Team #3: Optimizing Brewery Steam Production with Anheuser-Busch

PURDUE UNIVERSITY | Edwardson School of Industrial Engineering

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Client Background

Anheuser-Busch

100+ Brands

Budweiser · Michelob ULTRA · BUD LIGHT

12 U.S. Breweries

St. Louis, Missouri

Columbus, Ohio

Parent Company

ABInBev

Anheuser-Busch is a leading beverage company in the consumer-packed goods industry, dominating the alcoholic beverage market with 100+ diverse brands in their portfolio. The company operates 12 U.S. breweries and 9 canning plants. With a future focus on sustainability, the company strives to achieve a net-zero emissions value chain by 2040.

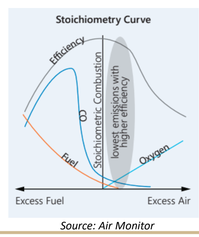
Problem Statement

Anheuser-Busch seeks to reduce emissions by 25% by 2025. AB's steam boilers lose 15-30% of their heat energy due to inefficiencies. These inefficiencies are heightened when the boilers are running at reduced loads, which is often the range of demand for the brewery. The economic feasibility of upgrading to new burners or further optimizing the existing system remains undetermined.

Relevant Knowledge

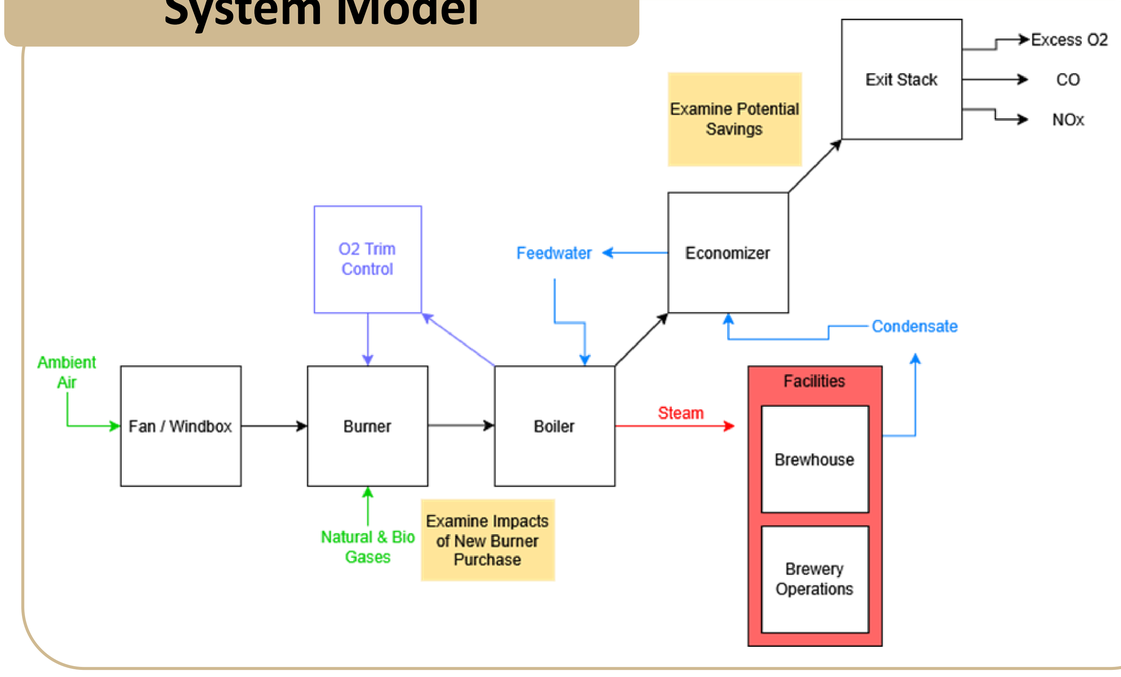
The client asked the group to target **combustion efficiency** to optimize fuel savings.

Efficient combustion is indicated by low **excess O_2** in flue gas, with the target percentage falling around **3%**.



Source: Air Monitor

System Model



Solution

PURDUE UNIVERSITY — Anheuser-Busch

Anheuser-Busch COL Boiler #1: Burner Replacement Financial Analysis (3-Year)

Proposal	
Zeeco Burner Proposal #1	
Date	4/10/2025

Project Costs	
Parts + Components	$150,000
Labor	$10,000
Training	$2,000
Downtime	$0
Other	$25,000
Total Project Cost	$187,000

Key Metrics & Returns	
ROI	**0.40**
ROI (NPV Adjusted)	0.31
IRR	19%

Key Assumptions	
Current NG $	4.00 ($/MMBtu)
NG Cost Growth	1.00% (Annually)
Est. %Less Fuel Consumption	**7.5%**

Note: 'Est. %Less Fuel Consumption' determines %less fuel consumed during low-load operation (10-40% of capacity)

