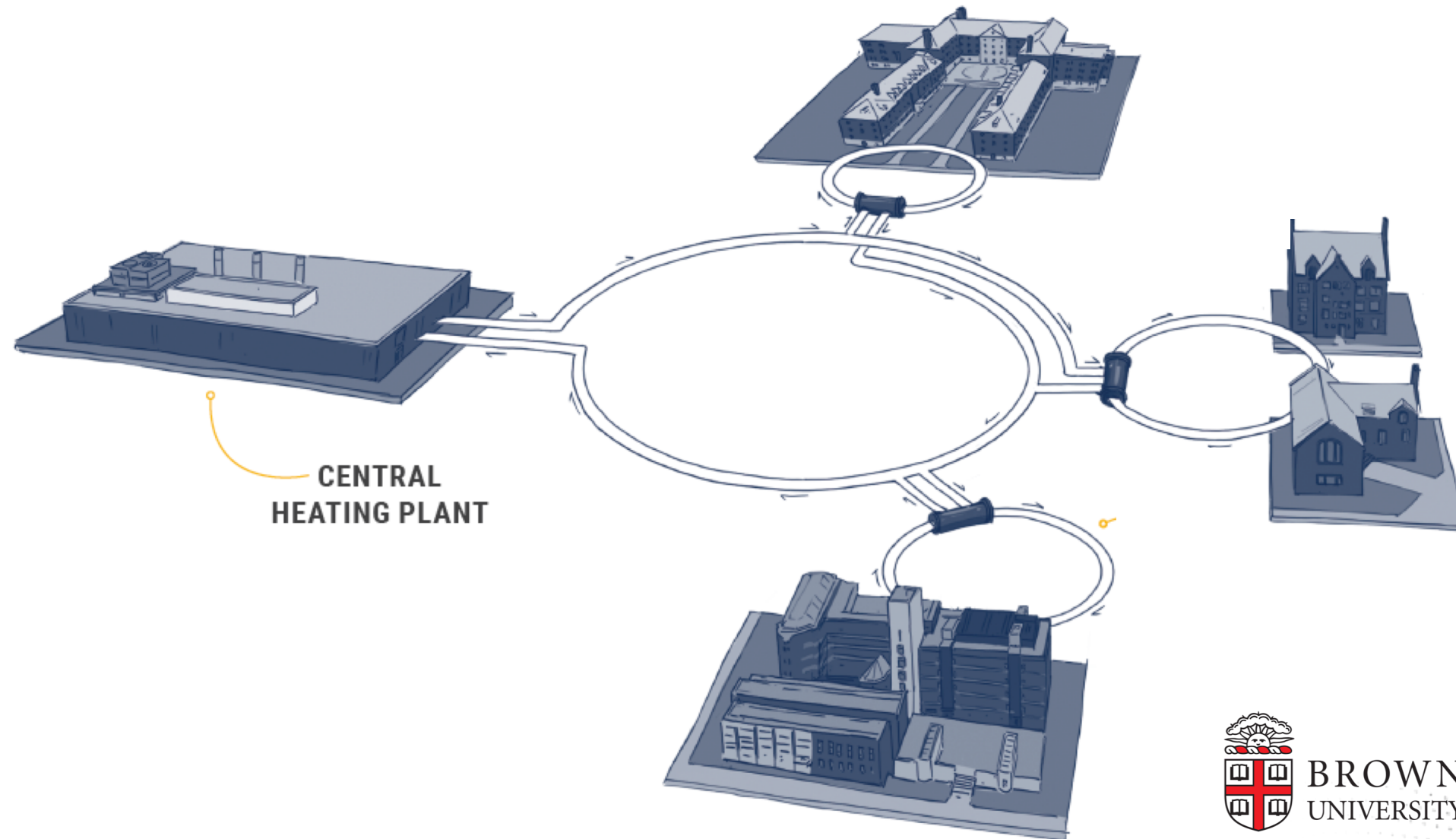
237
BUILDINGS

6.9M
SQUARE FEET

9,000
STUDENTS



Current District Heating System

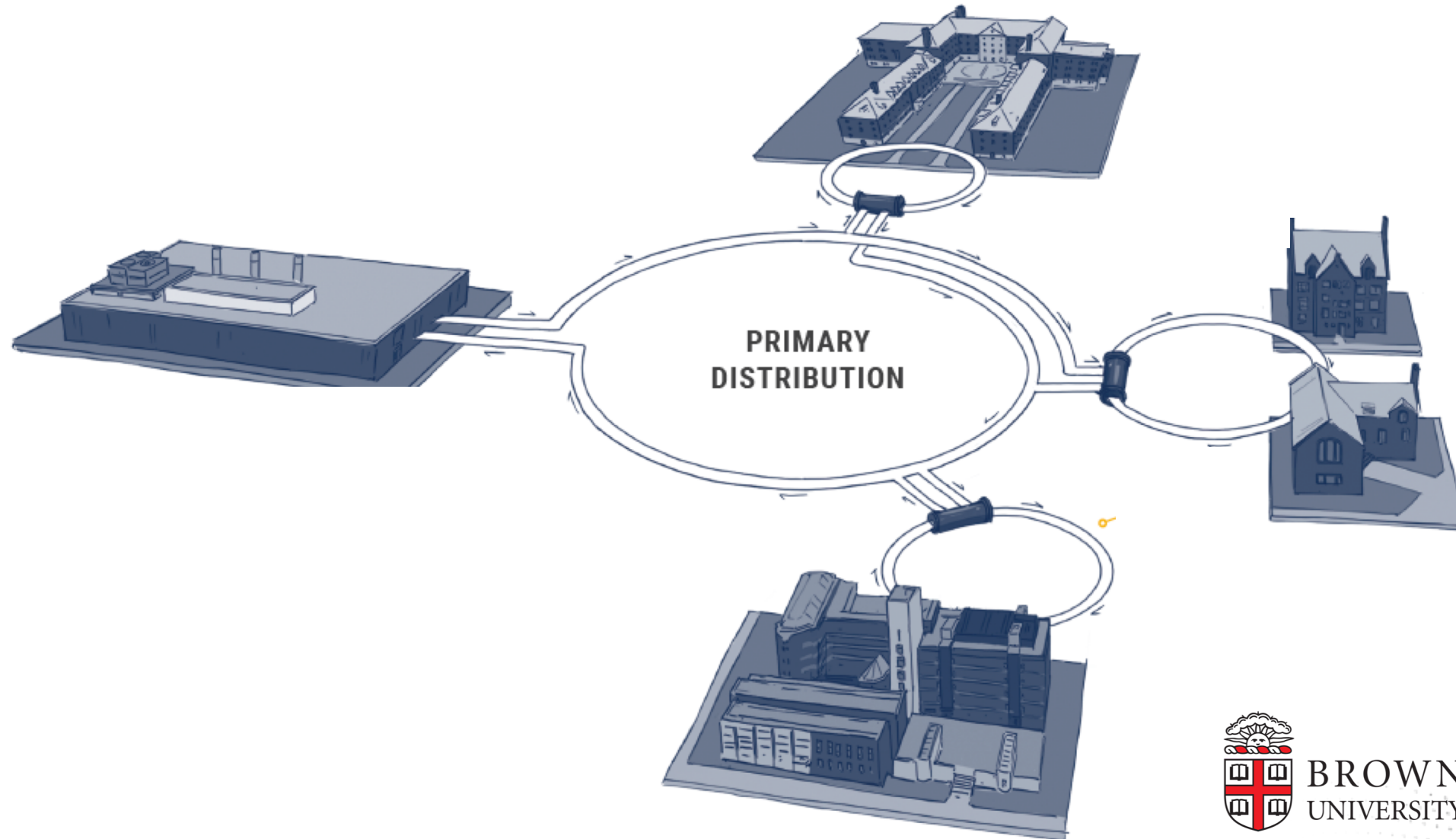


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Current District Heating System

