The Hilly Energy Inc.

Repowering the Stony Brook Power Plant

Jamaal Lake - Jhun Martinez - Alisa Mizukami - Bajinder Singh - Misbah Syeda

The Team

Bajinder Singh
Team Leader

Alisa Mizukami
Main Components

Jamaal Lake
Cycle Analysis

Misbah Syeda
Cycle Analysis
Balance of Plant

Jhun Martinez
EIS

Project Process

Leader Selection

Leader has lead our same senior design team

Division of Labor

Labor was split among us based on personal preferences

Research

Research was split into components and conducted as necessary

Project Process

Decision Making

Decisions were made through zoom meetings

Calculations

Calculations were done using MATLAB

Final Design

Final design was chosen once the requirements for the project were met

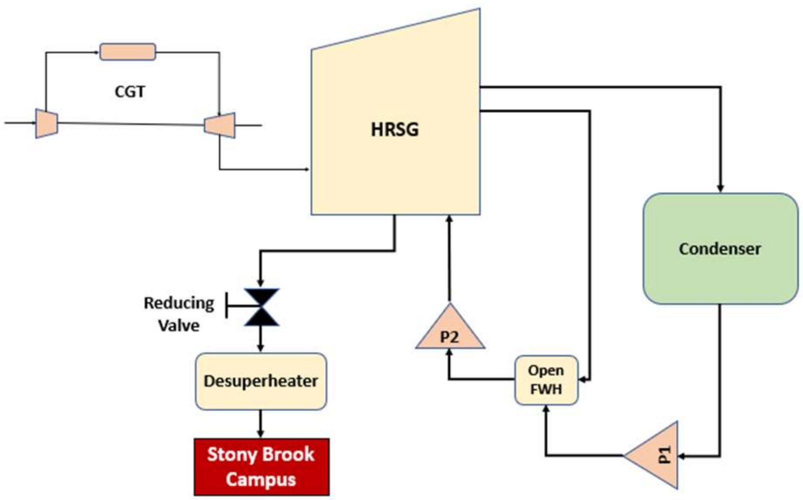
Introduction

Location

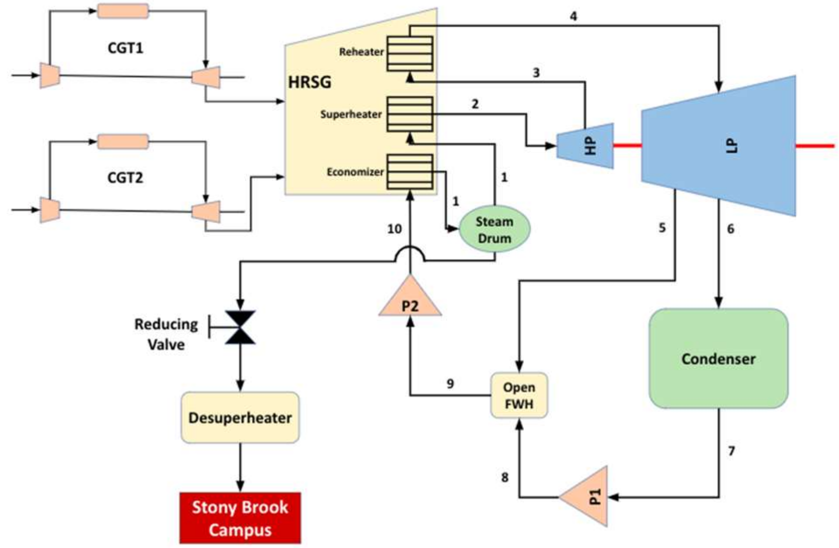
One of the largest consumers of electric power in Long Island

Stony Brook, NY

Our Design



Repowering



Simple Cycle
50 MW
457 x 10^6 BTU/hr

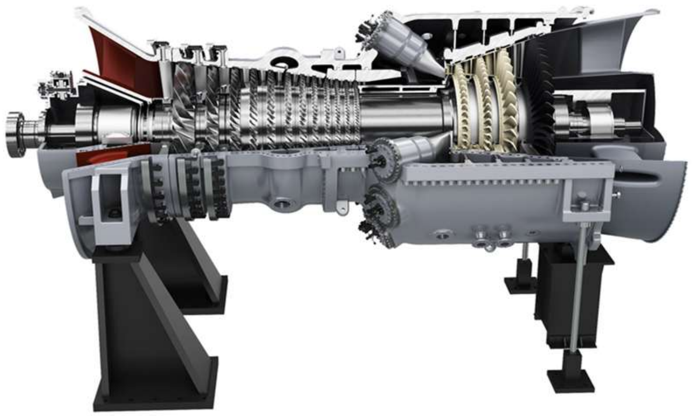
Combined Cycle
976+ MW
1206 x 10^6 BTU/hr

Main Components

Combustion Gas Turbine

- Outputs heat to use in the steam generator
- Chosen due to its high power output (compared to 50 MW)

Siemens SGT6-9000HL	
Simple Cycle Net Heat Rate	8,010 BTU/(kW-hr)
Simple Cycle Net Output	**405 MW**
Simple Cycle Net Efficiency	42.6%



Heat Recovery Steam Generator (HRSG)

