



# CampusEnergy2021

BRIDGE TO THE FUTURE

Feb. 16-18 | CONNECTING VIRTUALLY

WORKSHOPS | Thermal Distribution: March 2 | Microgrid: March 16





# District Heating Distribution Design to Meet University of California Davis Carbon Neutrality Goals

Kurt Wengler, PE, University of California, Davis  
Joanna Pyun, PE, Affiliated Engineers, Inc.  
Pius Kao, PE, Affiliated Engineers, Inc.

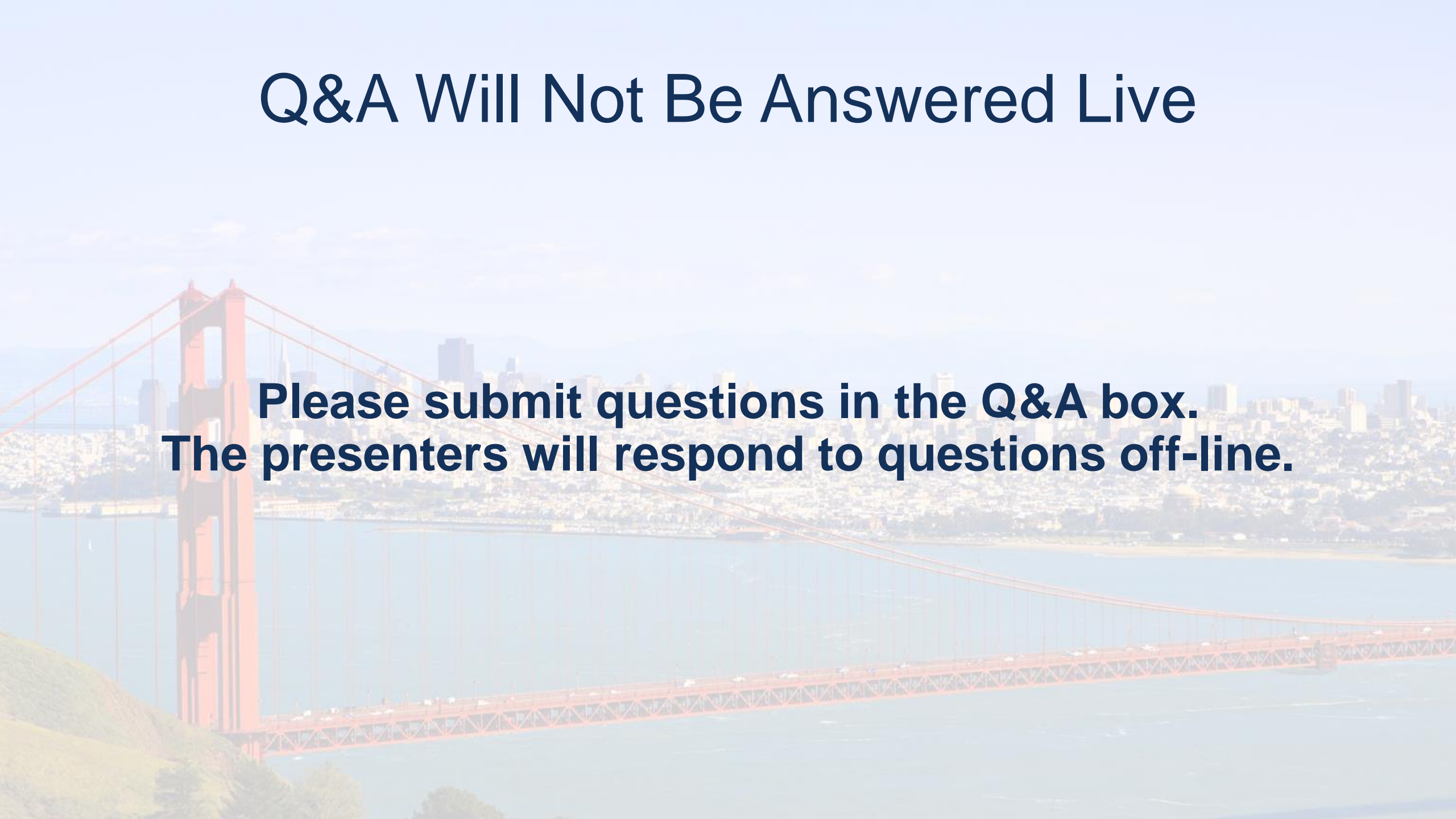


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# Q&A Will Not Be Answered Live