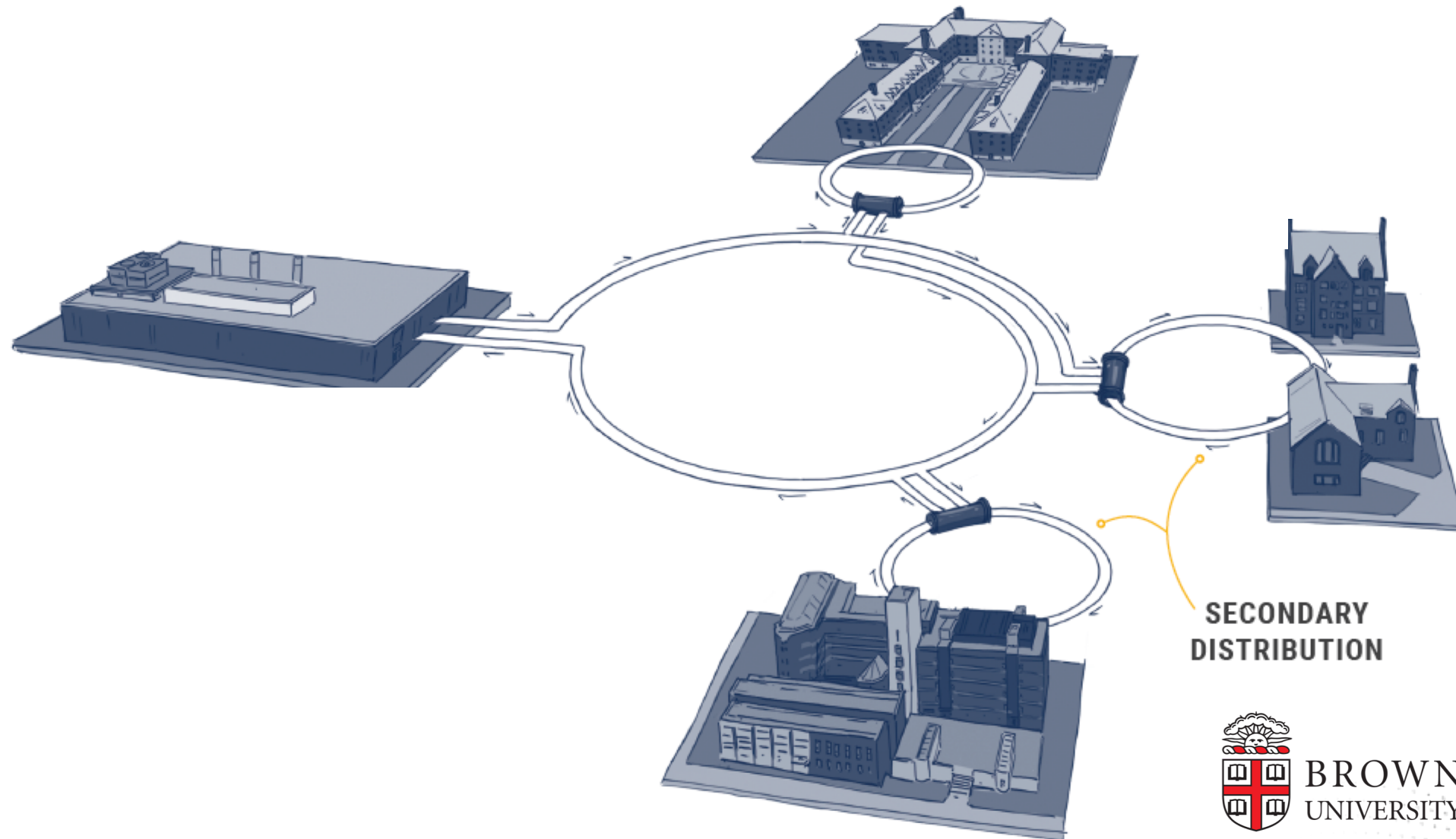


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Current District Heating System

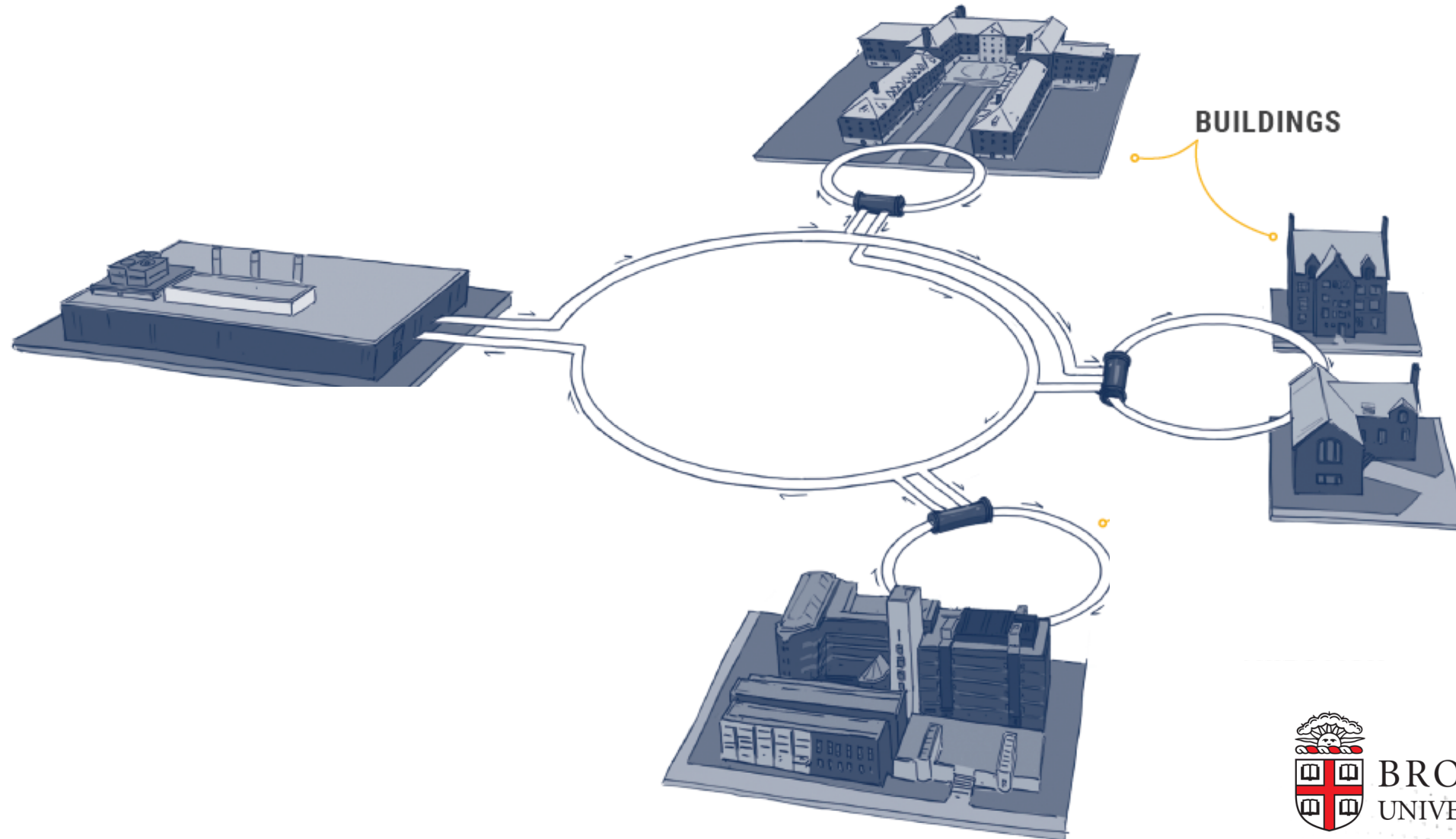


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Current District Heating System