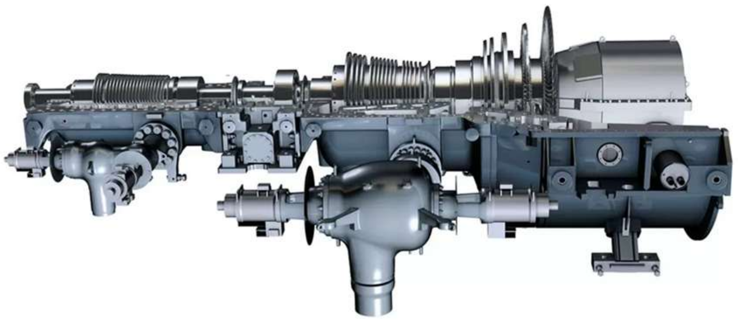
- **Economizer:** Uses heat from CGT to boil liquid water
- **Steam Drum:** Stores steam to be rerouted to campus and steam turbine
- **Superheater:** Superheats the steam
- **Reheater:** Reheats steam after it passes through high pressure turbine

Basic Data	
Heat Output (calculated)	2590 x 10^6 BTU/hr
Efficiency (assumed)	89%

Steam Turbine

- Uses steam from the HRSG to provide electricity
- Supply heated water back to the HRSG as part of the Rankine cycle

General Electric STF-A650	
Main Steam	Up to 2,680 psi (185 bar) Up to 1,112°F (600°C)
Reheat Temperature	Up to 1,112°F (600°C)
Frequency	50 Hz and 60 Hz (US)
Output	**85 MW - 300 MW**
Efficiency	48%



Rankine Cycle Parts

Condenser

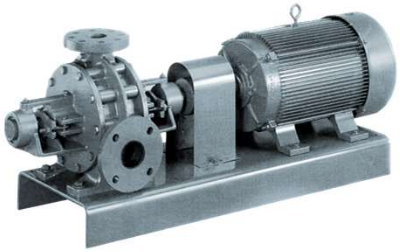
Condenses steam from the low pressure turbine to water

Open Feedwater Heater (FWH)

Mixes steam with water to get high temperature water

Pumps

Increases pressure out of condenser and FWH



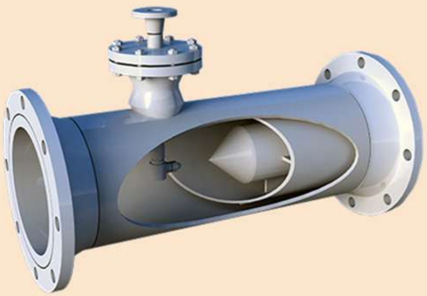
Heat to Campus

Reducing Valve

Reduces the pressure of steam going into campus

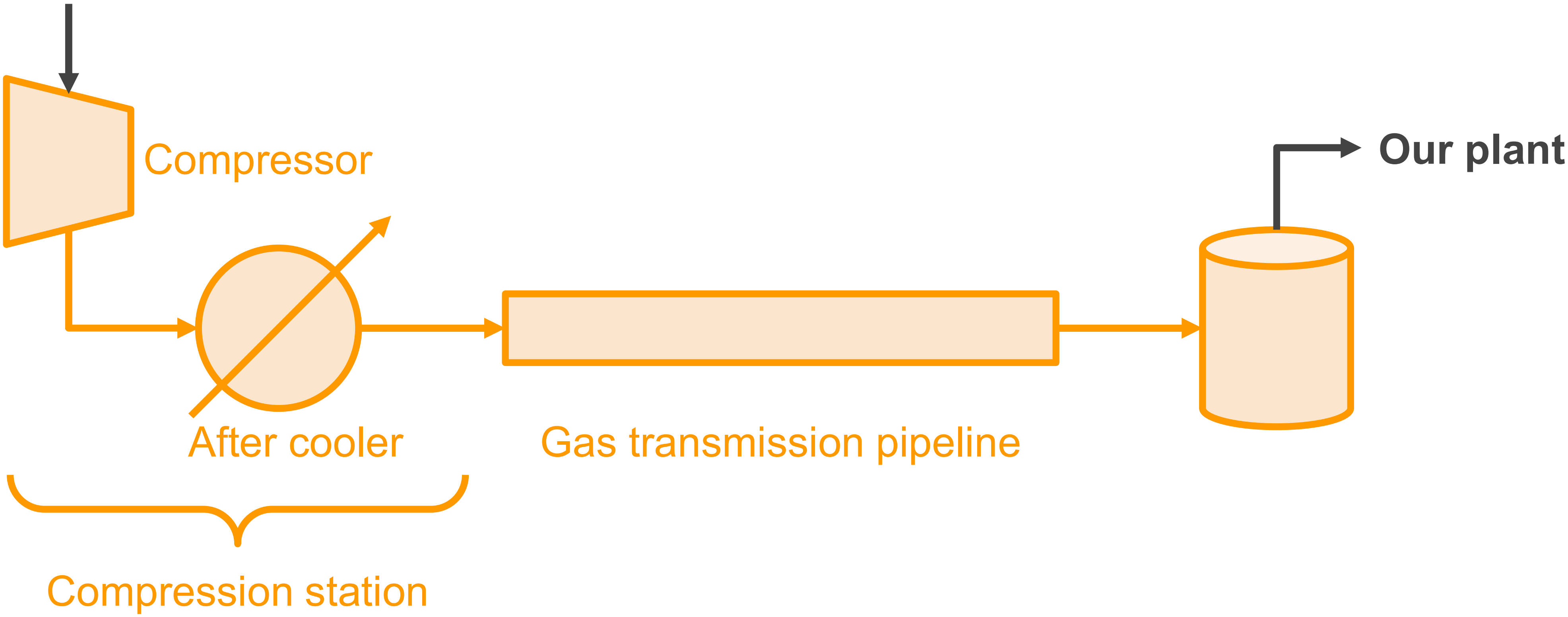
Desuperheater

Reduces the temperature of steam going into campus



Fuel, Storage, Handling

Processed natural gas (originally used by the Stony Brook Power Plant)



