Thermal Systems Taskforce Campus Public Forum

Brian Fox, *AVP Budget, Financial Analysis and Data Analytics*
Steve Mital, *Director of Energy and Sustainability*

Winter 2024 Project Update

UNIVERSITY OF OREGON

Presentation Agenda

- Overview of Process and Timeline
- Overview of Options
- *NEW Climate Protection Plan Update*
- *NEW* Project Option Costs, Campus Impacts, and Estimated Emissions Reductions
- *NEW* Initial/Draft Taskforce Recommendations & Discussion
- Facilitated Q&A
- Table Discussions

Thermal Taskforce

Work to Date & Process Forward

Thermal Systems Taskforce

- Taskforce Membership: Board members, faculty, students, staff

- Taskforce Charter:
  - **REVIEW technical reports**, energy markets/regulations and complete due diligence on a potential thermal system transition

  - **ENGAGE the campus community** on available options and incorporate feedback

  - **RECOMMEND to the president** a long-term plan to support the recapitalization of the UO's campus heating infrastructure, balancing the following goals:
    - reduction of greenhouse gas emissions,
    - resiliency of campus heat production to energy markets and natural hazards,
    - limited disruption to student's campus experience, and
    - appropriate fiscal stewardship.

UNIVERSITY OF OREGON

Thermal Systems Taskforce Timeline

Fall 2022
- Taskforce review phase I heating study, UO emissions, set workplan
- Commission phase II technical analysis

Winter 2023
- Taskforce review existing infrastructure, regulatory and market issues

Spring 2023
- Initial Community outreach and campus forums
- Taskforce reviews campus feedback

Summer 2023
- Analyze input costs, develop carbon intensity factors, and existing regulatory environment
- Work closely with consulting engineers to develop life cycle cost analysis (LCCA)

Fall 2023
- Begin Fall Term engagement with campus community
- Complete emissions reduction estimates, financial analysis and due diligence process

Winter 2024
- Receive Concept Design for water-based distribution system *(1/5/2024)*
- Review engineering and LCCA findings, develop initial recommendation
- Present findings and initial recommendation to campus community
- Review campus input and finalize recommendation(s) to President
- Submit report to President and present to Board of Trustees

Regulatory Updates
Climate Protection Program

Oregon's Climate Protection Program

- Formally adopted in 2021
- Required natural gas providers to reduce emissions over the next 30 years
  - 50% by 2035
  - 90% by 2050
- Was successfully challenged in Oregon State Court of Appeals in December 2023.
  - The court decided that DEQ did not fully comply with notice requirements during the rulemaking process, thereby invalidating the final rules and the program.
- On January 22, 2024 DEQ announced it would not appeal.
  - DEQ plans to resolve the issue by re-launching the rule-making process.
  - Expected to take 12 months

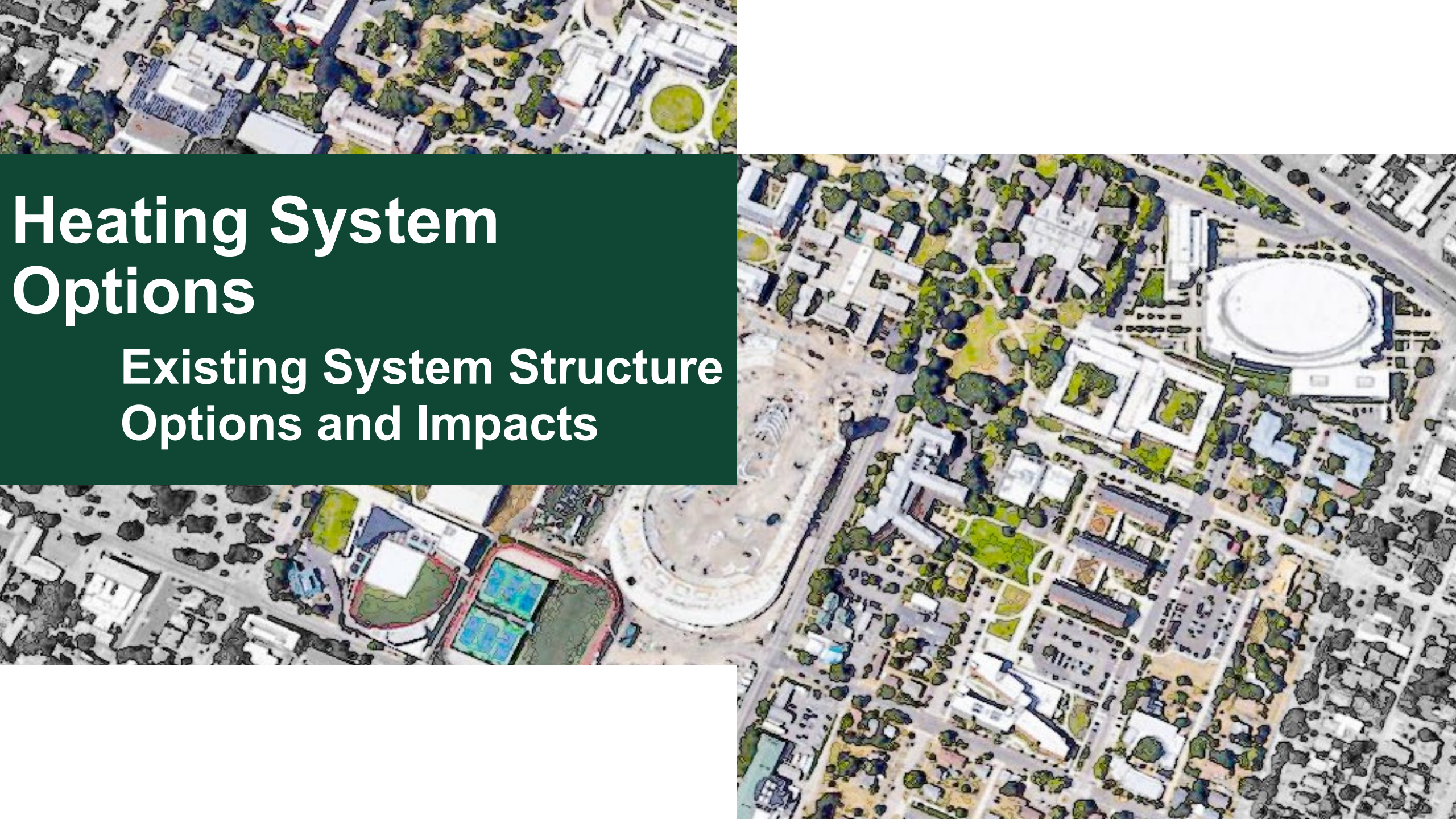
Oregon's Climate Protection Program

- UO conducted analysis of CPP cost, technical feasibility, and impact on emissions reductions.
- UO removed CPP from consideration until its legality is resolved.
- UO established "Business As Usual" (current operations) as the baseline to which emissions reduction options are compared.
- UO will continue to monitor CPP and all federal, state, and local regulatory and policy developments.

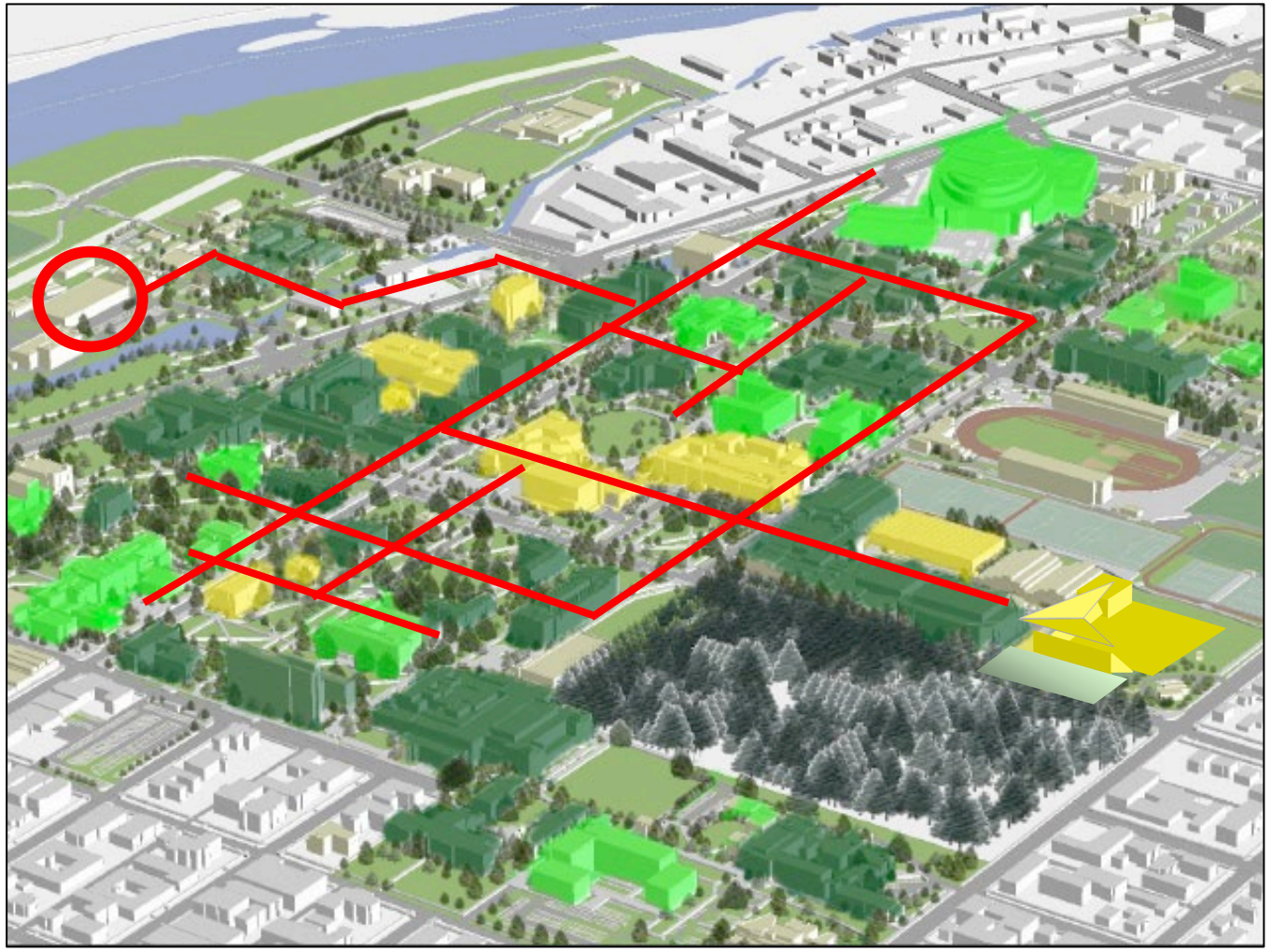
UNIVERSITY OF OREGON

Heating System Options

Existing System Structure Options and Impacts



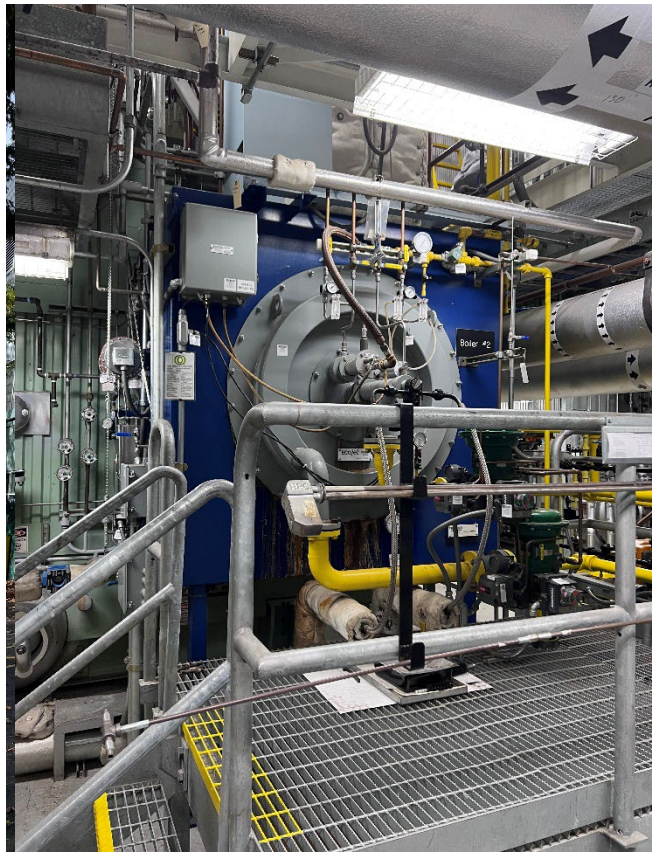
UO's Existing Steam District Heating System