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Decarbonization Plan

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 **2025**
75% REDUCTION

 **2040**
CARBON NEUTRAL



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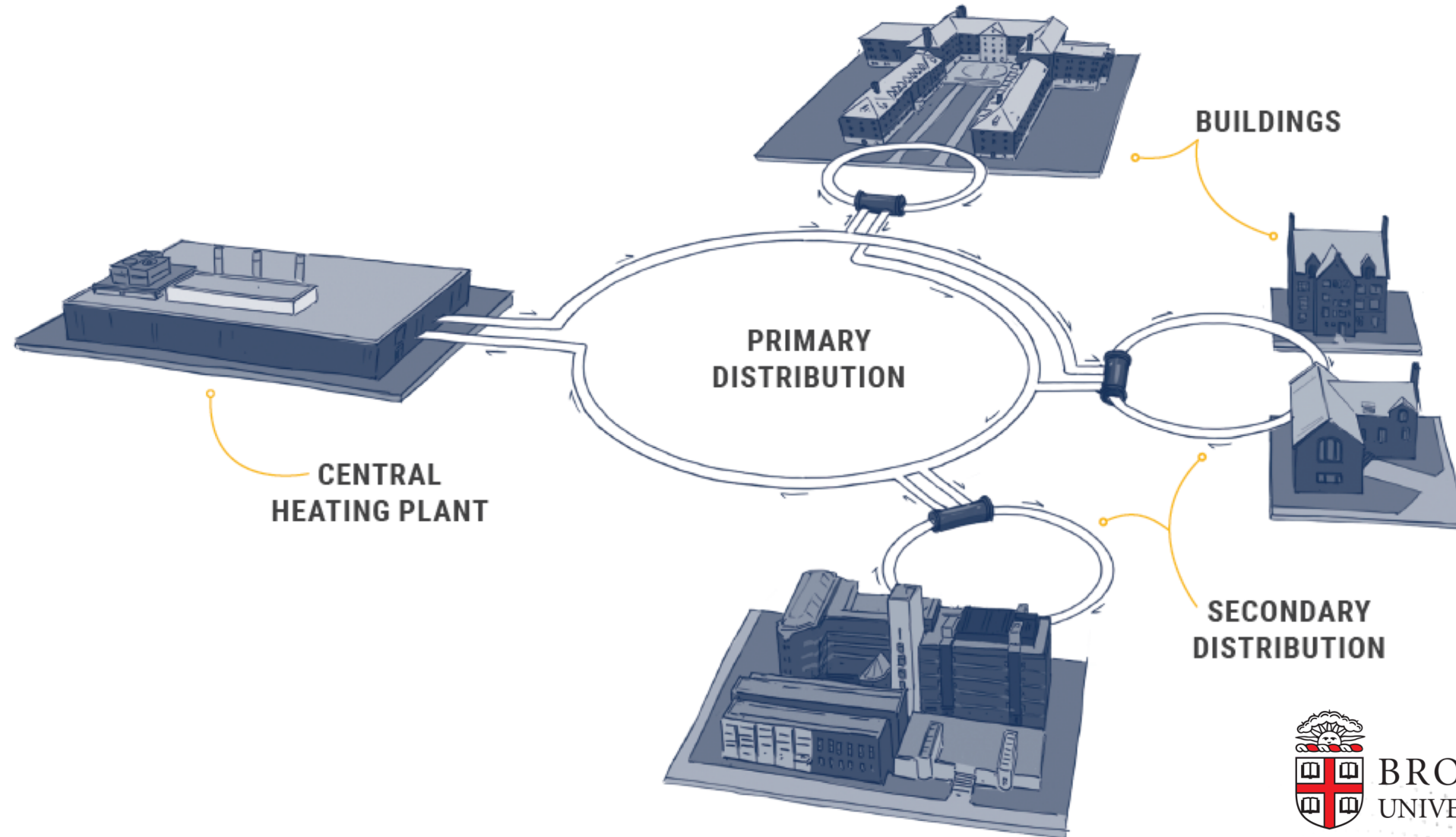


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Thermal Efficiency Project (TEP)



TEP: Unified HW System



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TEP ... on path to carbon neutrality

- Reduction of energy waste
- Conversion to lower temp hot water – necessary to electrification of heating

 **2025**
75% REDUCTION

 **2040**
CARBON NEUTRAL



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TEP – 3R's Approach

1. Reduce

- ...energy waste
- ...temperatures
- ...pressures

2. Rethink the systems

3. Repurpose existing assets



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TEP – Delivery Model

1. Proposal
2. Integrated design and construction process
3. 1-yr performance tracking



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TEP – Outcomes

OPERATIONAL

- ▶ Simplified maintenance
- ▶ Improved reliability

ENVIRONMENTAL

- ▶ 4,700 MTCDE/yr reduction
- ▶ 7.5M gallons/yr water savings

FINANCIAL

- ▶ \$1M/yr guaranteed energy savings
- ▶ \$1M incentives
- ▶ \$16.8M avoided costs
- ▶ \$25M investment



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Buildings

1. Introduction

2. Overview

3. History

4. Design

5. Construction

6. Maintenance

7. Conclusion

8. References

9. Appendix

10. Index

Typical Steam Building

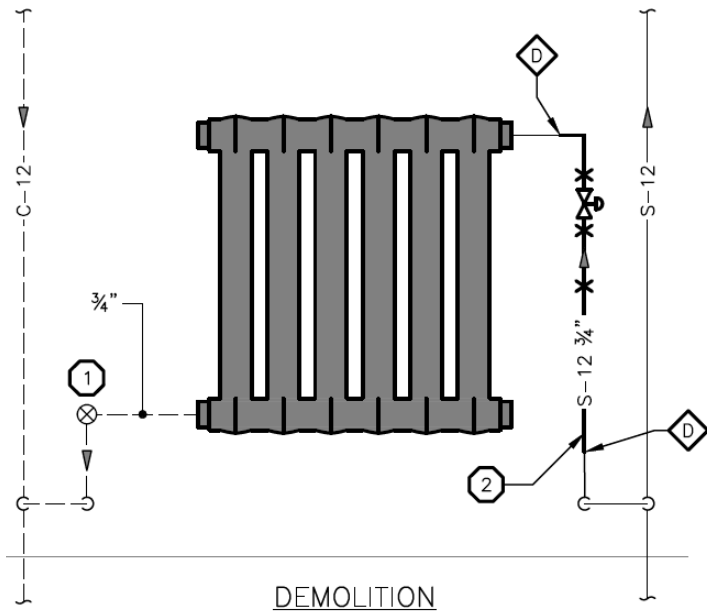


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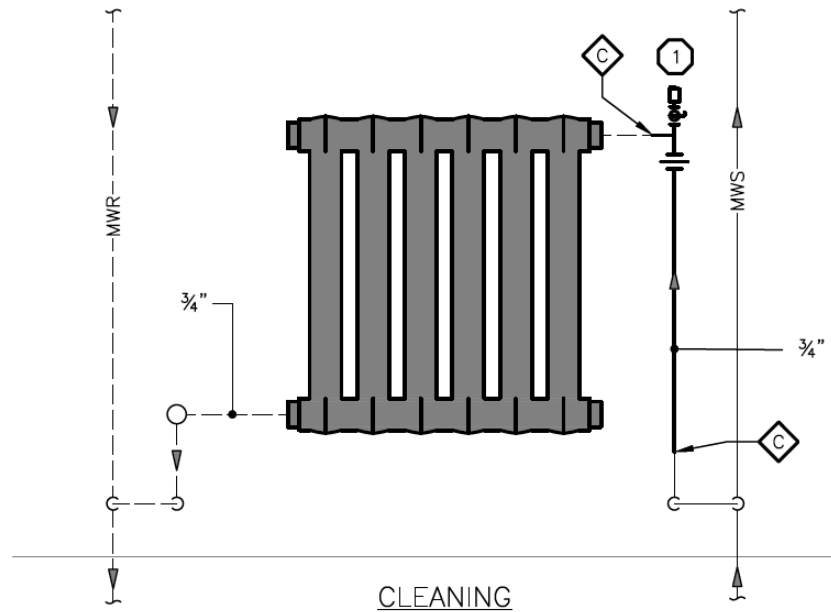


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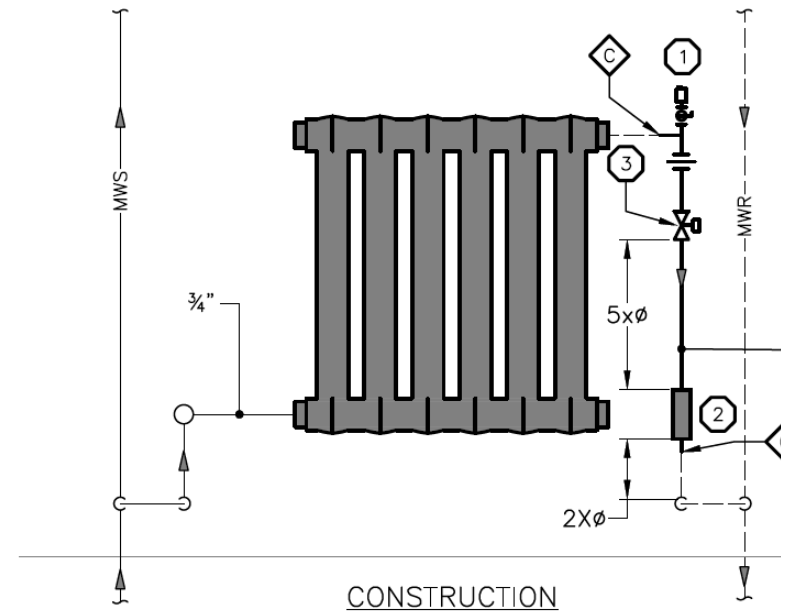
Repurpose Steam Radiators for HW use



- ① REMOVE INSIDE PART OF EXISTING STEAM TRAP TO MAKE IT HOLLOW TO LET WATER FLOW.
- ② UNSCREW OR CUT SUPPLY. EXISTING VALVE TO BE DEMOLISHED



- ① NEW AIR VENT WATTS MODEL HAV PROVIDED AND INSTALLED BY THE FOLLOWING CONTRACTOR. (AIR VENT INSTALLED DURING CLEANING PHASE; SAME AIR VENT AS IN ADJACENT CONSTRUCTION VIEW)



- ① NEW AIR VENT WATTS MODEL HAV PROVIDED AND INSTALLED BY THE FOLLOWING CONTRACTOR.
- ② NEW FLOW CARTRIDGE PROVIDED BY ECOSYSTEM BUT INSTALLED BY THE FOLLOWING CONTRACTOR. INSTALL 5 PIPE DIAMETERS DOWNSTREAM OF NEW CONTROL VALVE AND 2 DIAMETERS UPSTREAM OF FITTING.
- ③ NEW CONTROL VALVE. SEE PLAN VIEW AND SCHEDULE.