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



**Kurt Wengler, PE**  
**University of California, Davis**  
**Associate Director of Engineering**



**Joanna Pyun, PE**  
**Affiliated Engineers, Inc.**  
**Mechanical Engineer**



**Pius Kao, PE**  
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**Project Manager**

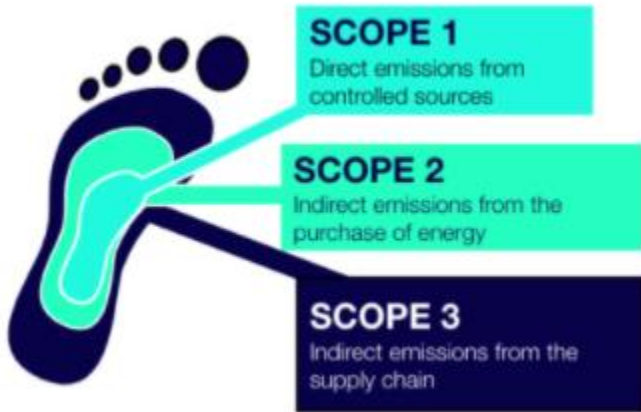
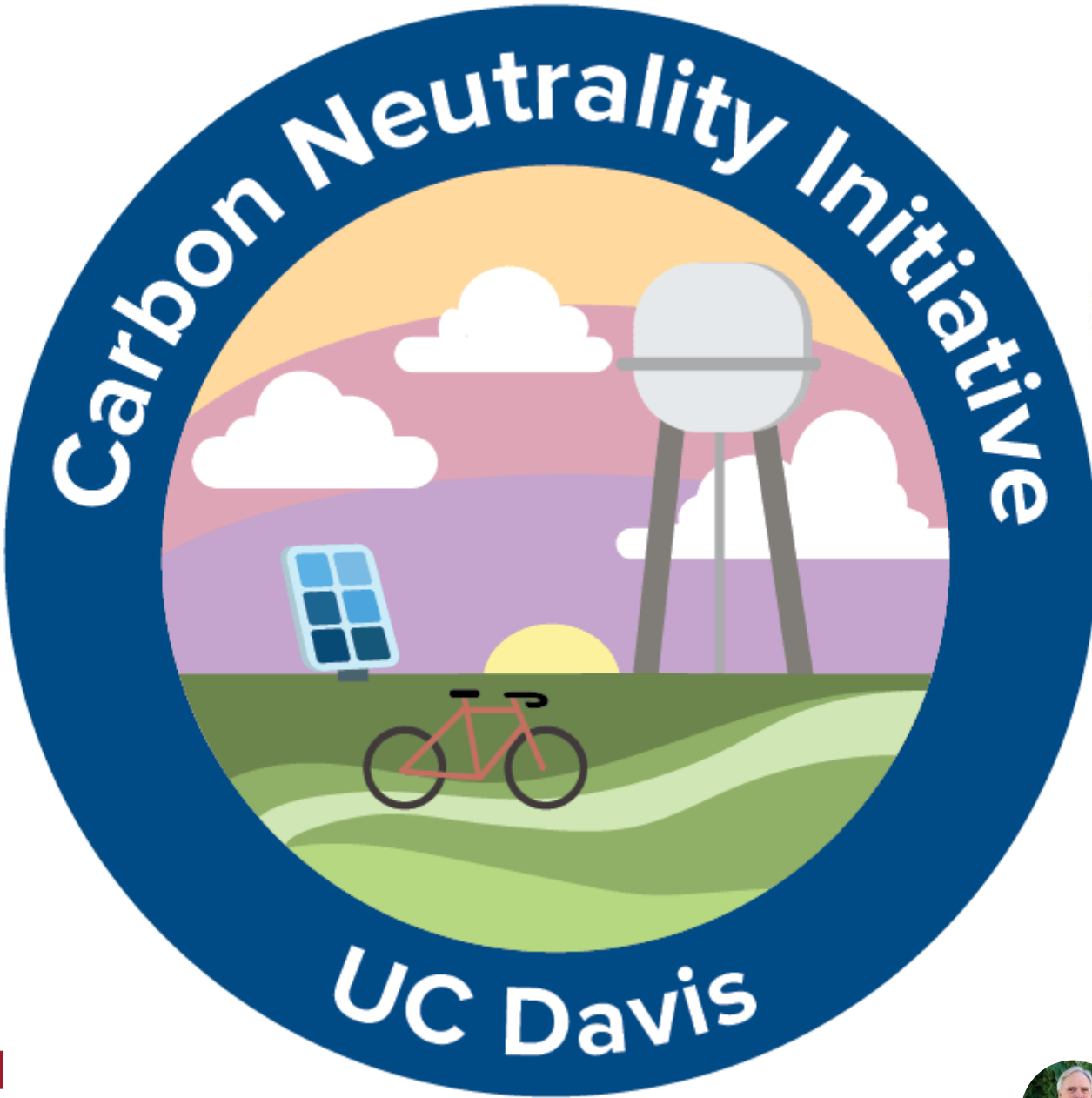




10 CAMPUSES.  
1 GOAL.

CARBON NEUTRAL  
BY 2025.

UNIVERSITY OF CALIFORNIA Carbon Neutrality Initiative



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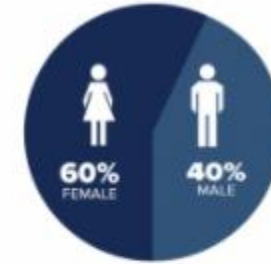


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## At a Glance



**39,152** enrolled students



**102**  
MAJORS



**22,000** bicycles on campus a day



**\$846 million**  
research funding for 2017-2018



**101**  
GRADUATE PROGRAMS



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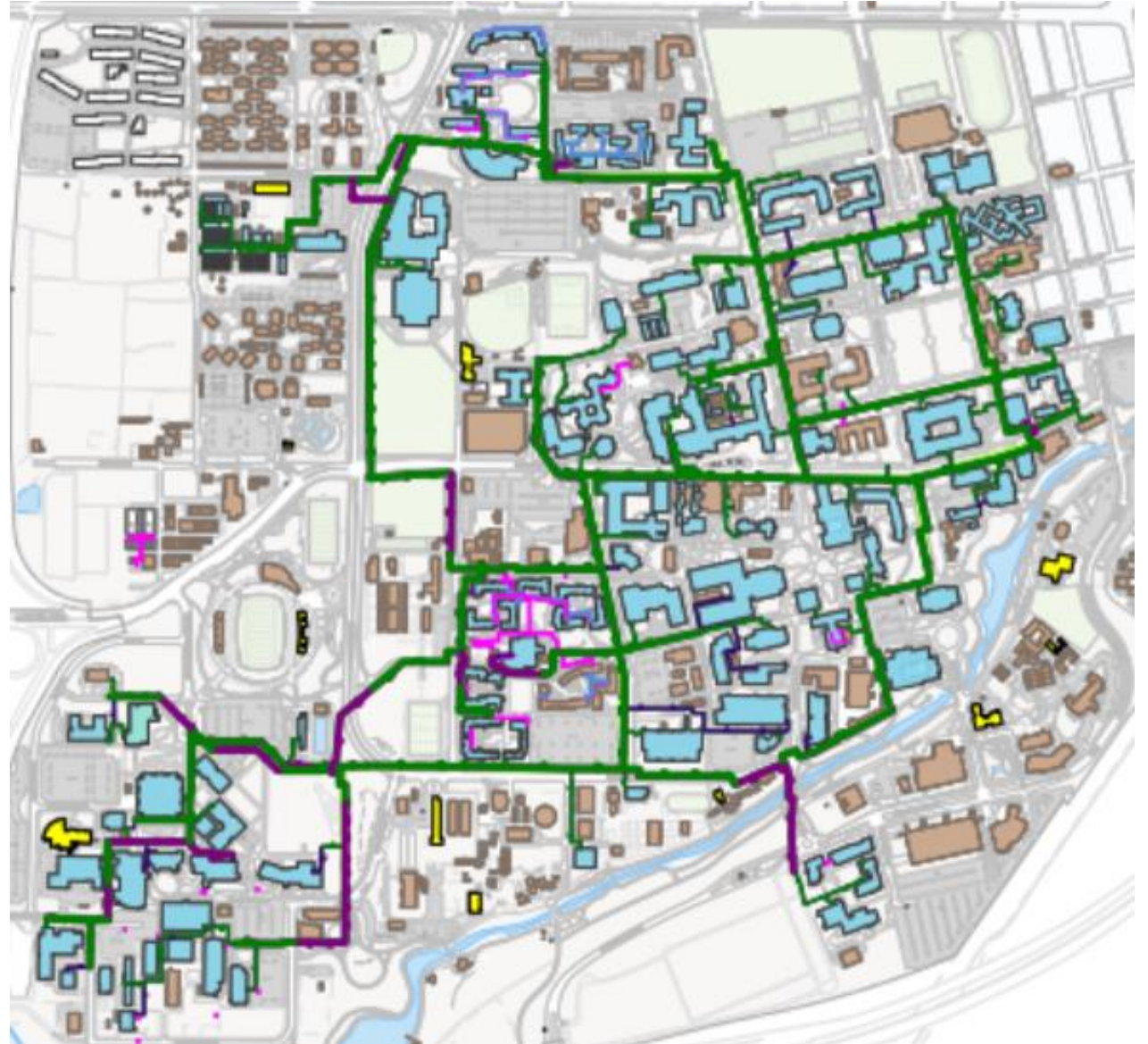
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# Steam System

