COLLEGE OF BUSINESS

TENASKA BUSINESS CHALLENGE

University Power Case Study

Background

The Board of Regents ("Board") for the University of Aksarben have approved and initiated construction of several new buildings to address enrollment growth and provide updated technology and equipment for evolving degree programs. All new facilities will be completed by January 1st, 2025 for immediate use.

Supporting the additional students and facilities will require approximately 25% increase in energy usage by the University, even after specifying buildings that are LEED compliant. This energy usage is comprised of both electrical power as well as heating and cooling needs.

The Board has asked your team to evaluate potential options to satisfy the increased energy demand, make a recommendation regarding which option to pursue, and design a marketing campaign and materials. See section titled "Deliverables."

As part of the decision-making process, the Board is seeking to reduce its environmental footprint while:

- Controlling operating costs to avoid an increase to students' tuition and fees.
- Maintaining the University's balance sheet (i.e. minimize capital expenditures) because leadership hopes that, outside of any upfront capital costs committed by the University, ongoing costs for fuel, operating costs, grid power purchases, carbon credits, loan interest, etc., will be funded through increased revenue from enrollment growth tied to the building campaign.
- Ensuring reliable energy supply for continued operations and safety of the students and faculty.

As a starting point, leadership is evaluating options that match the Chancellor's 15-year vision for the University, but other evaluation periods (e.g. 20 years) could be considered if there is a compelling justification.

To aid the teams, Attachment 1 contains a list of energy-related terminology.

Current Operations

Currently the University owns and operates a power plant ("Plant") that provides substantially all of its energy needs, with the exception of grid tie, a connection to the power grid that would be utilized for power should the University Plant not be able to generate electricity for some reason. The plant is comprised of four cross-tied natural gas boilers that produce high pressure steam that is expanded across steam turbines to generate electrical power. A portion of the steam is extracted from the turbines as needed to (a) provide building heating in the winter and (b) supply energy input for absorption chillers that provide chilled water for building cooling in the summer. Attachment 2 contains a simple block diagram of the Plant.

The University's steam demand (for heating or cooling) varies seasonally with ambient temperature. In addition, the electric power demand ("load") of the University varies significantly over a 24 hour period. For this case, the team can assume that the hourly energy profile for each day is the same, i.e. there is no seasonal variance. Attachment 3 contains current and anticipated future hourly load or power consumption information. The Plant has the operating flexibility to meet these seasonal and daily demand variations as well as the current peak power and steam demand with high reliability due to the redundant design configuration. This is a well-proven design with consistently high reliability (average of 99%) that has served the University well for many years.

Initial Options

Through initial brainstorming sessions, University leadership and the facilities planning group have identified three initial options to meet the increased energy demands, as outlined below. However, the University leadership is open to alternatives, including combinations of these options, other ownership models, etc.

1. Plant Expansion. The first option is to expand the existing Plant by adding a fifth boiler and turbine train which could be connected to the existing plant. This option has the benefit of being consistent with current operations and provides high reliability (99+%), but will require capital investment.

    If decided quickly, the expansion could be installed and commissioned prior by January 1, 2025, because no engineering design is required, space was previously reserved for an expansion, and spare equipment is immediately available. In addition, due to high reliability, the facilities planning group has decided that they do not need to procure firm service for uninterruptible power from the local Utility (defined below) and, therefore, is not expecting to pay a demand charge to backstop the Plant expansion option. That option could be necessary if the Plant needed to shut down due to high spot natural gas prices.

    The Plant expansion will increase the total air emissions attributable to the University due to the increased combustion of natural gas fuel. These emissions will include both criteria pollutants such as nitrogen oxides ("NOx") and greenhouse gases such as carbon dioxide ("CO_2"). Also, this option continues to expose the University to volatility of natural gas price fluctuations and the potential responsibility to buy carbon credits or pay carbon taxes if such a regulation is enacted by law. The Plant expansion will also use additional water which is available for purchase from city or could be sourced through on-site wells.

    The Board considers this the "Base Case" given that it is similar to how the University supplies its energy needs today. Thus, to the extent that other options are more costly, the Board assumes that incremental amounts will need to be covered by tuition increases.

    Attachment 4 contains conceptual design, operations, and cost information for the Plant expansion option. This includes fuel consumption and emission quantities for the anticipated operating profile.