LITTLE FIELD STEAM TO HOT WATER RADIATOR CONVERSION

SCALE: NONE

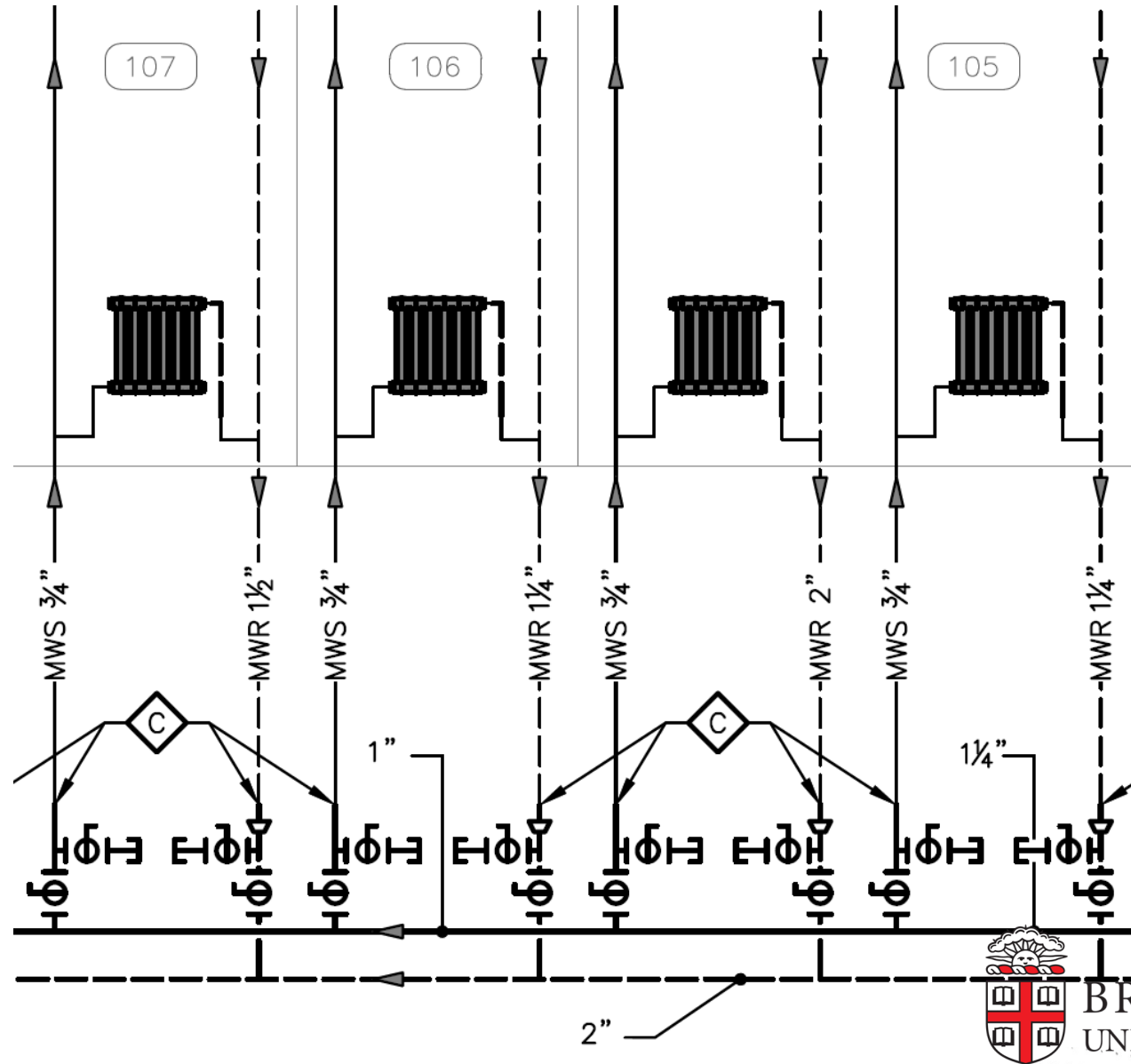


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Repurpose Steam Risers for HW use

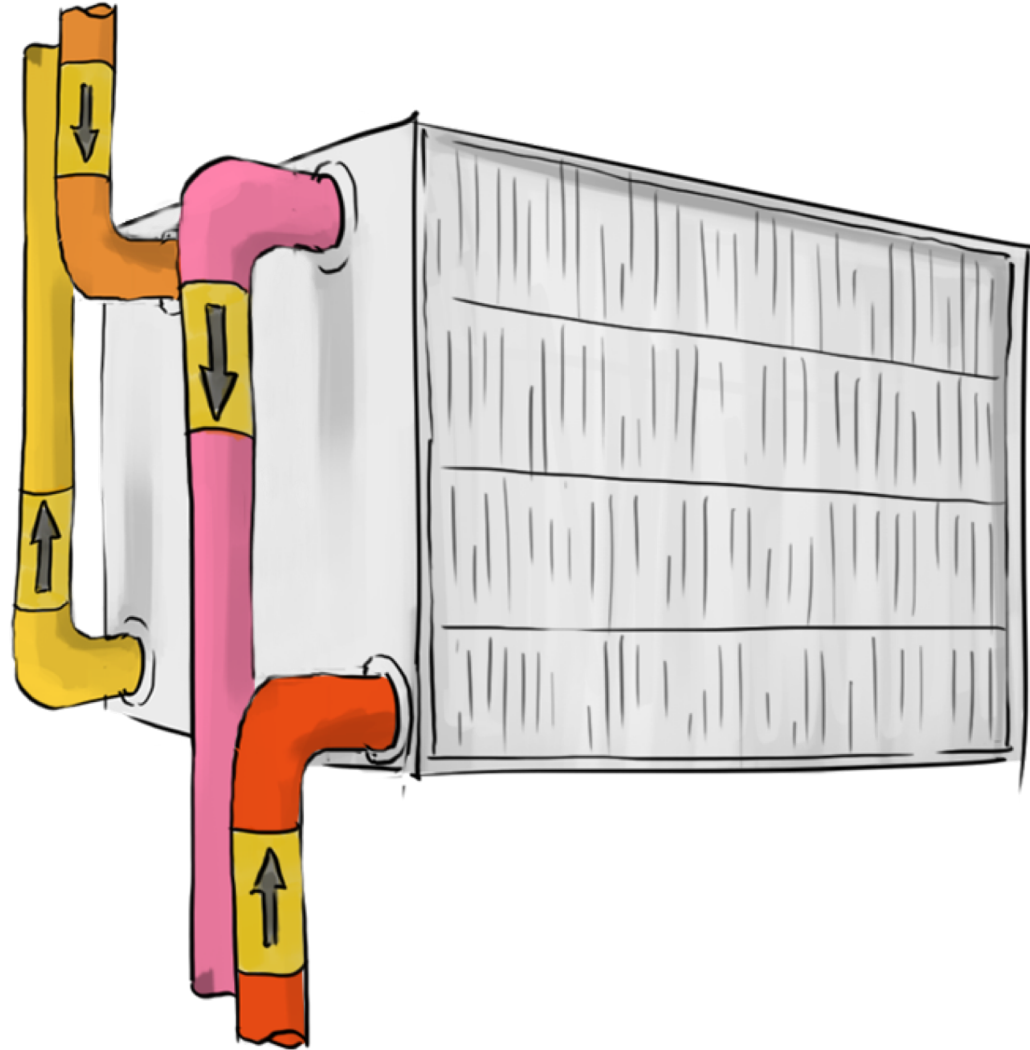


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Dual heat recovery / hot water coils



