ENGINE DRIVEN CHP: TEXAS WESLEYAN UNIVERSITY

A Small Campus Case Study

Presented to IDEA

February 11, 2016

Texas Wesleyan UNIVERSITY

AEI Affiliated Engineers

ABOUT THE CAMPUS

Texas Wesleyan University: Founded in 1890 in Ft. Worth, Tx

Undergraduate enrollment is approximately 2,000 students

75 acre campus

CAMPUS UTILITIES

- Utilities provided by Central Utility Plant and Satellite Plant
- Campus Electrical Distribution System Interconnects with Grid at the Central Plant
- University has 388,000 sq ft building space connected to campus electrical distribution and district energy system
- Equipment in Satellite Plant reaching the end of lifespan

UNIVERSITY EXISTING PRODUCTION CAPACITY AT CENTRAL PLANT

- 500 Tons Centrifugal Chiller with VFD
  - Peak CHW demand 500 tons
- 12,000 MBh fire tube boiler
  - Peak Heating Demand 5000 MBh
  - Issues with operating during low heating demand periods.
- Redundancy concerns and Lack of firm capacity

UNIVERSITY EXPANSION

- Addition of 45,000 Sq Ft new buildings connected to district energy system.
- 145 Tons peak cooling load increase
- 1260 MBh peak heating load increase

ISSUES NEEDED TO BE ADDRESSED IN CENTRAL PLANT

- University experienced electric utility interruptions during peak electrical demand periods.
- Oversized boiler with limited turndown capabilities during low HW demand periods.
- Short cycling of the centrifugal chiller in the central plant

TRADITIONAL FUNDING STREAMS WERE NOT AVAILABLE FOR INFRASTRUCTURE

1. University's Capital budget directed to campus expansion.
2. Budget allocations for utility production did not match campus requirements.
3. Additional utility issues required attention on the demand side in buildings.
    1. 3-way valves
    2. Constant speed booster pumps
    3. Building Controls Operability

- A solution was required to provide additional chilled water production, optimize heating hot water production, and improve electric service reliability
- Improvements to Central Plant could not be implemented with traditional capital expenditure projects

A NEW COMBINED HEAT AND POWER SYSTEM THROUGH ENERGY SAVINGS PERFORMANCE CONTRACT ADDRESSED THE ISSUES

OPTIONS CONSIDERED

- Gas Turbine was eliminated due to economy of scale.
- Microturbines were eliminated due to procurement.
- Cogeneration Engine was selected based on availability, performance history, and capital cost.

A FEW DETAILS…

- 800 kW natural gas reciprocating engine
  - 480V, 3 Phase, 60 Hz
  - Jacket Water and Engine Exhaust Heat Recovery in series to provide 3040 MBh heat recovery capacity.
  - Synchronous Operation with the Grid for import capability
- 250 ton Single Effect Hot Water Absorption Chiller
- 3000 MBh HX to supply Heating HW loop