Cycle Analysis

Overview

Stony Brook Power Plant is a **Cogeneration** power plant

Electricity

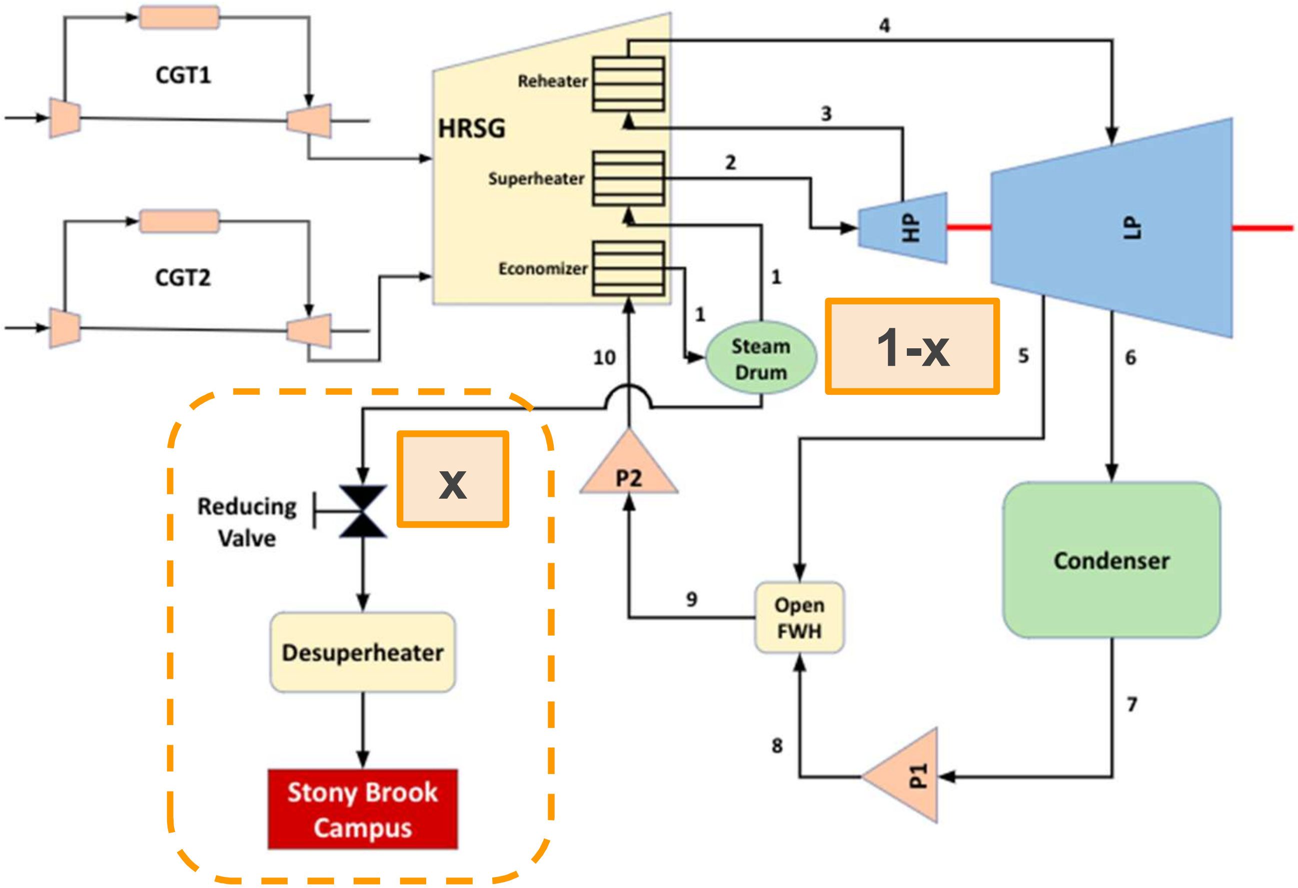
Need all year long!

Heat

Only need in the winter...