As an alternative to Plant expansion, the University could choose to electrify all the incremental energy needs created by the new facilities – i.e. both the electricity for lighting, etc., and heating/cooling could be satisfied through the use of electrical power. Heating would be satisfied by electrical resistance heaters and cooling would be provided by conventional refrigerant type air conditioners. Thus, the incremental electric power supply need will be higher by approximately 50% because both because electric power is being used for heating/cooling and because these electrically powered technologies are less efficient. As far as electrification, there are two options that have been proposed.

2.Utility Grid Supply. The local utility ("Utility") can immediately supply the incremental power that is available from underutilized power generation it owns and it has transmission capacity, which is the ability to deliver the power to the University on a continuous basis.

The Utility has offered to provide the incremental power for a special fixed rate of $40 per megawatt-hour ("MWh"), essentially insulating the University from fuel price volatility, plus a fixed demand charge of $100,000 per megawatt ("MW") of capacity representing the maximum amount of power used per year, if the University commits sourcing all of its additional energy needs from the Utility. However, to secure the rate, the Utility is asking for a minimum 3-year term. The Utility is willing to lock in this low rate for longer terms as well. The rate could change after the initial term. In addition, the Utility would pass along the cost of any carbon credits or carbon taxes, if those were ever created through regulation.

For this special offer, the Utility has indicated the incremental electrical energy would initially be derived from a power generation portfolio comprised of 50% coal, 30% gas, and 20% renewable/nuclear fuel sources and has indicated that the corresponding CO_2 emissions rate would be no greater than 0.683 tons per MWh. While the Utility is considering procurement of additional renewables to improve its environmental profile, there is no guarantee of this source of power with the special fixed rate. As a result, utilizing this approach would further increase the CO_2 emissions attributable to the University. In addition, the Utility indicates that payment of demand charge equates to 95% overall reliability as limited by a single transmission line that serves the University.

Attachment 5 contains Utility power supply rates, generating portfolio, and CO_2 emissions information.

3.University Owned PV Solar. As an alternative, the facilities team has proposed building a photovoltaic ("PV") solar power plant on a 250-acre agricultural research property adjacent to campus. While solar energy has zero air emissions, unfortunately, construction on the proposed property would disturb wetlands that are stopover for endangered crane species. As a result, the project permitting process is expected to take three years to complete and securing approval is not certain.

The facilities team initially assumed solar project plant capacity is 22.5 MW to match the University's incremental peak load for the electrification case. However, any other project capacity can be considered, up to 30 MW, which is limited by the property area available.

Note that a local solar project would only provide a Capacity Factor (see definitions) of approximately 25.8%, i.e. the project could only supply power for this percentage of time over a year due to clouds and limited hours of sunlight. Also, the daily solar generating profile does not perfectly match the University load profile (see Attachment 3). Thus, any hourly shortfalls will have to be fulfilled by other means.

One possibility is to source this additional electrical energy from the bulk power grid through the Utility. The Utility has indicated that variable back-up power supply price is $45/MWh, escalating at 1% per year with the same demand charge of $100,000 per MW of capacity per year. Any excess generation from the project will have to be exported back to the Utility at a fixed price of $10/MWh. The reliability of the solar plant is expected to be 95%.

Attachment 6 contains a power production profile, capital cost, operating cost, and schedule information for the potential solar Project. Also, the PV solar project will need to qualify for an investment tax credit ("ITC") equal to 30% of the estimated capital cost of the project. However, it is possible this tax credit will be repealed by the US Congress in the next term. This credit has been utilized to reduce the solar project cost estimates in Attachment 6.

Project Financing

With the building program, the University's is only able to commit up to $15M toward the capital investment for an energy project. However, if the University commits at least $10M, a regional bank has offered to fund the remaining balance under a loan at 7% interest rate amortizing over ten years. In addition, a group of alumni who are concerned about the environment have committed to donations of up to 10% of the cost of a solar project, not to exceed $3M. Lastly, the University could elect to pursue a Department of Energy loan program that would finance up to 80% of the capital cost of the solar project at a 10% interest rate fully amortizing over a ten-year term.

Deliverables

The Board has requested a brief (up to 10 minute) presentation comprised of two parts:

Part 1: Provide the recommended approach to address the growing energy needs including:

- The justification basis of the recommendation including all decision criteria;
- a comparison of alternatives – especially what variables would need to change in order to alter the recommendation (is this feasible?);
- a summary of financial analysis (with key metrics for each alternative considered); and
- an assessment of the risks and approaches to mitigation.

