PROJECT SUMMARY

5 MW CALCASIEU REFINERY CHP PROJECT COMPREHENSIVE FEASIBILITY STUDY

PROJECT SUMMARY

Bridgestone Associates prepared a detailed study on the technical, environmental and economic feasibility of installing an inside-the-fence combined heat and power (CHP) project at the Calcasieu Refining refinery in Lake Charles, Louisiana. The CHP plant would provide all of the Refinery's steam needs and a large percentage of the Refinery's electrical requirements. The project would provide this energy with less environmental impact and therefore enable the Refinery to produce refined products in a more sustainable manner.

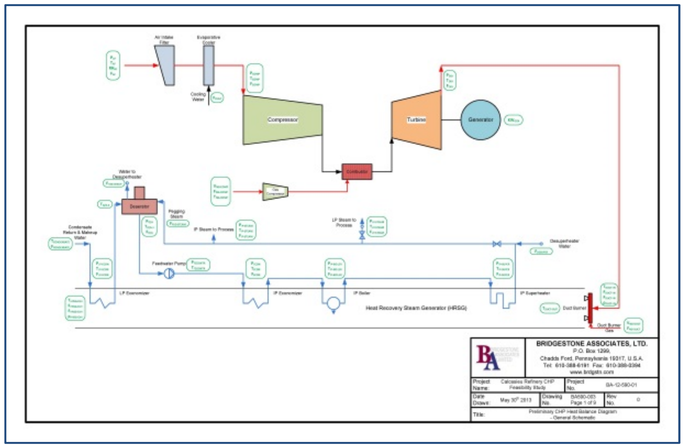
The selected design included a combustion turbine with air inlet cooling, a heat recovery steam generator (HRSG), and an auxiliary boiler. Duct firing would be included in the turbine exhaust duct to increase steam production to match the Refinery's varying steam loads.

PROJECT STATISTICS

Client:	Calcasieu Refining Corporation
Project Type:	Combined Heat and Power Comprehensive Feasibility Study
Size:	5 - 6 MW
Plant Size:	80,000 bbl/day
Estimated Project Cost:	US$12 million
Plant Location:	Calcasieu Parish, Lake Charles, LA, USA
Plant Elevation:	< 50 feet above sea level
Interconnection Voltage:	13.8 kV
Primary Fuel:	Natural gas
Fuel Characteristics:	1,050 – 1,100 Btu/cf
Fuel Use:	77 MMBtu/hr summer peak conditions maximum output
Refinery Steam Conditions:	20,000 lb/hr at 600 psig, 550 °F for crude Stabilizer re-boiler, 15,000 – 25,000 lb/hr 150 psig, 425 °F for process uses
Design Conditions:	95 °F, 65% RH summer peak
Inlet Cooling:	Evaporative cooling
Combustion Turbines:	Siemens SGT100, Solar Centaur 50, or Solar Taurus 60
Steam Turbine Generator:	None
Thermal Requirements:	471,199 MMBtu/year steam

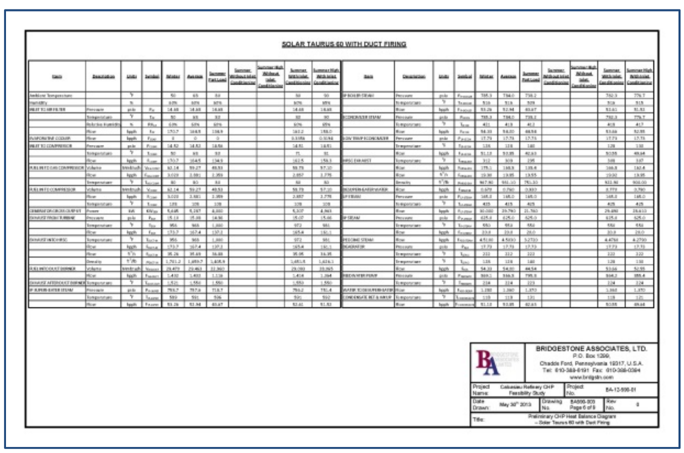
Electrical Requirements: 38,170 MWh/year, 5,872 maximum demand
CHP Electrical Production: 37,642 MWh/year
CHP Thermal Production: 471,199 MMBtu/year steam