- Steam distribution system is 60+ years old
- 30%-50% efficiency losses due to insulation deterioration
- High maintenance and repair costs
- Replacement cost ~\$50M



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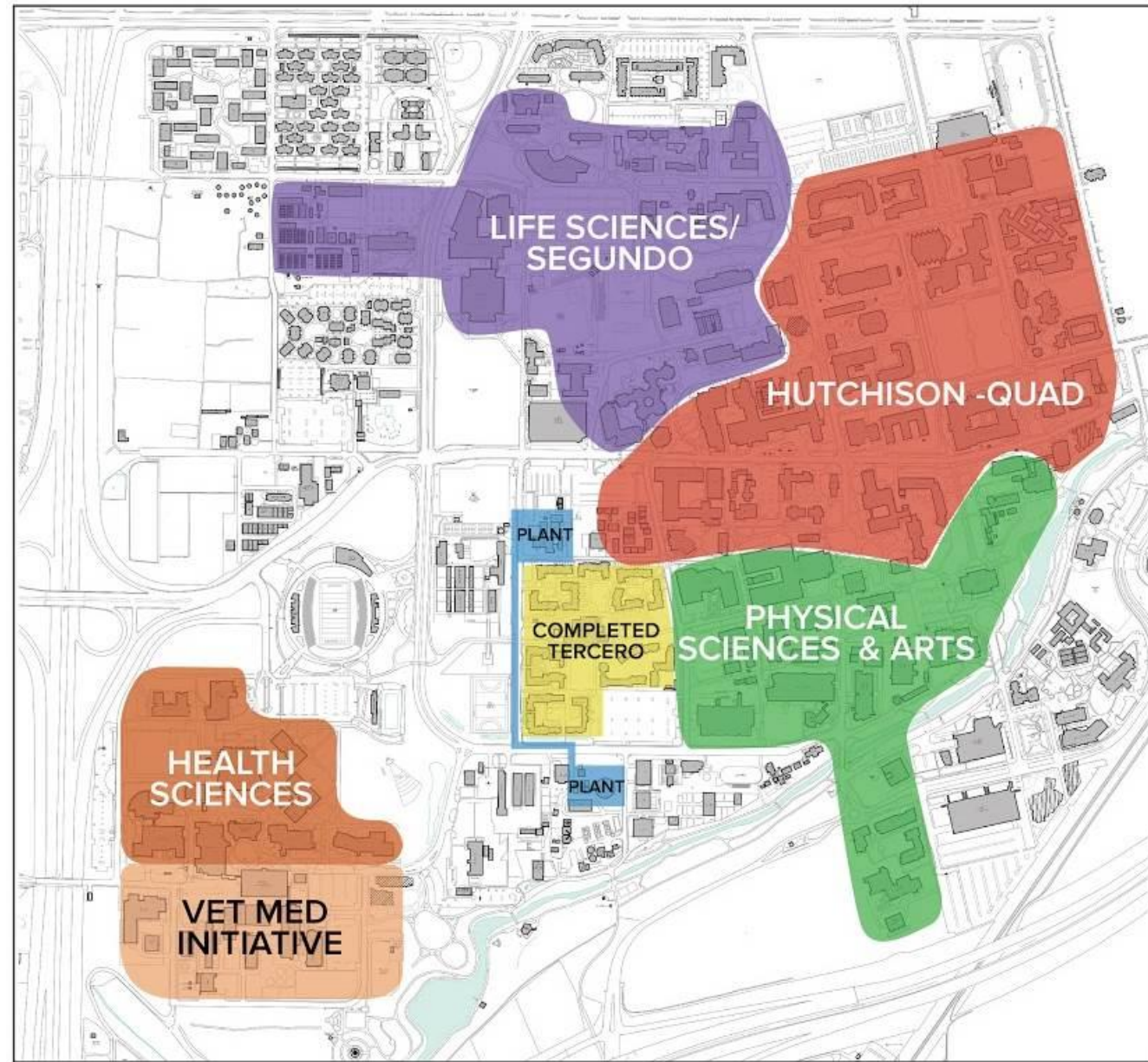


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# Main Campus

- Multiple zones
- Central plant steam boilers for heating – natural gas
- Chilled Water TES Plant



