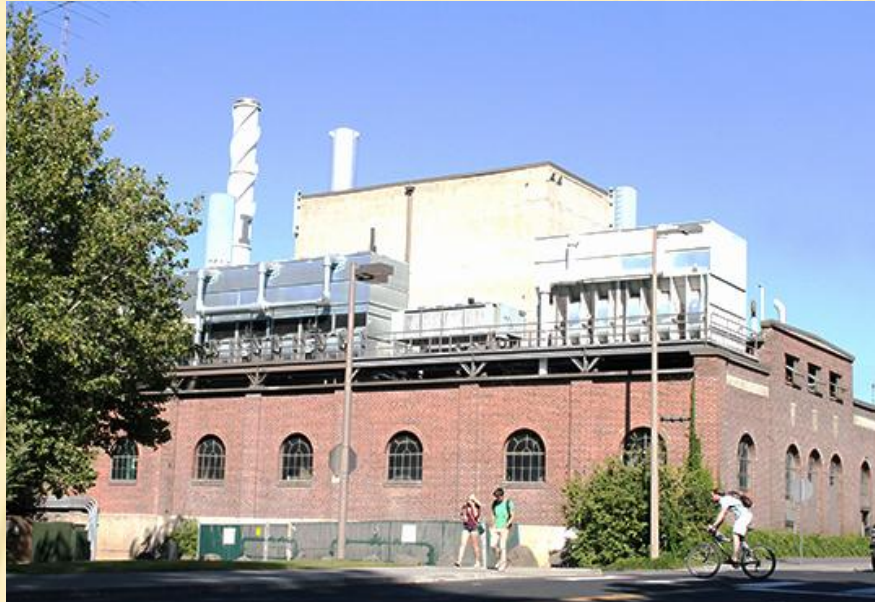


Cogeneration Feasibility Potential Design Review



<http://www.uidaho.edu/~~/media/Images/orgs/Natural-Resources/Facilities%20and%20Labs/Policy%20Analysis%20Group/steam-plant.ashx>

Client: University of Idaho Facilities Services

Team Members: Chris Anderson, Chad Dunkel, Donald Haines and Ryan Oliver

Faculty Advisors: Dr. Tao Xing, Dr. Steve Beyerlein, Dr. Herb Hess

Graduate Mentor: Amrit Dahal

Presentation Outline

Design Review One Accomplishments:

- Determine Two Of Six Models For Continued Analysis
- Establish Criterion For Analysis

Design review 2 material:

- Equipment Placement Within Existing Facility Footprint
- Turbine Savings Comparison Based on Mixed Fuels
- Engineering Economic Analysis
- Operational Considerations