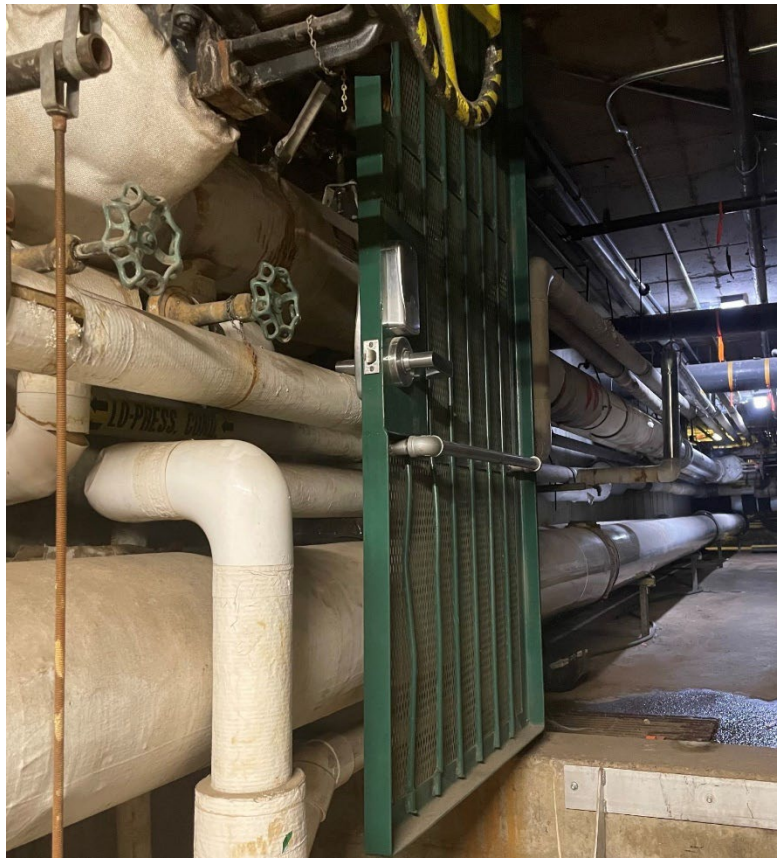
UNIVERSITY OF OREGON

UO District Heating System - BAU

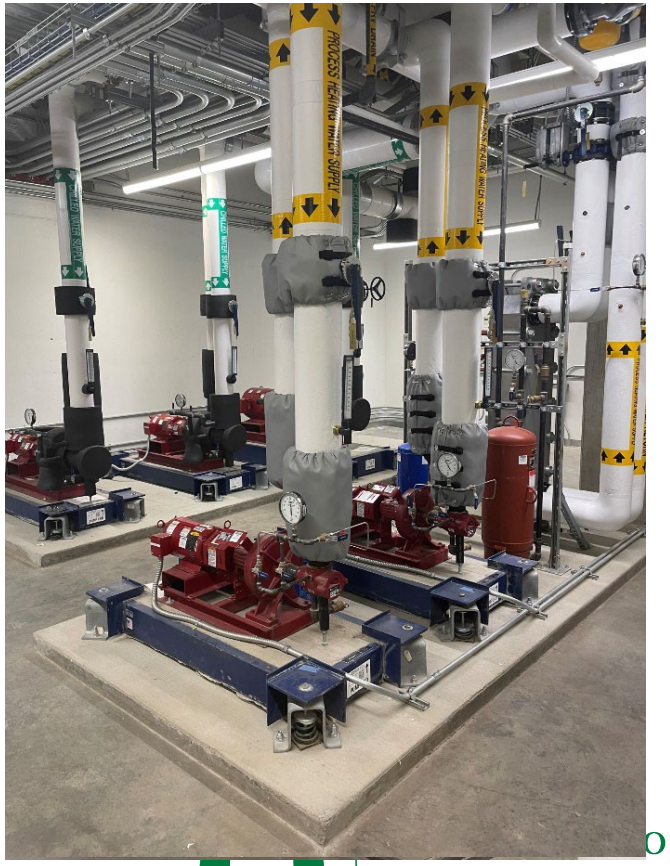
Central Boilers



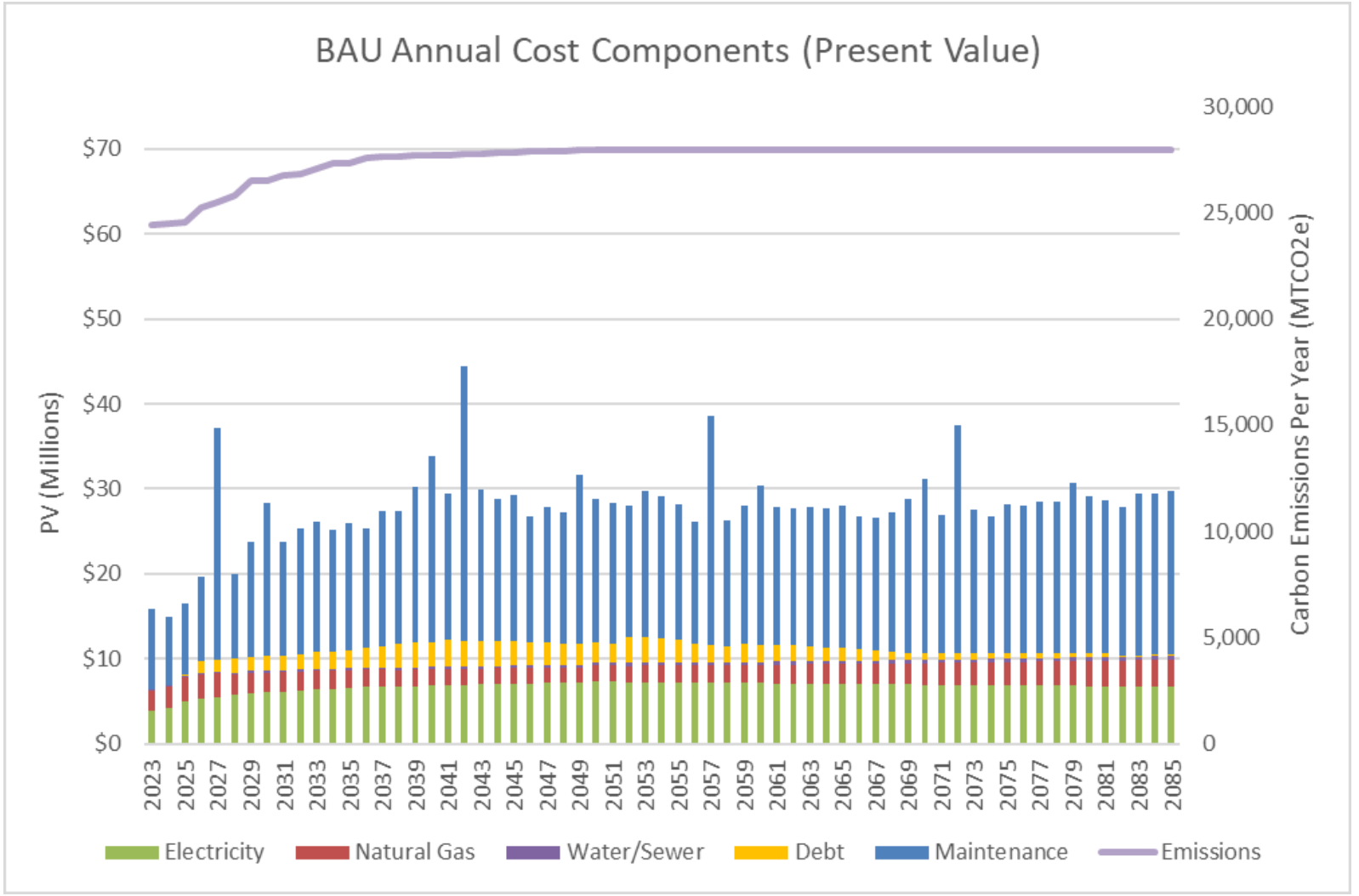
Steam Tunnels



Building Heat Systems



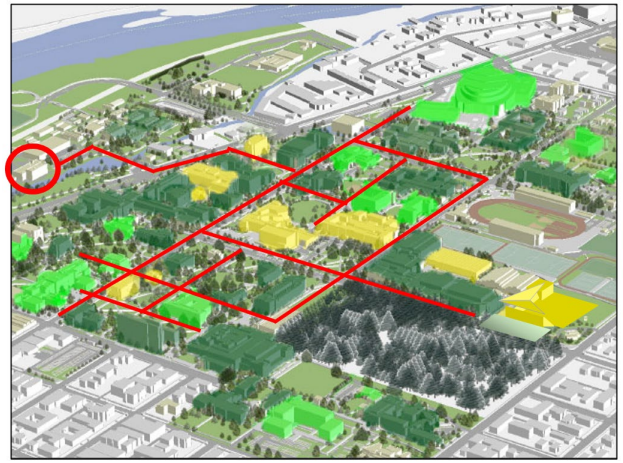
Business as Usual (BAU)
Estimated Cost & Emissions



UNIVERSITY OF OREGON

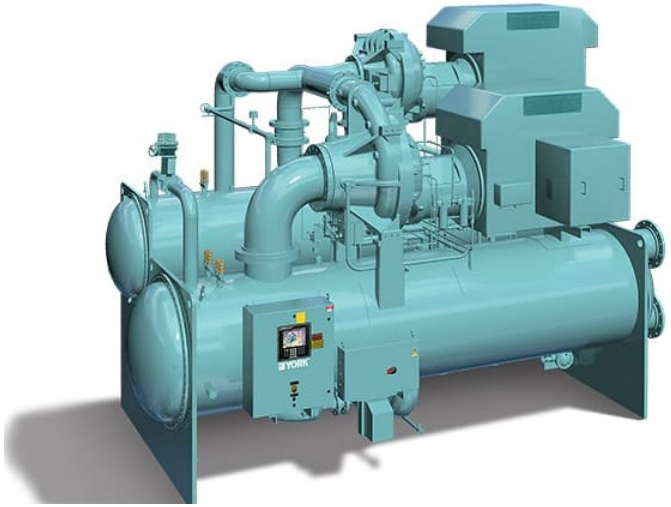
Thermal System Options Analyzed

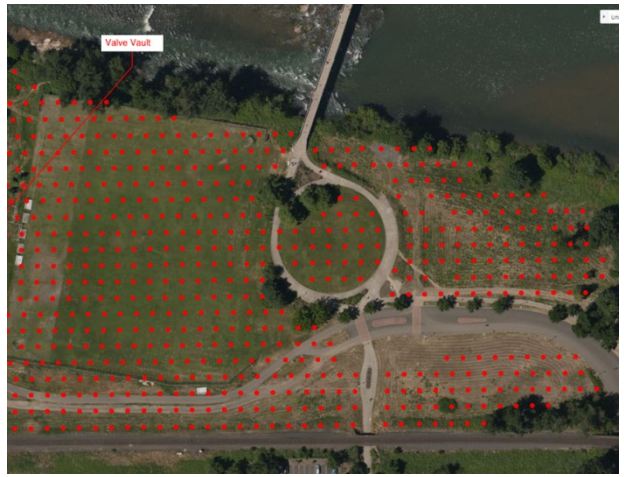
(1): SYSTEMS AS USUAL



(2): ELECTRODE BOILER

(3): HEAT RECOVERY CHILLER (HRC)