Distribution of **heat** will differ between **summer** and **winter**

Cogeneration Combined Cycle Power Plant

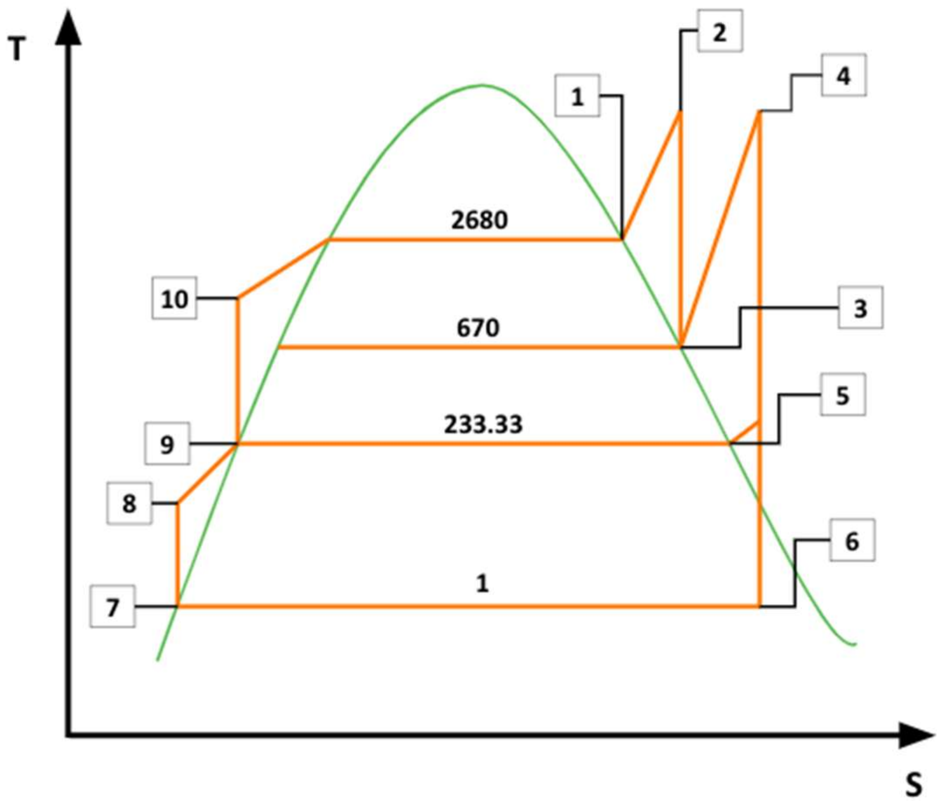


Winter

- Steam will be distributed between the steam turbine and the campus
- x = fraction of steam to campus
- 1 - x = fraction of steam remaining to steam turbine

winter

T-S Diagram



Steam turbine inlet pressure (psi)	2680
Reheat pressure (psi)	670
Feedwater heater inlet pressure (psi)	233.33
Condenser inlet pressure (psi)	1

Winter Heat Calculations

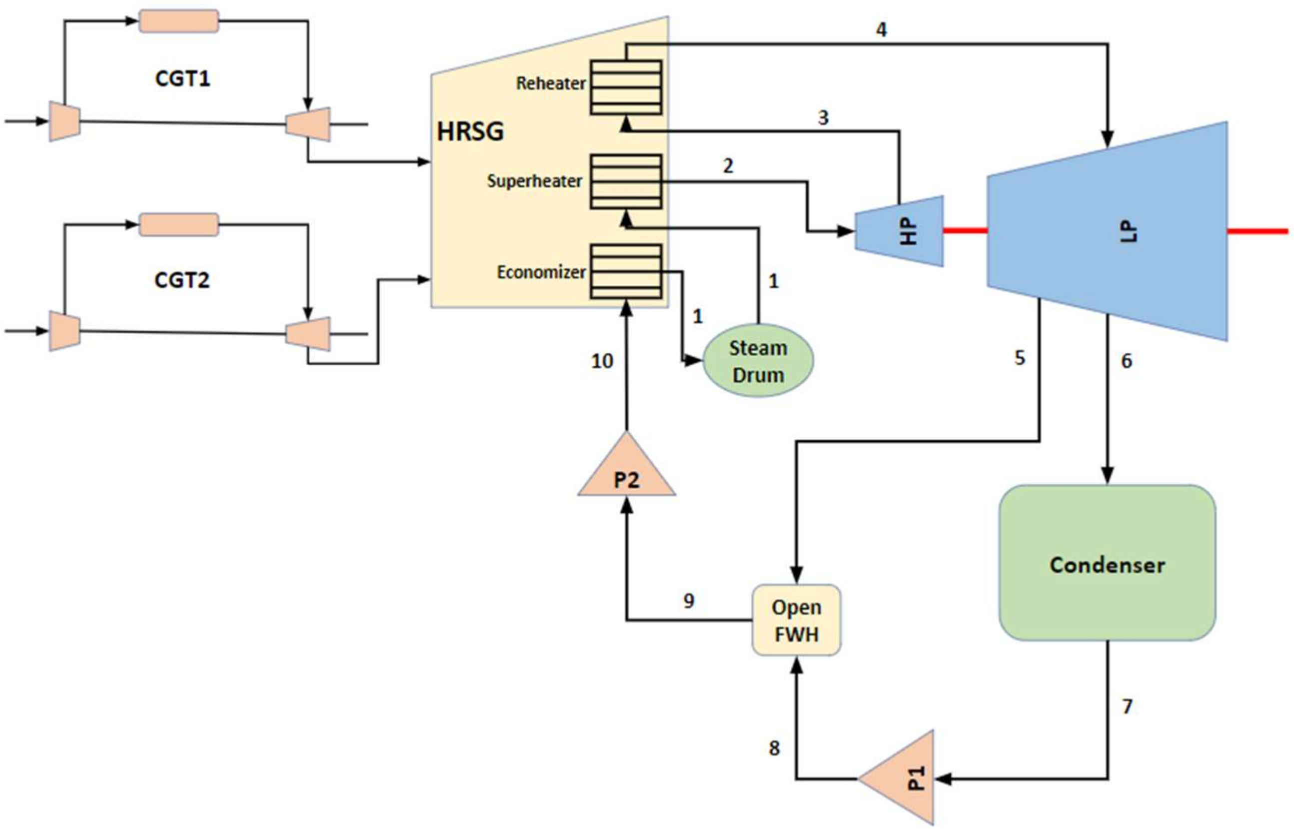
	Required Heat Input (10^6 BTU/hr)	Our Design (10^6 BTU/hr)
2 x CGT (43.93% efficiency)	6490	6490
HRSG (89% efficiency)	2911	3639
Steam Turbine	2133	2133
Campus	457	1206