Financial models must be available for inspection and auditing. To the extent that capital investment is recommended, the presentation must include the proposed method of financing the project.

Part 2: Develop a marketing campaign that would communicate the University's plans for power expansion and the perceived benefits for prospective students and their families. This campaign should:

- Increase the interest and awareness prospective families have in the University;
- Describe what platforms will be used to reach these audiences;
- Use quantifiable metrics to measure the success and impact of the campaign, and;
- Explain how the proposed decision will provide value to prospective students and their family, especially if the plan includes increased tuition costs.

The team should also consider the marketing campaign will be perceived by other stakeholders such as the local community, faculty, etc.

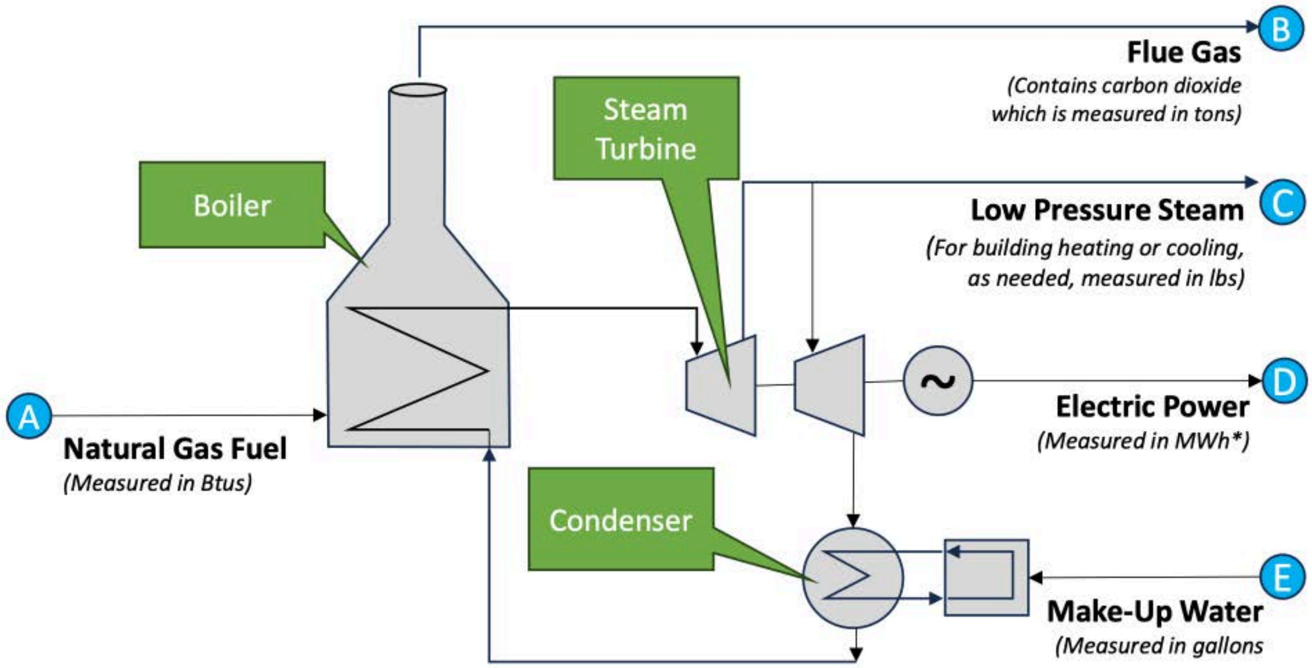
Attachments

1. Energy Industry Terminology
2. Simple Block Diagram of the University Utility Plant
3. Current and Anticipated Energy Load Information
4. University Plant Expansion Design and Operating Information
5. Local Utility power supply cost and emissions information
6. Potential solar project power generation, cost, and schedule information

