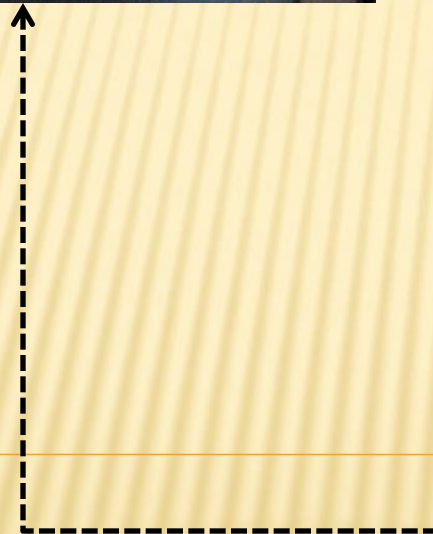


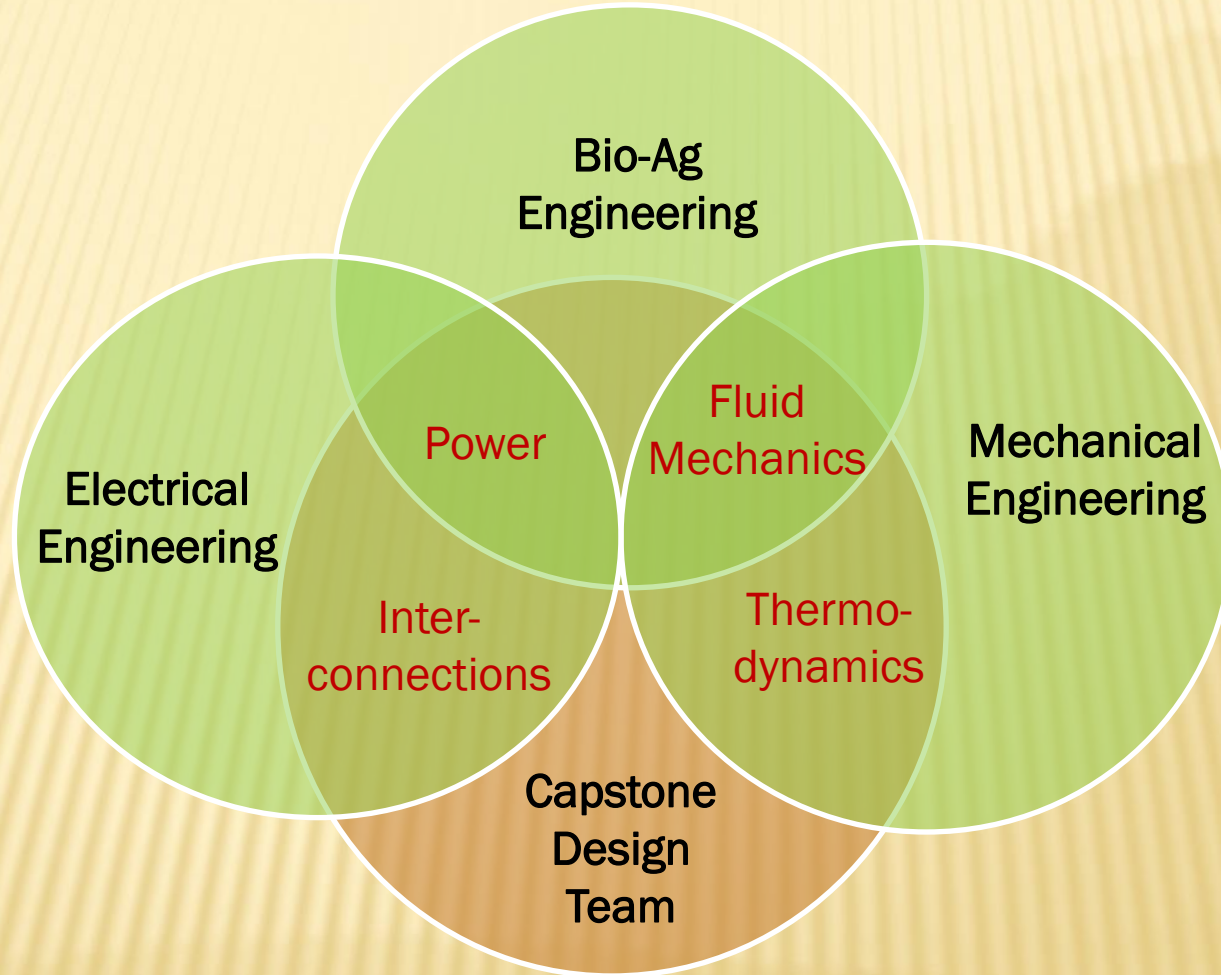
# Cogeneration at the University of Idaho Steam Plant

**Team Members:** Chad Dunkel  
Donald Haines  
Chris Anderson  
Ryan Oliver





# Discipline-Specific Project Contributions



# Current System

*\*This block diagram is neglecting the presence of boiler intake air economizer*