Requirements are met!

All excess heat was sent to campus

winter

Combined Cycle Power Plant



Summer

- Campus does not require heat
- Only electricity will be generated

summer

Summer Heat Calculations

	Required Heat Input (10^6 BTU/hr)	Our Design (10^6 BTU/hr)
2 x CGT (42.19% efficiency)	6490	6490
HRSG (89% efficiency)	2397	3725
Steam Turbine	2133	3339

Any excess heat could be used for unknown thermal loads

Requirements are met!

summer

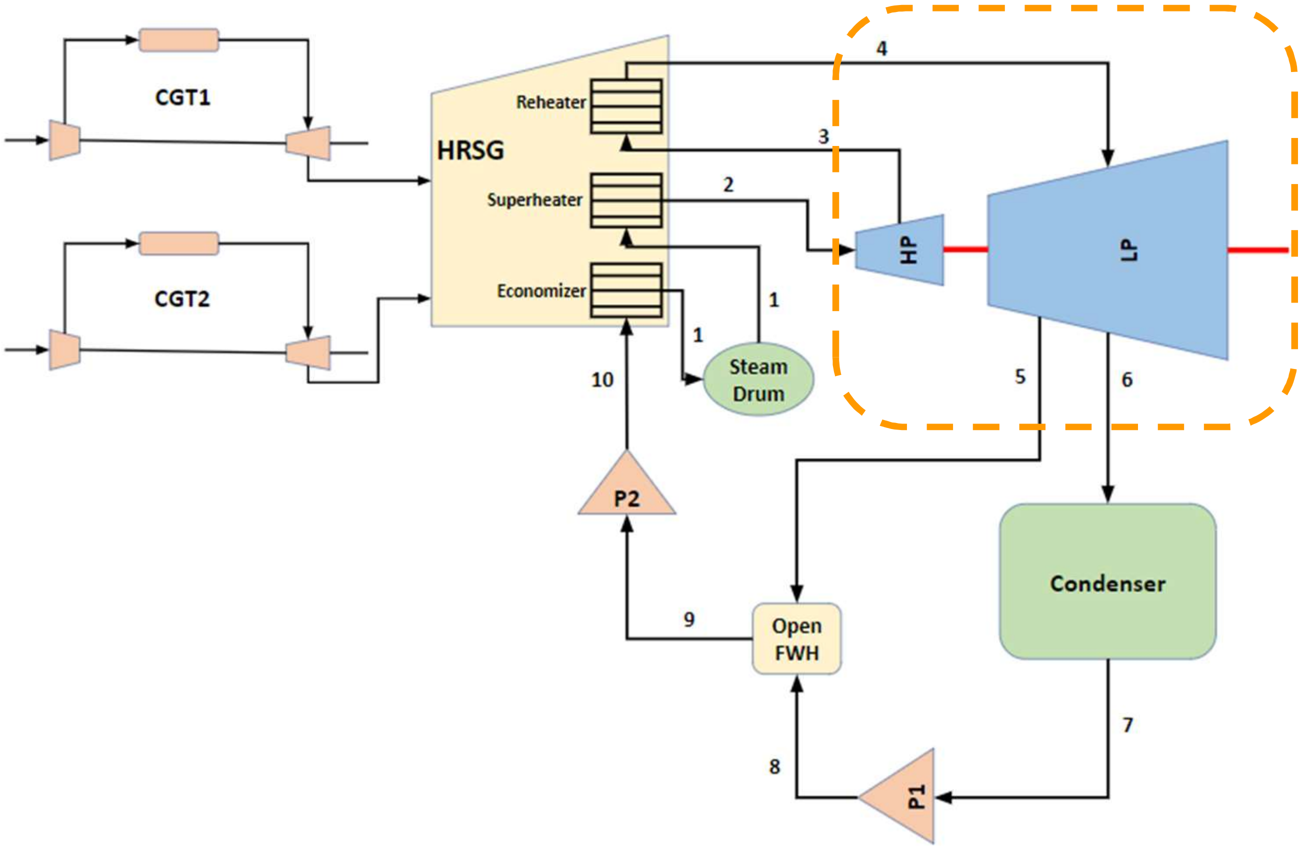
Cycle Efficiency

	Rankine Efficiency	Gas Turbine Efficiency (with correction factor)	Combined Cycle Efficiency
Winter	33.409 %	**43.927 %**	62.660 %
Summer	**36.959 %**	42.187 %	**63.820 %**

The summer season showed a higher efficiency

Balance of Plant

Steam Turbine



The steam turbine uses waste heat from the gas turbine to generate additional electricity