1. Energy Industry Terminology

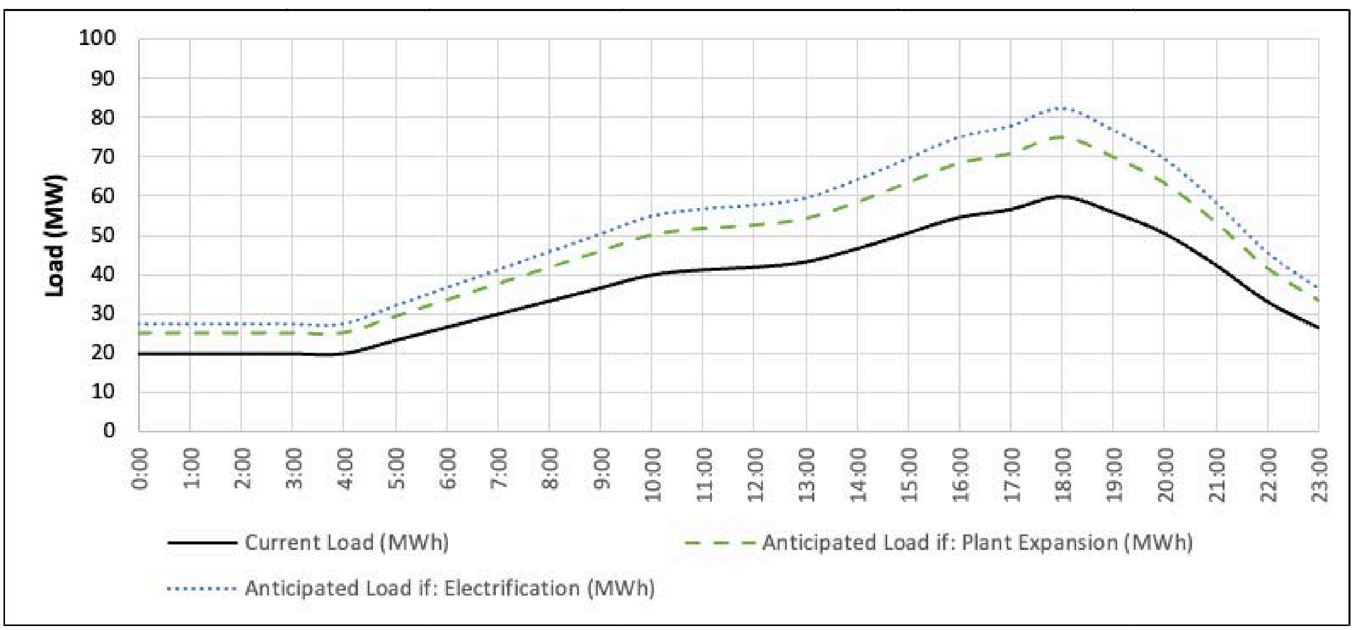
Term	Definition
Btu	British Thermal Unit; a measure of energy typically applied to quantities of natural gas.
Lbs	Pounds (in this case, a measurement of steam flows)
MM	Millions (for example, of gallons or pounds)
MW	Megawatt; a measure of power. Equal to MWh per hour
MWh	Megawatt-hour; a measure of energy, typically applied to quantities of electric energy
PV	Photovoltaic; a type of solar power project comprised of panels mounted on structures such as racking or rooftops.
CO_2	Carbon Dioxide – a molecule that results from burning fossil fuels and is exhaled by humans. Typically quantified in terms of tons per day or tons per year.
Demand Change	A cost paid for access to a certain production capacity, irrespective of the variable quantity acquired.
Capacity	For generation, the maximum power a source can generate given its technical design. For transmission, the maximum amount of power the network can carry given its technical design and system configuration.
Capacity Factor	Actual production over some time period divided by design capacity x 100%
Reliability	Fraction (or percentage) of time that an asset is available to produce. In this context, the term is used interchangeably with Availability.
Load	The amount of electric power demand a point in time. Generally quantified in terms of Megawatts.
ITC	Investment Tax Credit – an amount of money that can be deducted from federal income taxes as established under certain legislation and IRS guidance. For simplification purposes, can be considered a deduct to a capital investment.