3000 MBh
Heat
Exchanger

250 Ton Single stage
HW Absorption
Chiller

800 kW Gas Engine

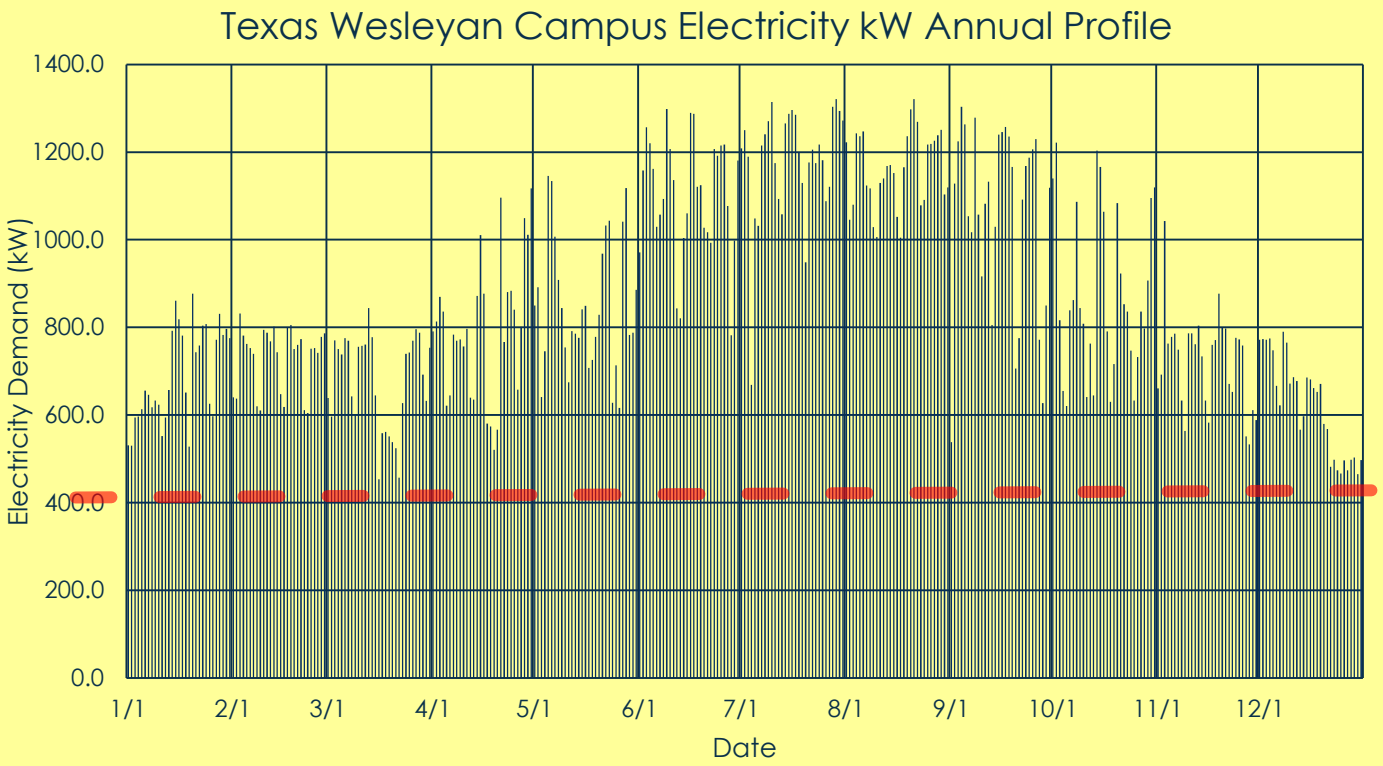
3100 MBh
Radiator
Cooler

- Cogeneration Engine Heat Rate 3920 BTU/kW
- Engine Thermal Cycle Efficiency of 75-80%
  - **Compared with 35-40% from Major Producers on TX Grid**
- Jacket Water piped in series with Exhaust to maximize total Engine Heat Recovery at 210 Deg F
- Absorption Chiller COP 0.72
- H/X Approach 2 Deg F