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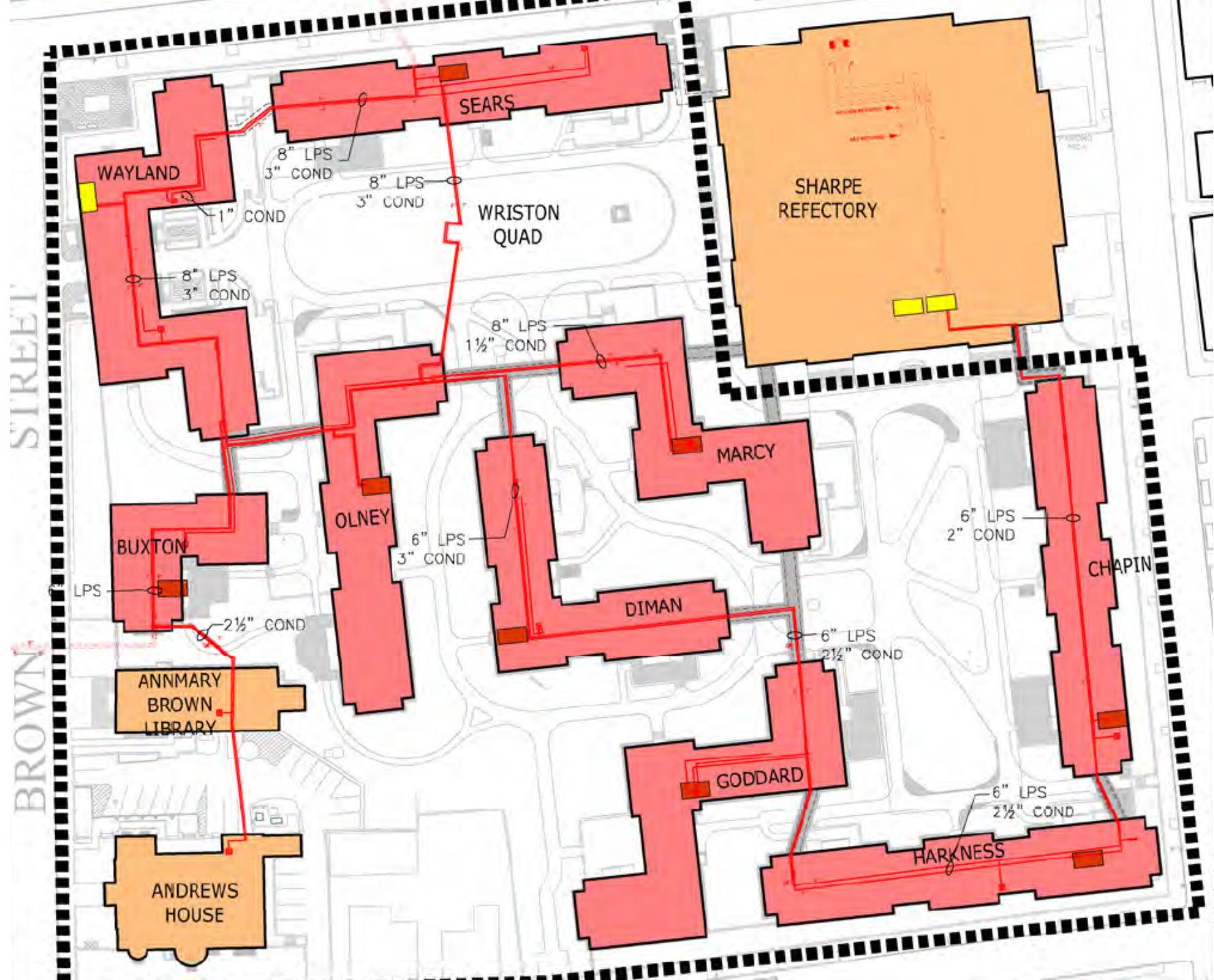
DISTRIBUTION

Secondary Loop (Steam Hubs)

Steam Hub STATUS QUO

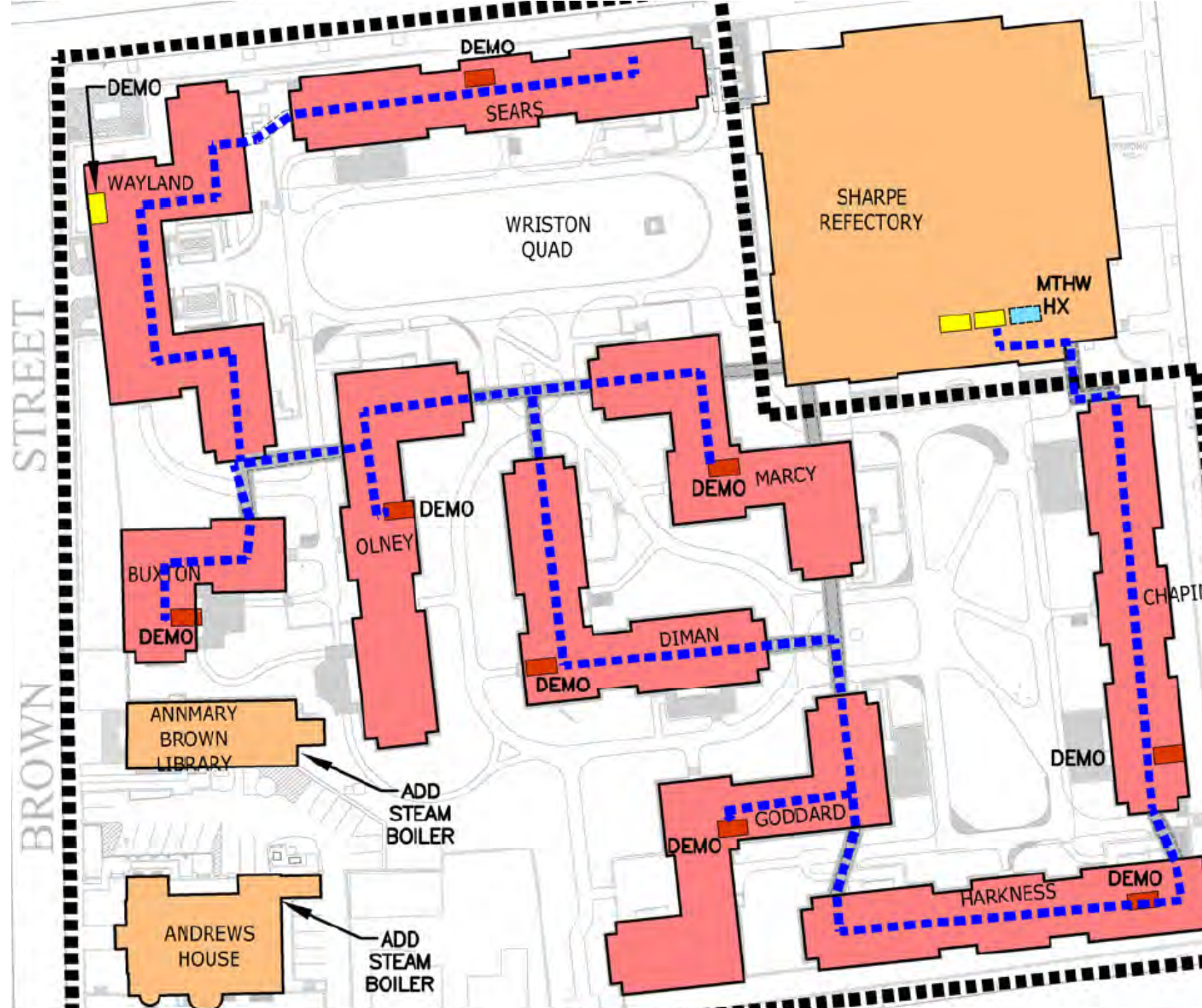
2 steam networks

- ▶ Heating (8")
- ▶ Process (4")