(4): GEO-EXCHANGE + HRC

UNIVERSITY OF OREGON

Overview of Options 2A and 2B – Electrode Boilers

Overview:

- Use electricity to make steam in place of existing natural gas boilers.
- Pairs with existing steam heat distribution system
- Estimated annual emissions reduction from BAU in 2028: 2A 78% | 2B 45%
- Estimated cumulative emissions reduction from BAU in 2028: 2A 53% | 2B 35%

Scenario	Capital Cost (2023 dollars)
18 MW Electrode Steam Boiler (Option 2A)	$29.7M
8 MW Electrode Steam Boiler (Option 2B)	$14.9M

Pros:

- Fastest and simplest (non-disruptive) change. Integrate directly with existing system.
- 2A electrifies 95% of heating. Requires electrical infrastructure improvements/investments.
- 2B electrifies 54% of heating. Fits within existing electrical and space constraints.
- Immediate emissions reductions upon implementation

Cons:

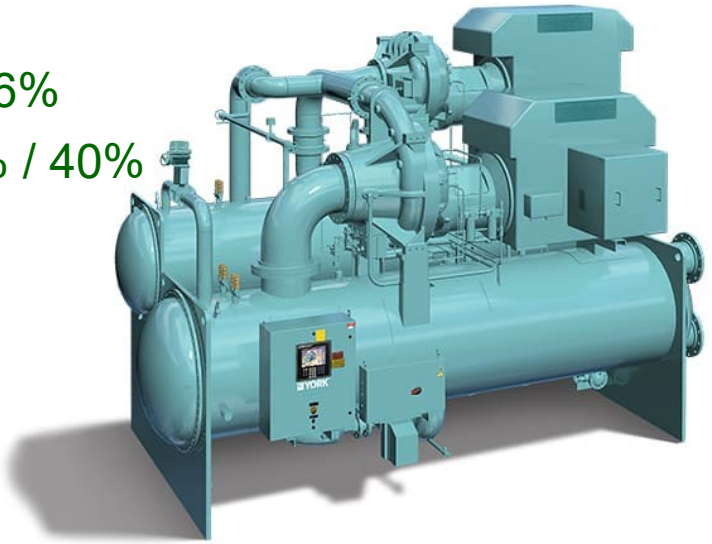
- Older/less efficient technology and potential stranded asset (2A)
- 2A boiler increases utility cost by $8.1 million per year in 2028
- 2B boiler increases utility cost by $4.4 million per year in 2028

UNIVERSITY OF OREGON

Overview of Option 3 – Heat Pump Chiller

Overview:

- Captures heat that would've been vented to atmosphere via cooling towers and uses it to meet heating needs
- Estimated annual emissions reduction from BAU in 2028 / 2043: 26% / 56%
- Estimated cumulative emissions reduction from BAU in 2028 / 2043: 10% / 40%



Pros:

- Reduces emissions by electrifying 58% of heating
- Extremely efficient use of energy and reduced maintenance reduces annual operating cost below BAU
- Estimated to receive $3.4M from IRA

Cons:

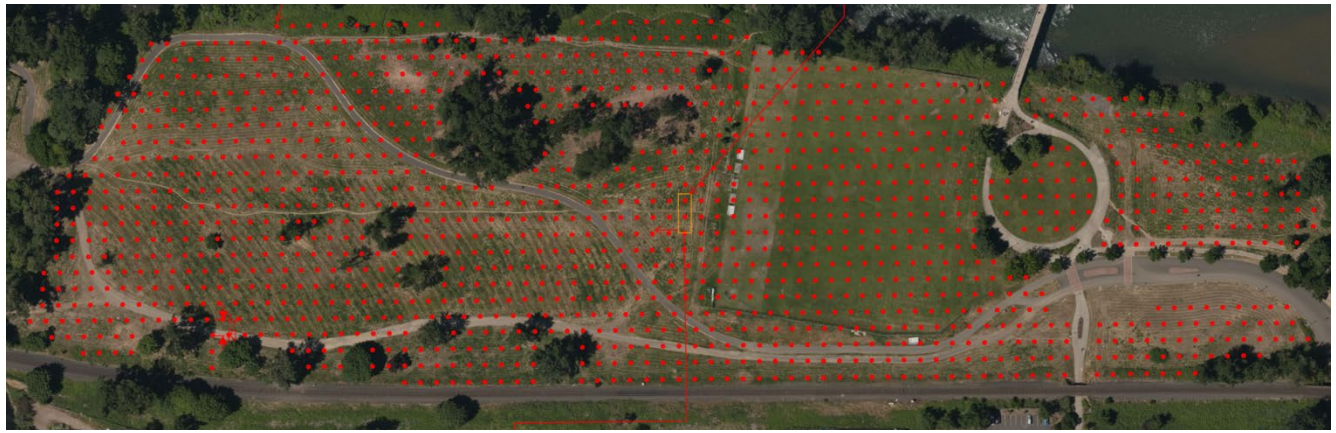
- Requires replacement of steam distribution system with hot water system and building system upgrades
- Emissions reductions phased in gradually over 12+ years while system is built
- Is less effective meeting wintertime heating needs

UNIVERSITY OF OREGON

Overview of Option 4 – Geo-Exchange

Overview:

- Adds to HRC (Option 3)
- Requires ~1,400 boreholes (600 ft deep)
- Estimated annual emissions reduction from BAU in 2028 / 2043: 29% / 76%
- Estimated cumulative emissions reduction from BAU in 2028 / 2043: 11% / 54%



Pros:

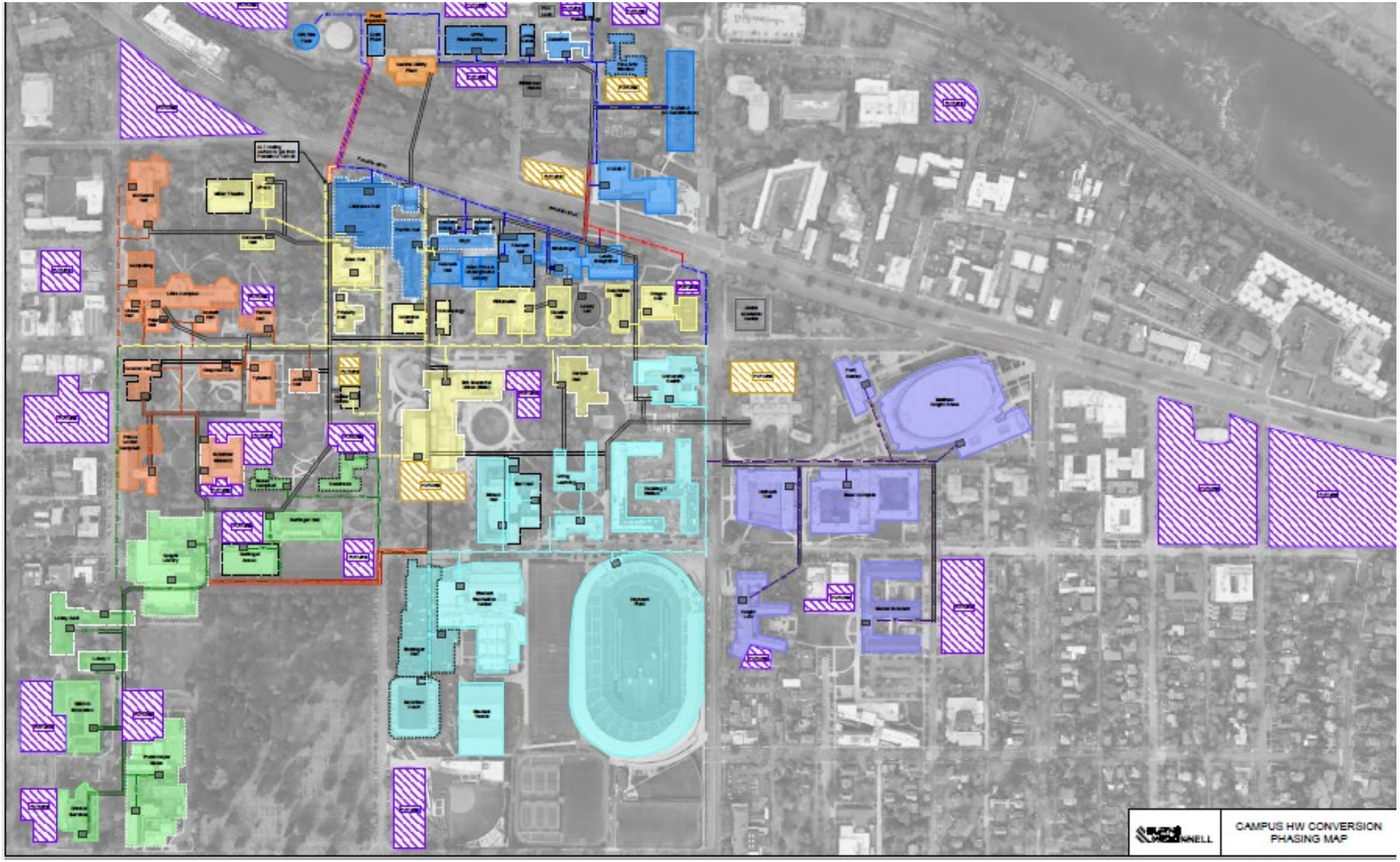
- Reduces emissions by electrifying 86% of heating
- Extremely efficient use of energy and reduced maintenance costs means annual operating cost below BAU (after debt service)
- Estimated to receive $27.2M from IRA and as much as $138.9

Cons:

- Requires replacement of steam distribution system with hot water system and building system upgrades
- Emissions reductions phased in gradually over 12+ years while system is built