INTERCONNECTION WITH UTILITIES

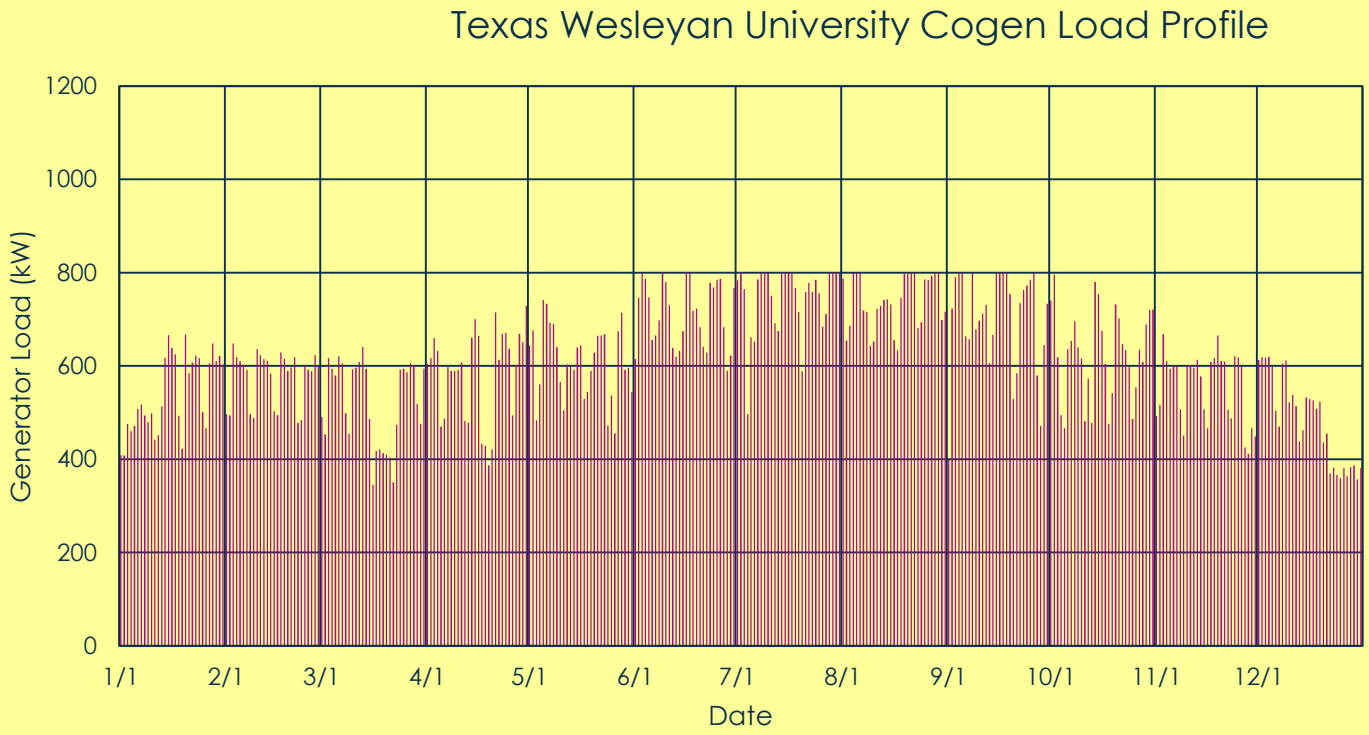
- New Dedicated Gas service for Central Plant added
  - New Service Qualified for reduced transportation rate
- Operation of Engine Generator will be limited to Import mode only.
- Streamlined Environmental Permitting Process
  - Texas Permit By Rule