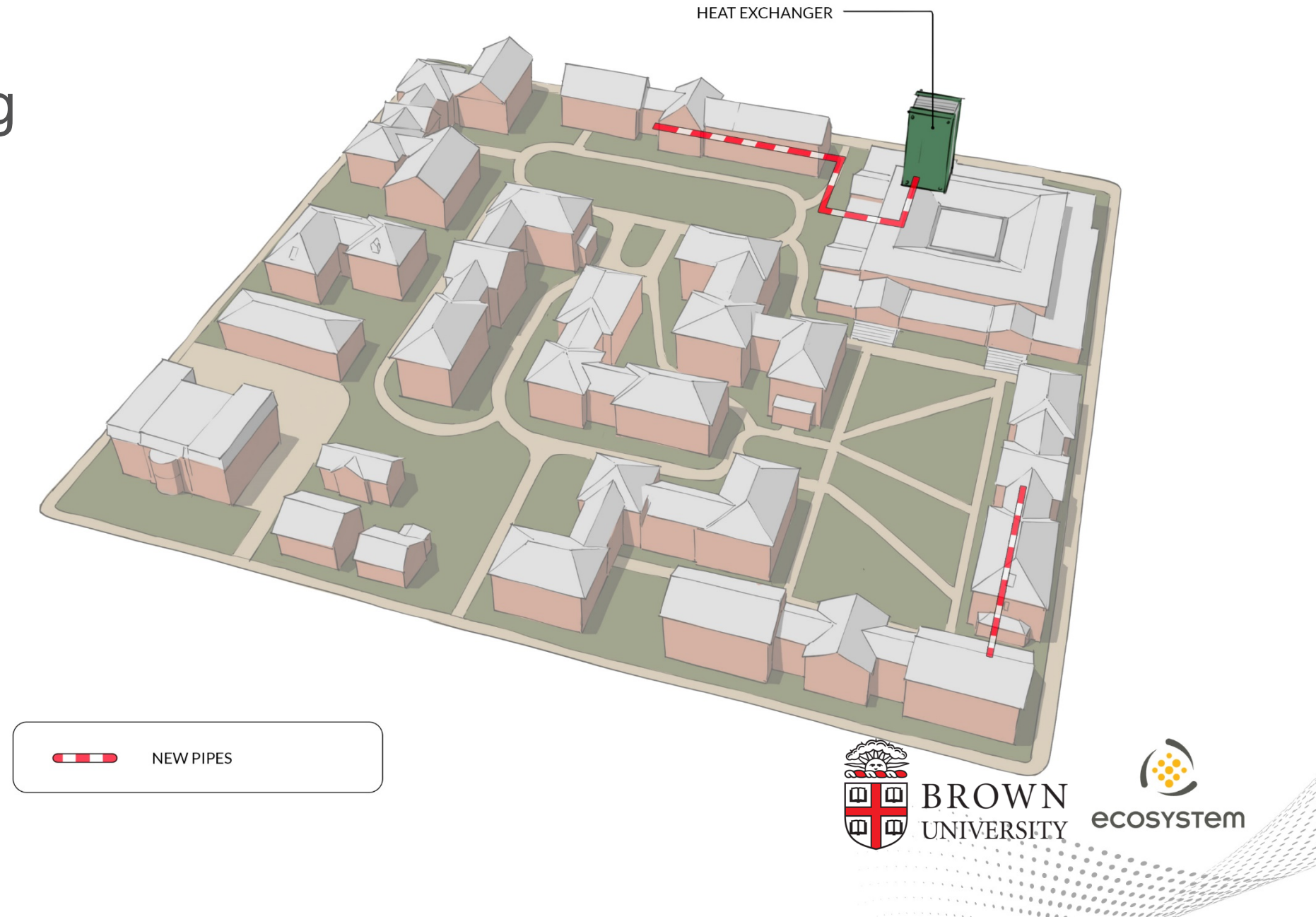
Steam Hub PLANNED WORK

- ▶ New HW piping
- ▶ High cost
- ▶ High impact
- ▶ Budget: \$4.3M



Steam Hub

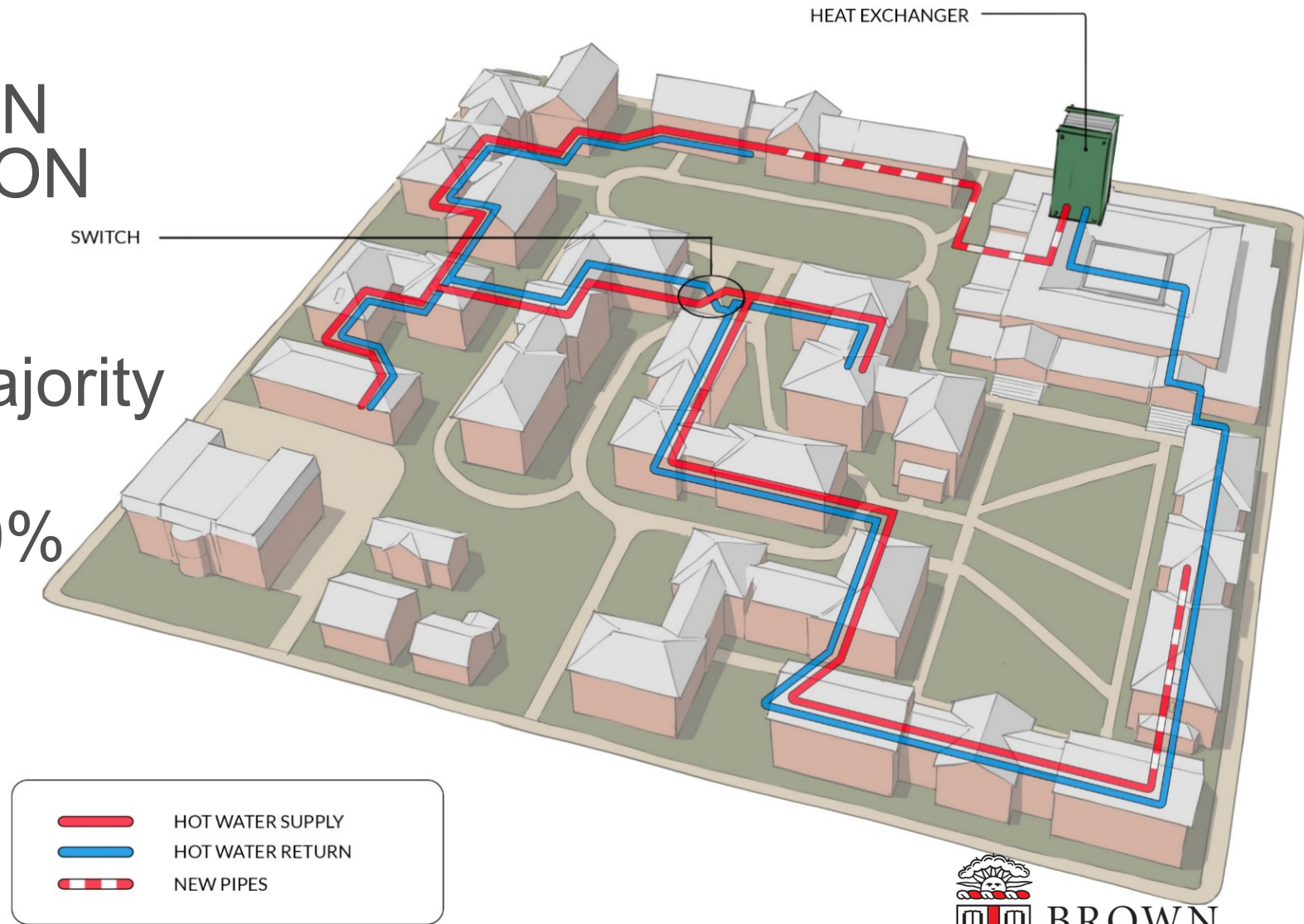
TEP: New Piping



Steam Hub

KEY INNOVATION FOR CONVERSION

- ▶ Repurposed majority of steam piping
- ▶ Cut costs by 50%



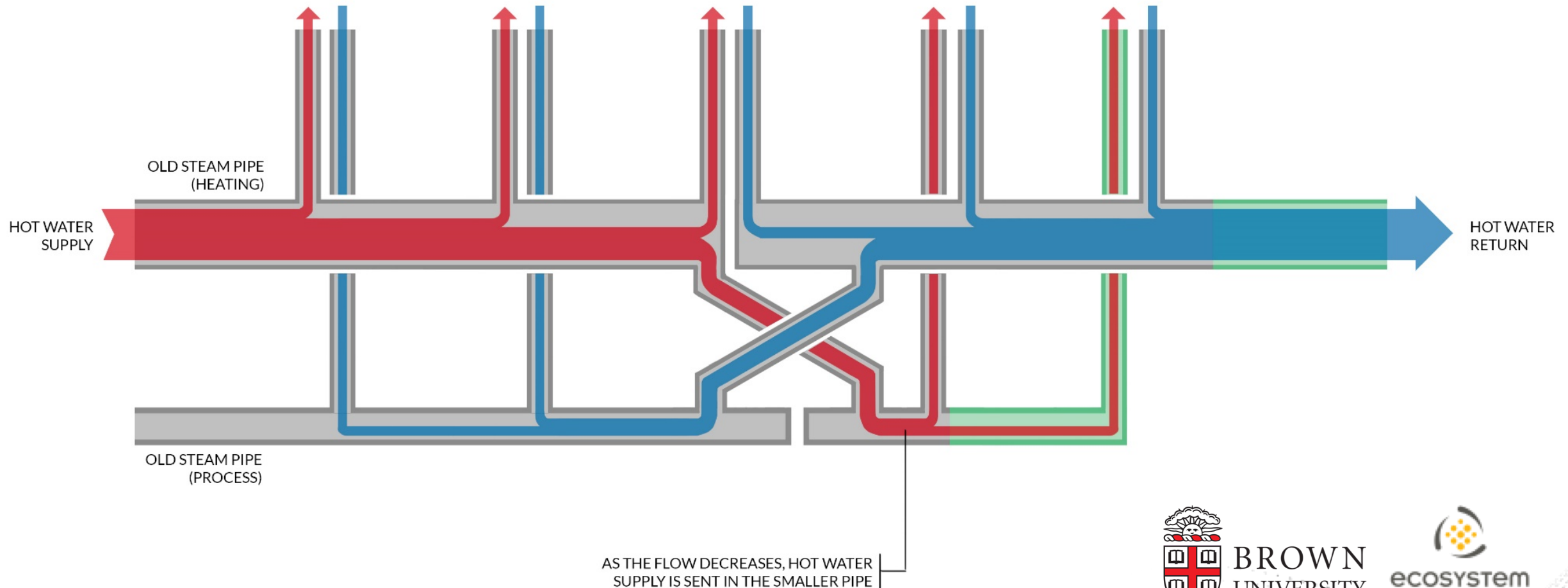
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Steam Hub Conversion