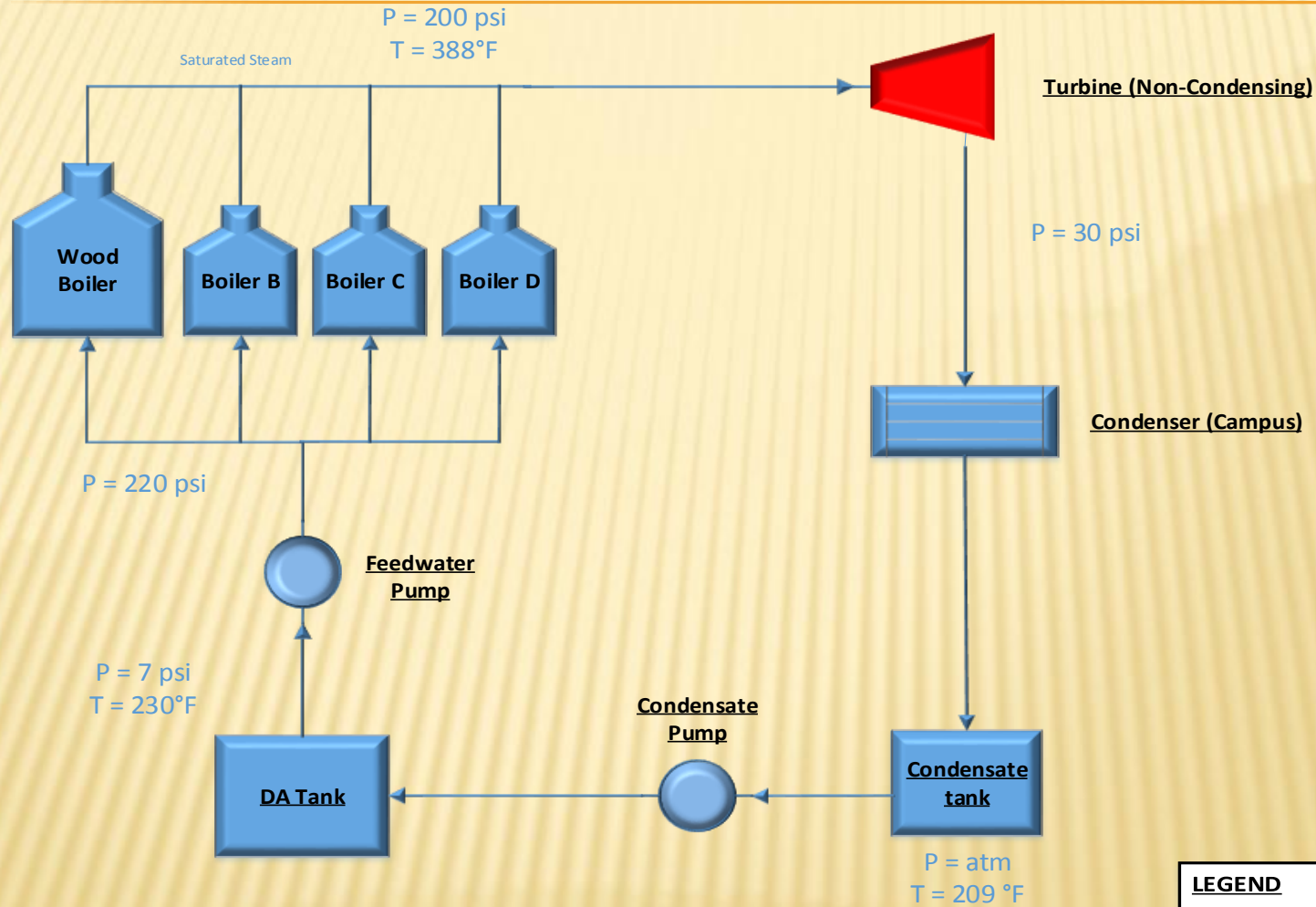
Currently working with Avista to determine:

- Campus Electrical Demand
- Utility Interface



Topics for future consideration:

- Humanistic
- Predictable Outcomes
- Plant Efficiency

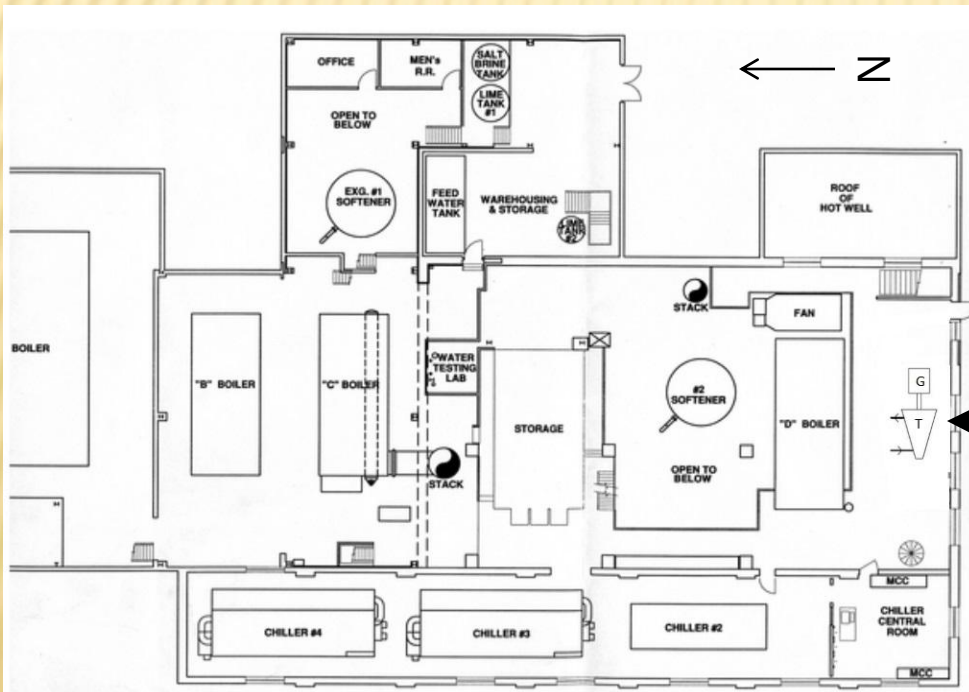
Simple Turbine Model

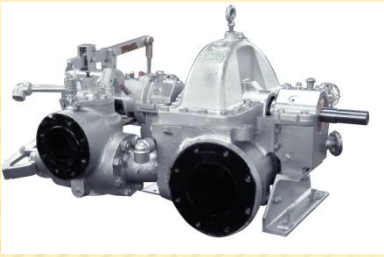


LEGEND

-  Current System Components
-  Proposed System Changes

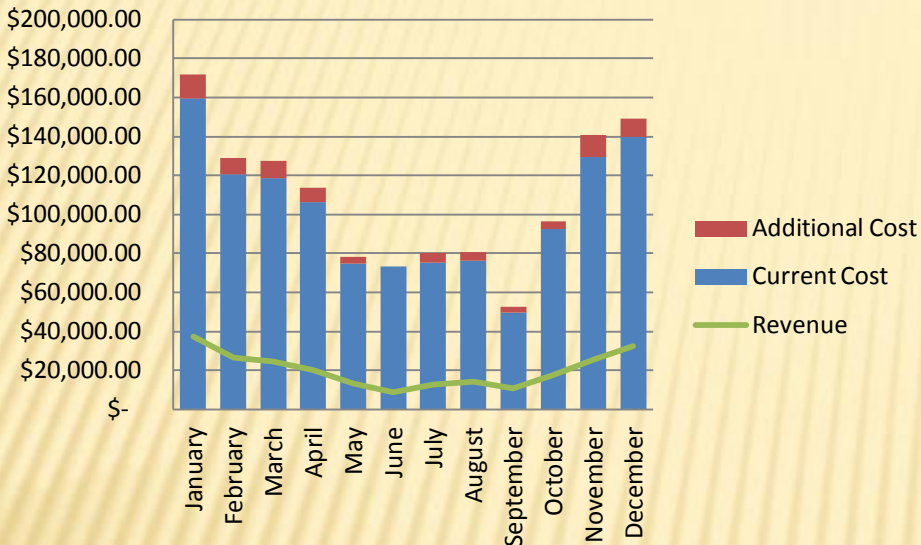
Proposed Turbine Location





Dresser-Rand 703E Frame Simple Turbine System

D-R 703E Fuel Cost and Revenue



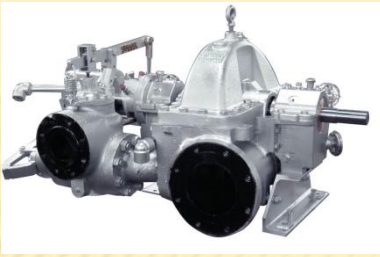
Capital Costs

Turbine=	\$	115,138
Base, couplings=	\$	50,000
Generator=	\$	40,000
Generators controls and contactor=	\$	75,000
Material cost=	\$	280,138
Assumed install of 25%	\$	70,035
System total Capital Investment	\$	350,173