2. Simple Block Diagram of the University Utility Plant



3. Current and Anticipated Energy Load Information

Hour Beginning	Current Load	Anticipated Total Load if:		Incremental Electrical Load if:	
		Plant Expansion	Electrification	Plant Expansion	Electrification
	(MWh)	(MWh)	(MWh)	(MWh)	(MWh)
	'A'	[125%] x A = 'B'	[150%] x (B-A) + A = 'C'	= B - A = 'D'	= C - A = 'E'
0:00	20.0	25.0	27.5	5.0	7.5
1:00	20.0	25.0	27.5	5.0	7.5
2:00	20.0	25.0	27.5	5.0	7.5
3:00	20.0	25.0	27.5	5.0	7.5
4:00	20.0	25.0	27.5	5.0	7.5
5:00	23.3	29.2	32.1	5.8	8.8
6:00	26.7	33.3	36.7	6.7	10.0
7:00	30.0	37.5	41.3	7.5	11.3
8:00	33.3	41.7	45.8	8.3	12.5
9:00	36.7	45.8	50.4	9.2	13.8
10:00	40.0	50.0	55.0	10.0	15.0
11:00	41.3	51.7	56.8	10.3	15.5
12:00	42.0	52.5	57.8	10.5	15.8
13:00	43.3	54.2	59.6	10.8	16.3
14:00	46.7	58.3	64.2	11.7	17.5
15:00	50.7	63.3	69.7	12.7	19.0
16:00	54.7	68.3	75.2	13.7	20.5
17:00	56.7	70.8	77.9	14.2	21.3
18:00	60.0	75.0	82.5	15.0	22.5
19:00	56.0	70.0	77.0	14.0	21.0
20:00	50.7	63.3	69.7	12.7	19.0
21:00	42.7	53.3	58.7	10.7	16.0
22:00	33.3	41.7	45.8	8.3	12.5
23:00	26.7	33.3	36.7	6.7	10.0
Average	37.3	46.6	51.3	9.3	14.0
Daily Total	894.7	1118.3	1230.2	223.7	335.5
Annual Total (100% Capacity Factor)	**326,553**	**408,192**	**449,011**	**81,638**	**122,458**



4. University Plan Expansion Design and Operating Information

Expansion Project Design and Operating Information

Stream Label	Stream	Capacity		Anticipated Annual Operating Profile (99% Reliability)	
A	Fuel Input	229	MMBtu/hr	1,283,377	MMBtu
D	Power Generation	15	MW	84,055	MWh
C	Steam Production	26,295	lb/hr	147	MM lbs
B	Flue Gas	13.1	Tons/hr as CO_2	73,632	Tons CO_2
E	Water demand	1.5	gallons per minute	50	MM gallons
Plant Reliability		99.0	%	99.0	%
Capacity Factor		NA	%	61.5	%
Power Imports		15.0	MW	816	MWh

Expansion Project Cost Information

Parameter	Value	Units
Capital Cost Estimate	25.0	$MM
Incremental Fixed Operating Costs	100,000	$/yr
Incremental Variable Operating Costs	3	$/MWh

Forecasted Natural Gas Price Information

Year	Gas Price ($/MMBtu)		
	10 year forward strip	Min	Max Peak
2024	2.50	1.50	5.00
2025	3.00	2.00	8.00
2026	3.25	2.25	9.00
2027	3.50	2.00	15.00
2028	3.50	2.00	18.00
2029	3.75	2.00	18.00
2030	4.00	3.00	18.00
2031	4.00	3.00	18.00
2032	3.50	3.50	18.00
2033	3.75	3.50	18.00
2034	3.75	3.50	18.00
2035	4.00	3.50	18.00
2036	4.00	3.50	18.00
2037	4.00	3.50	18.00
2038	4.00	3.50	18.00
2039	4.25	3.50	18.00
2040	4.50	3.50	18.00

5. Local Utility Power Supply Cost and Emissions Information

Element	Value	Units	Notes
Additional Grid Capacity for Electrification Option	22.5	MW	For increased peak load
New Imports if Electrified with 100% Grid Supply	122,458	MWh/yr	
New Imports to Supplement Solar Project	See Att 6	MWh/yr	Function of Solar Project Size
Utility Price Offer for 100% Supply Option	$40	$/MWh	Fixed
Minimum Term for 100% Supply Option	3	years	
Utility Price Estimate for Solar Supplement	$45	$/MWh	Escalating 1% p.a.
Fixed Demand Charge	100,000	$/MW/yr	To assure service
Blended Emissions Rate	0.683	Tons CO_2 / MWh	

Supporting Utility Emissions Rate Information

Coal Contribution	50	% of MWhs	
Natural Gas Contribution	30	% of MWhs	
Renewables/Nuclear Contribution	20	% of MWhs	
Coal Emissions Rate	1.10	Tons CO_2 / MWh	
Gas (combined cycle) Emissions Rate	0.44	Tons CO_2 / MWh	