KEY INNOVATION: Inverted supply-return arrangement



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DISTRIBUTION

Primary Loop

1. Distribution

2. Distribution

3. Distribution

4. Distribution

5. Distribution

6. Distribution

7. Distribution

8. Distribution

9. Distribution

10. Distribution

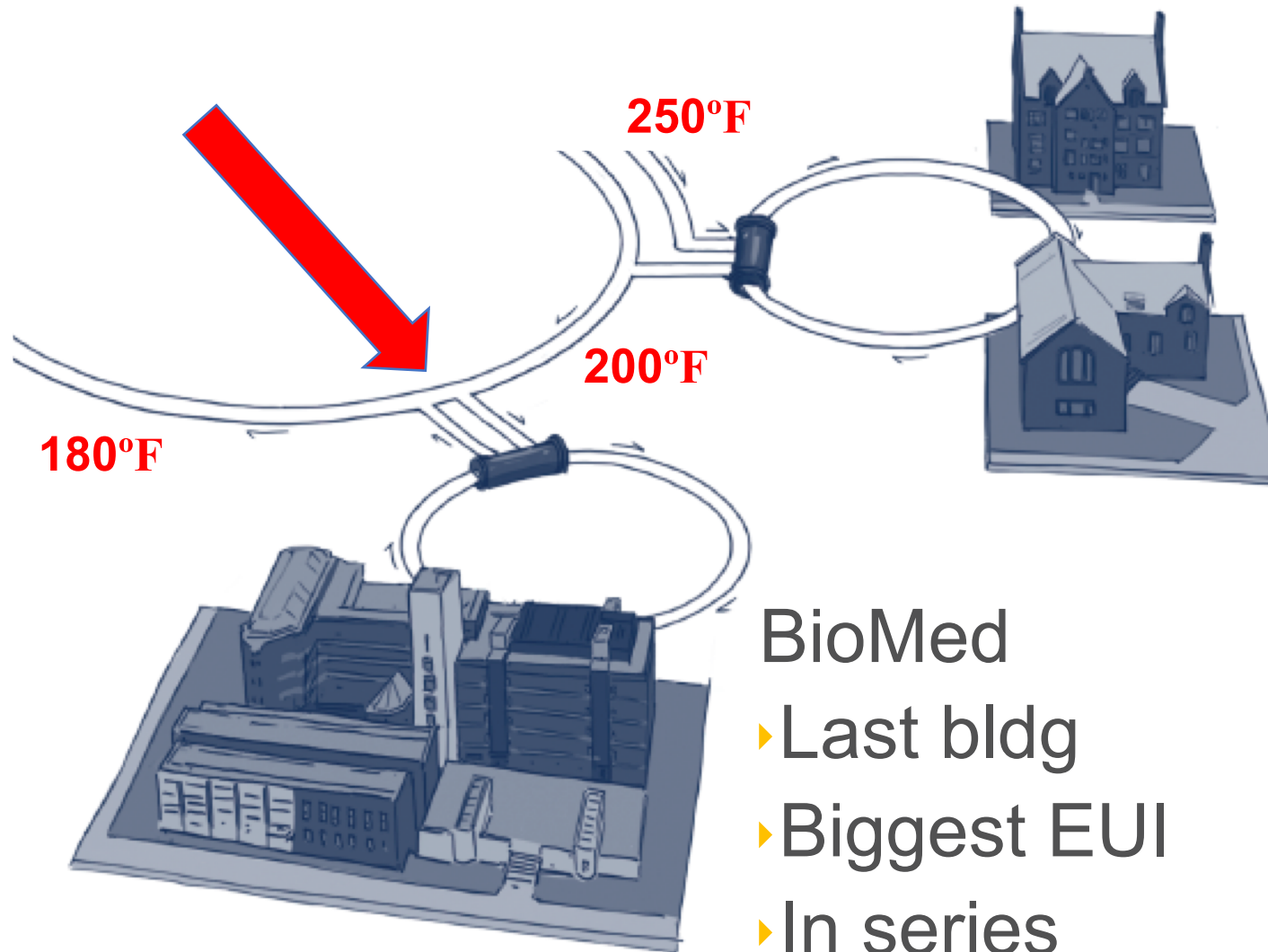
11. Distribution

12. Distribution





Primary District Loop Re-engineering



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Central Heating Plant

1. Introduction

2. Objectives

3. Scope

4. Methodology

5. Results

6. Discussion

7. Conclusion

8. References

9. Appendix

10. Glossary

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12. Bibliography

Central Heating Plant Conversion



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Converting the Boilers



- 3 x 80,000 lbs/hr
- Keystone O-type
- 150 psig steam

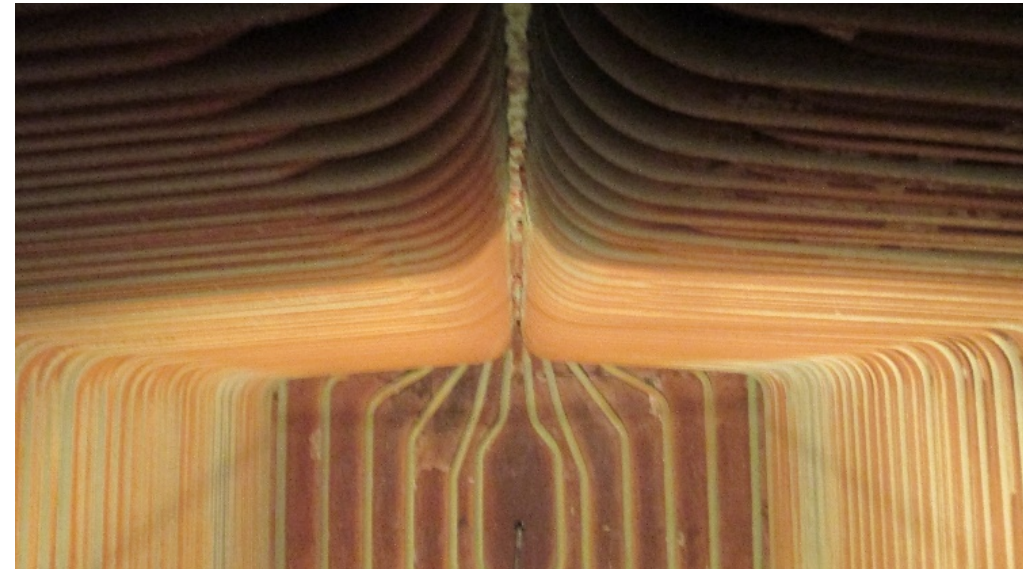
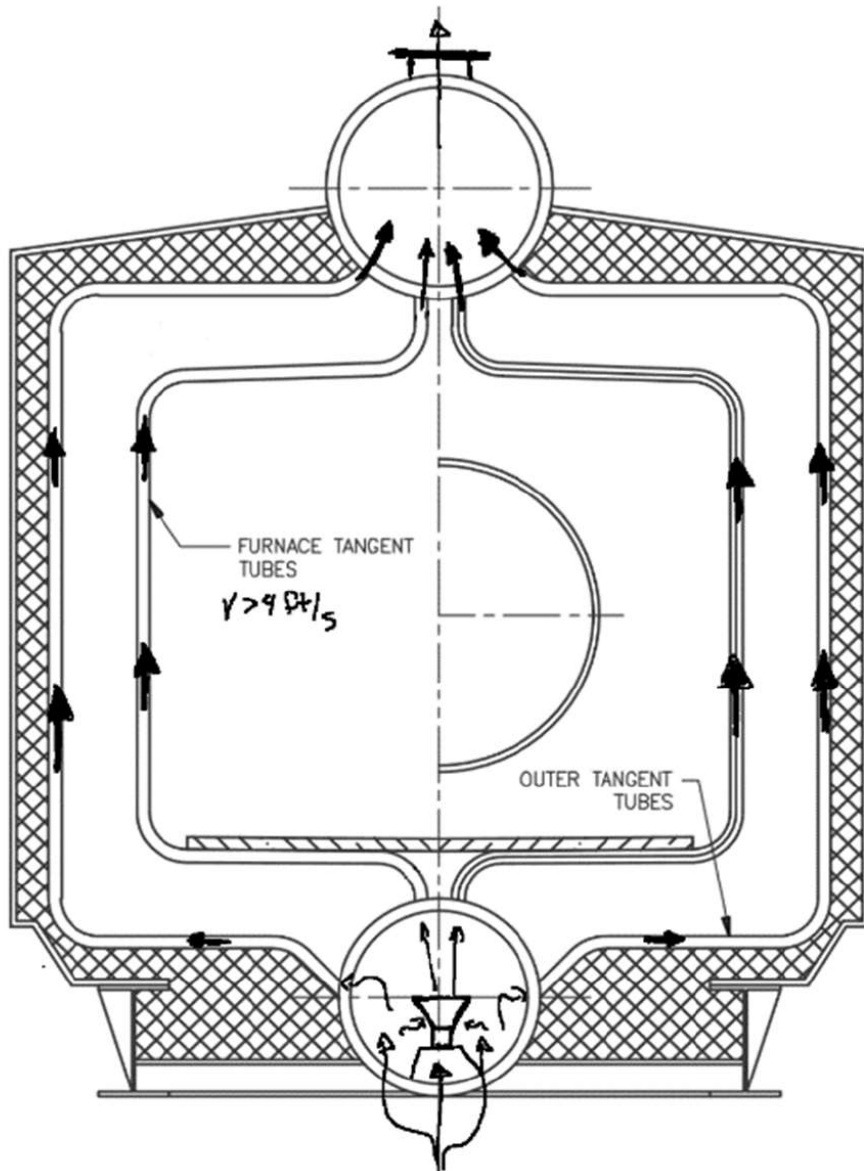


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Converting the Boiler



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Converting Boiler from Steam to HW



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NEXT STEP Carbon Neutrality

1. Introduction

2. Objectives

3. Scope

4. Methodology

5. Results