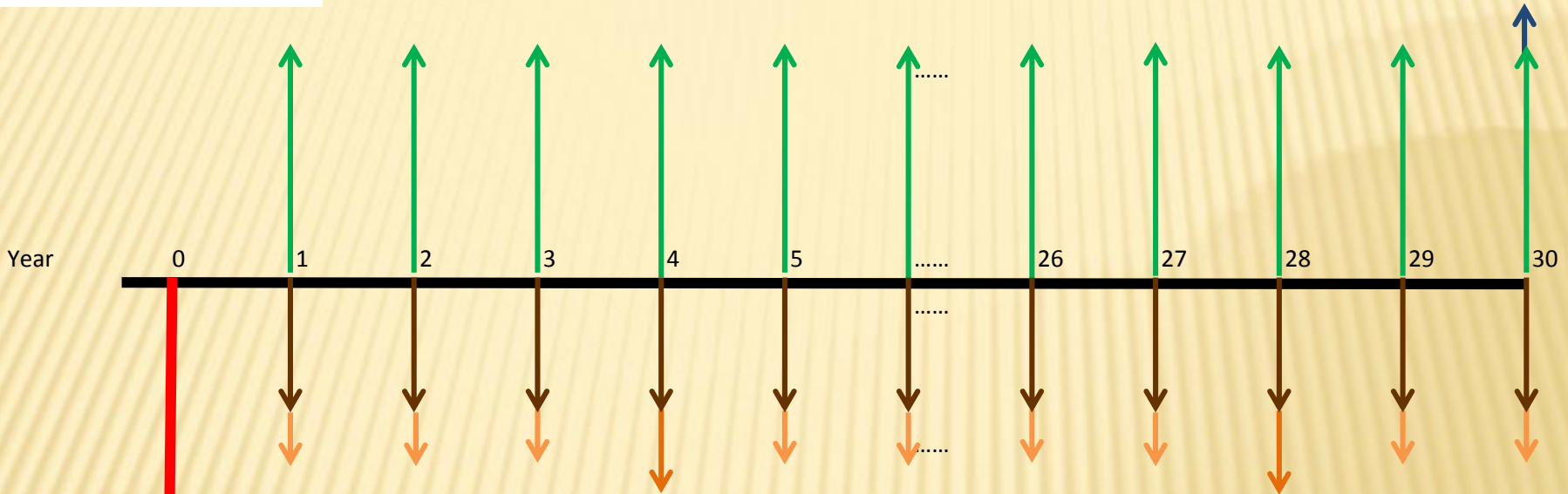
Annual Power Generation (kWh) 4,200,000

Specified Turbine Powers & Speed

	RATED	NORMAL	MINIMUM
Power (HP)	1187 HP	767 HP	322 HP
Generator Output (kW)	873 kW	564 kW	237 kW
Speed (RPM)	3625 RPM	3625 RPM	3625 RPM
Steam Flow (lb/hr)	50,000 lb/hr	35,000 lb/hr	20,000 lb/hr



Dresser-Rand 703e Frame Simple Turbine System Engineering Economic Analysis



Decision criteria, if $IRR > MARR$, do the project!

SPP= 2.16yr

IRR= 45%

MARR= 6%

Capital Investment= \$ 350,172.50

Market Value= \$ 5,000.00

Annual Revenues= \$ 245,056.80

Additional Fuel cost= \$ 76,967.22

Yearly Maintenance= \$ 6,300.00

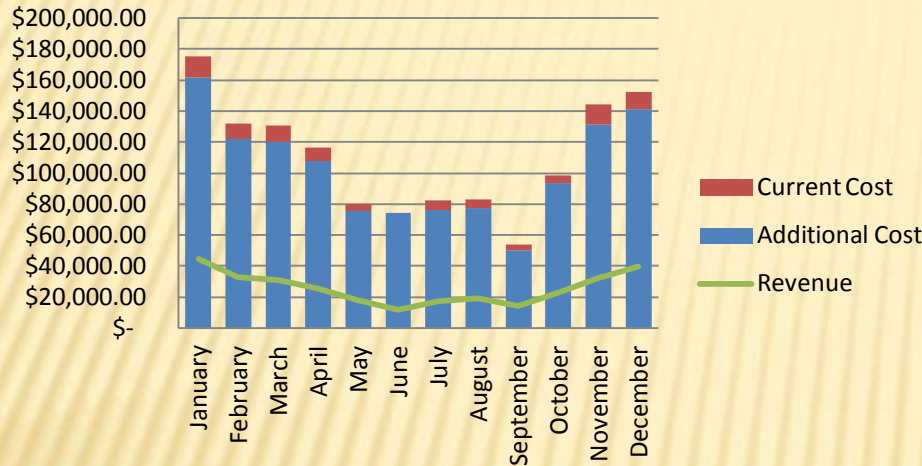
4 Year Maintenance= \$ 28,000.00

Study Period= 30yr



Dresser-Rand K Frame Simple Turbine System

D-R K Frame Fuel Cost and Revenue



Capital Costs

Turbine=	\$ 480,000.00
Base, Couplings, Lube System=	\$ 85,000.00
Generator=	\$ 40,000.00
Genererator Controls and Contactor=	\$ 75,000.00
Material Cost=	\$ 680,000.00
Assumed install of 25% =	\$ 170,000.00
System Total=	\$ 850,000.00