UNIVERSITY OF OREGON

Options 3 / 4 Require Steam to Hot Water Conversion



UNIVERSITY OF OREGON

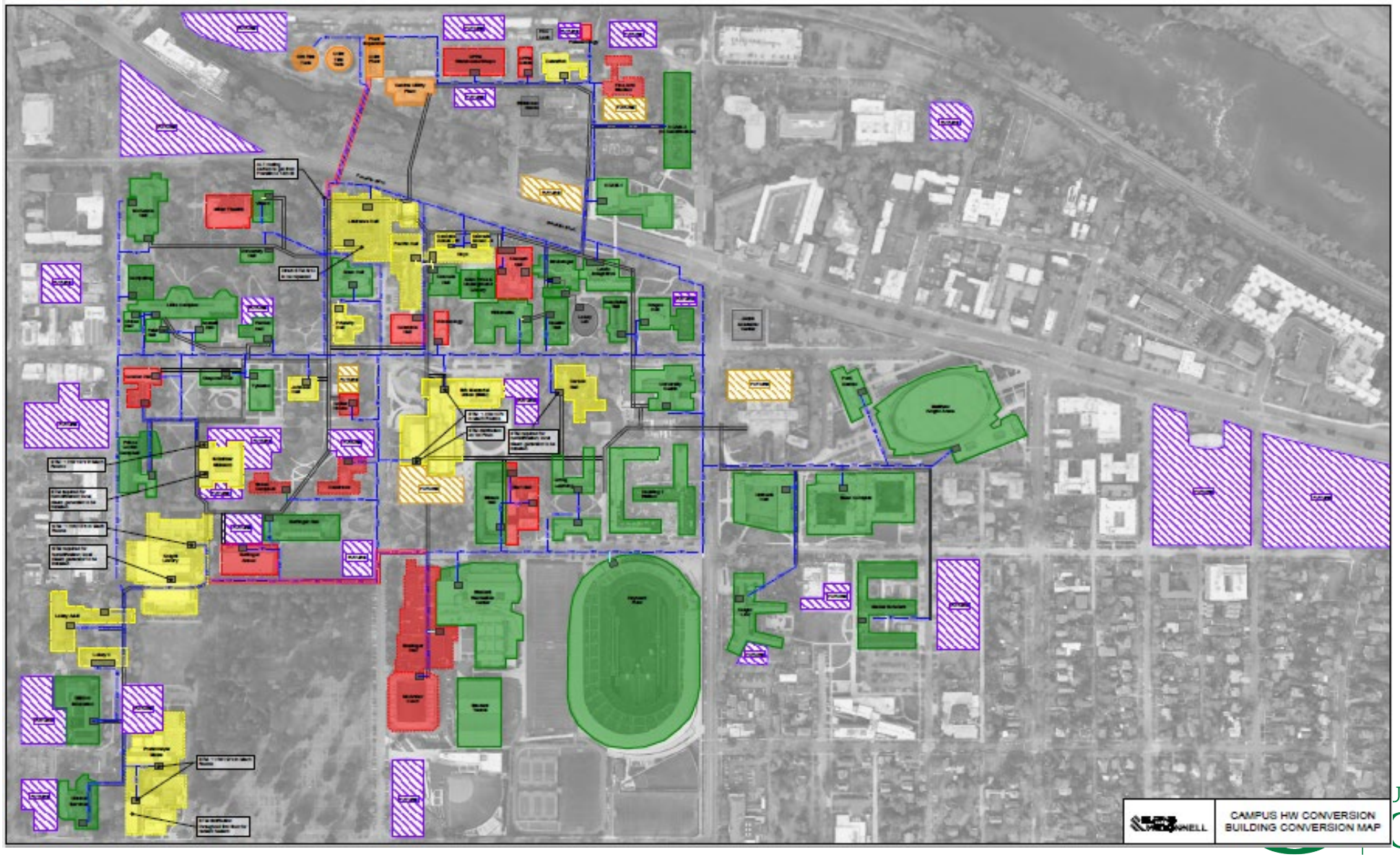
Hot Water Distribution System

- Distribution system transports hot water from the plant to the buildings for heating and back
- Only needed for options 3 and 4. System Design:
  - Direct bury
  - Loop design to have multiple pathways into buildings for increased resilience
- Significant campus disruption anticipated with potential impact to historic trees

Phase	2023 Cost	Notes
Initial	$43,400,000	Costs shown here are the estimated costs in 2023 dollars. The amounts include direct construction, design, and associated project costs. The costs shown do not include financing costs or estimated escalation to year of construction.
1	$60,600,000	
2	$57,200,000	
3	$21,600,000	
4	$40,400,000	
5	$31,700,000	
6	$31,100,000	
Total	**$286,000,000**	

UNIVERSITY OF OREGON

Options 3 / 4 Require Building Hot Water Conversions



UNIVERSITY OF OREGON

Building Conversions

- All buildings currently receive steam for heating and need to be converted from using steam from the central plant to hot water. Only applies to options 3 and 4
- Buildings divided between full steam distribution, partial steam distribution, full hydronics, and hot water temperature
- Included cost for displaced use (21 buildings requiring staff/program relocation, $55M)
- Included cost for rental boiler (2 small boilers throughout transition)

Phase	2023 Cost	Notes
1	$72,600,000	Costs shown here are the estimated costs in 2023 dollars. The amounts include direct construction, design, and associated project costs. The amounts do not include financing costs or estimated escalation to year of construction.
2	$45,400,000	
3	$39,500,000	
4	$67,000,000	
5	$44,600,000	
6	$27,800,000	
Total	**$296,900,000**	

UNIVERSITY OF OREGON

Total Construction Costs

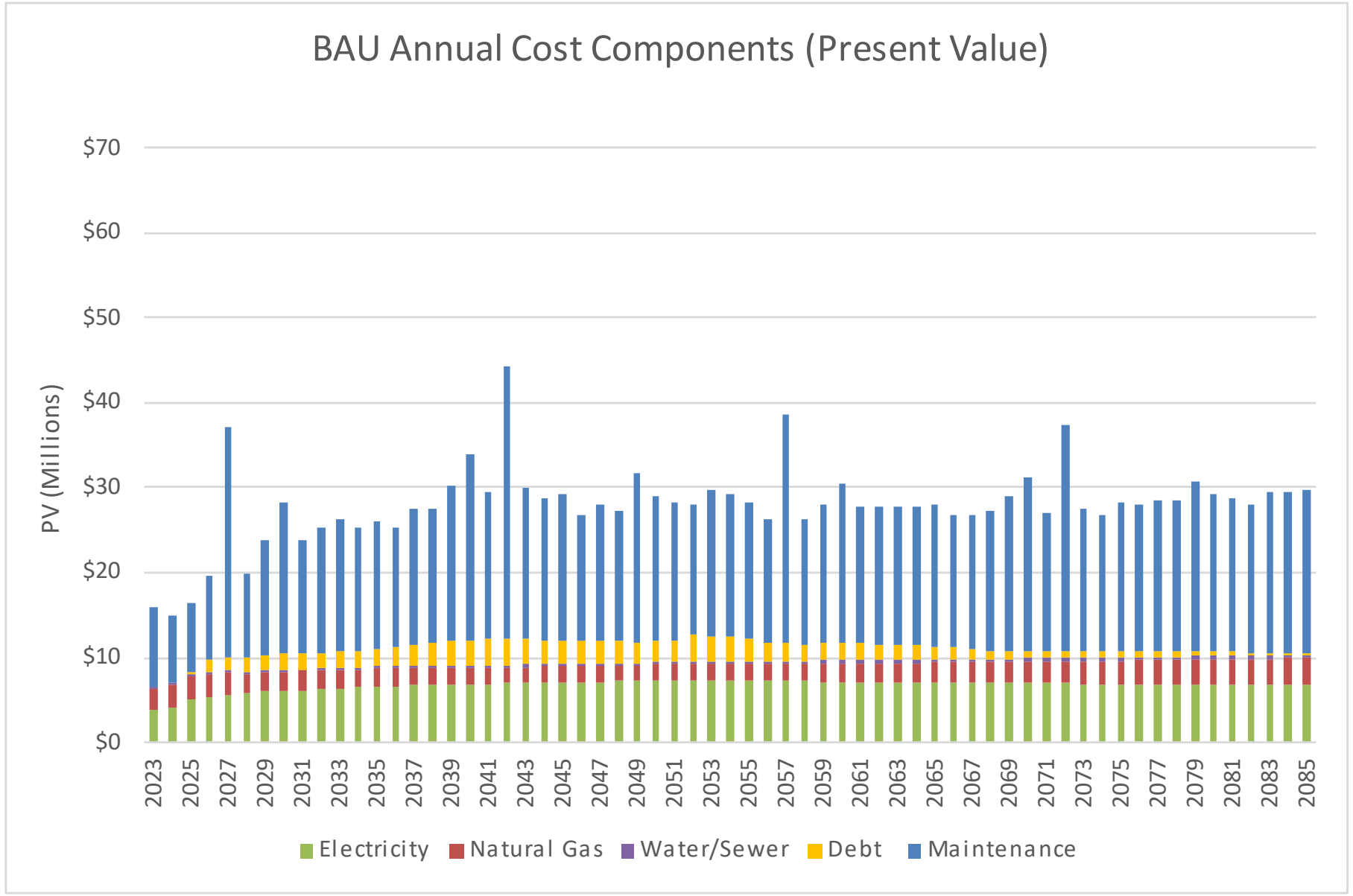
Estimated Project Costs (2023$)	Option 2a (18MW Ele Blr)	Option 2b (8MW Ele Blr)	Option 3 (HPC)	Option 4 (Geo)
Electrode Boiler and Electrical Modifications	$29,700,000	$14,900,000	$0	$0
Hot Water Distribution	$0	$0	$286,000,000	$286,000,000
Hot Water Building Conversions	$0	$0	$296,900,000	$296,900,000
Hot Water Plant Modifications	$0	$0	$93,500,000	$93,500,000
Geoexchange System	$0	$0	$0	$66,400,000
Potential IRA Credits	$0	$0	($3,400,000)	($27.6M) - ($138.9M)
Total Cost without IRA	**$29,700,000**	**$14,900,000**	**$673,000,000**	**$742,800,000**
Total Cost with IRA Credits	**$29,700,000**	**$14,900,000**	**$669,600,000**	**($715.2M) - ($603.9M)**

- Option 3 / 4 include:
  - Hot water distribution costs
  - Building conversation costs
  - Heating system (HRC and HRC + Geo-Exchange) costs
  - IRA credits
- Option 2A / 2B include:
  - Electrode steam boiler costs
  - Electrical and other infrastructure costs