Front Profile of Existing Boilers



Pressure Reducing Valve (PRV)



Feedwater Pump



Condenser (University of Idaho Campus Steam Distribution)

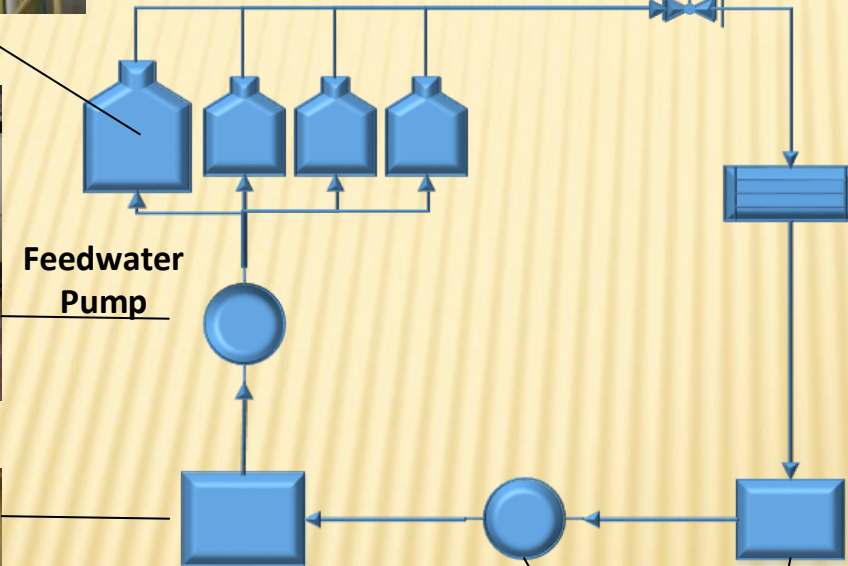


Deaerator Tank

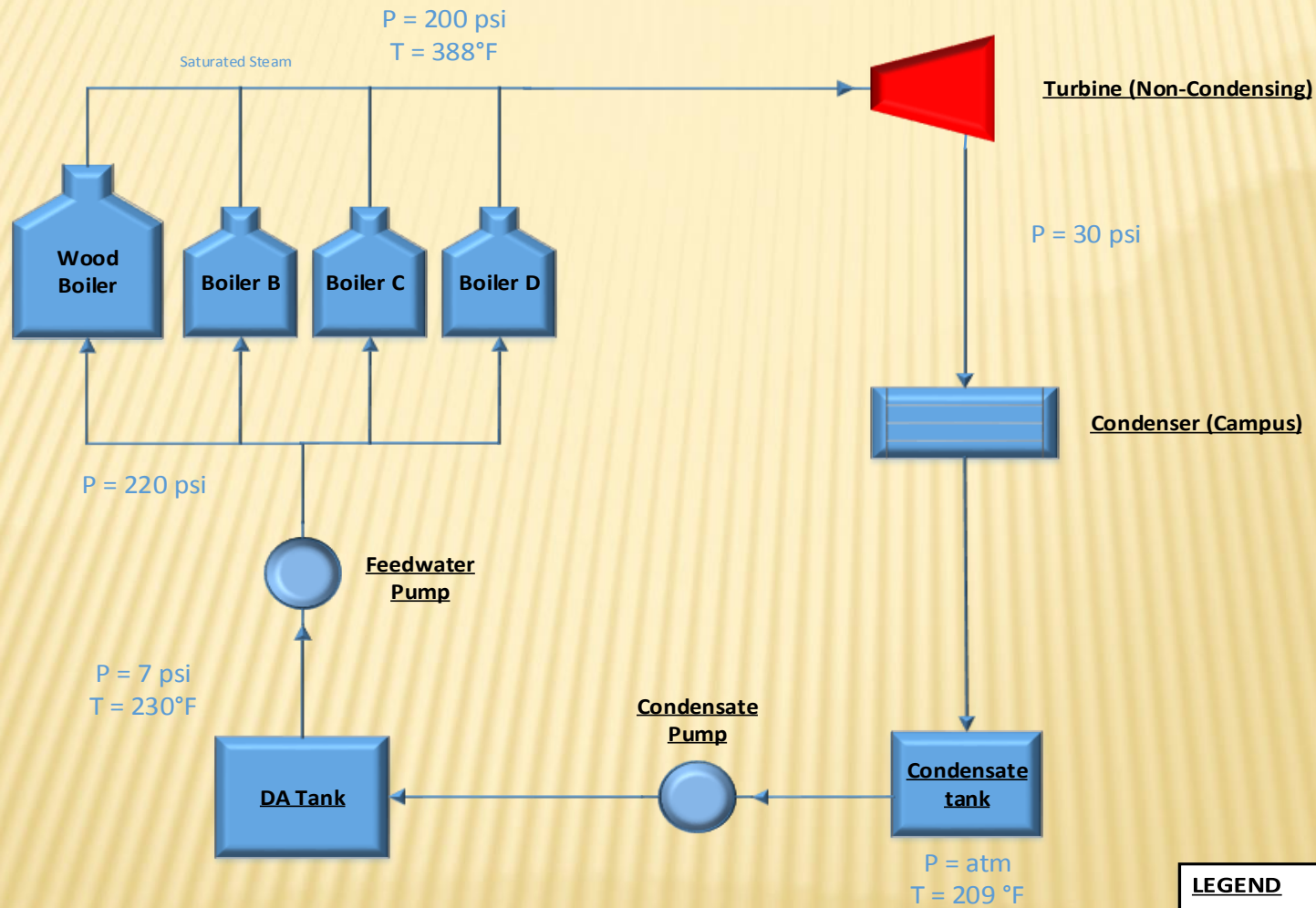




Condensate return tank (right side of image)

Condensate pump (middle of image)



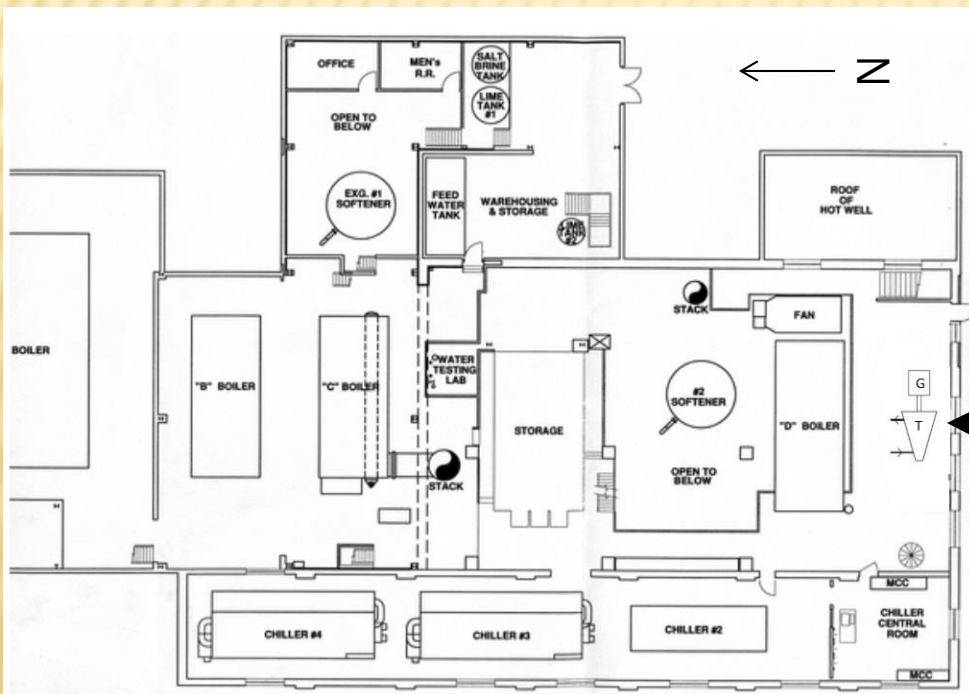
# Cogeneration



LEGEND	
	Current System Components
	Proposed System Changes



# Proposed Turbine Location



# Design Option Comparison

## Nondimensional Scaling

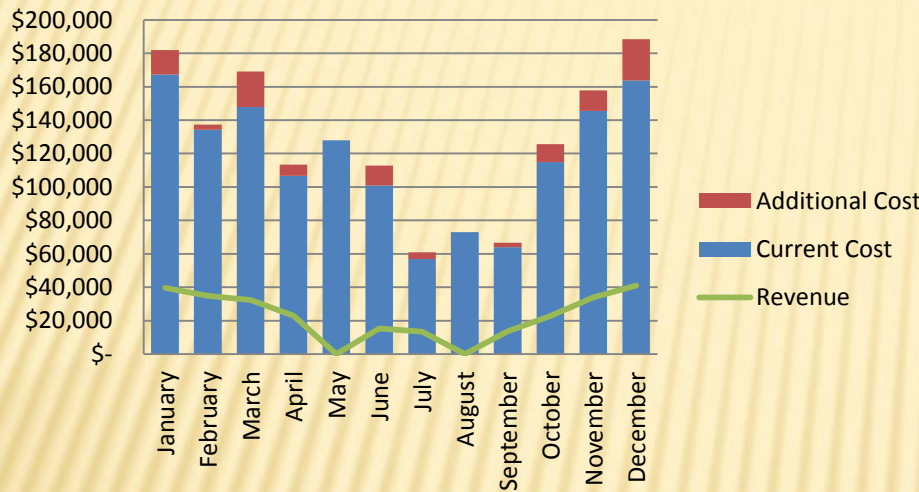
Attribute	<b>ALTERNATIVES</b>					
	<b>Non-Condensing Options</b>			<b>Condensing Options</b>		
	Single Back-Pressure Turbine Model	Two Back-Pressure Turbine Model	Reheat Back-Pressure Turbine Model	Multi-Stage Full Condensing Model (saturated)	Multi-Stage Full Condensing Model (superheated)	Max Generation Model
Boiler Load	1.00	1.00	1.00	0.00	0.00	0.00
Peak Generation (kW)	0.00	0.08	0.11	0.10	0.36	1.00
Annual Savings (\$)	0.94	0.97	0.99	0.83	1.00	0.00
System Modification	1.00	1.00	0.50	0.00	0.00	0.00
Deviation to Current System	1.00	1.00	0.50	0.00	0.00	0.00
Implementation Cost	1	0.5	0.5	0.5	0	0
<b>Sum</b>	<b>4.94</b>	<b>4.55</b>	<b>3.60</b>	<b>1.43</b>	<b>1.36</b>	<b>1.00</b>