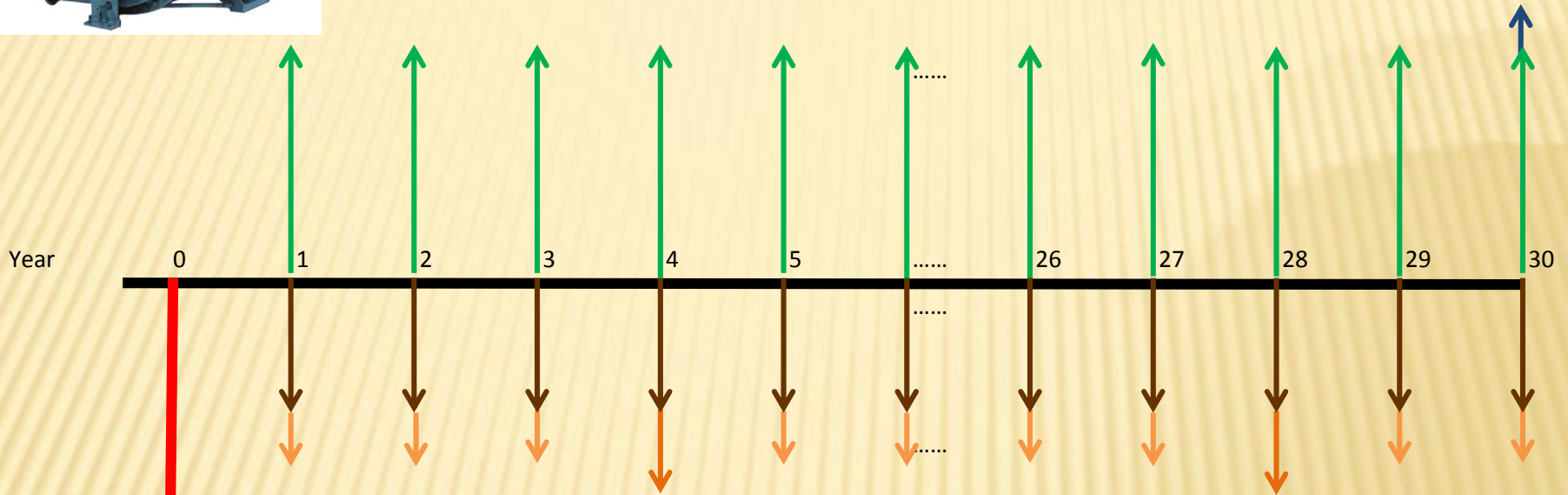
Annual Power Generation (kWh) 5,300,000

Specified Turbine Powers & Speed

	RATED	NORMAL	MINIMUM
Power (HP)	1390 HP	907 HP	430 HP
Generator Output (kW)	985 kW	640 kW	295 kW
Speed (RPM)	3625 RPM	3625 RPM	3625 RPM
Steam Flow (lb/hr)	50,000 lb/hr	35,000 lb/hr	20,000 lb/hr



Dresser-Rand K Frame Simple Turbine System Engineering Economic Analysis



Decision criteria, if $IRR > MARR$, do the project!

SPP= 3.80yr

IRR= 24%

MARR= 6%

Capital Investment= \$ 850,000.00

Market Value= \$ 5,000.00

Annual Revenues= \$ 309,143.60

Additional Fuel cost= \$ 91,965.89

Yearly Maintenance= \$ 6,300.00

4 Year Maintenance \$ 28,000.00

Study Period= 30yr

United Power and Waste Power Purchase Agreement

- UP&W will fully cover the cost of the turbine, install, and maintenance
- Sell to the University at \$.029 kW/hr (Current cost is \$.058 kW/hr)