UNIVERSITY OF OREGON

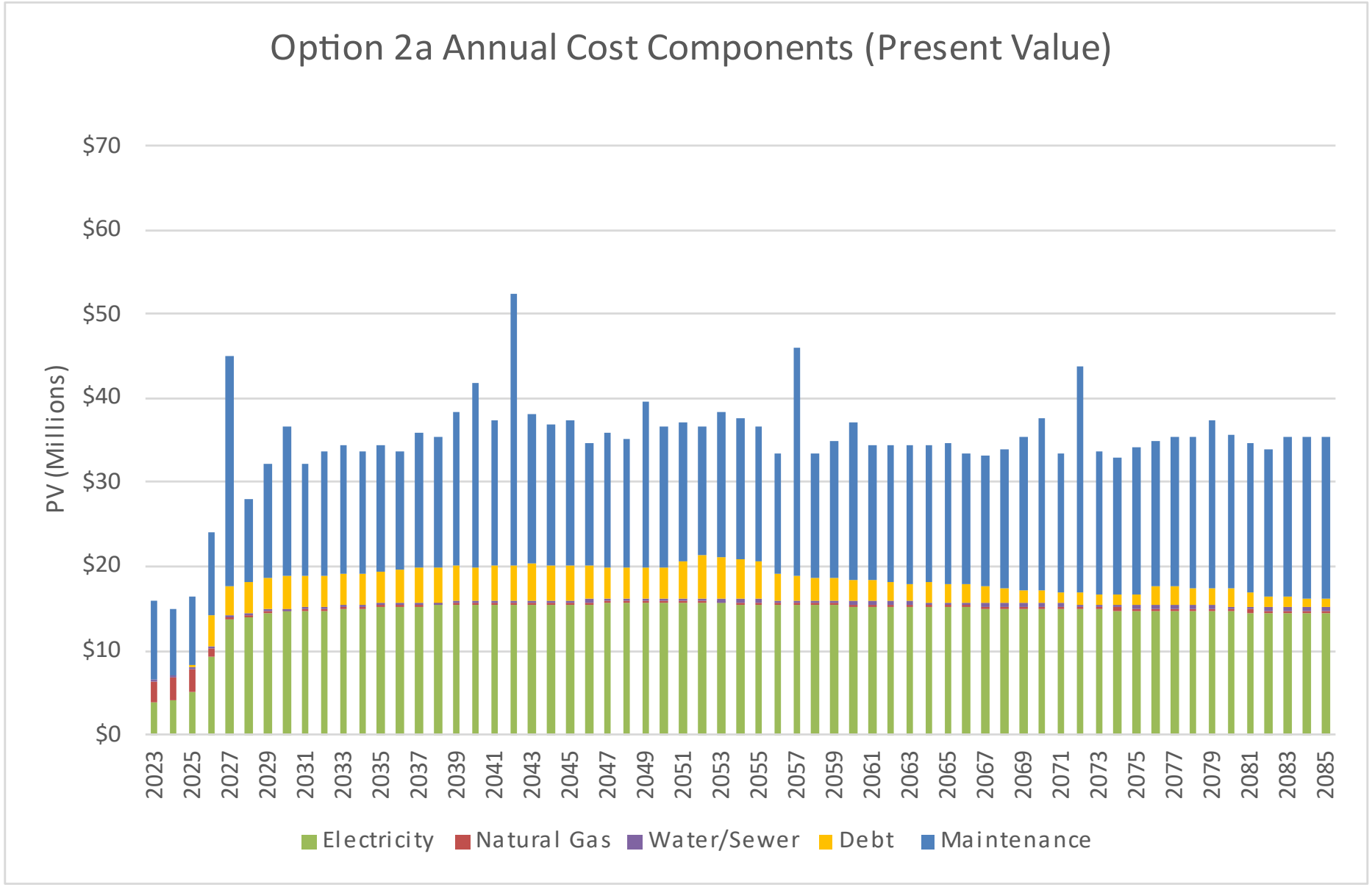
Estimated Costs & Emissions Reductions

Life Cycle Cost Results – Annual Operating Costs



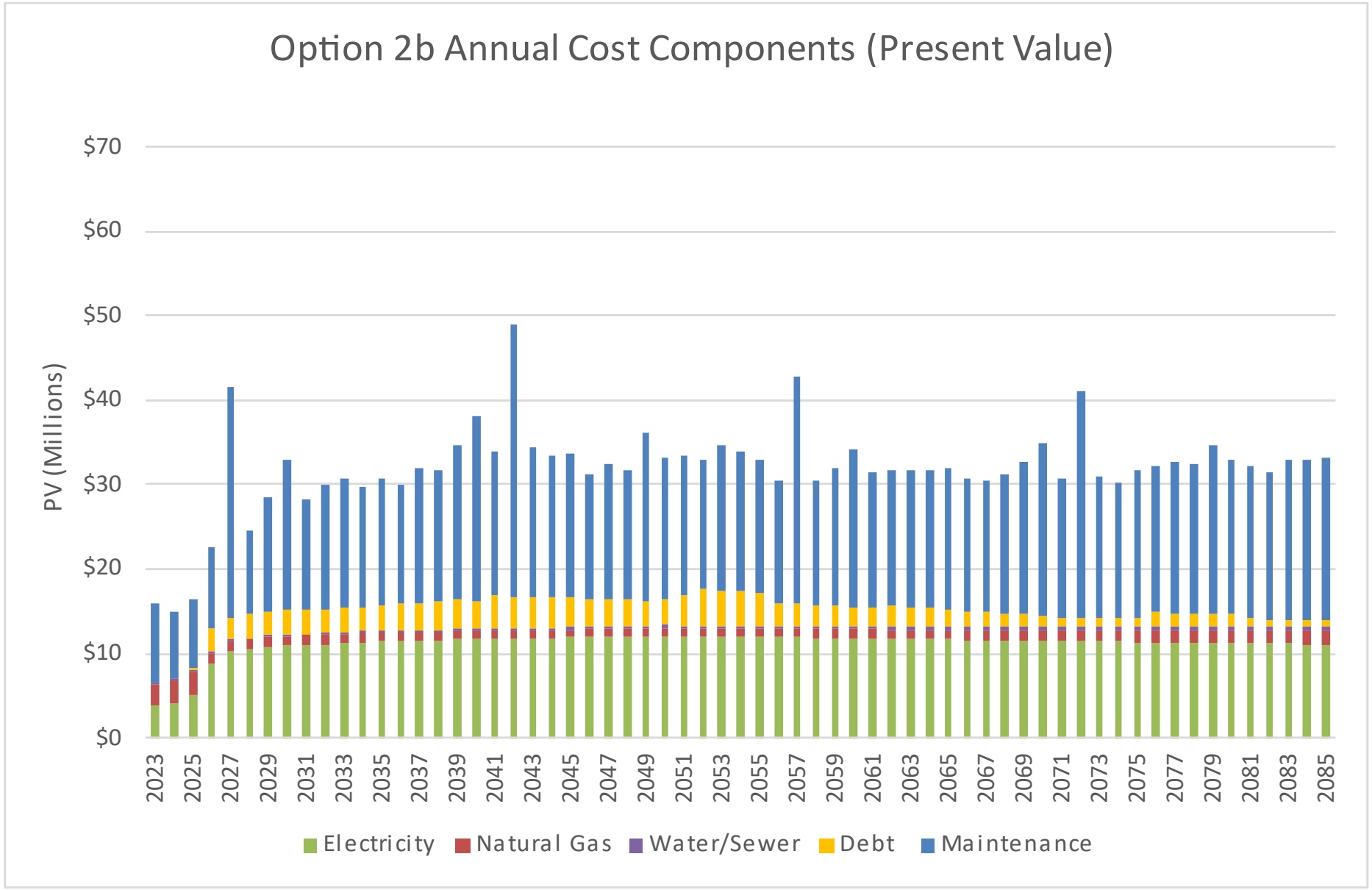
UNIVERSITY OF OREGON

Life Cycle Cost Results – Annual Operating Costs



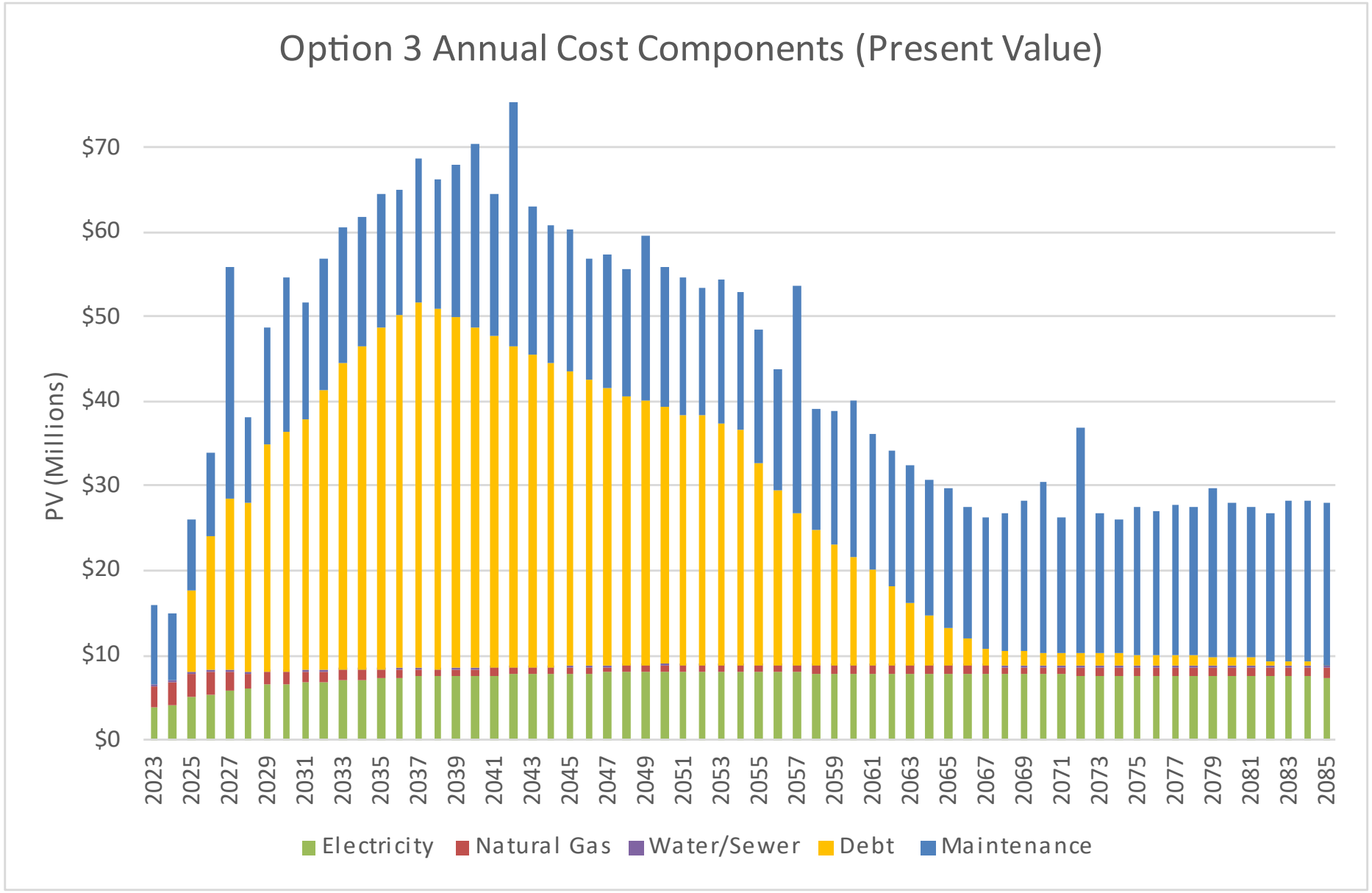
UNIVERSITY OF OREGON

Life Cycle Cost Results – Annual Operating Costs



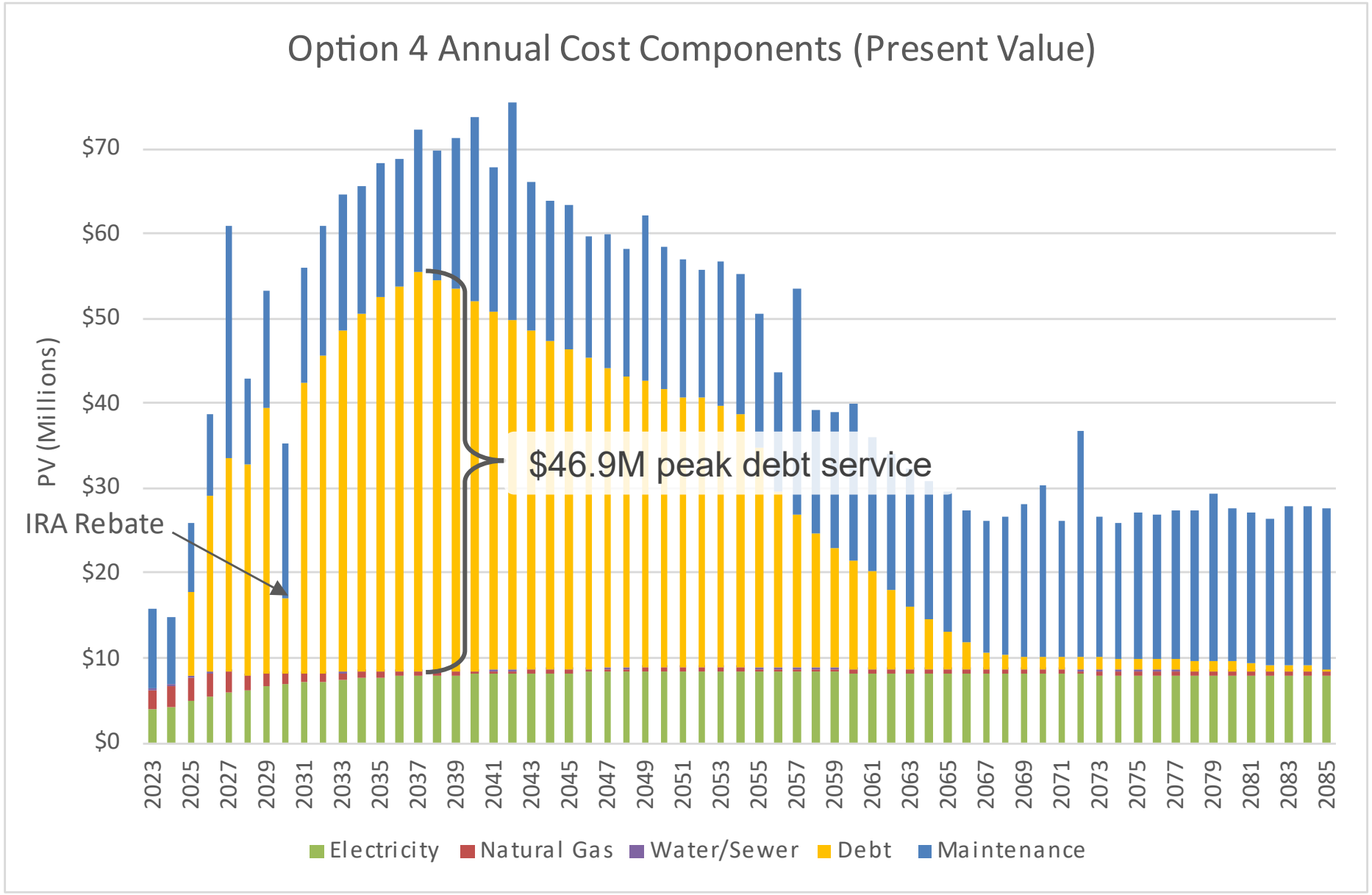