PROJECT DESCRIPTION



Bridgestone Associates was engaged by Calcasieu Refining Company to conduct a detailed feasibility study on the applicability of a Combined Heat and Power plant for their 80,000 bbl/day refinery. Bridgestone had conducted a previous study for the Refinery in 2002 when the Refinery had a refining capacity of only 30,000 bbl/day. In that study CHP was found to be technically feasible but economically did not meet the investment criteria of the Refinery. Since 2002 the Refinery has increased its refining capacity to 80,000 bbl/day approximately and is planning further expansion to 100,000 bbl/day. The new feasibility study was designed to examine the applicability of CHP with the increased electrical and thermal requirements of the expanded Refinery capacity allowing for future expansion.

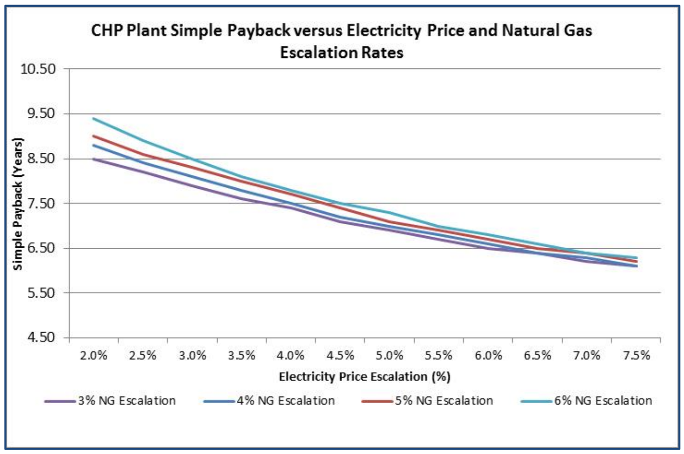
After initial data collection, the feasibility study started with identification and evaluation of all currently available combustion turbine models within the 4 – 7.5 MW size range. These included units from Kawasaki, Siemens, Solar and GE. Using the Thermoflow software program GT-PRO, preliminary heat balances were developed for each applicable model with and without turbine exhaust duct firing, and with and without inlet air evaporative cooling.



Bridgestone's proprietary CHP/IPP Evaluation Model was modified and adapted to suit the specific circumstances of the project, and then a detailed economic model was developed and used to conduct a preliminary examination of all these configuration alternatives. Based on these preliminary results, it was possible to reduce the number of configuration and combustion turbine alternatives to four primary alternatives: Kawasaki GPB60D; Siemens SGT100; Solar Centaur 50; and Solar Taurus 60. Heat balances were then developed for each of these for each season of the year including "winter", "average" (for spring/autumn), "summer" and "summer peak". These seasonal heat balances were then used in the evaluation model to estimate CHP plant performance for each month of the year.

Each of the combustion turbines was evaluated to see if they had the ability to meet the Federal New Source Performance Standard (NSPS) for combustion turbines. All of the combustion turbines met this criterion except the Kawasaki GPB60D. As this turbine would require after combustion controls to meet the NSPS, it was eliminated from further consideration.