Environmental Impact Statement

Current & Desired Emission Levels

Carbon Monoxide

10 ppm

↓

1 ppm

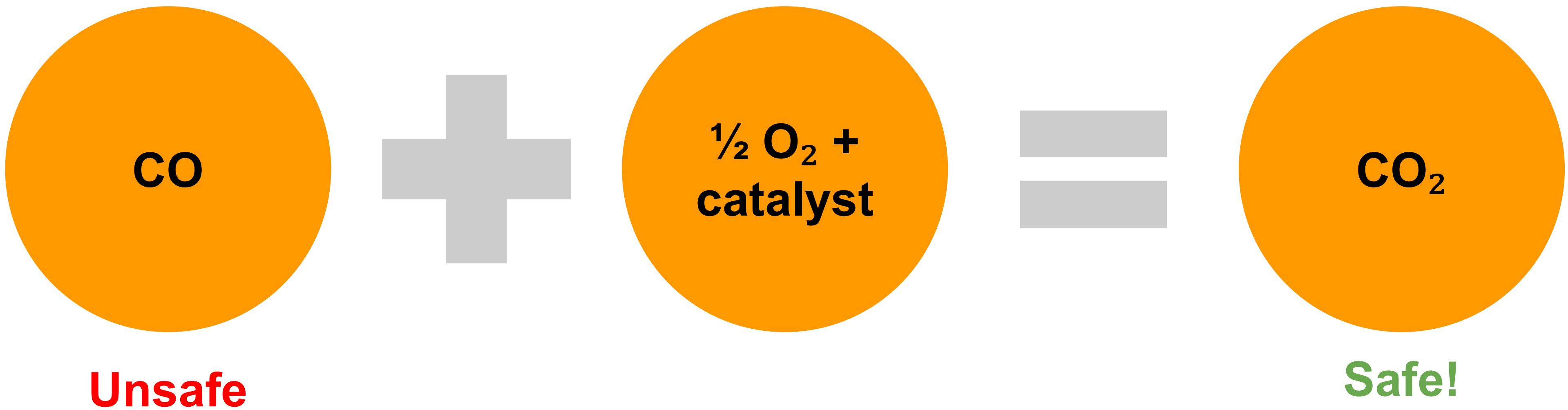
Nitrogen Oxides

25 ppm

↓

5 ppm

Carbon Monoxide (CO) Reduction



Carbon Monoxide (CO) Reduction

10 ppm CO

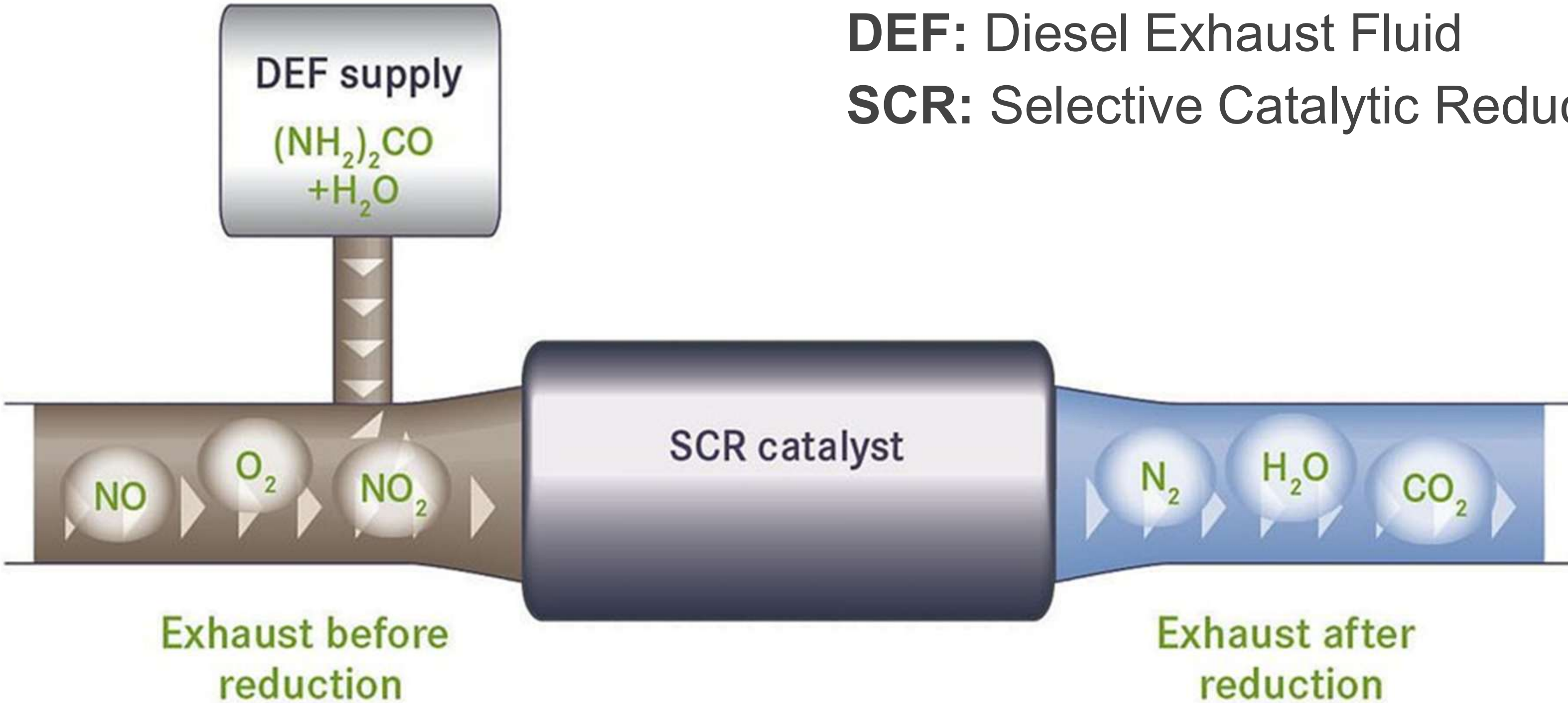
CO Catalyst
99% reduction

0.1 ppm CO < 1 ppm ✓

Nitrogen Oxide (NOx) Reduction

DEF: Diesel Exhaust Fluid

SCR: Selective Catalytic Reduction



Unsafe

Safe!

