$$ DISPATCHING FOR DOLLARS $$

REALIZING INVESTMENT VALUE

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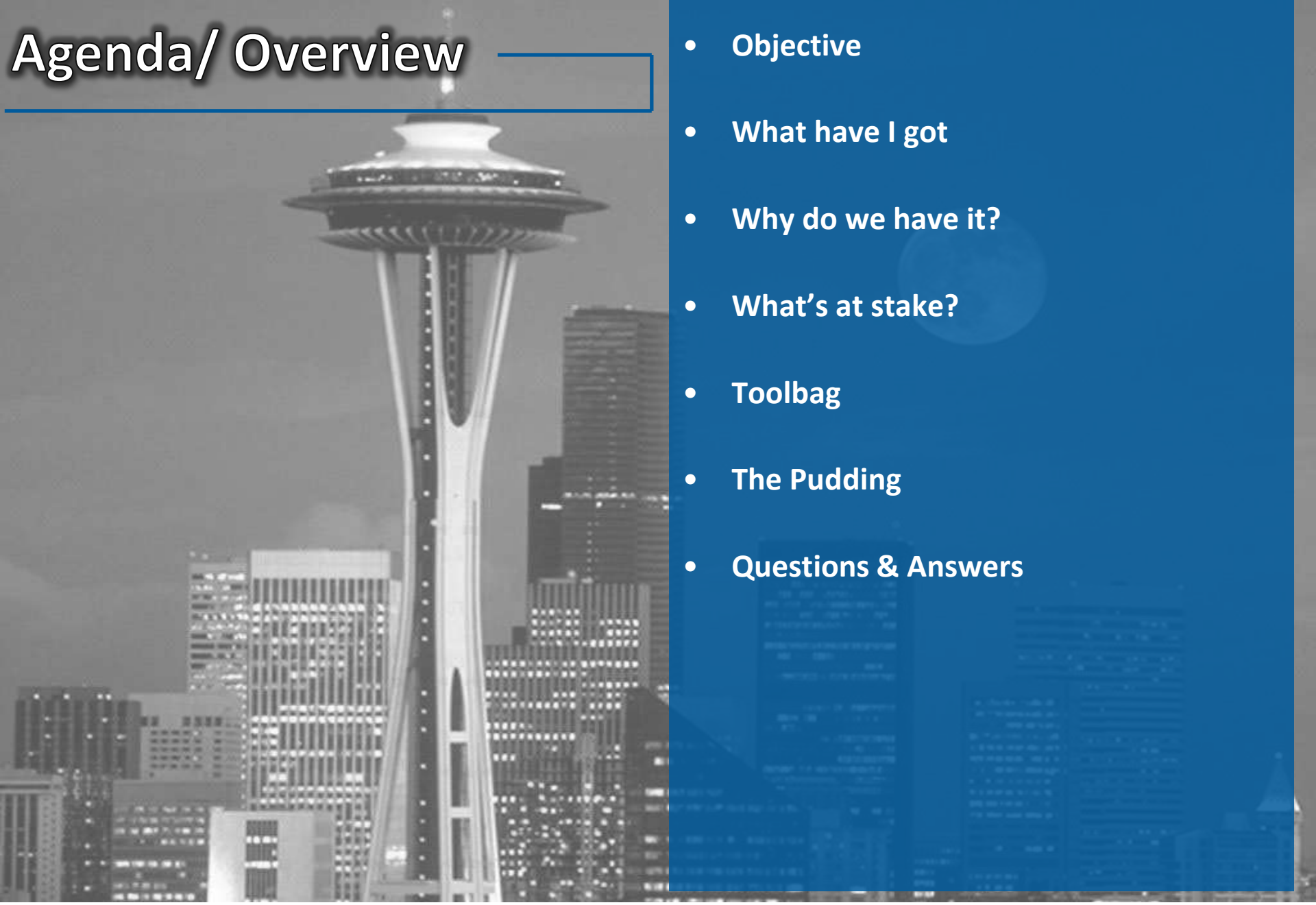
Agenda/ Overview



- Objective
- What have I got
- Why do we have it?
- What's at stake?
- Toolbag
- The Pudding
- Questions & Answers

Objective

3 Years Ago

2 Years Ago

18 Months Ago

4 Months Ago

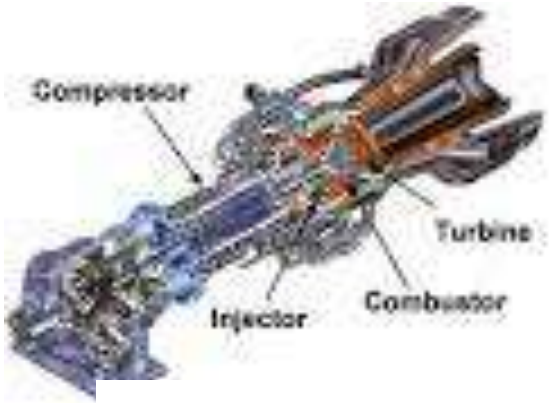
A Week Ago

Objective

TODAY

What Have I Got?