ANNUAL CAMPUS ELECTRIC LOAD PROFILE

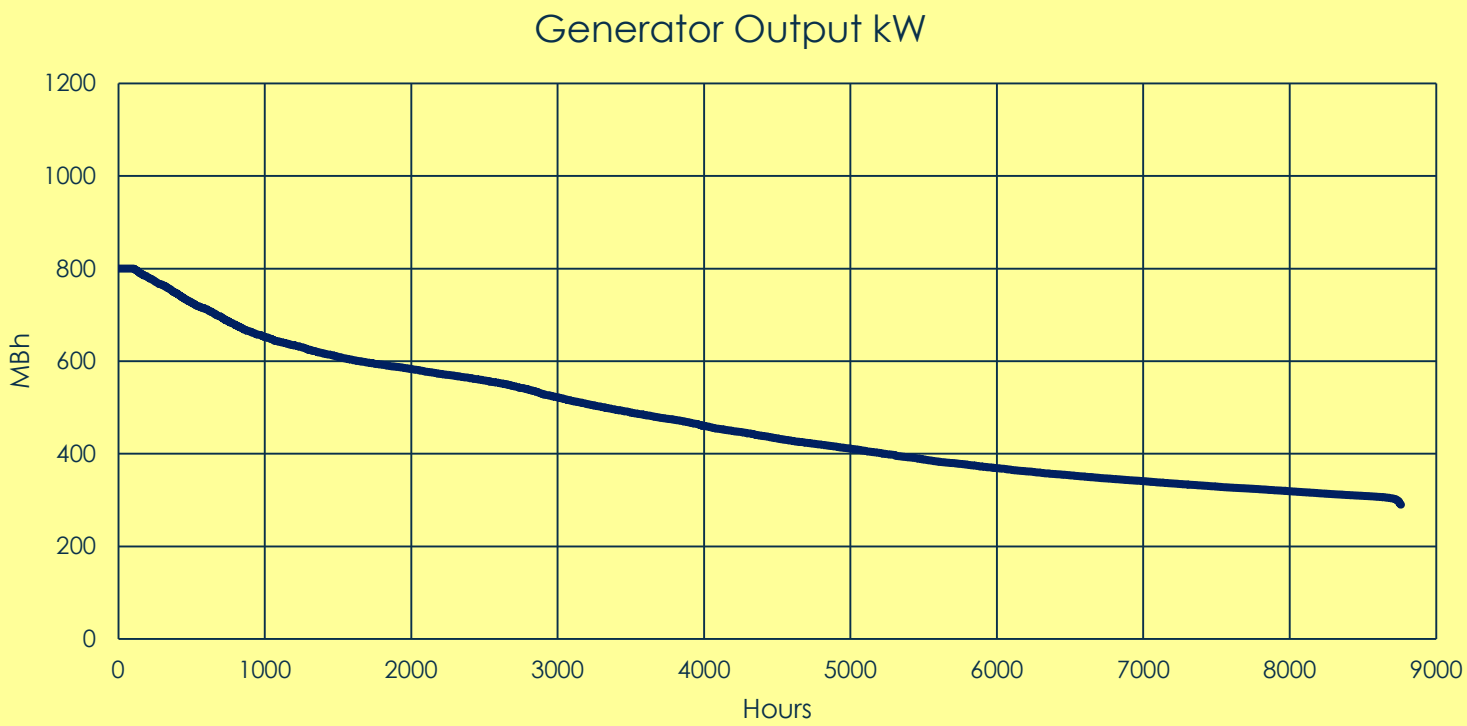


400 kW Baseline Electric Demand

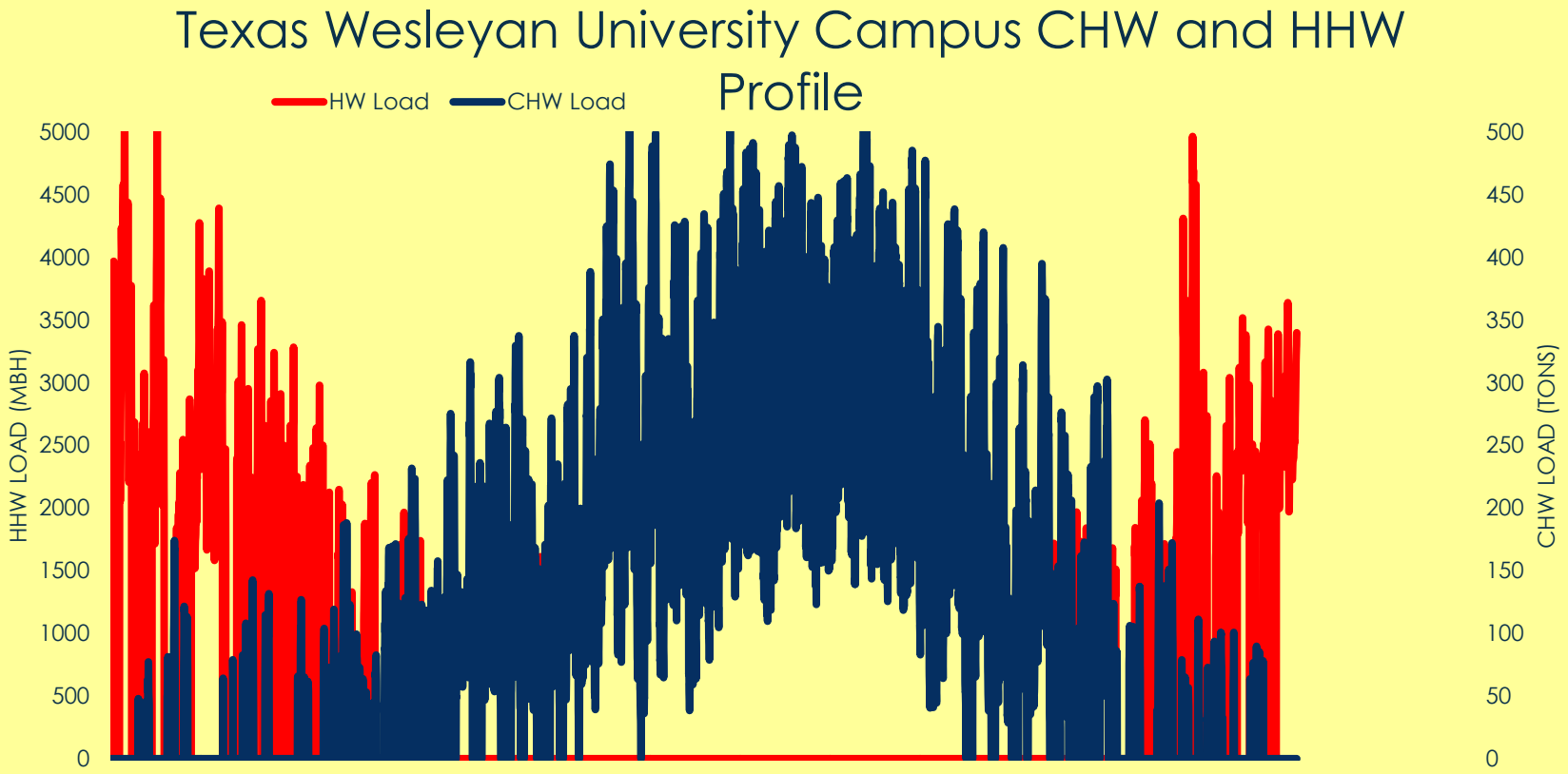
GENERATOR LOAD PROFILE



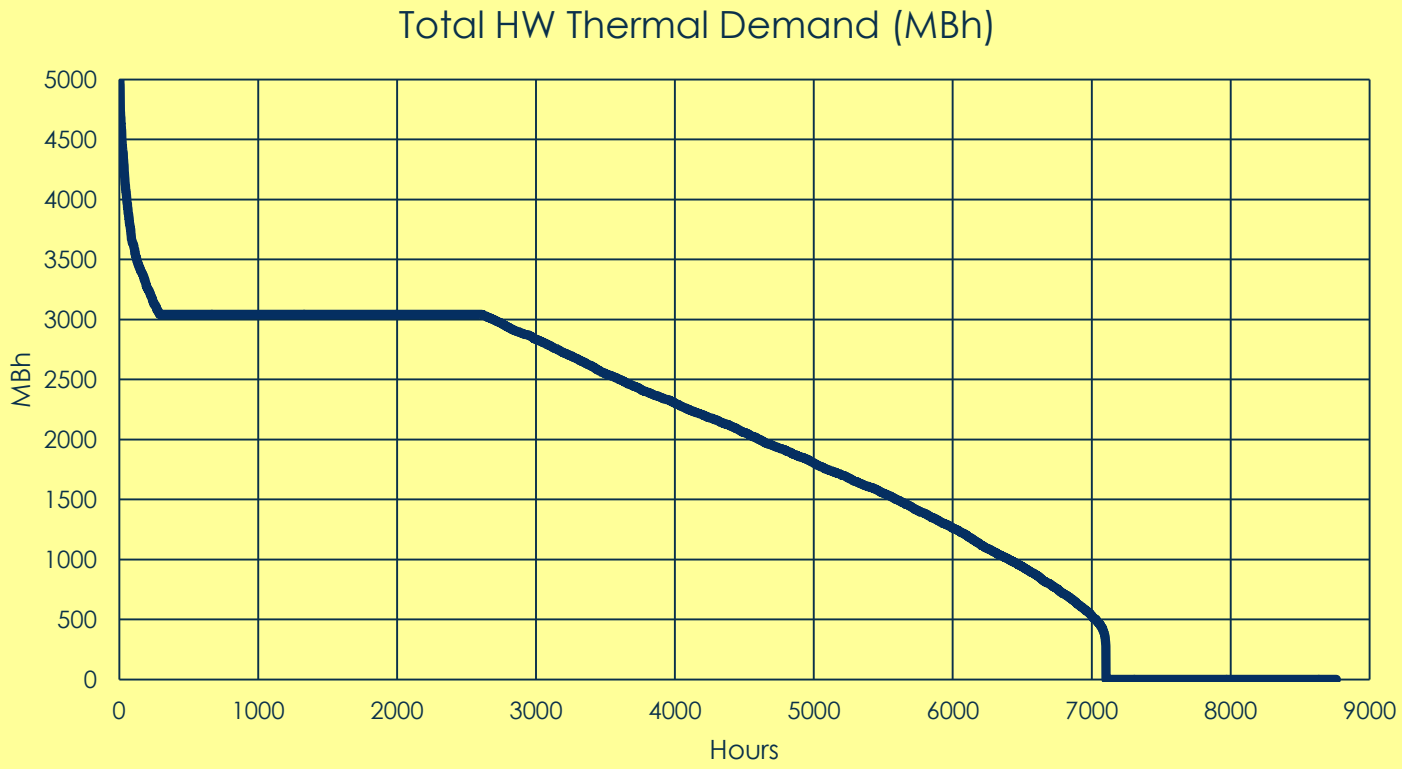
TEXAS WESLEYAN UNIVERSITY
ENGINE LOAD DURATION CURVE



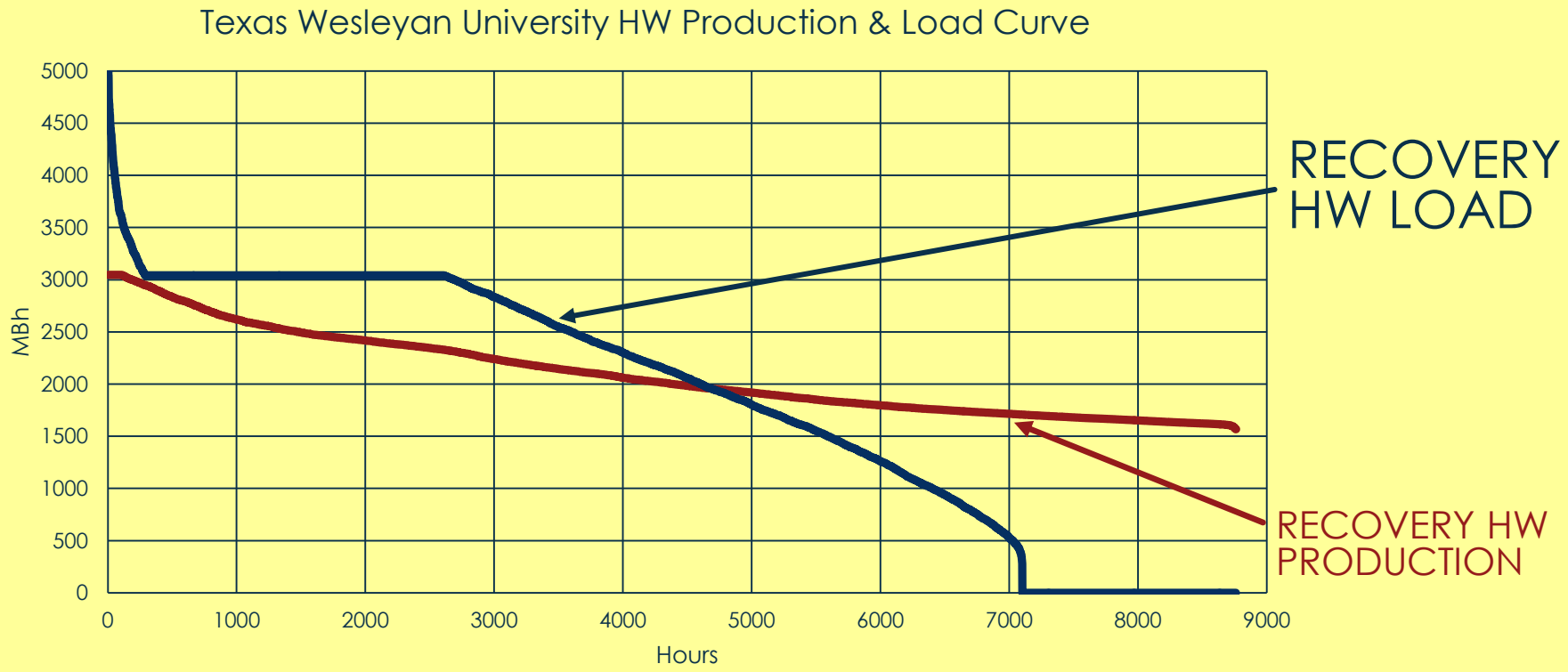
CAMPUS CHW AND HW DEMAND PROFILE