6. Discussion

7. Conclusion

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12. Acknowledgements

Campus Decarbonization Plan

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 **2025**
75% REDUCTION

 **2040**
CARBON NEUTRAL

2020

40 MW SOLAR PV

8 MW WIND

THERMAL EFFICIENCY PROJECT

Remove steam and lower
hot water temperature 50%
total carbon reduction

2023

**LIQUID BIOFUEL CONVERSION
OF CENTRAL PLANT**

80-85% scope 1 carbon reduction

2024-2035

BUILDING RENOVATIONS

**LOWER HOT WATER LOOP
TEMPERATURE TO 185°F**

*Continue to evaluate
low carbon technologies

2035-2040

ELECTRICAL UPGRADES

**CONVERT CEP TO AIR SOURCE
HEAT PUMPS (ASHP)**



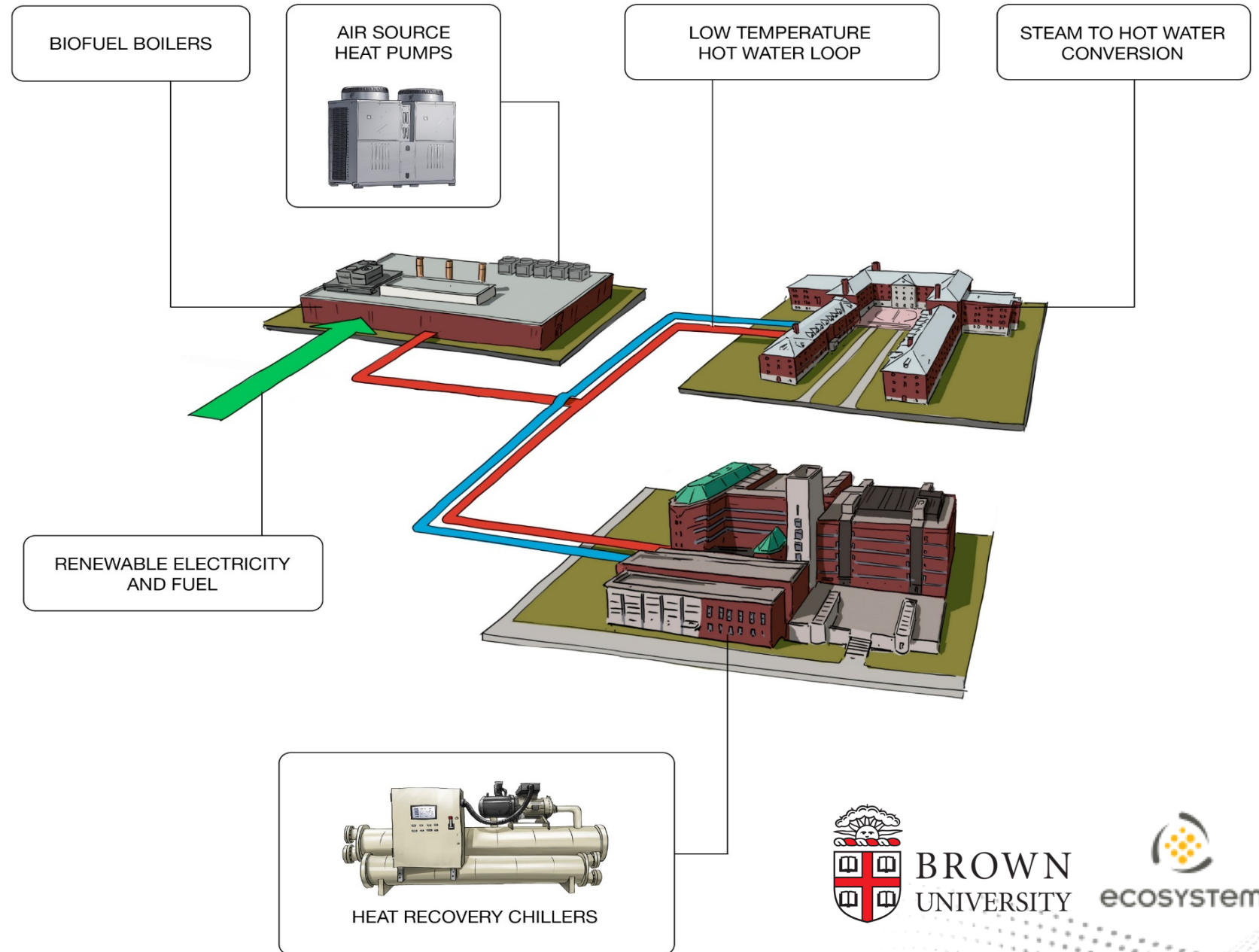
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↓ **2025**
75% REDUCTION

✓ **2040**
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Ecosystem

- ▶ Founded in Quebec, 1993
- ▶ Market driven by the lowest electricity costs in North America
- ▶ Drove innovation and 26-yr expertise in:
 1. Electrification of heating
 2. Heat pump applications
 3. Steam to hot water conversion

TO DATE, ECOSYSTEM HAS SUCCESSFULLY
DESIGNED, IMPLEMENTED, GUARANTEED,
AND OPTIMIZED MORE THAN

250

PROJECTS

WORTH

\$780M

IN

1,525+

BUILDINGS



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