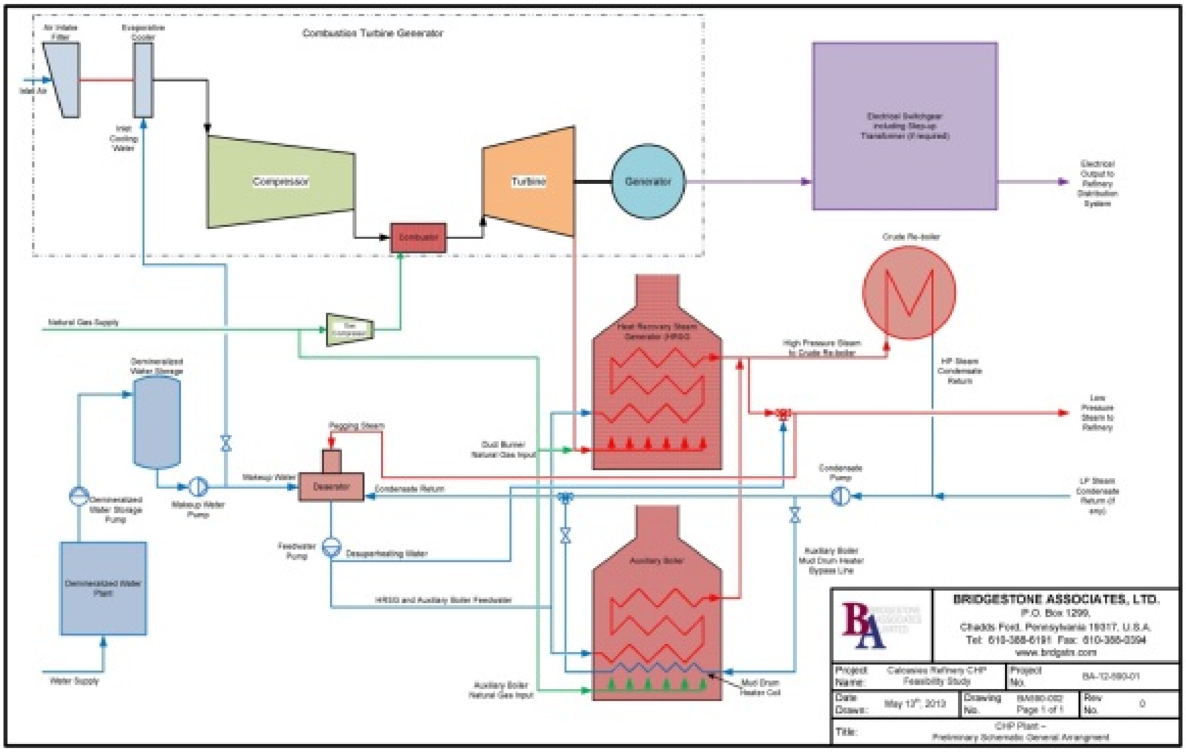
In addition to the NSPS screening, a detailed regulatory analysis was conducted for the proposed CHP plant. This included an assessment of necessary modifications to the Refinery's Title V operating permit. Additionally, an analysis of whether or not Prevention of Significant Deterioration (PSD) might apply to the proposed project. This included preparation of emissions estimates for the components of the project combusting natural gas. These were added to known cotemperaneous increases and evaluated against PSD applicability thresholds in the Louisiana Department of Environmental Quality (LDEQ) regulations. Based on this analysis, for the expected annual hours of operation, it was found that PSD would not be applicable to the project.



Detailed capital, operations, maintenance, development, and owner cost estimates were developed for each alternative combustion turbine. These cost estimates were based on vendor budget prices, R.S. Means data, other industry data, and past experience with similar projects. These detailed cost estimates were used as the basis for developing the overall pro-forma economics and Life Cycle Cost Analysis (LCCA).

Using the economic and technical evaluation model, a detailed analysis of the economic and technical performance of each plant configuration was conducted. This analysis included examination of sensitivity to all major assumptions and variables including capital cost, fuel costs, avoided electricity costs, operations and maintenance costs, Refinery steam and electricity loads, CHP plant availability, and CHP plant performance. The results of this sensitivity analysis and their implications to the feasibility of the project were included in the final written report submitted to the client upon completion of the study.

The configuration of the CHP plant proposed included a combustion turbine with evaporative inlet cooling, duct burners in the turbine exhaust, and an HRSG. Also included were an auxiliary boiler, deaerator, and demineralized water treatment plant. The auxiliary boiler would be fitted with a heating coil in its mud drum where hot (200 °F) condensate water from the Stabilizer crude re-boiler would be used to heat the mud drum water and maintain the auxiliary boiler in warm standby. This would avoid constant use of additional fuel to maintain the auxiliary boiler in warm standby and ready for immediate use. It also mitigates unnecessary emissions contributing to the Project's sustainability.



The feasibility study showed that CHP at the Refinery was technically, environmentally, economically feasible, and would enhance the Refinery's sustainable operations It would greatly mitigate disruptions in delivery of electric and steam energy to the Refinery in an area prone to weather related power outages and disruptions. This will in turn help the Refinery reduce overall downtime. As the Refinery plans to expand its refining capacity further, the availability of additional steam supply capacity from the CHP plant will allow the Refinery to take this steam supply into account when making design decisions in its processes and equipment selection.