UNIVERSITY OF OREGON

Life Cycle Cost Results – Annual Operating Costs



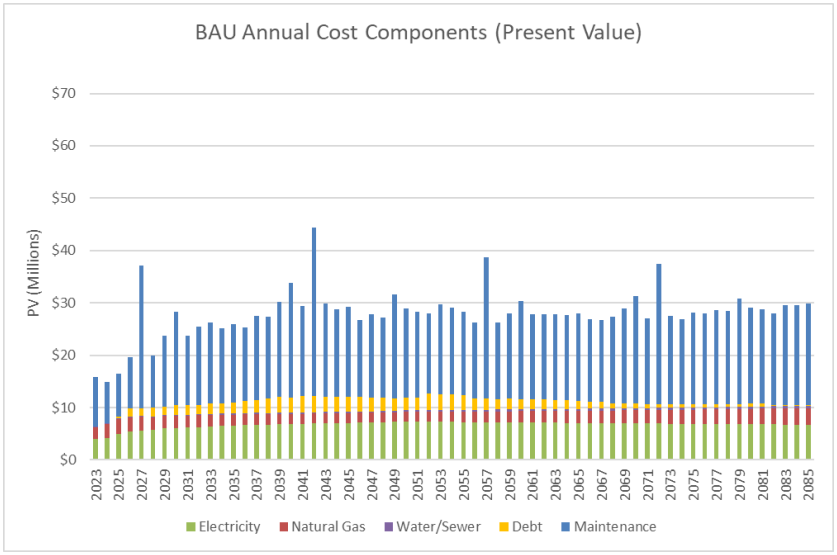
UNIVERSITY OF OREGON

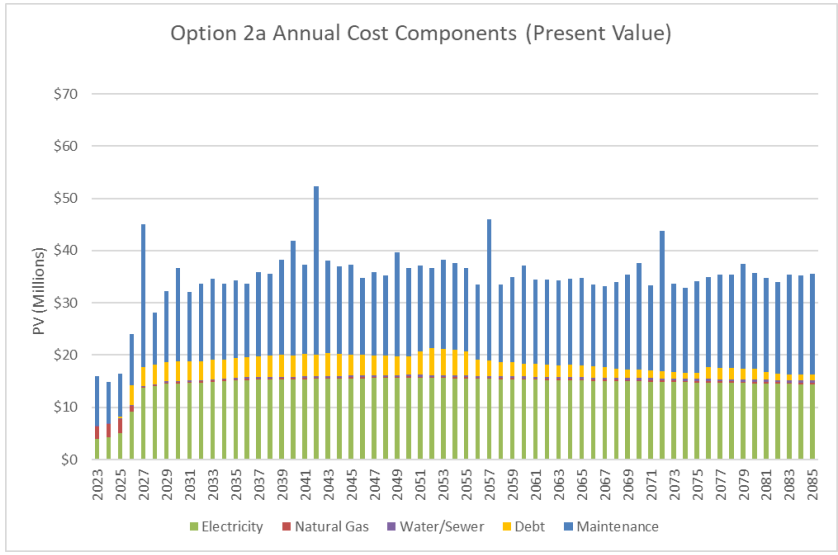
Life Cycle Cost Results – Annual Operating Costs

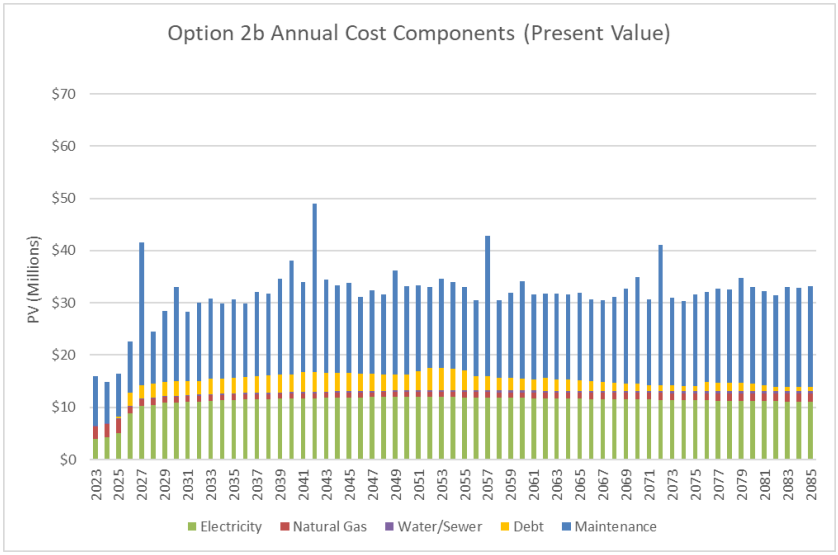


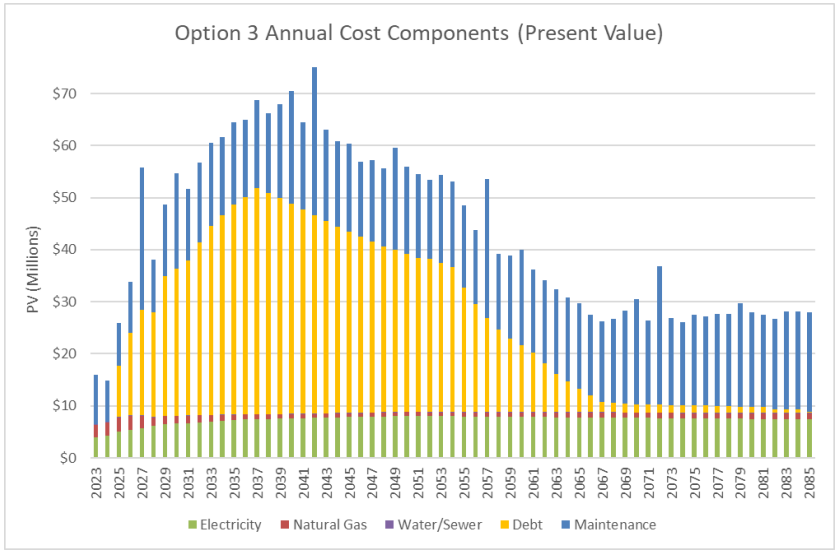
UNIVERSITY OF OREGON

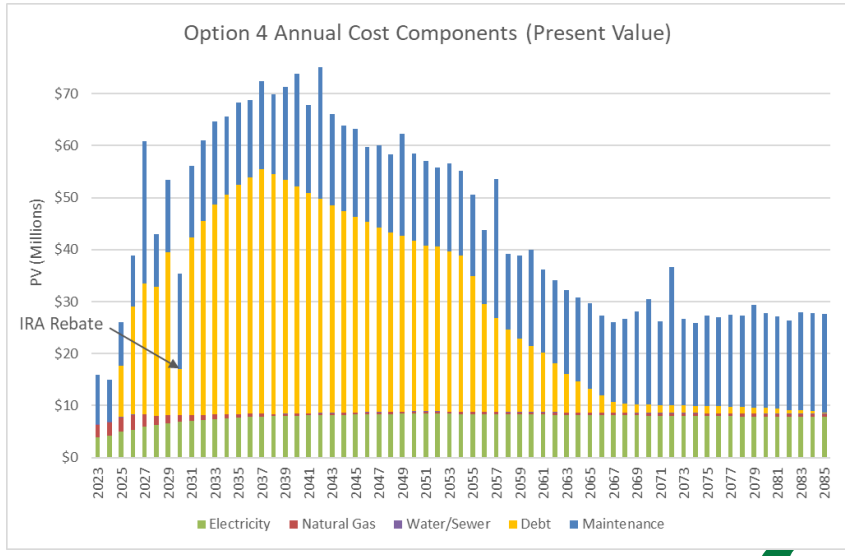
Life Cycle Cost Results – Cost Comparisons