*U.S. Energy Information Administration - EIA - Independent Statistics and Analysis

6. Potential Solar Project Power Generation, Cost, and Schedule Information

Table 1 -- Main Parameters

Element	Value	Units	Notes
Variable Operating Cost	0	$/MWh	(All fixed)
Variable Fuel Cost	0	$/MWh	(no fuel purchase)
Fixed Operating Cost	500,000	$/yr	
Capacity Factor	25.75	%	Before applying reliability factor
Reliability Factor	95	%	
Max Capacity	30	MW	Property Constrained
Overgen Export Selling Price	10	$/MWh	To Utility
Development & Construction Schedule	3	years	Environmental Permitting Delay / Risk
Utility Demand Charge to backstop Solar Project	100,000	$/MW/yr	Fixed

Table 2 - Capital Cost Information*

Capacity		Est. Capital Cost	Specific Cost
(MW)	(kW)	($)	($/kW)
5	5,000	$10,400,000	$2,078
10	10,000	$15,800,000	$1,575
15	15,000	$20,100,000	$1,339
20	20,000	$23,900,000	$1,194
22.5	22,500	$25,600,000	$1,139
25	25,000	$27,300,000	$1,092
30	30,000	$30,450,000	$1,015

**After Applying the 30% Investment Tax Credit as a reduction*

6. Potential Solar Project Power Generation, Cost, and Schedule Information

Table 3 - Daily Average Solar Generating Profile

Hour Beginning	(% of Installed Capacity)	Solar Project Capacity (MW) =		22.5	Solar Project Capacity (MW) =		30
		Power Generation	Under Generation (Remaining Need)	OverGen (Grid Export)	Power Generation	Under Generation (Remaining Need)	OverGen (Grid Export)
		(MWh/hr)	(MWh/hr)	(MWh/hr)	(MWh/hr)	(MWh/hr)	(MWh/hr)
0:00	0	0.0	-7.5	0.0	0.0	-7.5	0.0
1:00	0	0.0	-7.5	0.0	0.0	-7.5	0.0
2:00	0	0.0	-7.5	0.0	0.0	-7.5	0.0
3:00	0	0.0	-7.5	0.0	0.0	-7.5	0.0
4:00	0	0.0	-7.5	0.0	0.0	-7.5	0.0
5:00	0	0.0	-8.8	0.0	0.0	-8.8	0.0
6:00	1%	0.2	-9.8	0.0	0.3	-9.7	0.0
7:00	5%	1.1	-10.1	0.0	1.5	-9.8	0.0
8:00	20%	4.5	-8.0	0.0	6.0	-6.5	0.0
9:00	40%	9.0	-4.8	0.0	12.0	-1.8	0.0
10:00	50%	11.3	-3.8	0.0	15.0	0.0	0.0
11:00	80%	18.0	0.0	2.5	24.0	0.0	8.5
12:00	95%	21.4	0.0	5.6	28.5	0.0	12.8
13:00	100%	22.5	0.0	6.2	30.0	0.0	13.8
14:00	95%	21.4	0.0	3.9	28.5	0.0	11.0
15:00	80%	18.0	-1.0	0.0	24.0	0.0	5.0
16:00	40%	9.0	-11.5	0.0	12.0	-8.5	0.0
17:00	10%	2.3	-19.0	0.0	3.0	-18.3	0.0
18:00	2%	0.5	-22.1	0.0	0.6	-21.9	0.0
19:00	0%	0.0	-21.0	0.0	0.0	-21.0	0.0
20:00	0%	0.0	-19.0	0.0	0.0	-19.0	0.0
21:00	0%	0.0	-16.0	0.0	0.0	-16.0	0.0
22:00	0%	0.0	-12.5	0.0	0.0	-12.5	0.0
23:00	0%	0.0	-10.0	0.0	0.0	-10.0	0.0
Average	25.8%	5.2	-8.9	0.8	7.7	-8.4	2.1
Daily Total (MWhs/d)		139.1	-214.7	18.3	185.4	-201.1	51.0
Annual Total @ 100% Reliability (MWh/yr)		50,753	-78,366	6,661	67,671	-73,402	18,615
Annual Total @ 95% Reliability (MWh/yr)		**48,216**	**-80,903**	**6,328**	**64,287**	**-76,785**	**17,684**