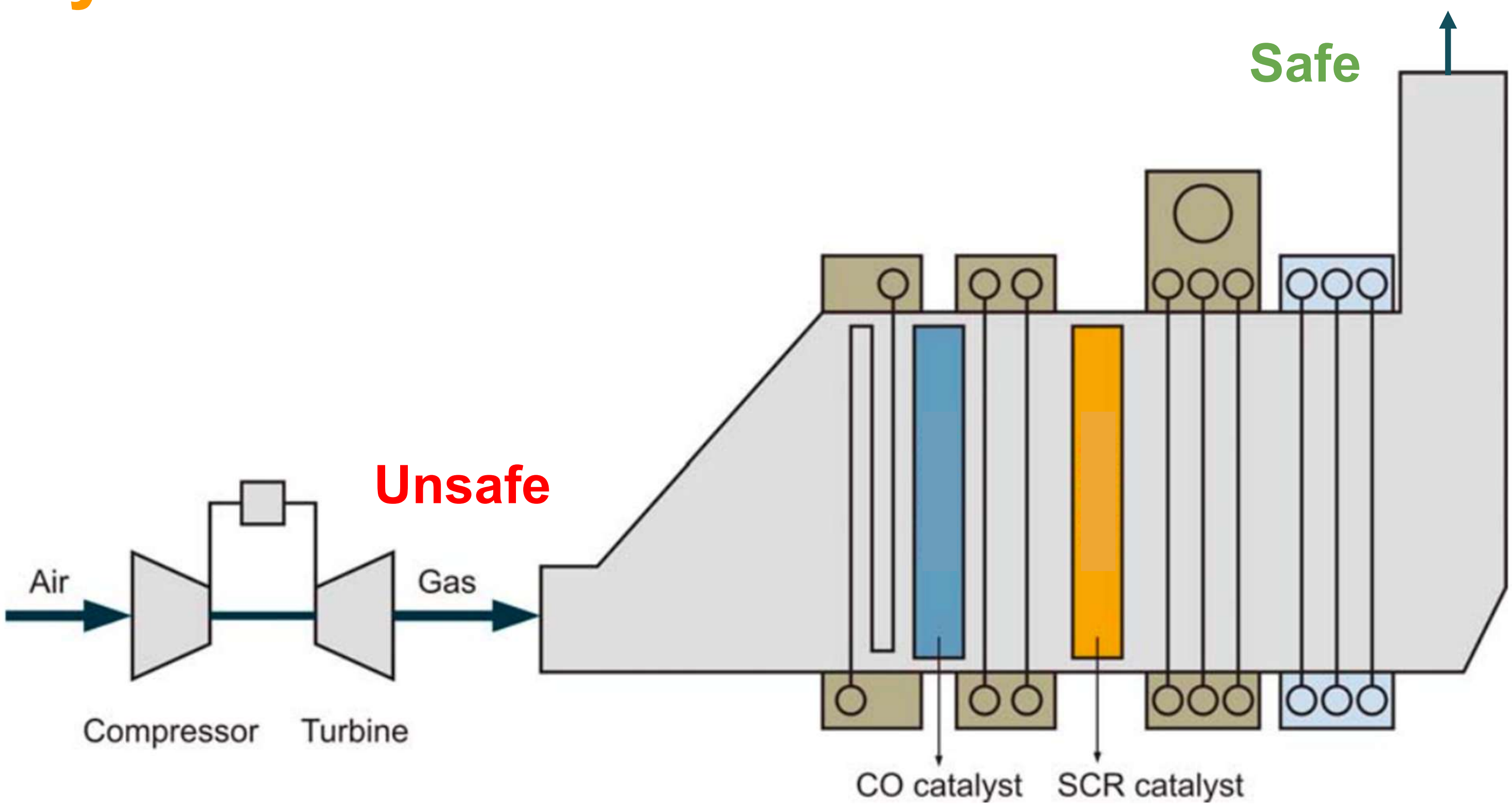
Nitrogen Oxide (NOx) Reduction

25 ppm NOx

NOx Catalyst
92% reduction

2 ppm NOx < 5 ppm ✓

Catalysts in HRSG



Final Emission Levels

Carbon Monoxide

0.1 ppm

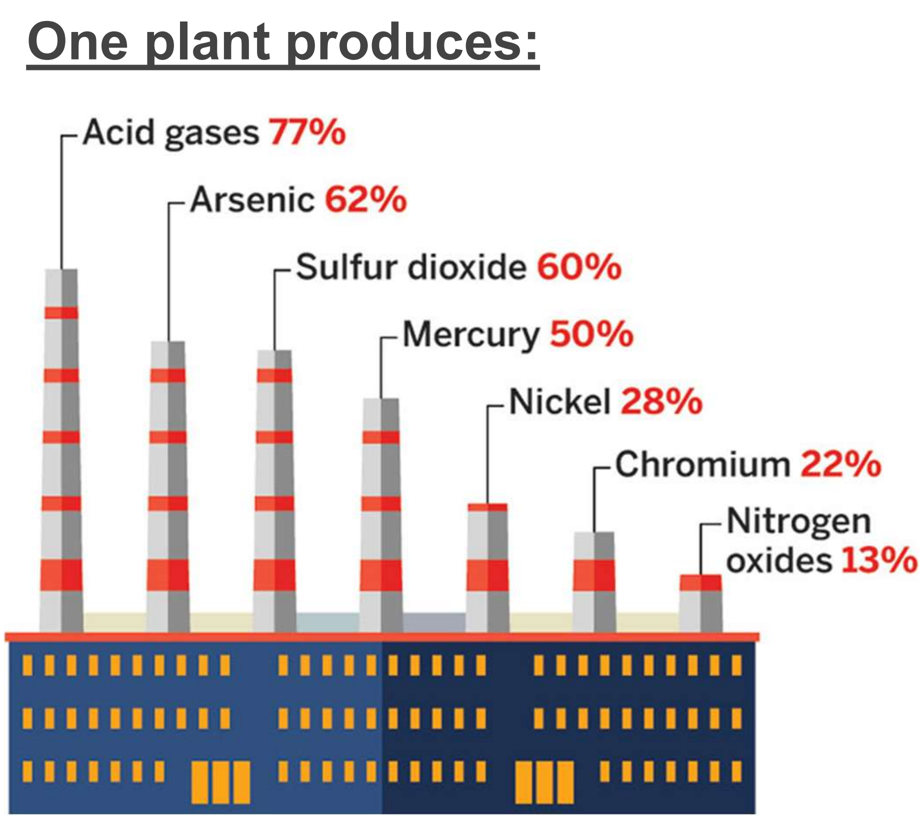
SAFE!

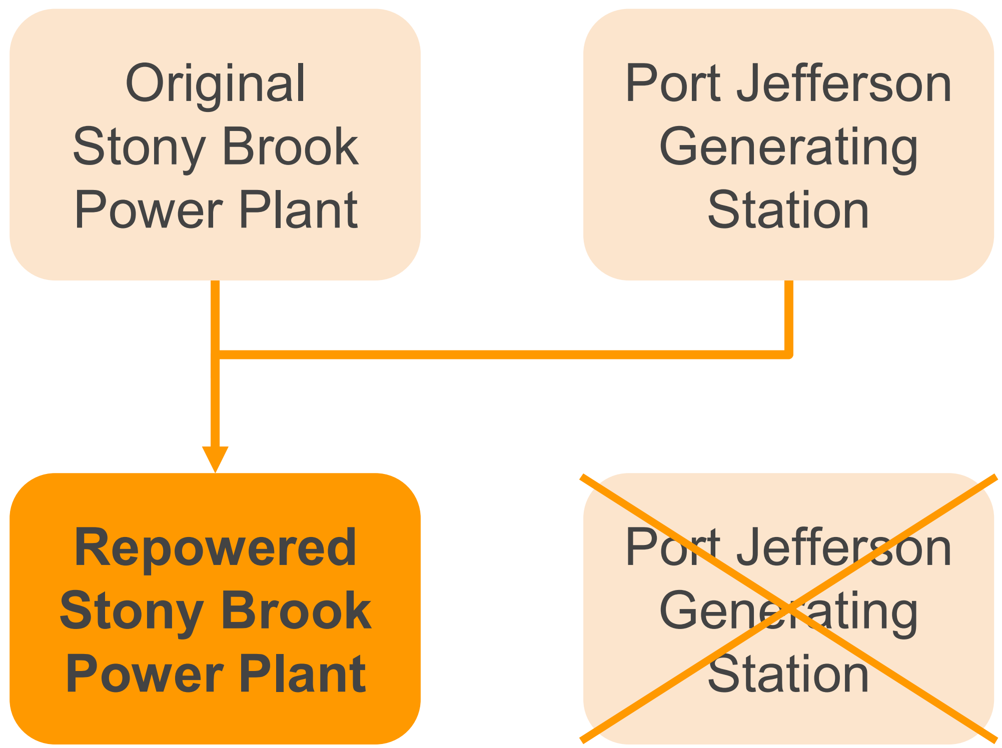
Nitrogen Oxides

2 ppm

SAFE!

Environmental Benefits





Efficient & Low emission

Conclusion

Conclusion

1 **Surplus Power**

926 MW

Surplus, more than **2x** the power generation of the Port Jefferson Generating Station

2 **Higher Efficiency**

16% higher

Than the Simple Cycle Port Jefferson Generating Station

The Hilly Energy Inc.

Thank you!