Summer 2000

Year 2000 Production Capacities

- **Peak Electrical Output : 4.2 Mw**
- **Peak Chill Water Output: 7,200 Tons, 20,000 gpm**
- **Peak Steam Output: 70,000 pph**

The Total Energy Team

- **Cogeneration Staff: 11**
- **Energy Staff: 2**
- **Plus many equipment & maintenance subcontractors**

Chiller Information

Unit	Manufacturer	Type	Tons	Ref.	Design Temp.	Year
1	*Future*	*Absorber*	*1000*	*H_2O w/LiBr*	*43°F*	*2004*
2	Carrier	Absorber	1500	H_2O w/LiBr	43°F	1998
3	Hitachi	Absorber	1125	H_2O w/LiBr	43°F	1988
4*	Carrier	Centrifugal	1950	R-114	41°F	1979
5	Trane	Centrifugal	1000	R-123	41°F	1998
6	*Future*	*Centrifugal*	*2000*	*R-123*	*41°F*	*2001*
7	Trane	Centrifugal	2000	R-123	41°F	1998
8	*Future*	*Centrifugal*	*2000*	*R-123*	*41°F*	*2005*

*Chiller # 4 will be replaced by installing future Chiller #6

Thermal Storage Information

Unit	Manufacturer	Type	Ton-Hours	Gallons	Design ΔT	Year
TST-X	*Future*	*Chill Water*	*20,000*	*2,900,000*	*14°F*	*2005*

Combustion Turbine Information

Unit	Manufacturer	Type	Fuel	MBtu/ Hour	HP Out	Stack Temp.	Year
CGT-I	Ruston 5000	Stationary	Gas/Oil	51,300	5400	920°F	1987
CGT-II	*Future*	*Stationary*	*Gas*	*110,000*	*12500*	*920°F*	*2005*

Turbine Generator Information

Unit	Manufacturer	Kilowatts	Volts	Service Volts	Year
GEN-I	Electric Machinery	5,000	4,160	12,470	1987
GEN-II	*Future*	*10,000*	*12,470*	*12,470*	*2005*

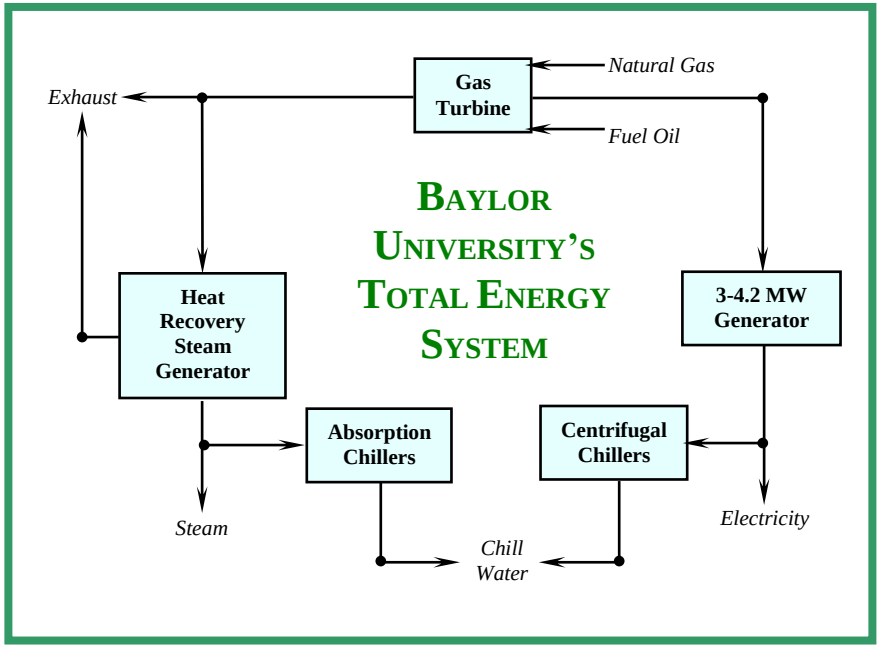
Boiler Information

Unit	Manufacturer	Type	Fuel	Lbs./ Hour	Psig	Steam Temp.	Year
Back-up	Bigelow/ Coen	Water Tube	Gas/ Oil	60,000	160	370°F	1973
HRSG-I	ERI/ Coen	Heat Recovery	Gas	70,000	250	400°F	1999
HRSG-II	*Future*	*Heat Recovery*	*Gas*	*120,000*	*250*	*400°F*	*2005*

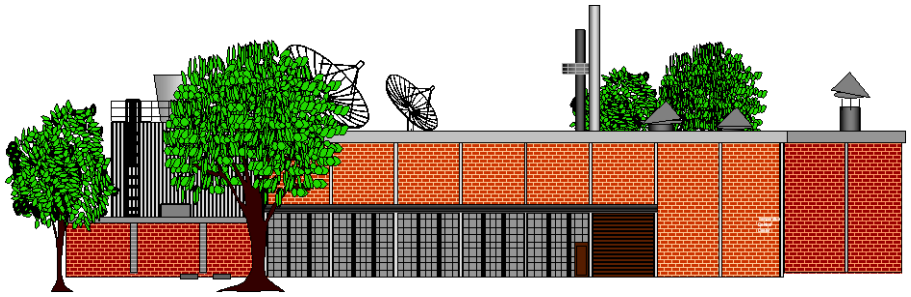
BAYLOR UNIVERSITY

Waco, Texas

Tri-generation System



TOTAL ENERGY MANAGEMENT



Baylor University's
Year 2000 Energy Needs

Baylor University buys electricity and gas from TXU and produces electricity, steam and chill water in a central energy plant known as the Temperature Control Center or TCC. The TCC serves the majority of the campus buildings through tunnels and overhead and buried utility lines.