# Cogeneration Achieved via a Dresser-Rand K Frame Turbine

## D-R K Frame Fuel Cost and Revenue



### Capital Costs

Turbine=	\$	480,000.00
Base, Couplings, Lube System=	\$	85,000.00
Generator=	\$	45,000.00
Generator Controls and Contactor=	\$	75,000.00
1800 RPM Reduction Gear Adujstment=	\$	315,000.00
Material Cost=	\$	1,000,000.00
Assumed install of 25% =	\$	250,000.00
Interconnection Cost=	\$	250,000.00
<b>System Total=</b>	<b>\$</b>	<b>1,500,000.00</b>
Annual Power Generation (kWh)		5,300,000

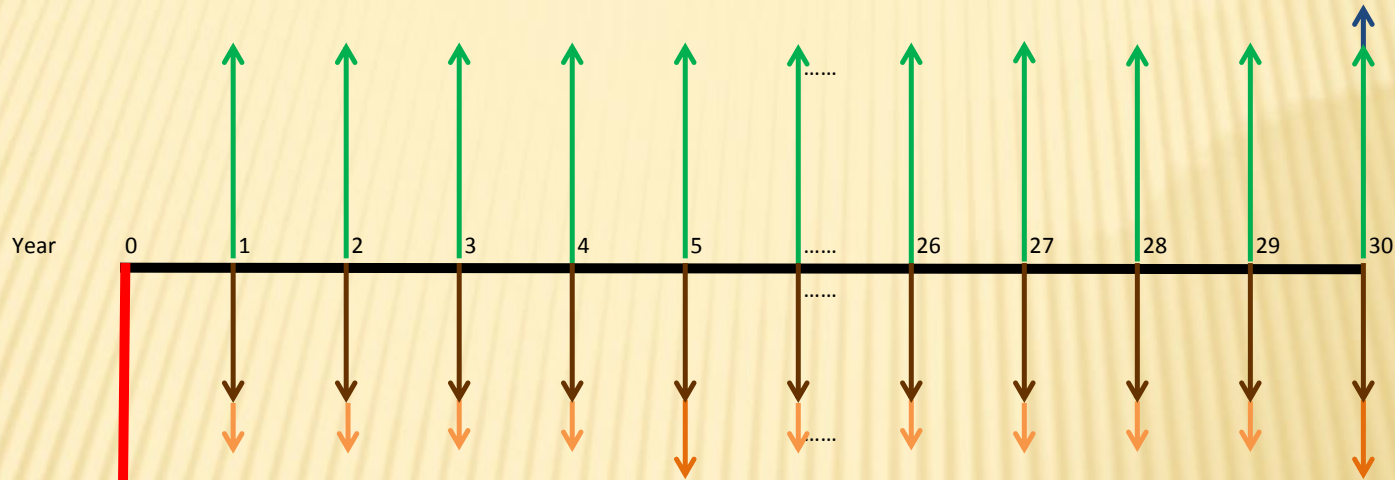
## Specified Turbine Powers & Speed

	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





# Cogeneration Economic Analysis For Dresser-R and K Frame



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