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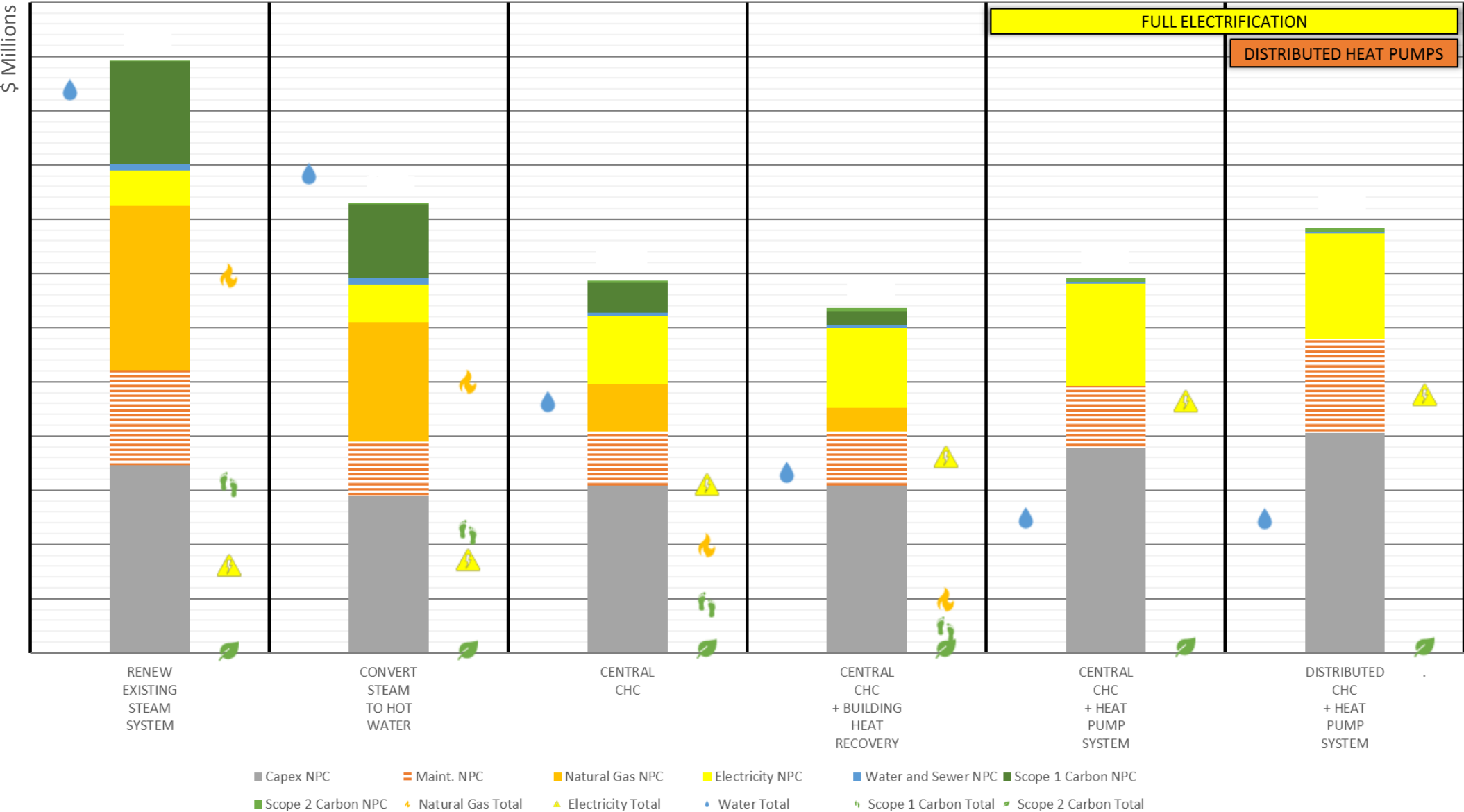
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UCD Campus Heating Options - 60 Year Net Present Cost



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LARGE CAMPUS  
HEAT EXCHANGERS

CENTRAL PLANT

CAMPUS MAIN  
RING LOOP

TES



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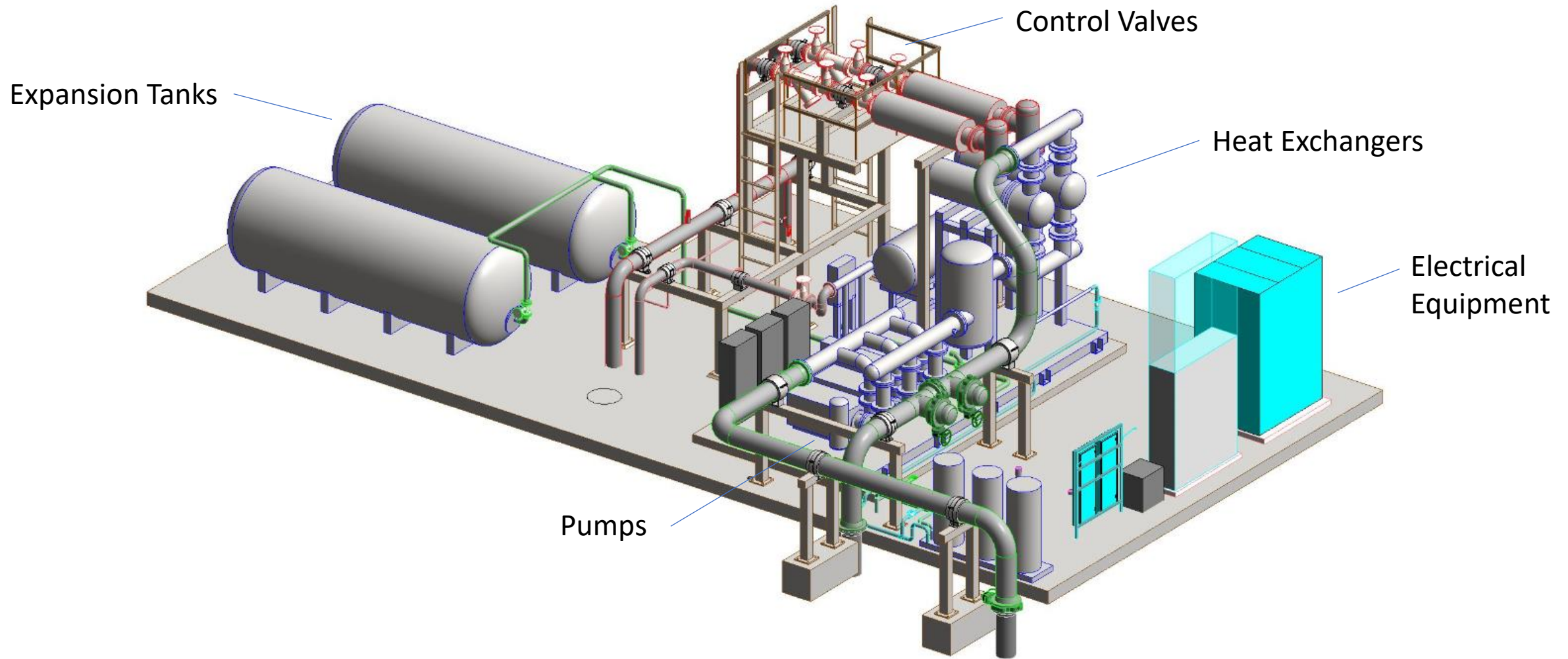
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# Steam to HW HX Skids from Stanford