- Combustion Turbine?
- Backpressure Steam Turbine?
- Extraction/Condensing Steam Turbine?
- New Steam Driven Equipment?
- Bunch of Variable Frequency Drives?



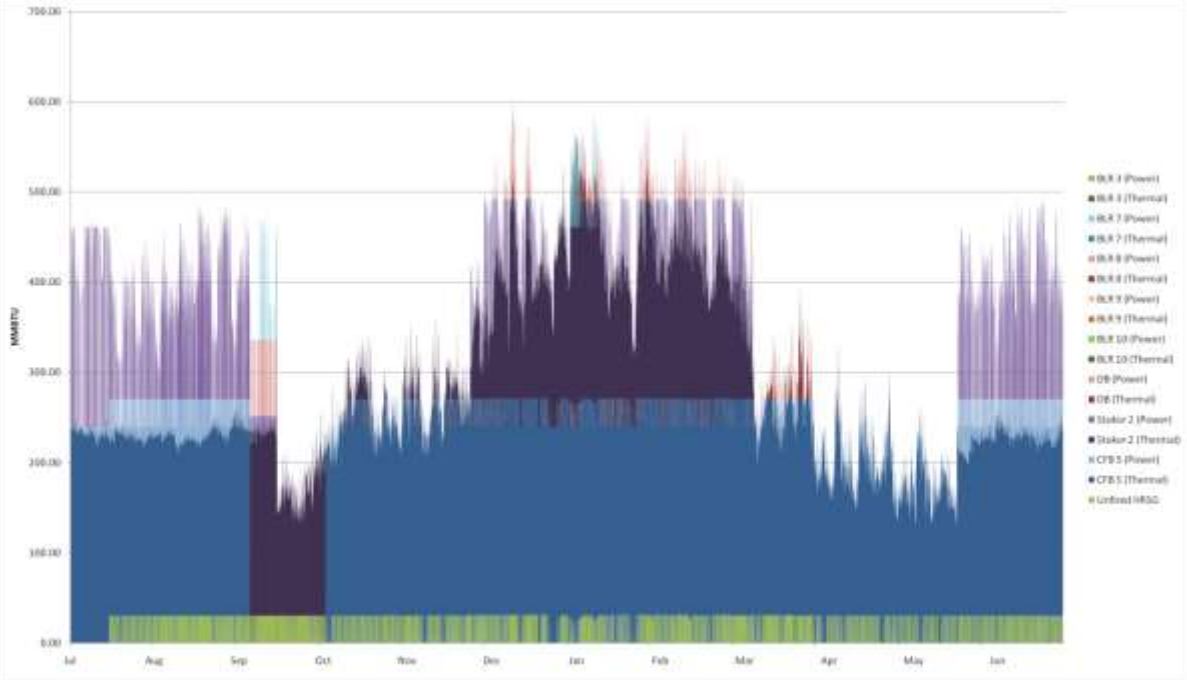
What Have I Got?

- SAFETY
- Performance Curves
  - Do the appropriate people have access to them
- Training
  - Who is getting it? Operators, Engineers, Managers, Accountants
  - When is it happening? Before/After equipment is in operation? During commissioning? In the future?
- PM Schedules
  - Who is contracted to perform?
  - Are they loaded in CMMS software?
  - Has OEM reviewed?
  - Are procedures readily available?
- What are the Limits
  - Ramp Rates
  - Emissions
  - Emergency procedures

Think about these early and often!

Why do I have it?

- Who's Idea Was It?
- What's the Goal?
  - Improve efficiency?
  - Save Money?
  - Increase Reliability?
  - Reduce Emissions?
- What Operating Profile Was Anticipated?
  - 24/7, 365 at 100%
  - Seasonal Loading
  - Daily Loading
  - Cyclic
  - Emergency