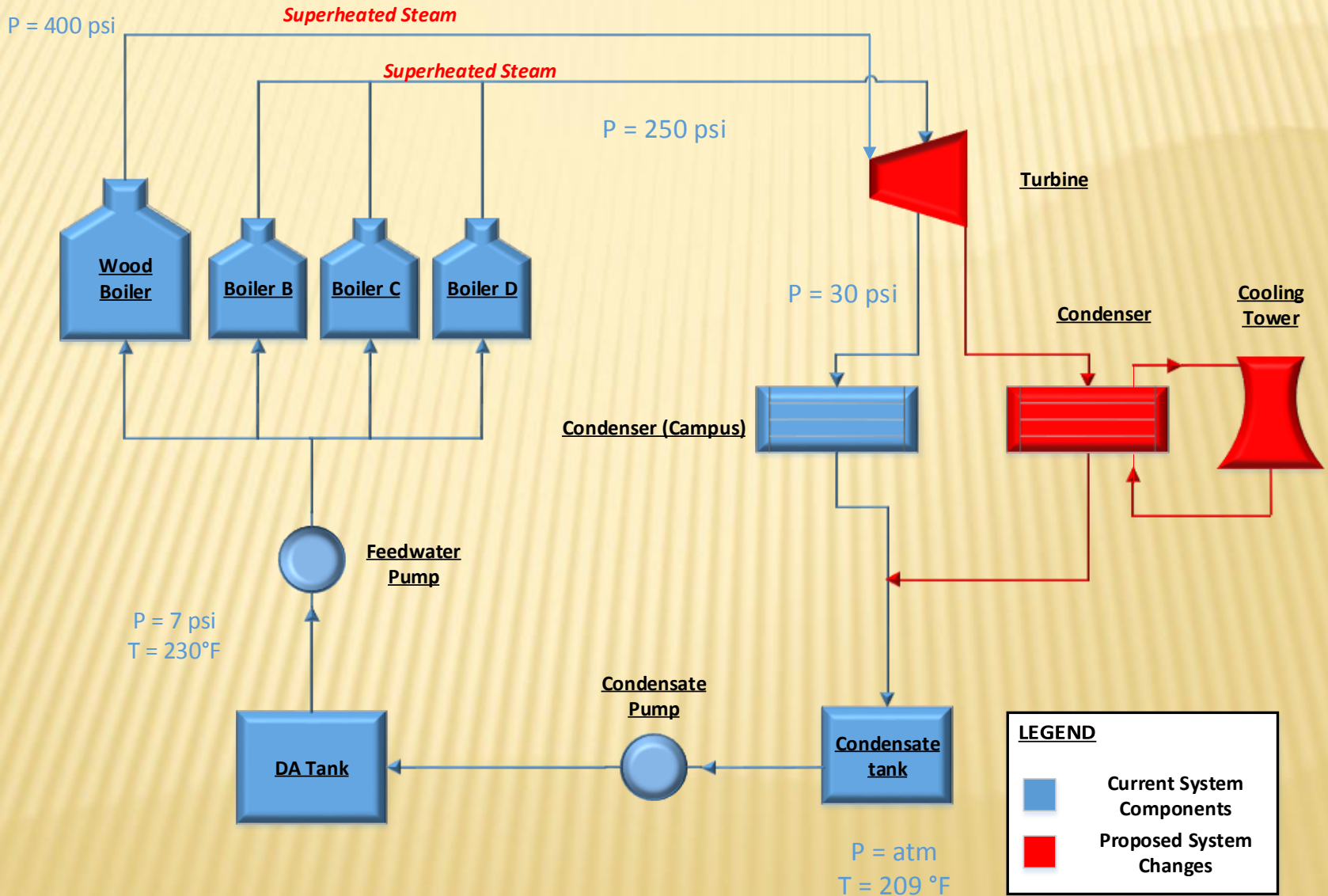
- Model K- PPA Proposal
- Power Generated: 5,300,000 kWh
- Current power cost (@ \$0.0586/kWh): \$309,000
- PPA selling price (@ \$0.029): \$153,700
- Savings from PPA for the University of Idaho: \$155,300
- Annual savings after additional fuel costs: \$63,300

- The overall savings for the Model K turbine operating at 200 psig inlet conditions related to our current system settings would be \$63,000.

United Power and Waste Power Purchase Agreement

- Contract lasts for 15 years.
- Buy-out at 3, 8 or 15 years; typically 100%, 70% & 30% of the installed cost.
- You guarantee a minimum amount of steam for the first 5 years (this is set below the lowest historical level – intended for unusual situations, e.g. you shut down your plant); after that it's as-available.
- University has rights to review the system engineering, monitor & halt operations, etc – we understand that we can't interfere with your system. The existing PRV stays in place so turbine can be by-passed.