# Campus Steam to Hot Water Heat Exchanger

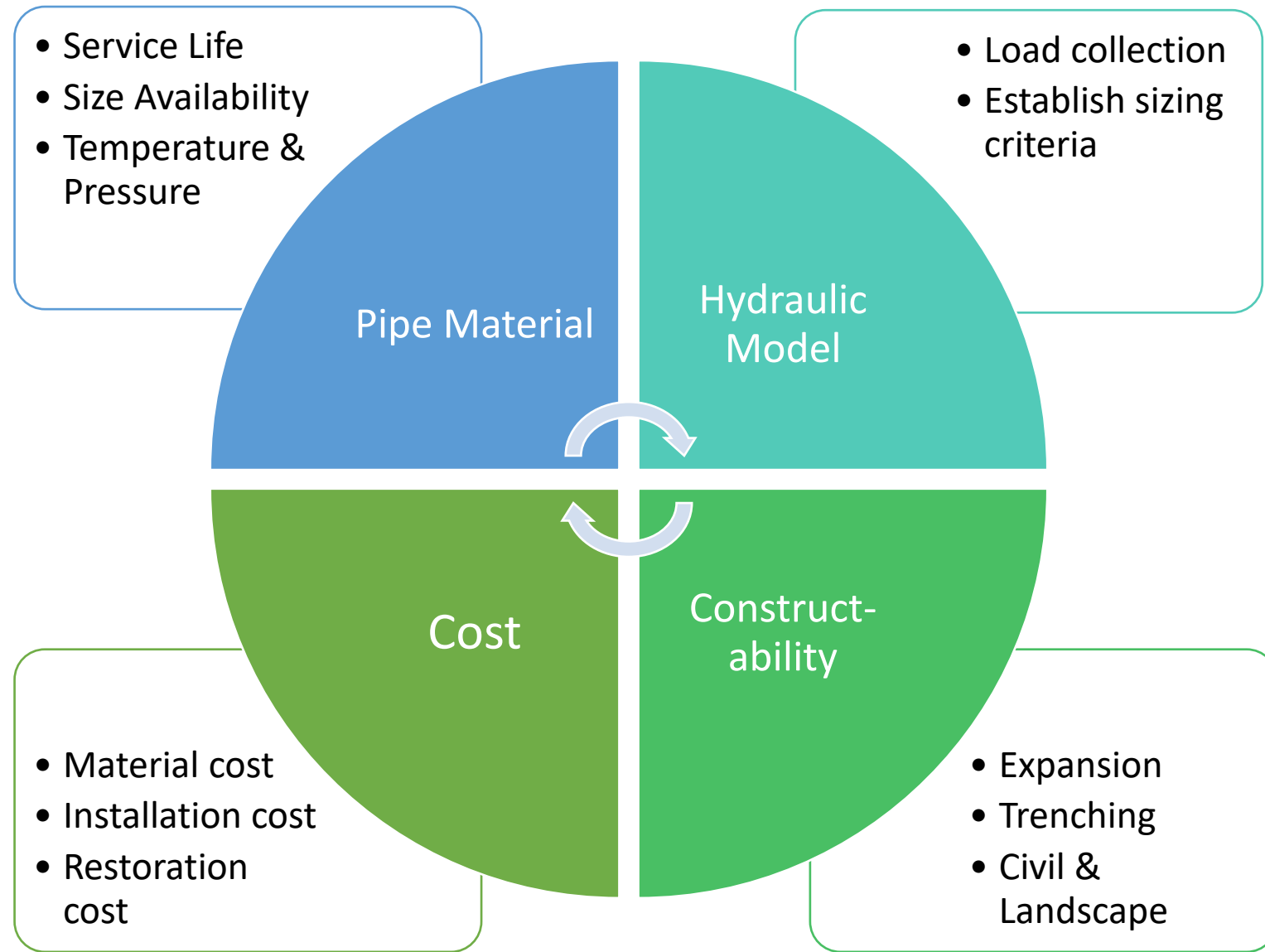


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# Hydraulic Considerations

- Future load growth & locations
- Failure scenarios: Redundancy needs vs. wants
- Maintenance requirements – valves

## FINAL BUILD-OUT

Normal: 65 psig +/-

Fault Condition: 90 psig +/-



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# Pipe Material Selection

- Standard Steel
- European Thin Wall
- HDPE Raised Temperature
- PP-R, PP-RCT
- PEX