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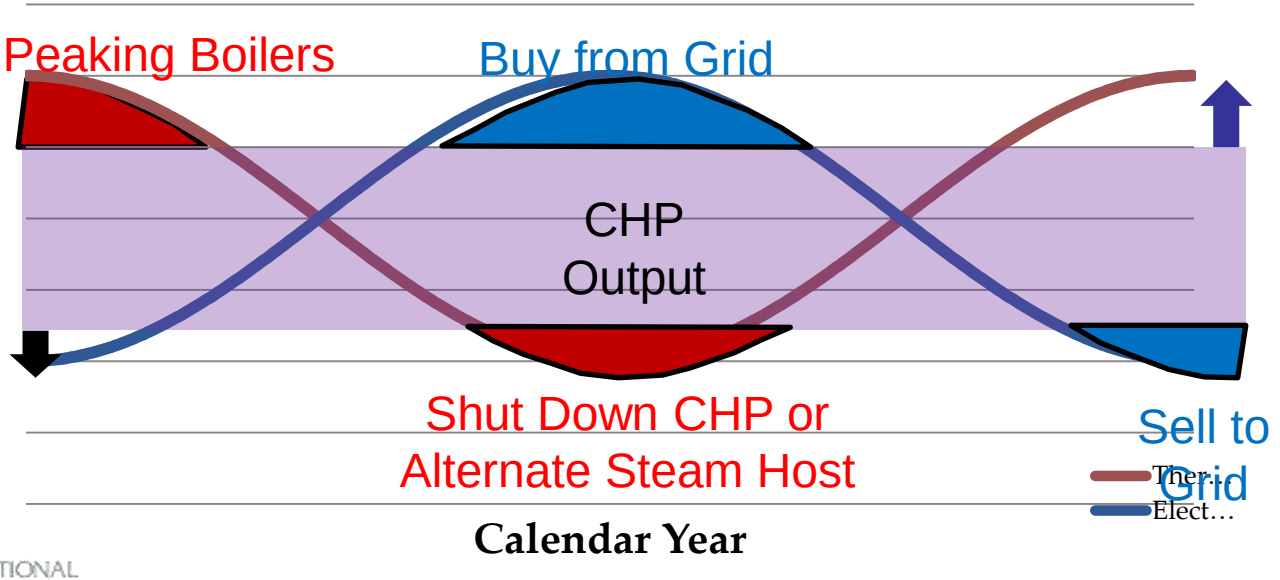
What's at Stake?

- **Emissions Targets**
  - What's the Bogey? 20% Reduction?
  - What's the penalty/reward?
- **Reliability Targets?**
  - Blackstart?
  - % availability?
  - Know the cost of downtime, seasonally.
- **Dollars and Cents**
  - What did the asset cost?
  - What are the anticipated annual, monthly, hourly savings?
  - Know the impact of derates
  - How was the project funded? Performance Contract?
  - WHAT WAS IT SUPPOSED TO SAVE?

TOOLBAG

- What are the right tools for decision making and who needs them?
  - Annually – Senior Management, Accountants, Energy Managers, Commodity Purchasers
  - Seasonally – Maintenance Planners/Managers, Plant Managers, Asset Managers, Dispatchers, Production Managers
  - Monthly/Weekly – Energy Managers, Operators
  - Daily/Hourly – Operators