SPP= 7.68 yrs

IRR= 11%

MARR= 6%

**Capital Investment**= \$ 1,500,000.00

**Market Value**= \$ 5,000.00

**Annual Revenues**= \$ 298,546.55

**Additional Fuel cost**= \$ 112,724.87

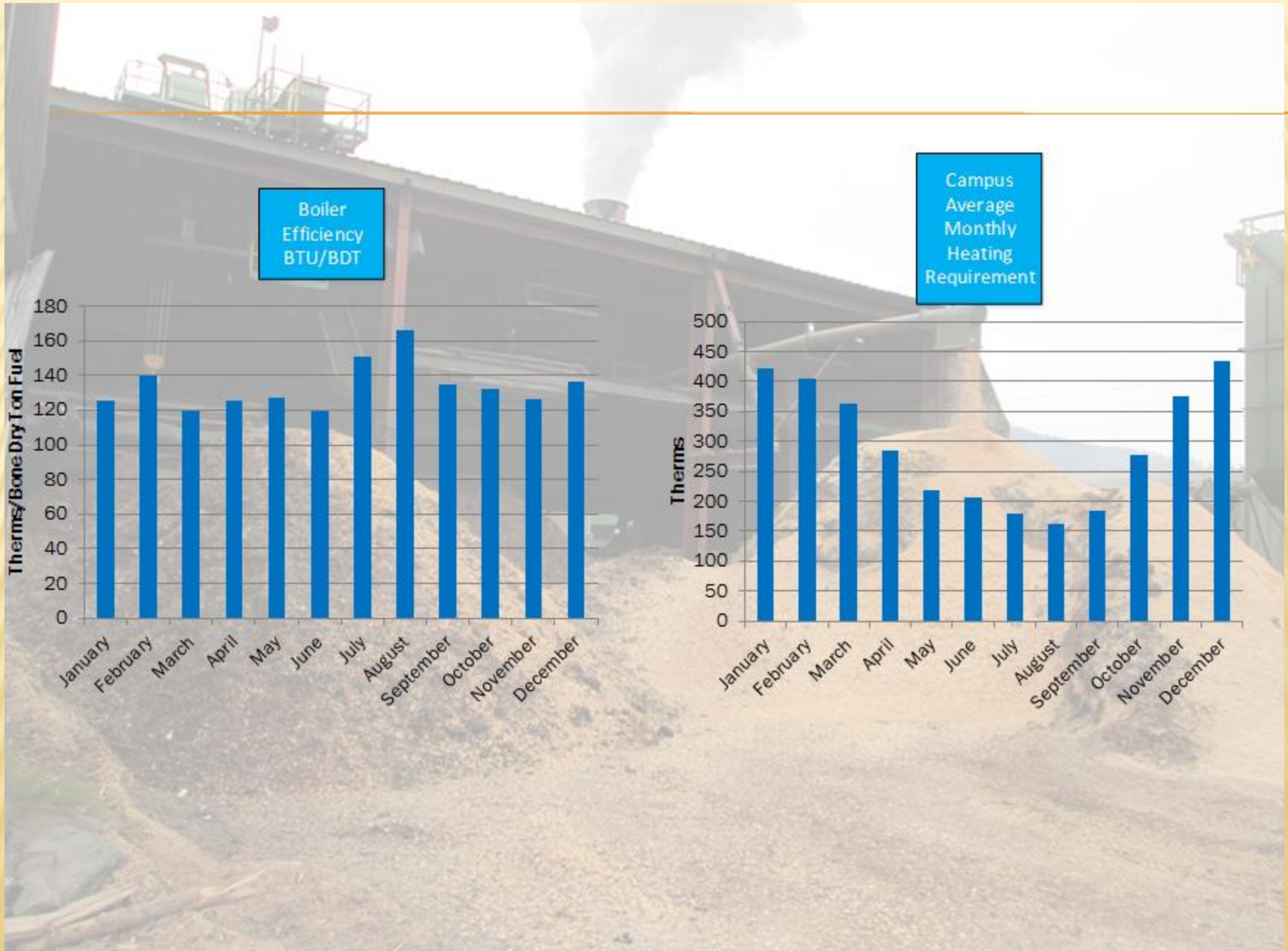
**Yearly Maintenance**= \$ 9,500.00

**5 Year Maintenance** \$ 37,500.00

**Study Period**= 30yr





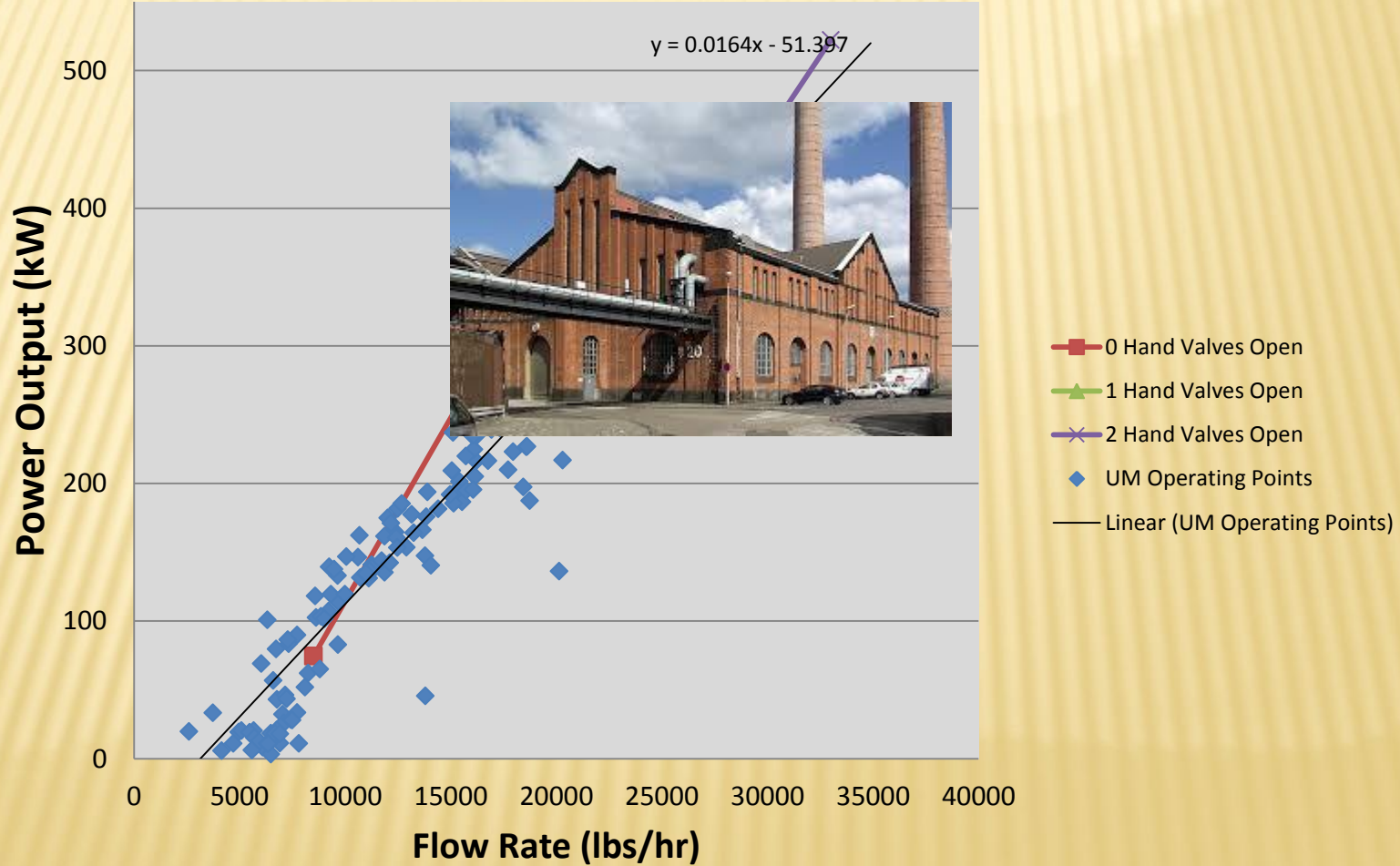