FINAL BUILD-OUT  
90 psig +/- @ 180°F

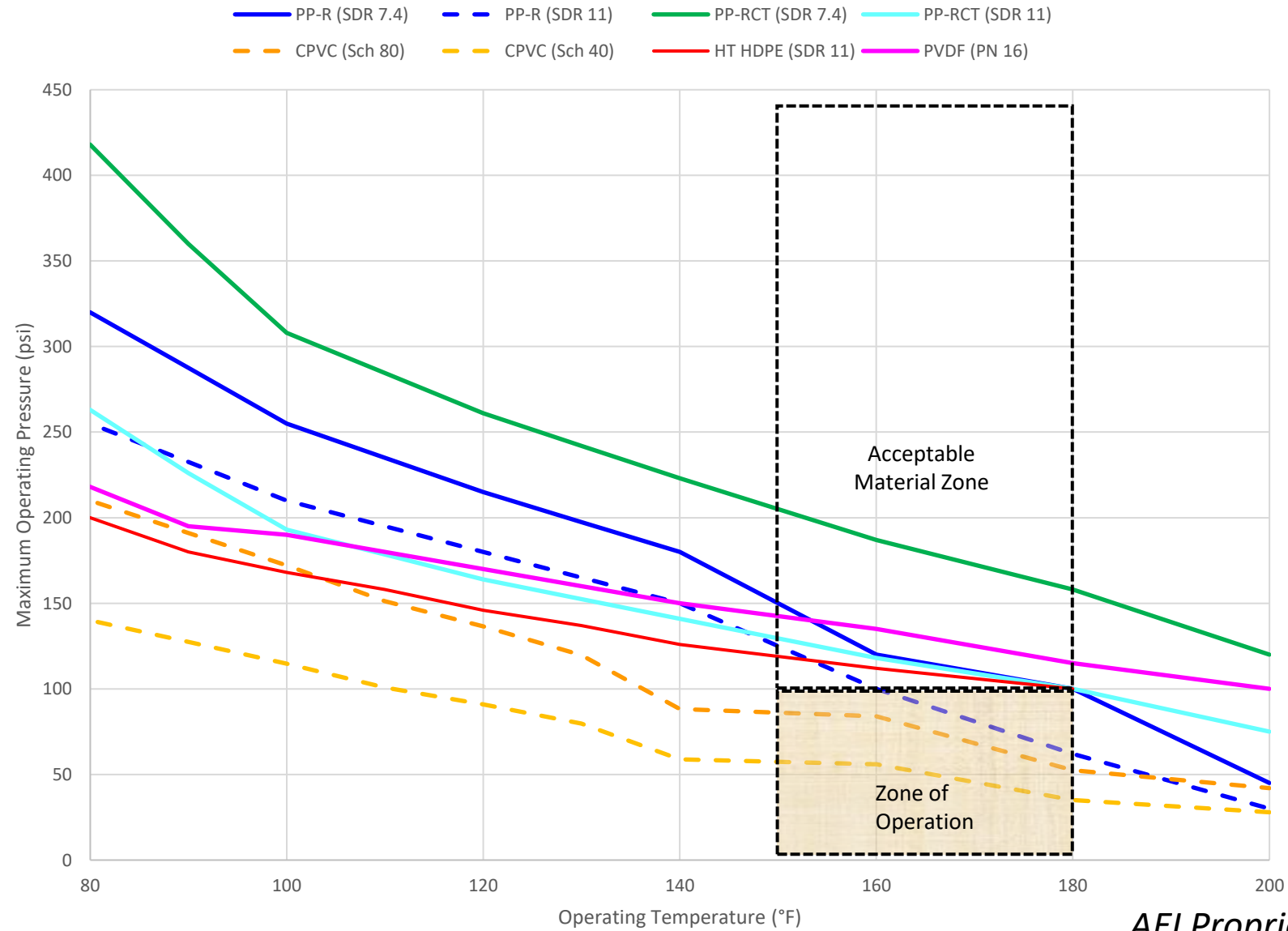


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## Maximum Operating Pressures of Plastic Piping



AEI Proprietary



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Materials unable to meet minimum operational requirements of 180°F and 100 PSIG

- ABS
- HDPE
- PE
- PVC
- PEX

Materials with limited pipe size

- PEX
- PB
- Copper



Materials able to meet minimum operational requirements of 180°F and 100 PSIG

- Standard Steel
- European thin-wall steel
- Stainless Steel
- HDPE High Temperature
- PEX High Temperature
- PP-R, PP-RCT



Common Industry Designation	Common Name	Pressure Pipe Application		Pipe Size Range	Service Life @ 160/180°F
		Upper Service Temperature	Typical Temperature and Pressure Rating	(inches)	(Years)
<b>Copper</b>	Copper	250°F	††	1/4" - 6"	25+
<b>PE-RT (SDR11)</b>	Polyethylene of Raised Temperature	180°F	126 PSIG @ 140°F 112 PSIG @ 160°F 100 PSIG @ 180°F	2" - 24"	50
<b>PEX</b>	Cross-linked Polyethylene	200°F	145 PSIG @ 240 F	3/4" - 5.5"	25
<b>PP-R (SDR 11)</b>	Random Copolymer Polypropylene	180°F	100 PSIG @ 160 F 62 PSIG @ 180 F 30 PSIG @ 200 F	1" - 18"	50/25
<b>PP-RCT (SDR 11) Fiber Glass</b>	Random Copolymer Polypropylene	180°F	118 PSIG @ 158 F 100 PSIG @ 176 F 75 PSIG @ 203 F	1" - 20"	60/25
<b>EN 253</b>	Thin-wall Steel	250°F	††	1/2" - 30"	25+
<b>SS</b>	Stainless Steel	250°F	††	1/2" - 30"	25+
<b>Steel</b>	Steel	250°F	††	1/2" - 30"	25+

Legend:



Good



Fair



Poor

† Material not suited for LTHW.

†† Pressure and temperature exceed LTHW requirements – excess of 200°F and 100 psi.