Plummer Model Superheated



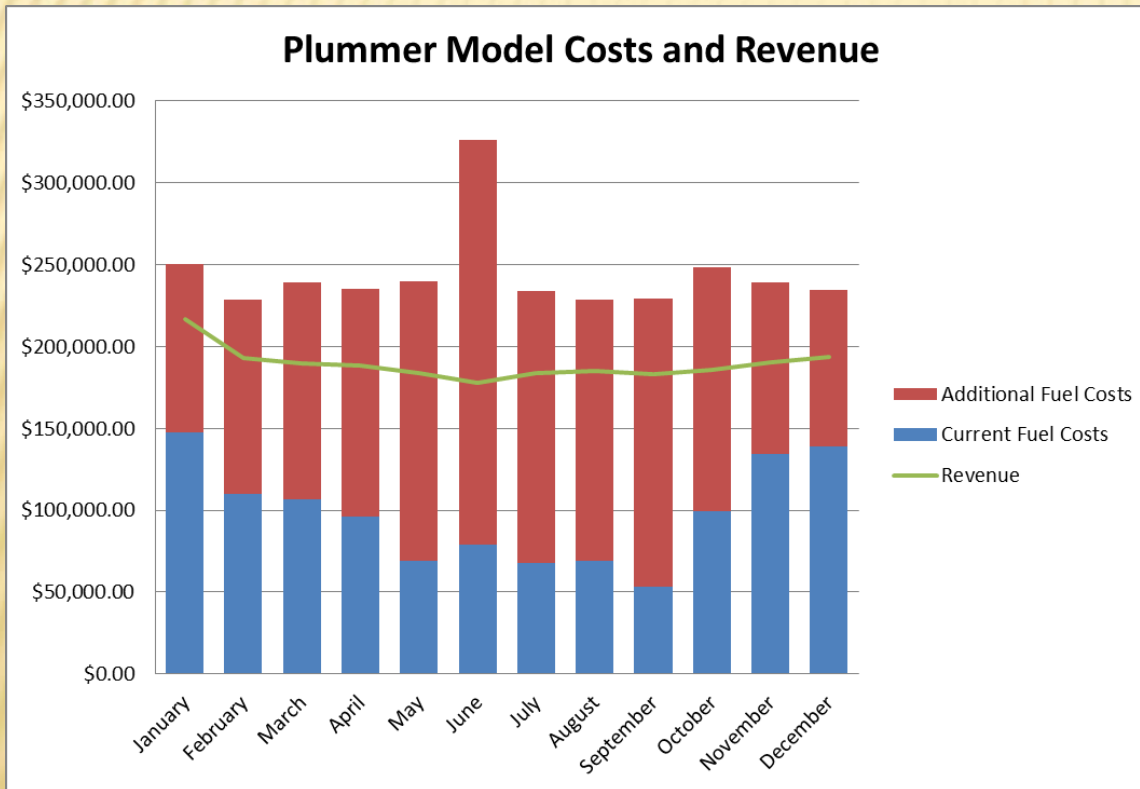
LEGEND	
■	Current System Components
■	Proposed System Changes

Plummer Model Superheated

- Average generation: 5500 kW
- Peak generation: 5800 kW
- Annual savings: \$510,000

Pros

- Close to constant power generation



Cons

- Requires a full condensing system
- High cost implementation
- Large increase in fuel consumption

Future Topics for Consideration

Detailed analysis on:

1. Utility Interface and generator selection

Use of synchronous machine could increase cost by \$100K

Requested: Bus load states and campus load from Avista

2. Maintenance costs

Current estimate based on data provided by Middlebury College for RLH-24 turbine but reduced on recommendation by vendor

Installation costs

Vendors are providing conflicting estimates based on percentages of material cost

Proposed Action: Obtain detailed Installation and Maintenance bids to improve engineering economic analysis

Time Requirement: 2/27- 3/27

Future Topics for Consideration

3. **Compile a comprehensive report to include:**
 - I. Congruence with Long Range Campus Master Plan
 - II. Baseline current plant efficiency vs. proposed model efficiency
 - III. Predicted baseline carbon footprint vs. proposed model carbon footprint
 - IV. Engineering economic analysis
 - V. Calculations section

Time Requirement: 3/27-5/1

4. **Additional client imposed deliverables?**

Question and Answer Session

Validation