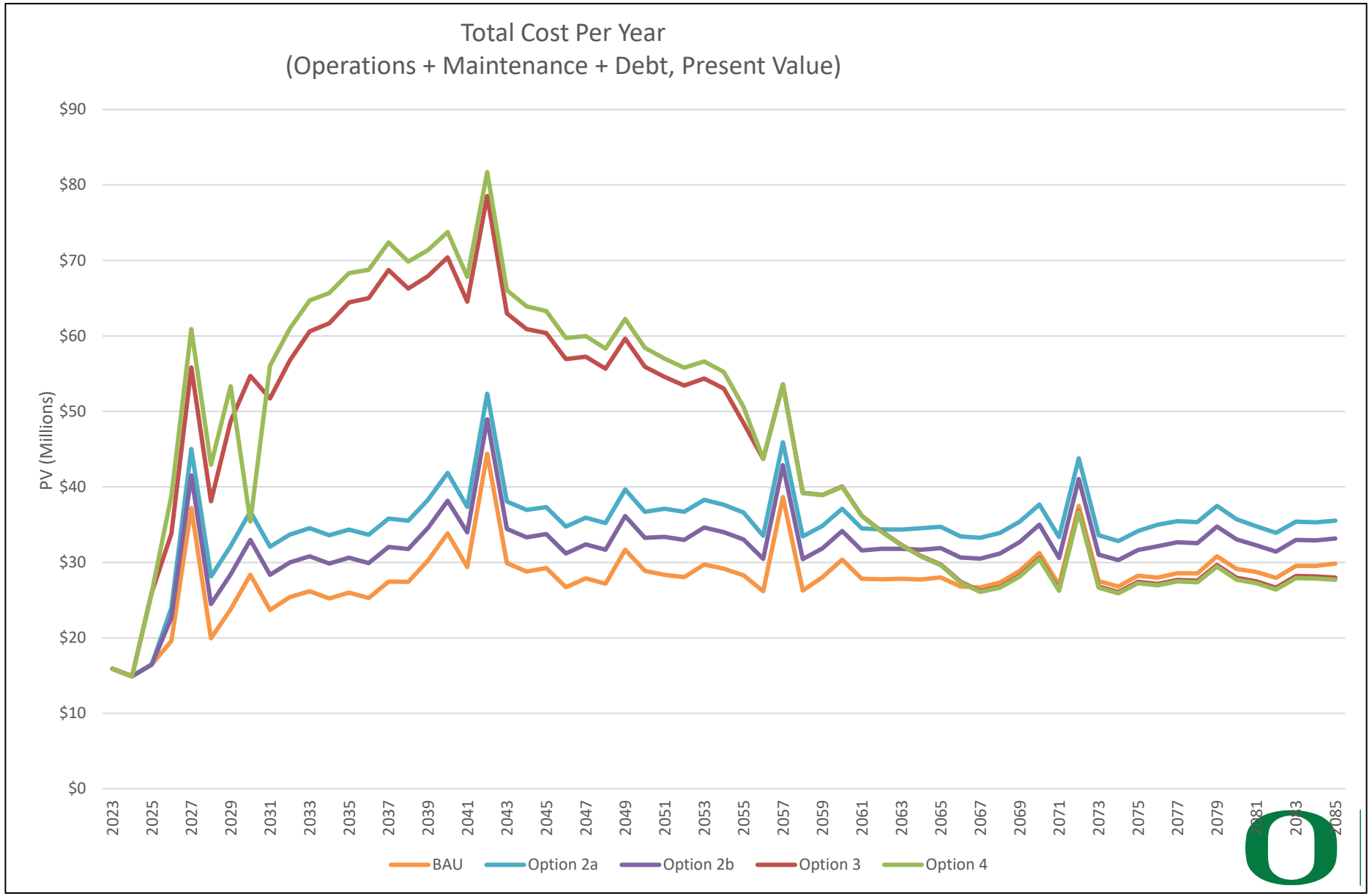






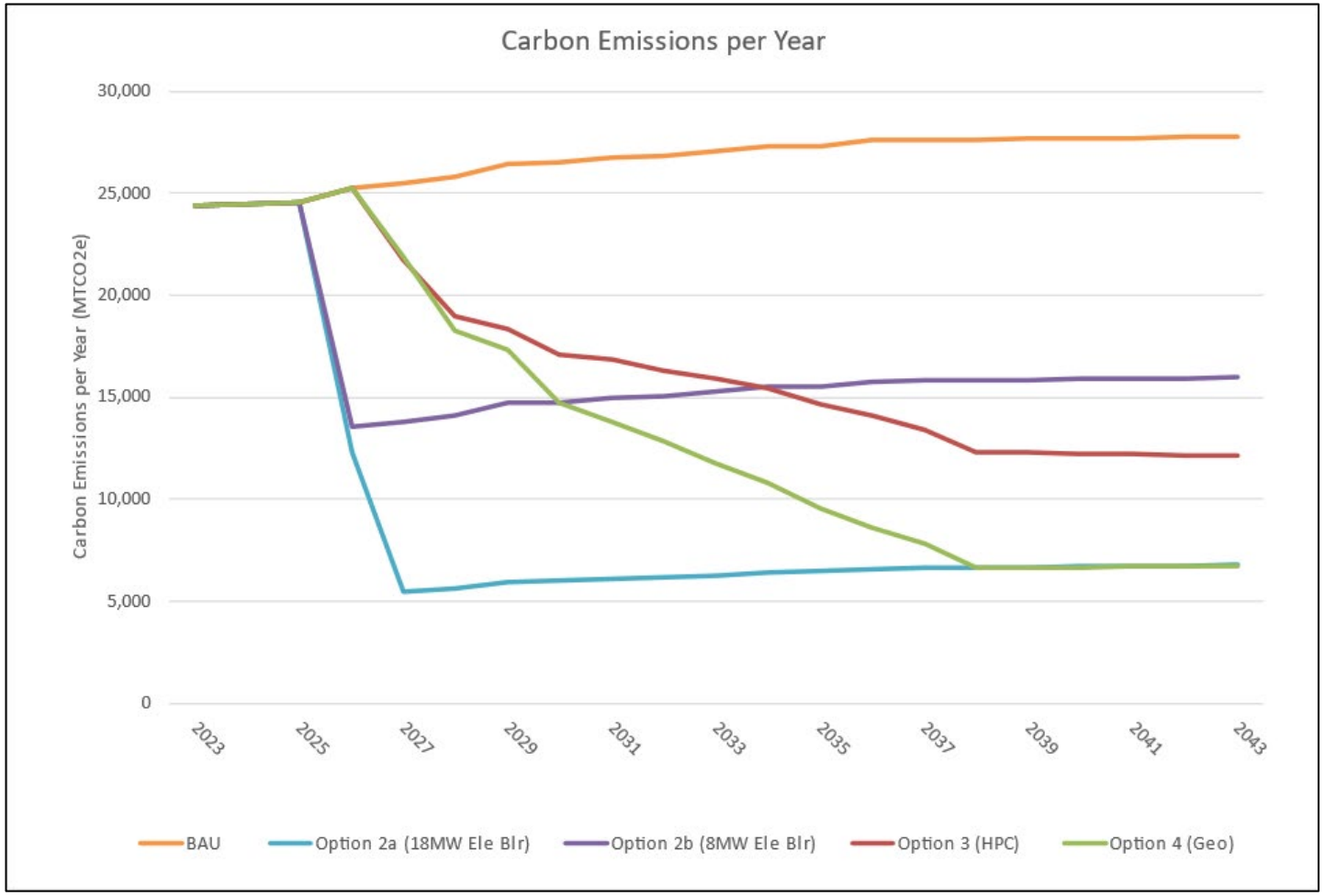
UNIVERSITY OF OREGON

Life Cycle Cost Results – Cost Comparisons



UNIVERSITY OF OREGON

Life Cycle Cost Results – Emissions Reductions



Annual Emissions Reduction (vs BAU)	Option 2a (18MW Ele Blr)	Option 2b (8MW Ele Blr)	Option 3 (HPC)	Option 4 (Geo)
2028	78%	45%	26%	29%
2033	77%	44%	41%	56%
2043	76%	42%	56%	76%
2053	75%	42%	58%	75%
2083	75%	42%	58%	75%

Cumulative Emissions Reduction (vs BAU)	Option 2a (18MW Ele Blr)	Option 2b (8MW Ele Blr)	Option 3 (HPC)	Option 4 (Geo)
2025 – 2028	53%	35%	10%	11%
2025 – 2033	67%	40%	25%	32%
2025 – 2043	72%	41%	40%	54%
2025 – 2053	73%	42%	46%	61%
2025 – 2085	74%	42%	52%	69%

This analysis utilizes the prior 10-year average GHG intensity for EWEB provided electricity, as calculated by Oregon DEQ. This chart does not reflect that during early years of the analysis peaker plants may be used to fulfill new electrical load that generate higher GHG emissions. It also does not incorporate EWEB's 95% decarbonization plan and additional planned decarbonization of the northwest grid.

UNIVERSITY OF OREGON

Total Capital and Operating Costs (NPV) and Cumulative Emissions Reductions

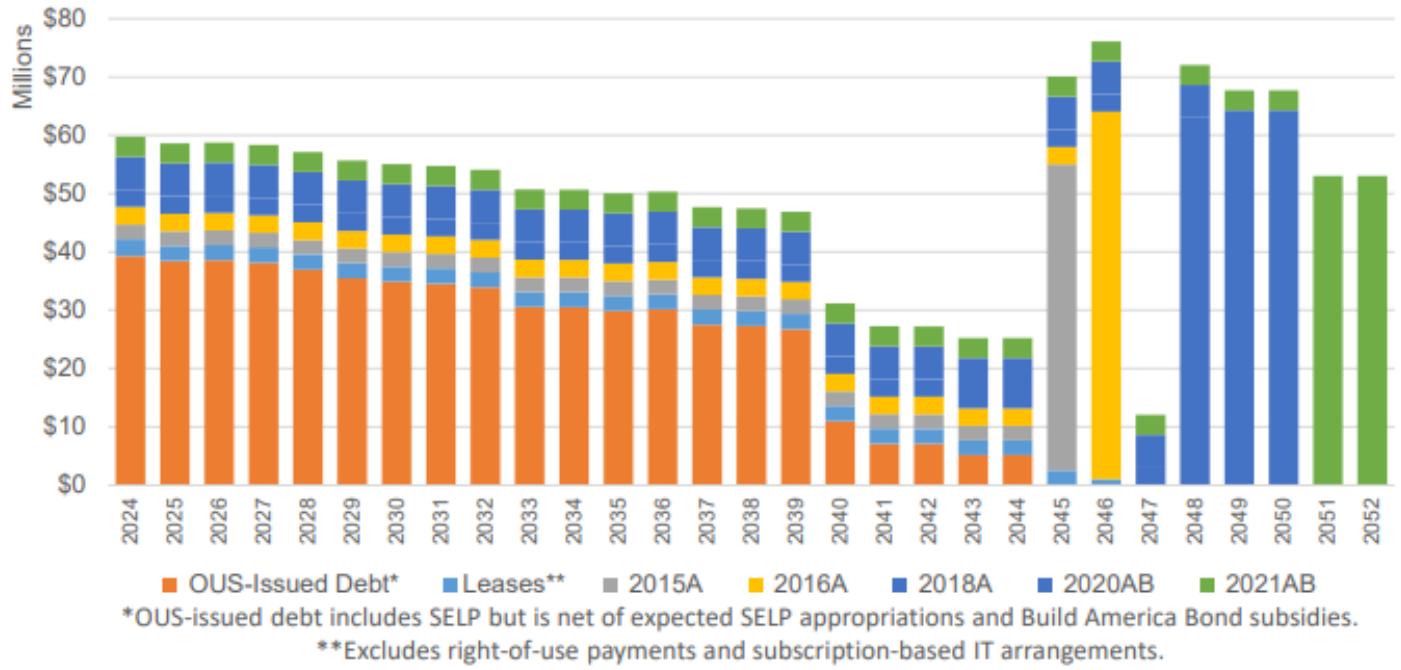
	BAU	BAU (with CPP)	Option 2a (18MW)	Option 2b (8MW)	Option 3	Option 4
Capital Construction Costs (Present Value, Financed)	$105,000,000	$105,000,000	$179,300,000	$147,300,000	$1,096,800,000	$1,174,100,000
IRA Benefit (Present Value)	$0	$0	$0	$0	-$3,400,000	-$27,200,000
Marginal Cost vs BAU	-	$0	$74,300,000	$42,300,000	$991,800,000	$1,069,100,000
Operating and Maintenance Costs (Present Value, Cumulative)	$1,657,000,000	$1,699,600,000	$2,020,800,000	$1,864,500,000	$1,599,700,000	$1,596,900,000
Marginal Cost vs BAU	-	$42,600,000	$363,800,000	$207,500,000	-$57,300,000	-$60,100,000
Total Option Cost (Present Value, Financed)	$1,762,000,000	$1,804,600,000	$2,200,100,000	$2,011,800,000	$2,696,500,000	$2,771,000,000
Total Marginal Cost vs BAU	-	$42,600,000	$438,100,000	$249,800,000	$934,500,000	$1,009,000,000
2038 Annual Operating + Maint + Debt Service (Present Value)	$27,500,000	$28,200,000	$35,600,000	$31,800,000	$66,300,000	$69,900,000
2085 Annual Operating + Maint + Debt Service (Present Value)	$29,900,000	$30,600,000	$35,600,000	$33,200,000	$28,000,000	$27,700,000
Total Cumulative Emissions (20233-2085, MTCO2e)	1,735,000	822,000	486,000	1,027,000	854,000	578,000
Cumulative Emissions Reduction (2023-2085, MTCO2e)	-	(913,000)	(1,249,000)	(708,000)	(881,000)	(1,157,000)
Cumulative Emissions Reduction (%) (vs BAU)	-	53%	72%	41%	51%	67%
~Cost per MTCO2e Reduction (Present Value)	-	$47	$351	$353	$1,061	$872