TOOLBAG

Simple

- Laminated Charts
- Sequencing Charts

Moderate

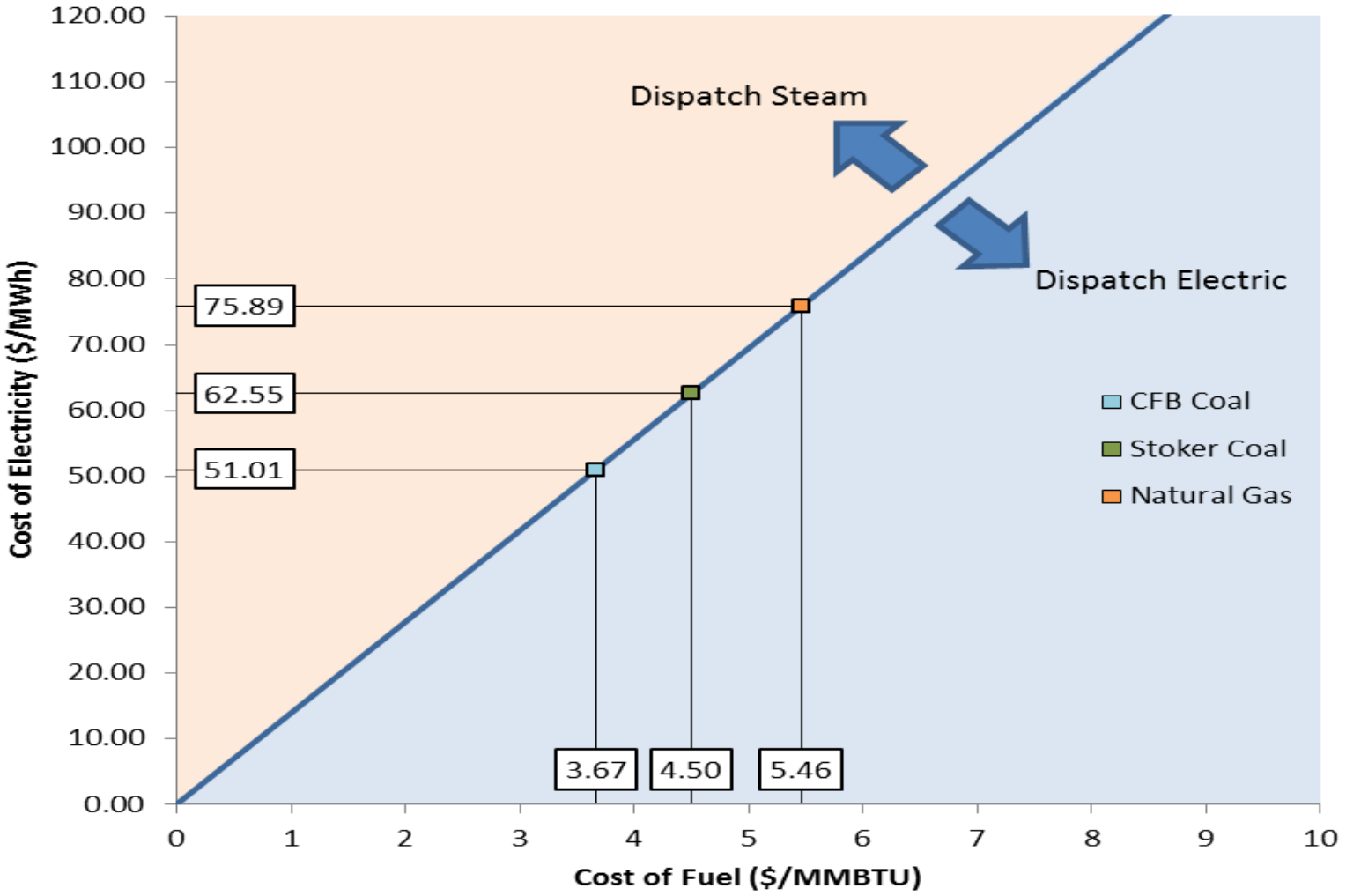
- Spreadsheets
- What if tools

Advanced

- DCS Integrated, real time decisions tools
- Dynamic thermodynamic models

TOOLBAG

SIMPLE



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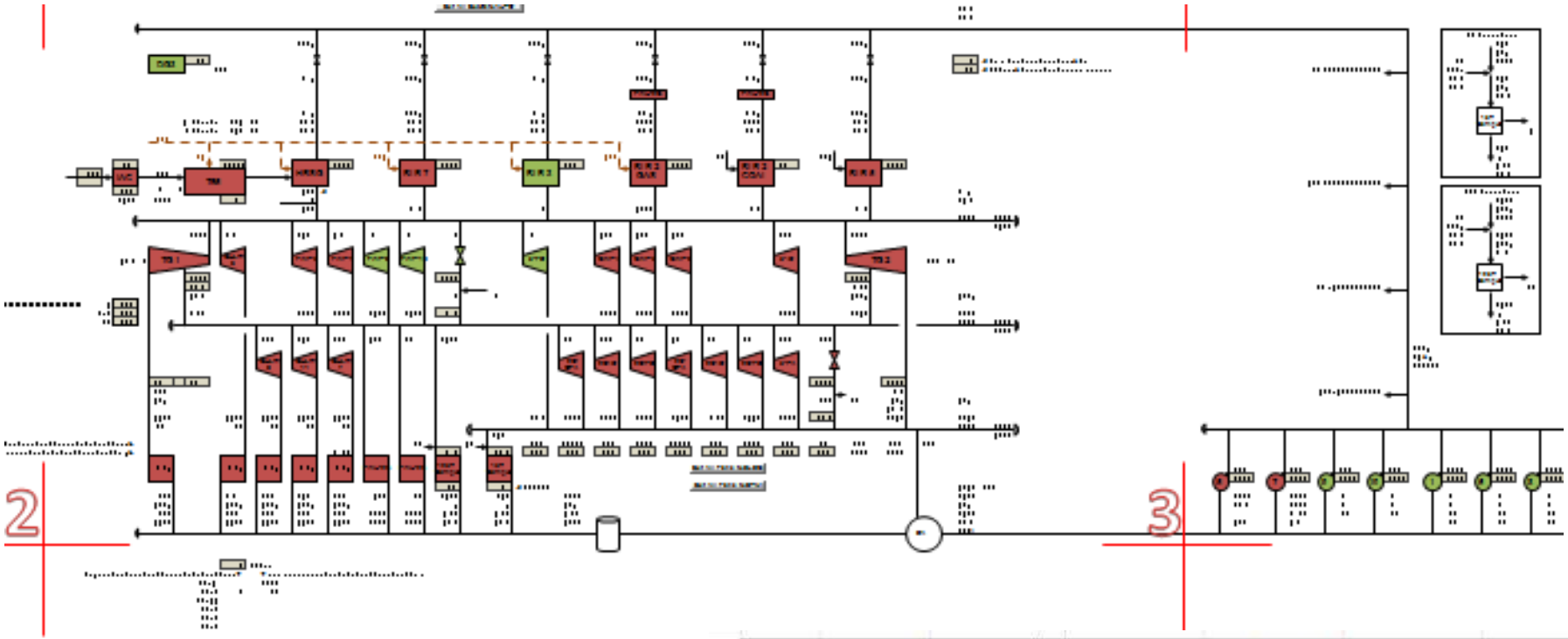
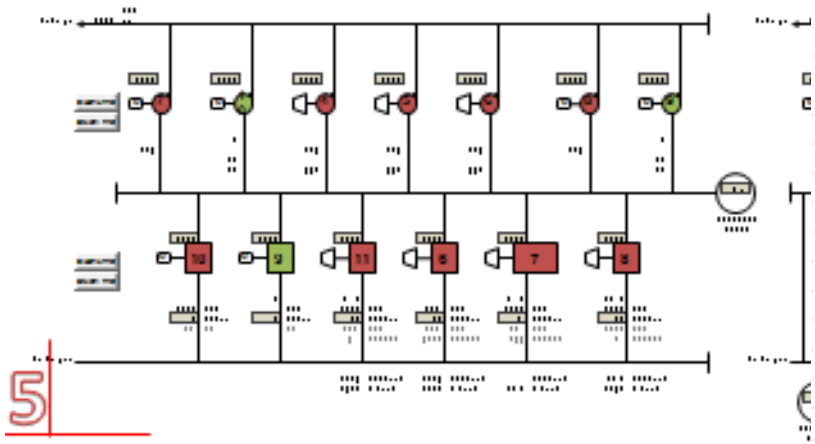
MODERATE