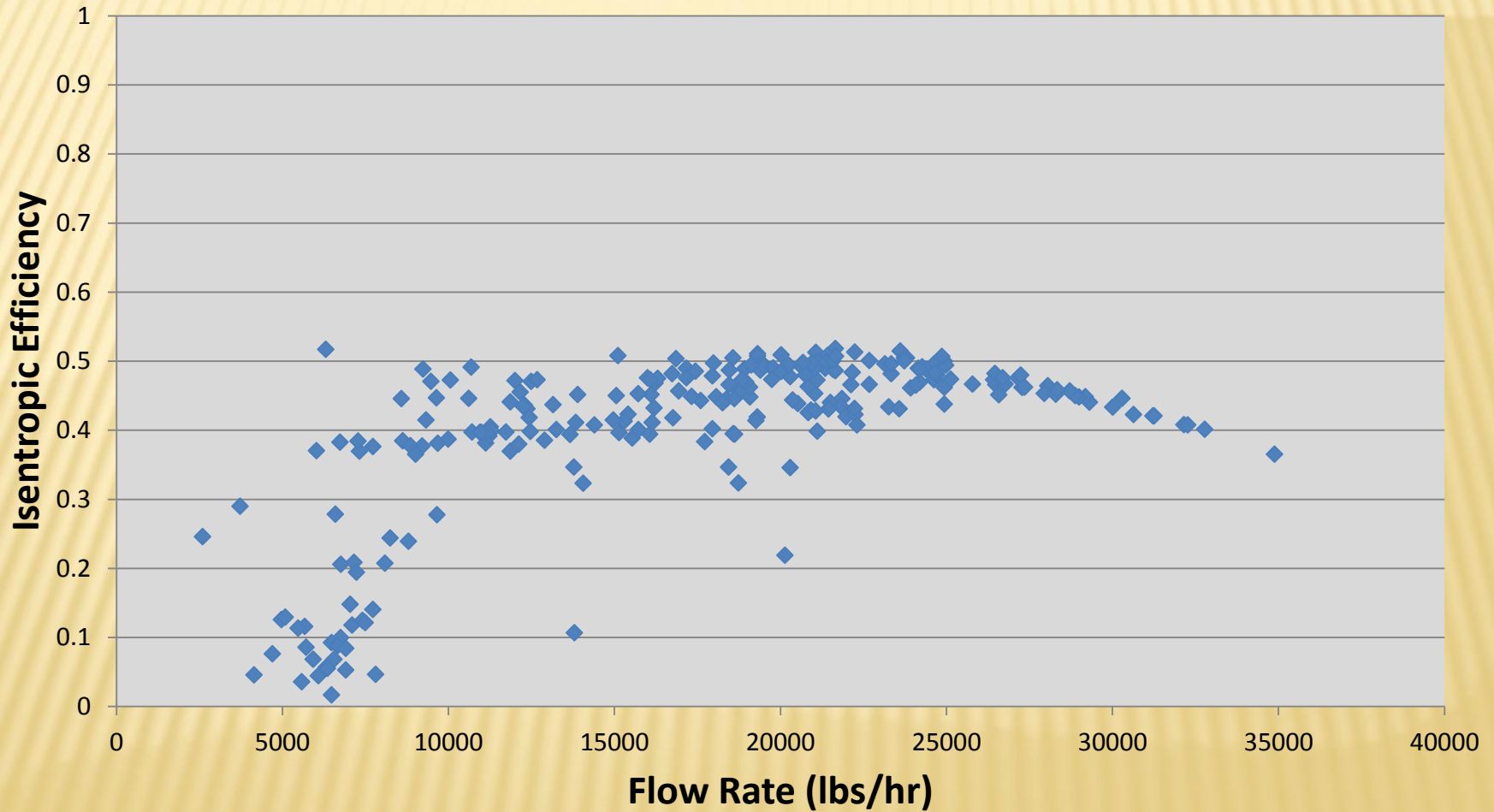
# Montana Validation

## UM Turbine Power Output vs. Flow Rate (2012)



# Montana Validation

## Isentropic Efficiency vs. Flow Rate (2012)

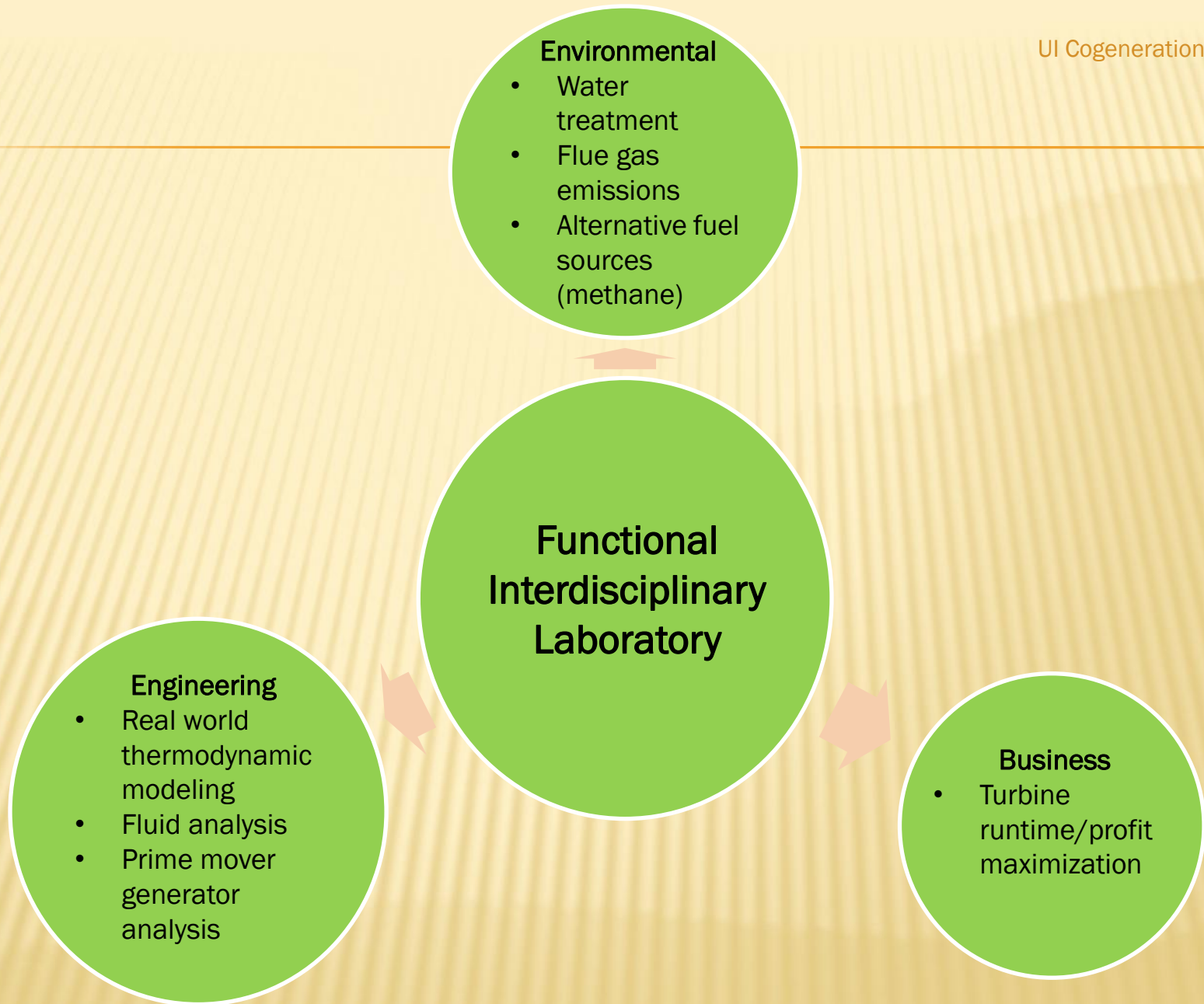




# Montana Validation

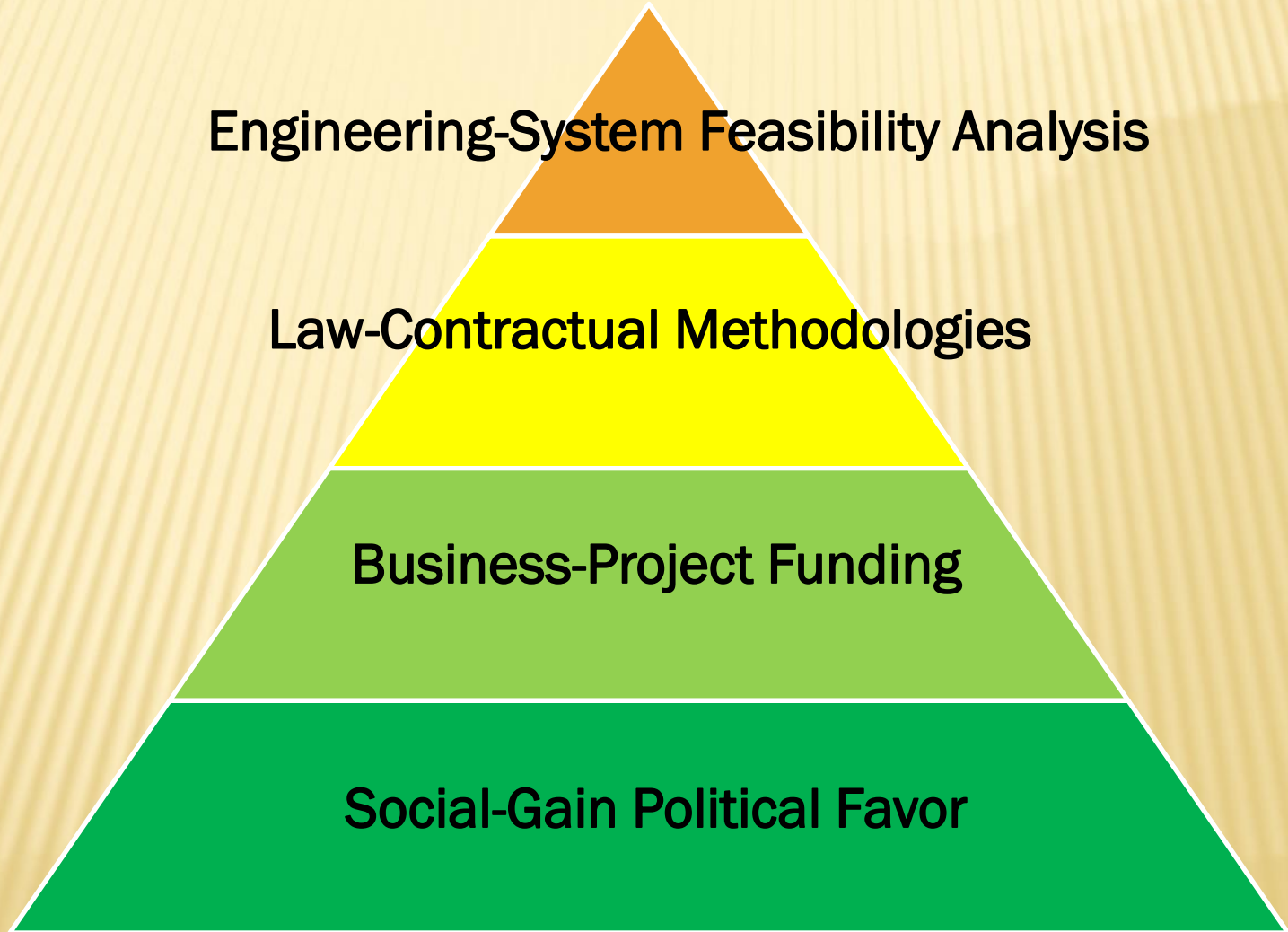
Actual		Theoretical		% Difference
Flow	efficiency	Flow	efficiency	
8500	28.00%	8500	29.19%	4.15%
15500	44.00%	15500	56.02%	24.04%
18000	46.00%	18000	48.24%	4.76%
23000	47.00%	23000	53.93%	13.74%
26500	47.00%	26500	46.81%	0.40%
33000	41.00%	33000	52.63%	24.84%

**Average Difference: 12%**



# Interdisciplinary Project Impediments

---





---

# Question and Answer Session

Validation