UNIVERSITY OF OREGON

University Finances

Existing University Debt Service & Lease Payments

Debt Service and Lease Payments



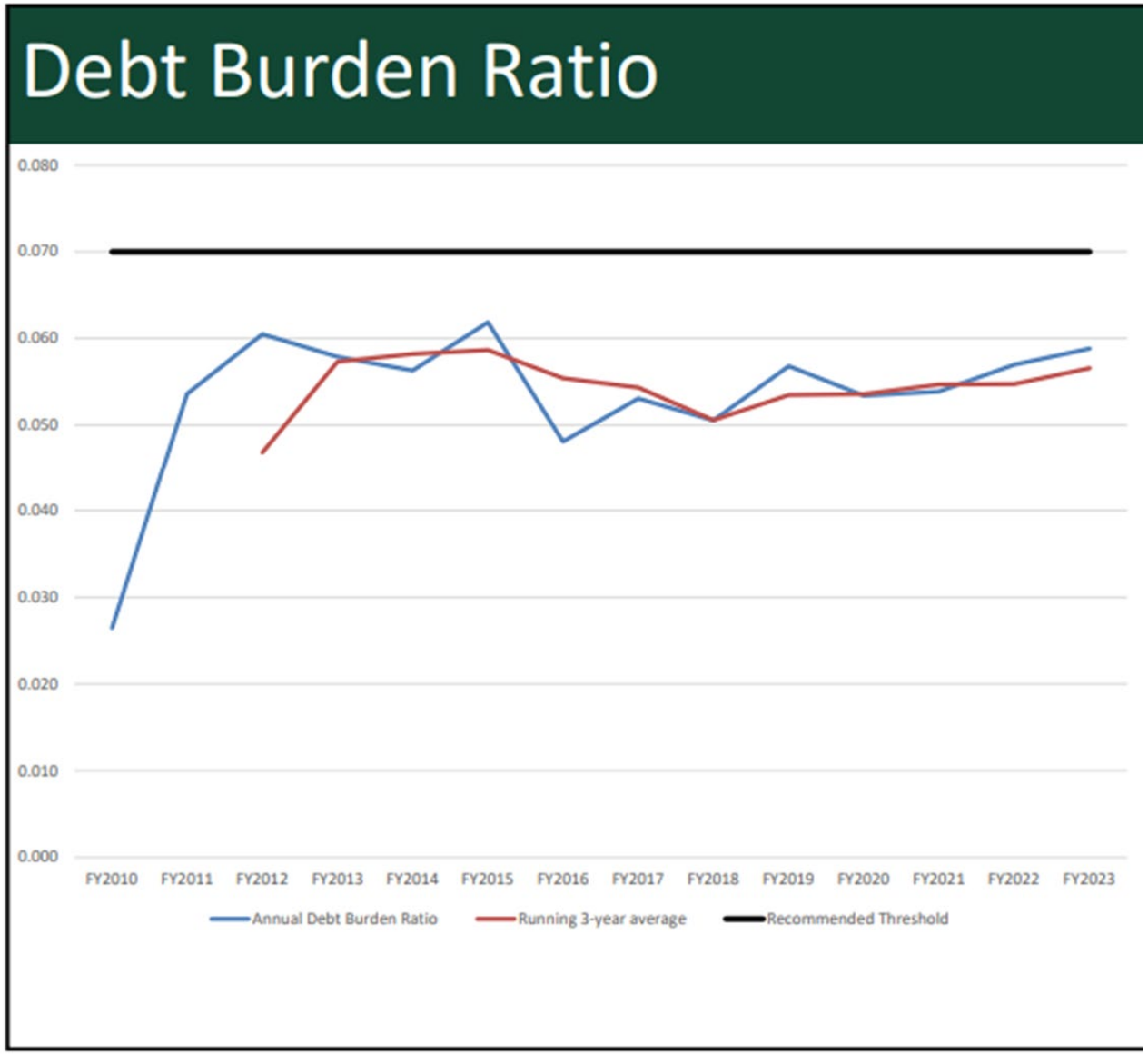
*OUS-issued debt includes SELP but is net of expected SELP appropriations and Build America Bond subsidies.
**Excludes right-of-use payments and subscription-based IT arrangements.

The current principal balance of outstanding debt, including capital leases, is approximately $846 million

This is a decrease of approximately $32 million from the same date a year ago

UNIVERSITY OF OREGON

University Debt Burden Ratio



UNIVERSITY OF OREGON

Major Revenue Sources & Academic Expenditures

School and College Education & General Budgets	FY 2023
College of Design	$26M
College of Arts & Sciences	$153M
Honors College	$3M
Lundquist College of Business	$36M
College of Education	$20M
School of Journalism & Communication	$16M
School of Law	$26M
School of Music and Dance	$14M

E&G Revenue Source	FY 2023
State Appropriations	$91M
Res Undergrad Tuition & Fees	$85M
Non-Res Undergrad Tuition & Fees	$288.M
Institutionally Funded Remissions	$69M
Annual Strategic Investment Fund	$2M

UNIVERSITY OF OREGON

Annual Operating Costs

Annual Costs – First Year in Operation

Annual Costs in 2028	BAU	BAU w/ CPP	Option 2a	Option 2b
2028 Nominal Value	$23,200,000	$23,500,000	$32,700,000	$28,400,000
Marginal cost vs BAU		$300,000	$9,500,000	$5,200,000
Present Value	$20,000,000	$20,300,000	$28,200,000	$24,500,000
Marginal cost vs BAU		$300,000	$8,200,000	$4,500,000

- 2027 is anticipated first year in operation for the electric boilers but had large maintenance cost across all options
- Operating annual cost premium for options 2a and 2b due to electricity costs

Annual Costs in 2038	BAU	BAU w/ CPP	Option 3	Option 4
2038 Nominal Value	$42,800,000	$43,900,000	$103,300,000	$108,800,000
Marginal cost vs BAU		$1,100,000	$60,500,000	$66,000,000
Present Value	$27,500,000	$28,200,000	$66,300,000	$69,900,000
Marginal cost vs BAU		$700,000	$38,800,000	$42,400,000

- 2038 is first year in full operation for options 3 and 4
- Significant annual cost premium for both options 3 and 4 due to debt service on capital

UNIVERSITY OF OREGON

Key Takeaways

Key Takeaways

- Significant and immediate emissions reductions with Options 2A, 2B but not with Options 3 and 4 (vs BAU)

Annual Emissions Reduction (vs BAU)	Option 2a (18MW Ele Blr)	Option 2b (8MW Ele Blr)	Option 3 (HPC)	Option 4 (Geo)
Annual Emissions Reduction in 2028	78%	45%	26%	29%
Annual Emissions Reduction in 2033	77%	44%	41%	56%
Annual Emissions Reduction in 2043	76%	42%	56%	76%
Annual Emissions Reduction in 2053	75%	42%	58%	75%
Annual Emissions Reduction in 2085	75%	42%	58%	75%

- Significantly larger construction cost and campus disruption associated with Options 3 and 4

Construction Costs	Option 2a (18MW Ele Blr)	Option 2b (8MW Ele Blr)	Option 3 (HPC)	Option 4 (Geo)
Estimated Project Cost (2023 $)	$29,700,000	$14,900,000	$673,000,000	$742,800,000
Potential IRA Credit	$0	$0	($3,400,000)	($27.6M) - ($138.9M)

- Timeline to implementation for Options 2A/2B is much quicker than Options 3 and 4
  - Options 2A / 2B can be completed in 3 to 5 years
  - Options 3 / 4: 12 years to implementation (if no unforeseen conditions / issues exist)
- Annual operating cost increases vary greatly depending on the option

Annual Operating Costs Above BAU (NPV) First Year All Systems Operations	Option 2a (18MW Ele Blr)	Option 2b (8MW Ele Blr)	Option 3 (HPC)	Option 4 (Geo)
2038 Marginal Cost (NPV)	$8.1M	$4.4M	$38.9M	$42.4M

UNIVERSITY OF OREGON

Evaluation Principles

Evaluation Principles

- Reduction of greenhouse gas emissions
- Consideration of technical feasibility risk
- Resiliency of campus heat production to energy markets and natural hazards
- Impact on the campus experience
- Maintaining appropriate fiscal stewardship

Initial Recommendation

Taskforce Assumptions

1. ***BAU is not acceptable going forward.***

2. ***The electrical grid is less GHG intensive than the natural gas*** **pipeline** and the taskforce believes is inherently more conducive to GHG reductions over time.

3. ***Time is of the essence***, and moving forward with decarbonization efforts which reduce GHG emissions in the short-term is critical to be directionally consistent with the science of climate change. Carbon emissions reductions now are more important that decarbonization efforts later.

4. Regulatory uncertainty around Oregon's CPP will continue for at least the next few years as Oregon DEQ, natural gas providers and the courts work through legal issues. Improvements through ***the CPP could be useful adjuncts to whatever plan the UO moves forward with but should not be the basis of our GHG reduction efforts***.

UNIVERSITY OF OREGON

Initial Taskforce Recommendation

1. The university should ***move forward with Option 2B*** as it provides for significant and immediate emissions reductions (up to 45% annually) and is a ***partner technology*** to Option 3, Option 4 and could be the first step towards Option 2A or to additional/new heating technology as it develops.

Option 2B is not sufficient on its own over the long-term and is a first step.

2. The university should make a ***clear and public commitment including timelines*** and charging an office, likely the Office of Sustainability ***through the Climate Action Plan 3*** (to be approved in Spring 2024) to complete the following additional analysis:

- Refinements to and/or next steps associated with Option 2B such as ***battery or thermal storage systems*** which could further increase system efficiency and reduce campus GHG emissions.
- ***Technological and regulatory developments*** that may further alter the GHG emissions and economic realities of the options evaluated by the Taskforce or others unforeseen today that could trigger additional investment.

UNIVERSITY OF OREGON

Discussion of Other Options

Option 2A:

Moving forward with Option 2A fully commits the university to a relatively old technology that is expensive to operate, may become a "stranded asset" and does not use electricity as efficiently as possible. This could be a future option if other technology does not develop but is not advisable at this time.

Option 3 /4:

Moving forward with the steam to hot-water construction project and associated building conversions, does not make sense at this time because;

- Equal or greater GHG reductions are available with Options 2A or 2B
- The long phase-in period (12+ years) will not deliver meaningful emissions reductions for a protracted period of time
- The extremely high cost in both relative and absolute terms when compared to either Options 2A and 2B could not be absorbed without significant budget cuts and negative impacts to our teaching, research and public service mission
- The significant activity/incentives around technological innovation in steam production technology because of the IRA and other decarbonization efforts over the coming years may create other more attractive options.

UNIVERSITY OF OREGON

Questions & Feedback

UNIVERSITY OF OREGON