	BASE OPERATION	ALTERNATE OPERATION			
	$/hr	$/hr	$/day	$/month	$/year
BASE PURCHASE	$780	$0	$0	$0	$0
RTP PURCHASE	$600	-$341	-$8,187	-$249,021	-$2,988,178
CTG	$275	$46	$1,106	$33,645	$403,740
DB	$0	$0	$0	$0	$0
Boiler A	$1,309	$0	$0	$0	$0
Boiler B	$0	$327	$7,854	$238,885	$2,866,623
Boiler C	$300	-$300	-$7,195	-$218,838	-$2,626,050
Boiler C1	$866	$188	$4,510	$137,139	$1,646,118
Boiler D	$1,018	$0	$0	$0	$0
DIESEL	$0	$0	$0	$0	$0
TOTAL FUEL	$3,767	$261	$6,275	$190,832	$2,290,431
CURRENT COST	$5,148	-$80	-$1,912	-$58,190	-$697,747

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MODERATE

UNIVERSITY

Inputs and Assumptions

Dispatch Year	2013	
Selected Operation Mode	Peak Follow	
Gas Turbine Model	Taurus 70	
GT Maintenance Start Date	9	month
	1	day
	9/1/2013	
GT Maintenance End Date	9	month
	2	day
	9/2/2013	

HTHWG - 3

Hot Water Output	105000	MBTU
Combustion Efficiency	74%	
Low Fire Limit	7500	MBTU

HTHWG - 4

Hot Water Output	105000	MBTU
Combustion Efficiency	74%	
Low Fire Limit	7500	MBTU

HTHWG - 6

Hot Water Output	40000	MBTU
Combustion Efficiency	83%	
Low Fire Limit	4000	MBTU

Natual Gas Pricing

HP Natural Gas	$4.56	per MMBTU
LP Natural Gas	$3.56	per MMBTU

Electric Rates Sch. 9

Customer Charge	$	247.00	per customer					
Facilities Charge	$	2.12	per kW					
Power Charge								
On-Peak 1	$	13.32	per kW	Months 5	to 9	Hours 13:00	to 21:00	
On-Peak 2	$	9.03	per kW	Months 10	to 4	Hours 7:00	to 23:00	
Off-Peak	$	-						
Energy Charge								
On-Peak 1	$	0.0444	per kWh	Months 5	to 9	Hours 13:00	to 21:00	
On-Peak 2	$	0.0334	per kWh	Months 10	to 4	Hours 7:00	to 23:00	
Off-Peak 1	$	0.0279	per kWh					
Off-Peak 2	$	0.0279	per kWh					
DSM Cost Adjustment		3.21%						

Electric Rates Sch. 31

Customer Charge	$	577.00	per customer					
Facilities Charge	$	3.66	per kW					
Contract Supply		14.9	MW					
Contract Back-Up		3.05	MW					
Back-up Power Charge								
On-Peak	$	0.62	per kW Day	Hours 7:00	to 23:00			
Maint	$	0.31	1/2 On-Peak Charge					
Off-Peak	$	-						
Excess Power Charge								
Primary Voltage	$	43.59	per kW					
DSM Cost Adjustment		3.37%						

Hourly Dispatch Mode

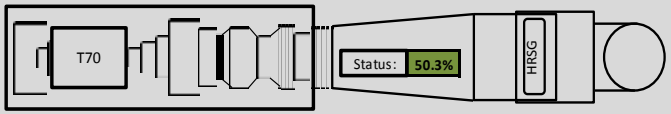
Loads				
Hot Water	75000	MBH	Ambient Air Temp	55 F
Elec Sub Bank #4	6	MW/h		
Elec Sub Bank #5	7	MW/h		
Month	7			
Day	2			
Time	13:00	00:00 military		