Financial Analysis:	Year 0	Year 1	Year 2	Year 3	Totals	NPV
Parts + Components	$ (150,000)	-	-	-		
Total Project Cost	$ (187,000)	-	-	-		
Est. Pre-Replacement OC	$ -	(1,150,547)	(1,162,053)	(1,173,673)		
Est. Post-Replacement OC	$ -	(1,064,256)	(1,074,899)	(1,085,648)		
Fuel Savings	$ -	86,291	87,154	88,025	$ 261,470	$ 239,305
Net Cash Flow	$ (187,000)	86,291	87,154	88,025	$ 74,470	$ 57,752

Note: 'Fuel Savings' estimatates gains from improved efficiency during low-load operation ONLY (10-40% of capacity)

Note: Efficiency gains realized at loads >40% are considered to be marginal and excluded for a more conservative approach

Sensitivities

ROI	Est. %Less Fuel Consumption								
Monthly Natural Gas Price Growth (%)	4.00%	4.50%	5.00%	5.50%	6.00%	6.50%	7.00%	7.50%	8.00%
0.00%	-0.26	-0.17	-0.08	0.02	0.11	0.20	0.29	0.38	0.48
0.20%	-0.26	-0.17	-0.08	0.02	0.11	0.20	0.29	0.39	0.48
0.40%	-0.26	-0.17	-0.07	0.02	0.11	0.20	0.30	0.39	0.48
0.60%	-0.26	-0.16	-0.07	0.02	0.11	0.21	0.30	0.39	0.49
0.80%	-0.26	-0.16	-0.07	0.02	0.12	0.21	0.30	0.40	0.49
1.00%	-0.25	-0.16	-0.07	0.03	0.12	0.21	0.31	0.40	0.49
1.50%	-0.25	-0.16	-0.06	0.03	0.12	0.22	0.31	0.41	0.50
2.00%	-0.25	-0.15	-0.06	0.04	0.13	0.22	0.32	0.41	0.51
2.50%	-0.24	-0.15	-0.05	0.04	0.14	0.23	0.32	0.42	0.51

A central deliverable of this project is the Cost-Benefit Analysis Tool, designed for adaptability and scalability across all Anheuser-Busch breweries. The tool evaluates the return on investment (ROI) of new boiler equipment purchases by quantifying the financial impact of changes in boiler efficiency. It calculates the potential cost savings—or additional expenses—associated with installing new components that affect steam generation performance. By rapidly estimating the long-term fuel costs of new equipment, the tool supports informed, data-driven investment decisions for both regulatory compliance and operational optimization.

Methodology

Site Visit and Research

Sales engineers on site in Columbus provided insight into the boiler burner market and AB's situation in Columbus. Staff at Wade Utility Plant offered advice regarding a burner replacement that was recently completed.

Anheuser-Busch Columbus, OH Brewery

Purdue University Wade Utility Plant

Current System Analysis

Performance data revealed that desired excess O_2 levels (~3%) could be obtained by the current burner, indicating efficient combustion, but only at mid-high load (40%+). **This motivated the team to look for burner alternatives that could operate more efficiently at low loads.**

Boiler 1		
Firing Range	Excess O2	% Time in Firing Range
11-20%	5.15%	5.29%
21-30%	3.66%	8.13%
31-40%	3.25%	29.88%
40%+	3.13%	56.71%

Boiler 3		
Firing Range	Excess O2	% Time in Firing Range
11-20%	8.76%	3.63%
21-30%	6.15%	38.51%
31-40%	4.73%	30.85%
40%+	3.81%	27.02%

Boiler 2		
Firing Range	Excess O2	% Time in Firing Range
11-20%	N/A	N/A
21-30%	5.78%	2.41%
31-40%	4.42%	15.69%
40%+	3.16%	81.69%

Boiler 4		
Firing Range	Excess O2	% Time in Firing Range
11-20%	6.40%	12.88%
21-30%	5.94%	27.36%
31-40%	4.79%	33.00%
40%+	3.32%	26.56%

Budget Proposals

Working with manufacturers, proposals were acquired for alternative burners, including a breakdown of implementation costs and performance projections.

ZEECO · INDUSTRIAL COMBUSTION · VICTORY ENERGY · CleaverBrooks · JZ

Cost-Benefit Analysis Tool

Based on inputs provided within budget proposals, alternative burner performance is simulated in this tool, quantifying fuel savings due to increased efficiency. These savings are used to "pay back" installation costs over time, yielding ROI and IRR calculations to judge implementation feasibility.

Impact & Future Implications

Regulations

As emissions regulations are growing **stricter**, investing in **low-emissions technology** will ensure **continued compliance** with future standards.

Sustainability

Implementing modern technology leads to reduced emissions which assists in achieving AB's **2040 Net-Zero Value Chain goals**.

Scalability

The tool can be used for **future boiler technology upgrades, complete burner replacement,** and **efficiency calculations** at all U.S. breweries.