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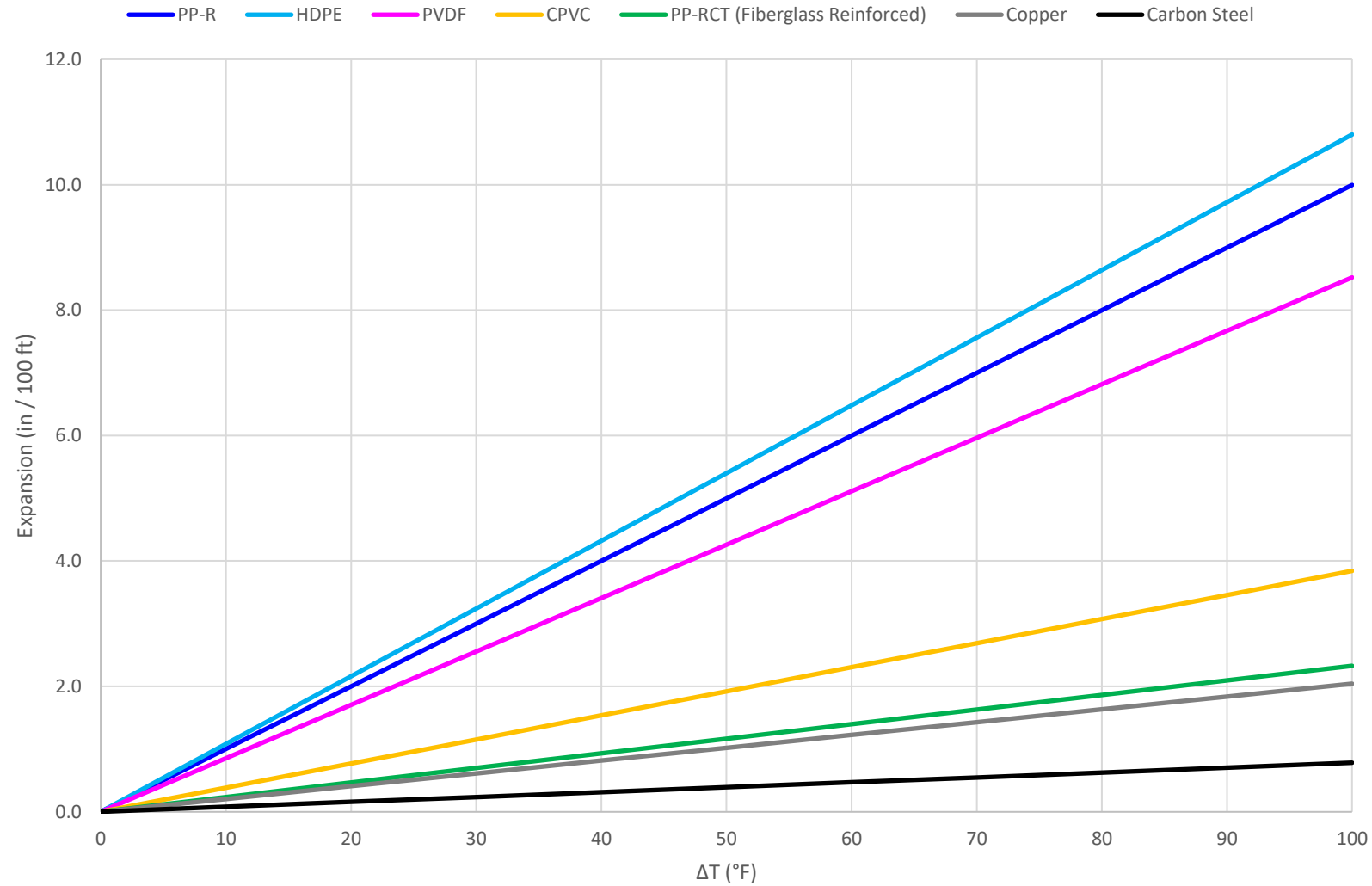


# Pipe Sizing

Internal Pipe Diameters				
	EN 253 Thin-wall 12" ID (in)	HT HDPE 12" ID (in)	PP-RCT 12" ID (in)	Steel 12" ID (in)
SDR 11	-	10.29	10.15	-
STD	11.87	-	-	11.94

*HT HDPE has a smaller ID and can require upsizing*

## Thermal Expansion of Plastic Pipe



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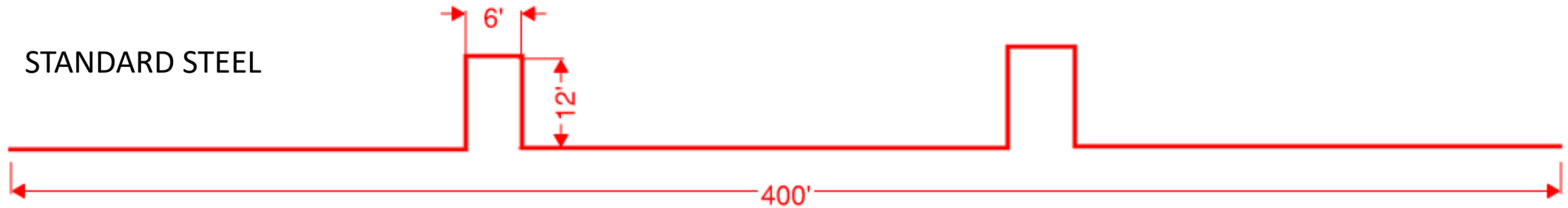


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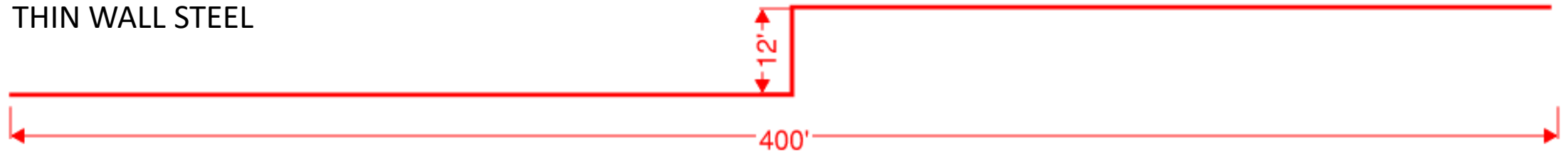