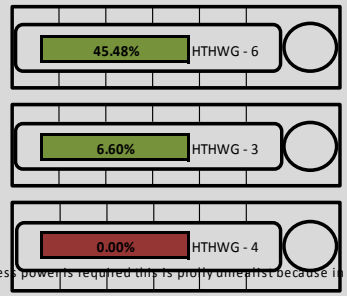
Fuel and Electric Cost

	Gas Cost	kwh Cost	kw Cost	Total Cost
HRSG First	$569	$316	$94,767	$95,652
BLRS First	$341	$595	$178,718	$179,655
T70 Off	$341	$595	$178,718	$179,655

Dispatch Output

Running Operation Mode	Peak Follow
Gas Turbine Avg Load	50%
DB Avg Load	17%
HTHWG - 3 Efficiency	-
HTHWG - 4 Efficiency	-
HTHWG - 6 Efficiency	82%





Fuel and Electic Cost

HRSG First	$8,372,597	per year
BLRS First	$9,671,868	per year
T70 Off	$9,671,868	per year

HRSG Peak Following

Cost	$8,293,432	**Most economicaly combination
Starts Stops	601	* This is happening every eight hours during the all year except when excess power is required this is pretty unrealist because in reality this maybe unpredictable and an abserd number of swings
Hours T70 off	4341	

ADVANCED

- DCS Integrated Dispatch Recommendations
- Dynamic thermodynamic modeling that measures and predicts plant and equipment performance including degradation.
- Commodity Market and weather inputs
- Economic reporting

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Location	Newark
Prime Mover	Titan 250

Update Input Fields

Load GateCycle

Design	
Ambient Temperature (F)	55
Relative Humidity	0.6
Elevation (ft)	30
Engine Power Output (kW)	21,340
Engine Net Heat Rate (Btu/kW-hr, LHV	8,952
Engine Exhaust Flow (lb/hr)	541,124
Engine Exhaust Temp (F)	869

Run This Case

Run & Update Summary

Run & Update All Cases

Off Design	99% Fired	99% Unfired	1% No IC Fired	1% No IC Unfi	1% IC Fired	1% IC Unfired	ISO Fired	ISO Unfired
Ambient Temperature	15.5	15.5	91	91	91	91	59	59
Ambient Relative Humidity	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Equivalent Elevation	30	30	30	30	30	30	30	30
Net Power	23,493	23,493	17,800	17,800	17,800	17,800	21,006	21,006
Net Heat Rate	8,881	8,881	9,428	9,428	9,428	9,428	8,981	8,981
Exhaust Gas Outlet Flow	578,616	578,616	480,324	480,324	480,324	480,324	535,248	535,248
Exhaust Gas Outlet Temperature	848	848	911	911	911	911	872	872

GC Version:
Date:
Starting Time:
ol\Gatecycle — Ending Time:
Status:

s		UOM	Description	Case No Value
		F	Ambient Temperature	40.8
			Ambient Relative Humidity	0.6
		ft	Equivalent Elevation	20
		MW	Net Power	22.2
		BTU/kW-hr	Net Heat Rate	8,905
		lb/hr	Exhaust Gas Outlet Flow	556,889
		F	Exhaust Gas Outlet Temperature	860
		kW	Auxiliary Losses	187
			Elect. Chiller Method Flag	0
		F	Desired Gas Outlet Temperature	40.8
		psig	Outlet Pressure	350
		psig	Desired Exit Pressure	426
			Firing Method Flag	1
		F	Desired Burner Exit Temperature	1500
SPHT1[SPHT]	SuperheaterODMethodFlag[0]		Superheater OD Method Flag	3
TMX1[TMIX]	DesiredOutletTemperature[0]	F	Desired Outlet Temperature	750
V1[PIPVLV]	DesiredInletPress[0]	psig	Desired Exit Pressure	750
AUX1[AUXBLR]	DesiredFlow [0]	lb/hr	Desired Flow rate	0
ST1[ST]	BypassSTFlag[0]		Bypass ST Flag	Y
ST1[ST]	Pres[1]		ST Exit Pressure	750
ST1[ST]	UserInputEfficiency[0]		Overall Efficiency	0.871039867
SYSTEM[SYSTEM]	BOPLossasFixedValue[0]	kW	BOP Loss as Fixed Value	400
SPHTP[MACRO]	Enabled[0]		Macro Enabled	Y
STEP[MACRO]	Enabled[0]		Macro Enabled	N
MU1[MAKEUP]	Temp[1]	F	Outlet Temperature	125
GateCycle Outputs				
SYSTEM[SYSTEM]	AmbientTemperature[0]	F	Ambient Temperature	41
SYSTEM[SYSTEM]	AmbientRelativeHumidity[0]		Ambient Relative Humidity	1
SYSTEM[SYSTEM]	EquivalentElevation[0]	ft	Equivalent Elevation	20
DB1[BURNER]	MethodFlag[0]		Firing Method Flag	1
ELC1[CHILLR]	ElectChillerMethodFlag[0]		Elect. Chiller Method Flag	0
S35[GAS]	Pres[1]	psig	Outlet Pressure	350
C1[GTCOMP]	Pres[1]	psig	Main Outlet Pressure	426
S24[SINK]	Flow [0]	lb/hr	Inlet Flow	134,648
S24[SINK]	Pres[0]	psig	Inlet Pressure	747
S24[SINK]	Temp[0]	F	Inlet Temperature	750
S24[SINK]	Enth[0]	BTU/lb	Inlet Enthalpy	1372
ST1[ST]	Flow [0]	lb/hr	Steam Inlet Flow	146616
ST1[ST]	Pres[0]	psig	Steam Inlet Pressure	750
ST1[ST]	Temp[0]	F	Steam Inlet Temperature	750
ST1[ST]	Enth[0]	BTU/lb	Steam Inlet Enthalpy	1372
ST1[ST]	Flow [1]	lb/hr	Main Outlet Flow	146616
ST1[ST]	Pres[1]	psig	Main Outlet Pressure	750
ST1[ST]	Temp[1]	F	Main Outlet Temperature	750
ST1[ST]	Enth[1]	BTU/lb	Main Outlet Enthalpy	1372
FPT1[FPTMOD]	Flow [1]	lb/hr	Outlet Flow	67,324
FPT1[FPTMOD]	Pres[1]	psig	Outlet Pressure	0
FPT1[FPTMOD]	Temp[1]	F	Outlet Temperature	180
FPT1[FPTMOD]	Enth[1]	BTU/lb	Outlet Enthalpy	148
S31[SOURCE]	Flow [1]	lb/hr	Outlet Flow	70,163
S31[SOURCE]	Pres[1]	psig	Outlet Pressure	0
S31[SOURCE]	Temp[1]	F	Outlet Temperature	70
S31[SOURCE]	Enth[1]	BTU/lb	Outlet Enthalpy	38
DA1[DEAER]	Flow [2]	lb/hr	Main BFW Inlet Flow	134,487
DA1[DEAER]	Pres[2]	psig	Main BFW Inlet Pressure	15
DA1[DEAER]	Temp[2]	F	Main BFW Inlet Temperature	125
DA1[DEAER]	Enth[2]	BTU/lb	Main BFW Inlet Enthalpy	93
DA1[DEAER]	Flow [0]	lb/hr	Main Steam Inlet Flow	11,968

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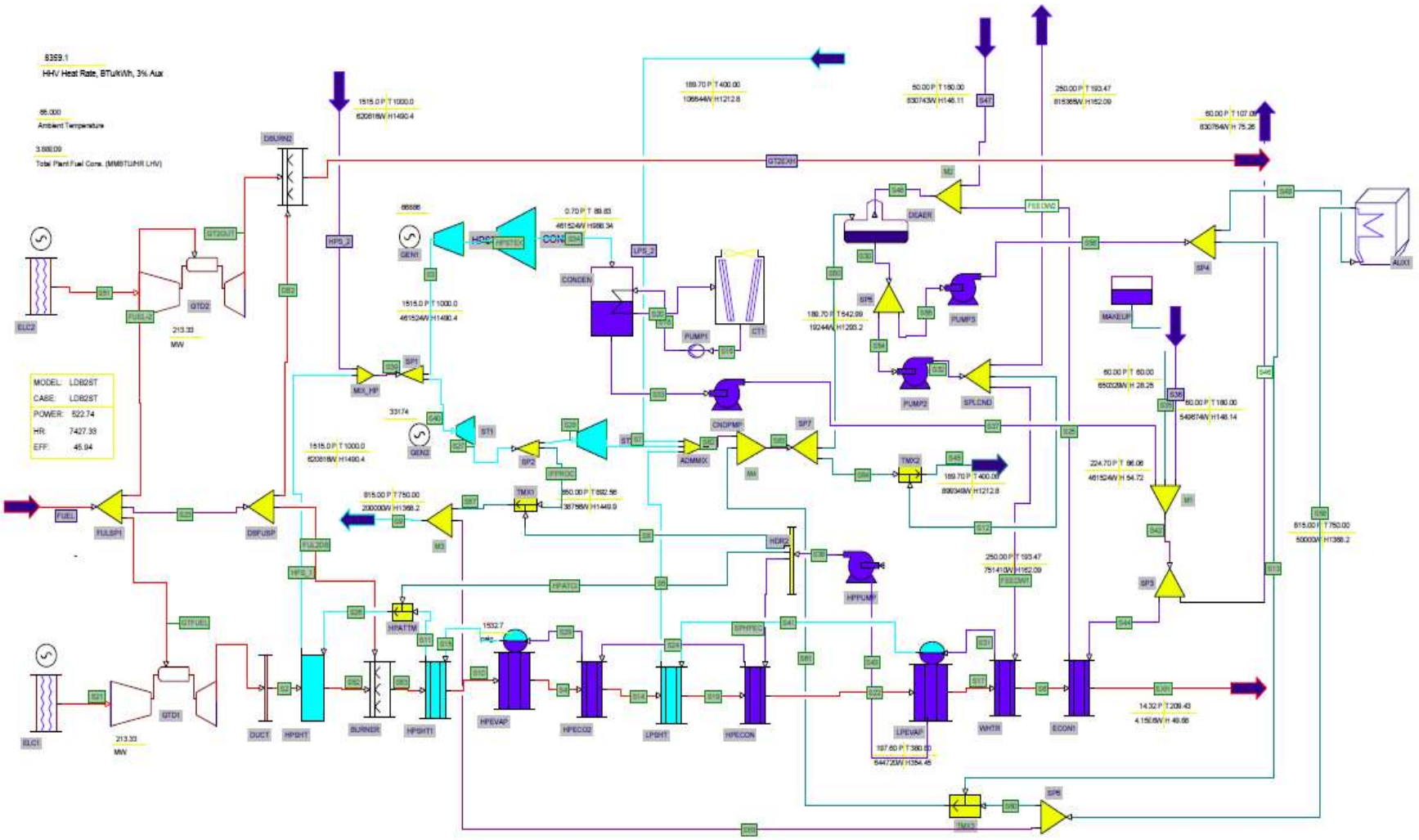