TEXAS WESLEYAN CAMPUS HW LOAD DURATION CURVE – COMBINING HEATING HW AND ABSORPTION CHILLER REQUIREMENT



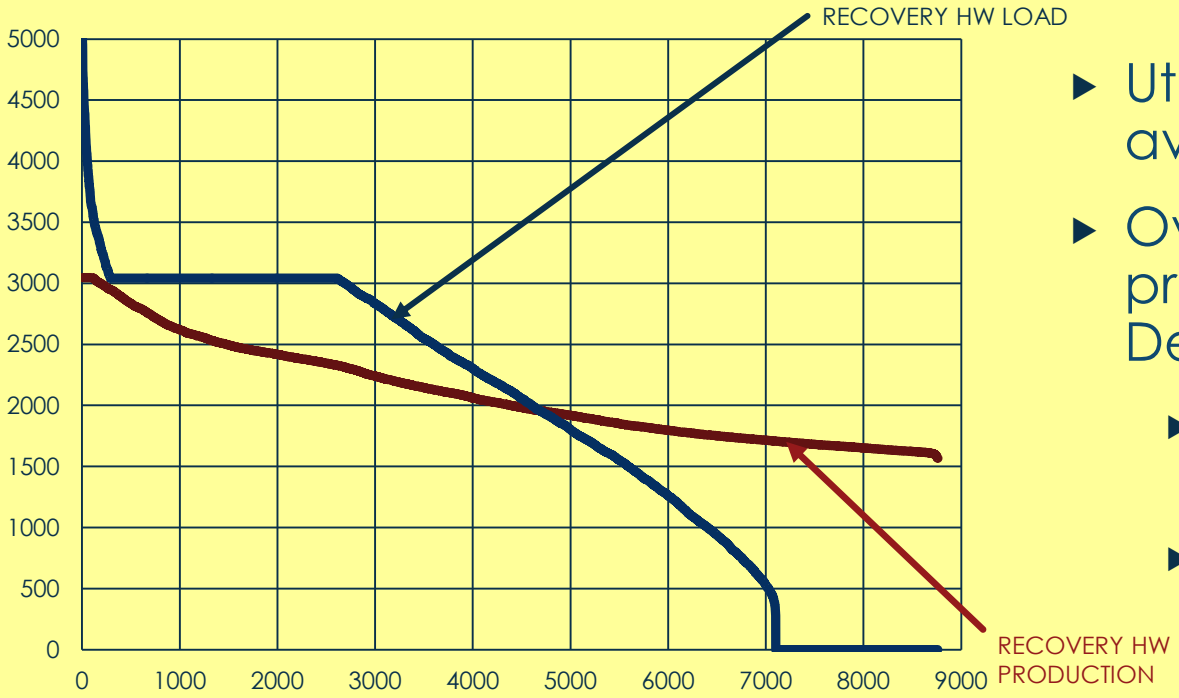
COMPARING HW LOAD AND PRODUCTION



EFFECT ON GAS AND ELECTRIC UTILITIES

- Utilizing Combined Heat and Power eliminates approximately 6,475,000 kWh in electricity purchase
  - Annual Consumption cost reduced by $745,000
- Electrical Peak Demand reduced from 1895 kW to 1065 kW
  - Over 40% reduction in peak demand
- Associated increase in Gas Consumption is approximately 48,750 MCf
  - Additional gas cost approximately $219,500
- Annual Utility Cost savings $525,500

NEXT STEPS…



- Utilize the surplus heat available
- Over 3000 hours with HW production exceeding Demand Conditions
  - Connect to Natatorium for Pool Heat
  - CHW Thermal Storage

PROJECT SUMMARY

- Combined Heat and Power is a technology available to Owners with limited capital budgets.
- CHP can work for smaller district energy systems.
- Significant energy cost savings are available when equipment replacement is needed.