BU will purchase 765 million cubic feet of natural gas to produce electricity and steam. BU also anticipates using 70,000 Megawatt hours (MWH) of electricity of which it will purchase 40,000 MWH and produce 30,000 MWH at a competitive price.

BU's Total Energy Management goal is to maximize the use of waste heat. Since the requirement for heat is low in the summer in Waco, TX, two absorption chillers which use steam to cool were installed to help use waste heat. A large heat recovery steam generator (HRSG) was installed to turn the waste heat into steam.

Heat recovery from the combustion gas turbine exhaust is expected to save over $500,000 in gas and electrical costs. Electrical peak shaving from the electrical generator powered by the combustion gas turbine is expected to save $700,000 and peak shaving from the absorption chillers is expected to save over $400,000. Combined savings amount to less than the total of the above but will be well over $1,000,000.

BU anticipates electrical consumption will increase over 20,000 MWH per year and gas consumption by 200 million cubic feet per year over the next 5 years

Recently Completed Energy Infrastructure Improvements

BU employed Sempra Energy Services (SES) Company to make improvements to reduce energy costs. The following improvements were completed:

- Retrofit interior fluorescent lighting Campus-wide to electronic ballasts and T-8 lamps with reflectors
- Install campus-wide energy management system to set-back or shutdown HVACR equipment during periods not required to run
- Install variable frequency drives on pumps and fans to reduce speeds to meet operational requirements
- Renovate TCC to include removal/ replacement of two wooden cooling towers, chill water header, condenser water header, two old chillers, two old boilers, deaerator, boiler feed pumps, and condensate surge tanks.
- Upgrade TCC to include adding higher capacity HRSG, 1500 ton absorption chiller, 200 HP chill water pump, variable frequency drives on pumps and fans, new boiler controls, condensate polishers, new water softeners, and new dealkalizers.
- Renovate/upgrade TCC control room to include expansion, additional viewing windows, new ceiling and floors, new consoles, dedicated circuits, UPS NEC compliance, employee break area and new maintenance office.
- Add turbine air inlet cooler and replace turbine inlet air filter system
- Add TCC Refrigerant Safety System
- EPA/TNRCC Compliance
- Miscellaneous chill water and steam system improvements.

Pending TCC
Renovations and Improvements

Additional equipment at the TCC will be considered to meet the future energy utility requirements safely, reliably and cost-effectively. The projects proposed over the next 5-years to ensure energy systems are adequate to safely, reliably and cost-effectively support campus needs are as follows:

- Renovate Ceramic cooling tower cells to include new fill, drift eliminators, air inlet louvers, and riser piping (50% complete)
- Replace turbine lube oil cooler
- Add chill water supply/return service to support new campus facilities (under construction)
- Restore Boiler #3 to full capacity including back-up fuel capability
- Upgrade/Replace Combustion Gas Turbine Control System with reliable modern system
- Upgrade/Replace Boiler #3 Control System with reliable modern system
- Add pump and trough on Ceramic cooling tower system to provide firm capacity corresponding to firm chiller capacities
- Add replacement chiller for obsolete R-114 chiller (#4)
- Add chillers and boiler and upgrade campus electrical service to meet thermal and electrical requirements for new buildings especially the new science complex
- Replace/upgrade UPS to include capacity for all TCC controls and to extend UPS run time to 2 hours
- Upgrade transformers & electrical service to support new chillers and equipment
- Upgrade Ceramic cooling tower fans to support increase capacity from 2,300 to 3,000 gpm per cell to support new chillers and equipment
- Add cooling towers to support additional chillers
- Add 200 HP chill water pump with VFD to support additional chillers
- Add stratified chill water thermal storage tank to support 20,000 ton- hours of cooling
- Add same or larger capacity cogeneration system to provide prime power generation capability and support electrical and thermal requirements for new buildings especially the new science complex
- Convert campus from central high pressure steam system to High Temperature Hot Water (HTHW) system to eliminate failing hazardous condensate lines and litigation risks

Energy Cost Projections

Natural gas costs are expected to remain stable and promote its use as an economical energy source of choice. Electrical deregulation is expected to drive prices up sharply with cycles similar to what the gas market did. The economic viability of adding a second cogeneration unit by Baylor University primarily for electric power production will likely improve. Environmental compliance and tighter emission requirements will raise energy costs for everyone.

*For more information, contact the **TCC**:*

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