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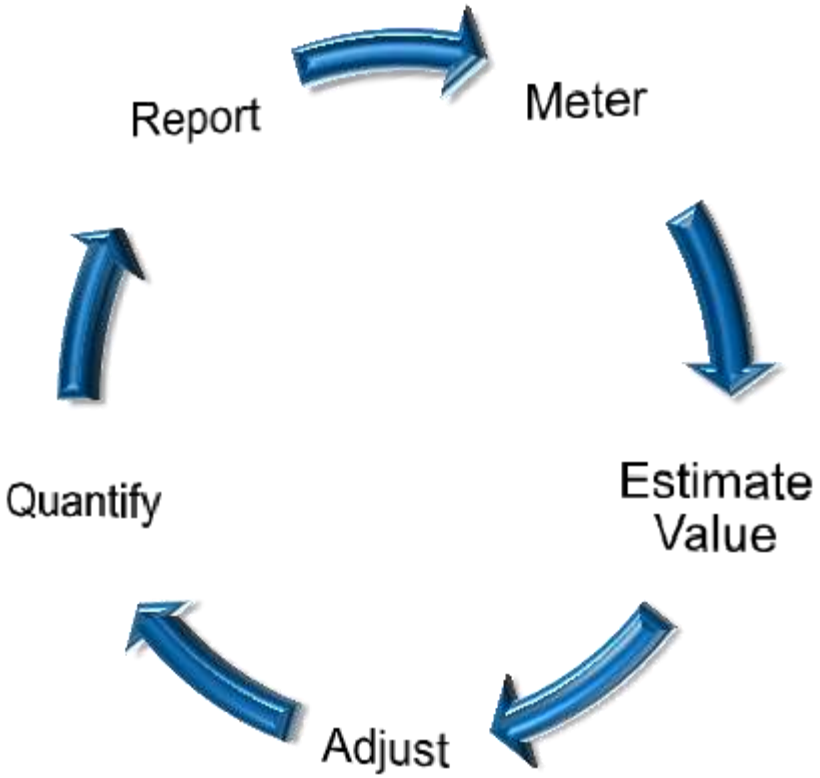
The Pudding

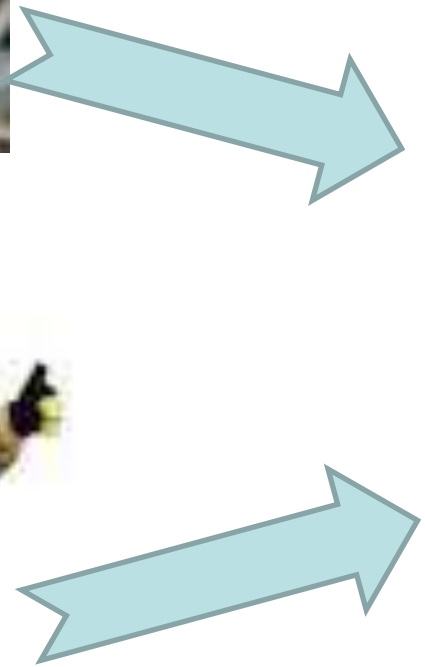


- Savings Realized
- Budget Variances
- Emissions Reductions

Summary

- Establish a feed forward loop
  - Consultants, Engineers, OEM's
- Budget for the tools to make great decisions
  - Simple to Advanced, select according to situation, market, and assets
- Respond to market changes
  - Why do we run like this? Is it still appropriate?
- Understand equipment
  - Degradation, limits, upgrades

Summary



Questions & Answers

Thank You

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