# 12" Pipe @ 180°F

STANDARD STEEL



THIN WALL STEEL



HIGH TEMP HDPE



# Standard Steel



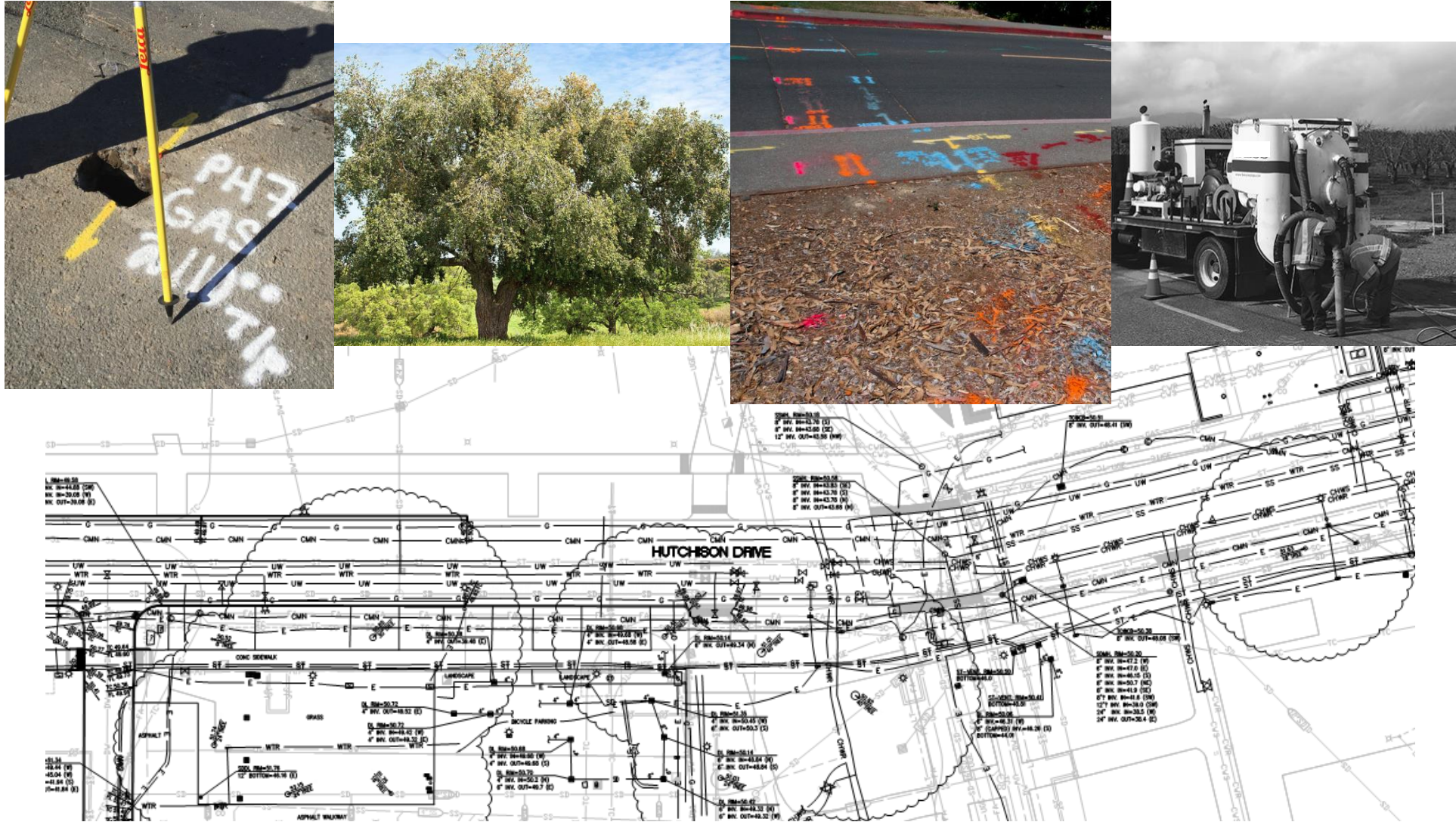
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# Site Considerations & Utilities Congestion

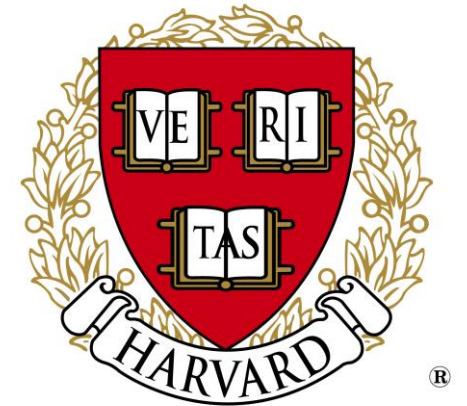
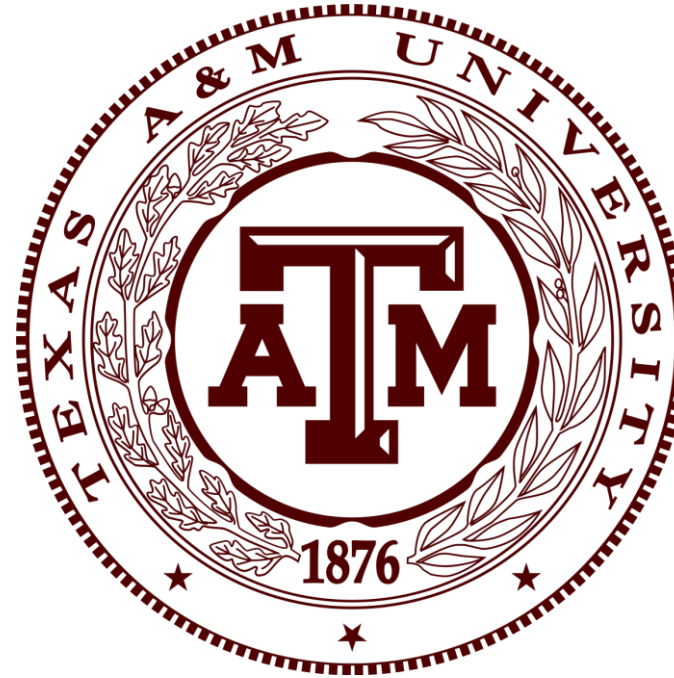


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# Knowledge Sharing Across Universities



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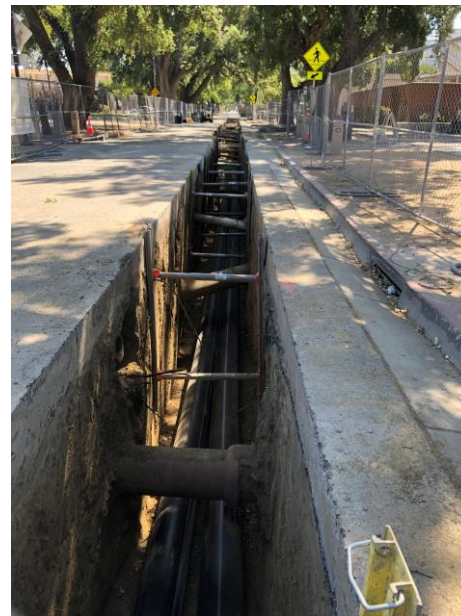


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# Selection: High Temperature HDPE

- No corrosion, no leak detection
- Meets 180°F temperature @ 100 psig & 50 year service life
- Flexibility of pipe beneficial for campus with utilities congestion
- Ease of installation: fusion vs welding
- No expansion compensation
- Material can be sourced easily



# Questions?



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