

Calvin College Co-gen Plant

Engr 333 Section B, Calvin College CEAP 2017



Introduction

Previously, Calvin College had a co-generation system with the purpose of generating electricity and heat, through the combustion of natural gas, for Calvin's campus. The original co-gen system was removed in 2017 due to high costs associated with maintenance and operations. Without a co-gen system, Calvin College is fully dependent on the grid. To save money and help in the President's Carbon Commitment, PCC, the mechanical engineering students of ENGR 333 (section B) propose the implementation of a new co-gen system.

Objective

Determine what is required to save Calvin College \$150k/year on energy costs using a new co-gen system.



Figure 1. Location of the new co-gen on Calvin's Campus
www.calvin.edu

Approach

Five groups were created focused on finance, engine selection, interconnections, natural gas savings, and CO₂ savings. Working together the groups tackled the task of analyzing the co-gen system compared to purchasing electricity from the grid.

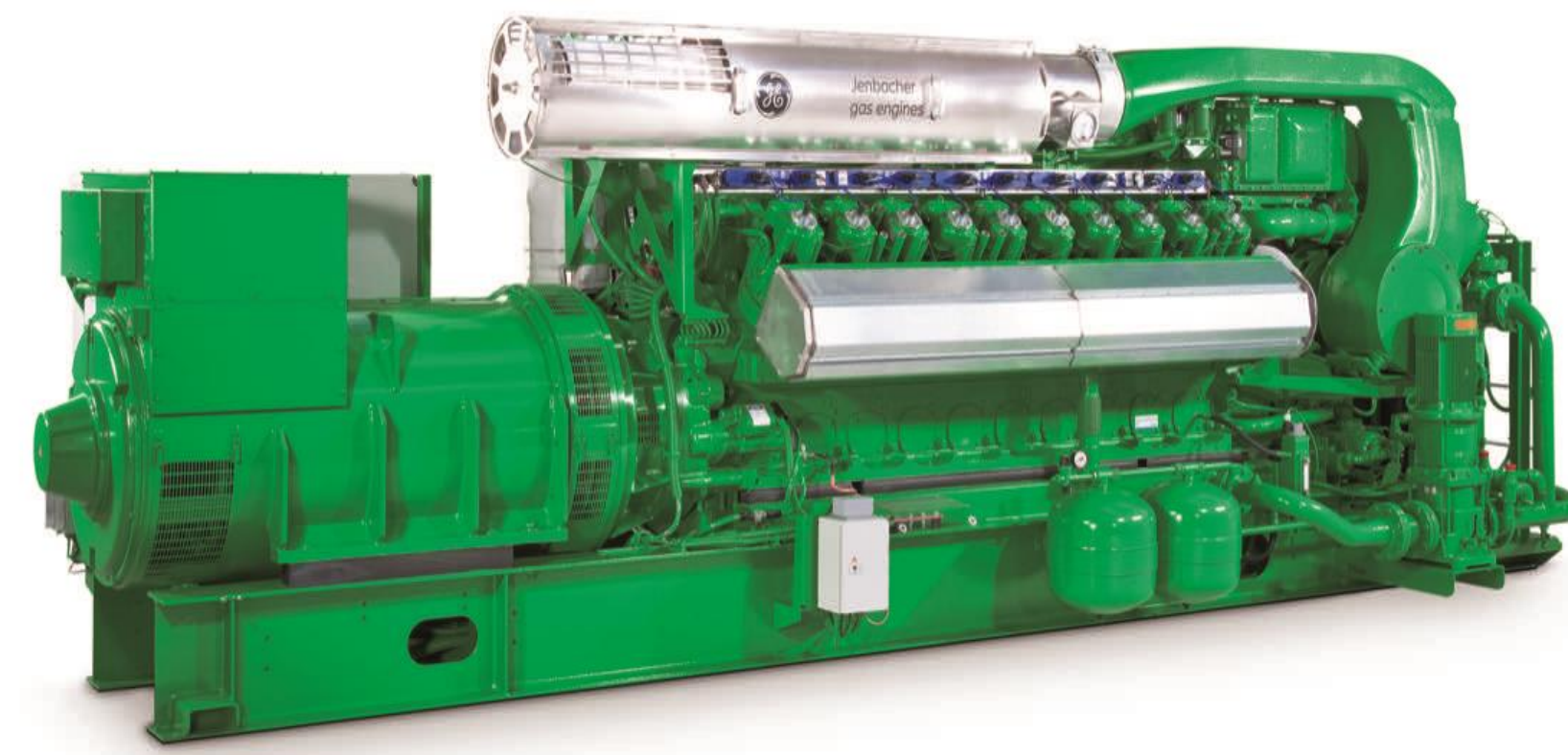


Figure 2. GE Jenbacher Type 4 J 416
https://www.gepower.com/content/dam/gepower-pgdp/global/en_US/images/product/galleries/reciprocating/jen-type4/1200_J420_Rolf_middle.jpg

Considerations

The following considerations guided the teams to make decisions.

- Electricity and natural gas usage
- Previous co-gen specifications and use
- Type of engine
- Amount of electricity produced
 - Produce more electricity than needed and sell back or under produce and buy remaining
- Potential future carbon trade
- Ease of installation
- President's Carbon Commitment
- Environmental impact

Results

Engine: GE Jenbacher Type 4 J 416

It is determined that GE's Genbacher 4 J416 engine suits Calvin's needs best. The engine power output is around 1 MW. The engine plus installation will cost \$1.4 million.

Electricity Savings: Calvin College currently spends roughly \$1.55 million on electricity per year. The total cost with the cogeneration plant would be \$1.23 million per year. Therefore, the savings would be around \$320,000 a year.

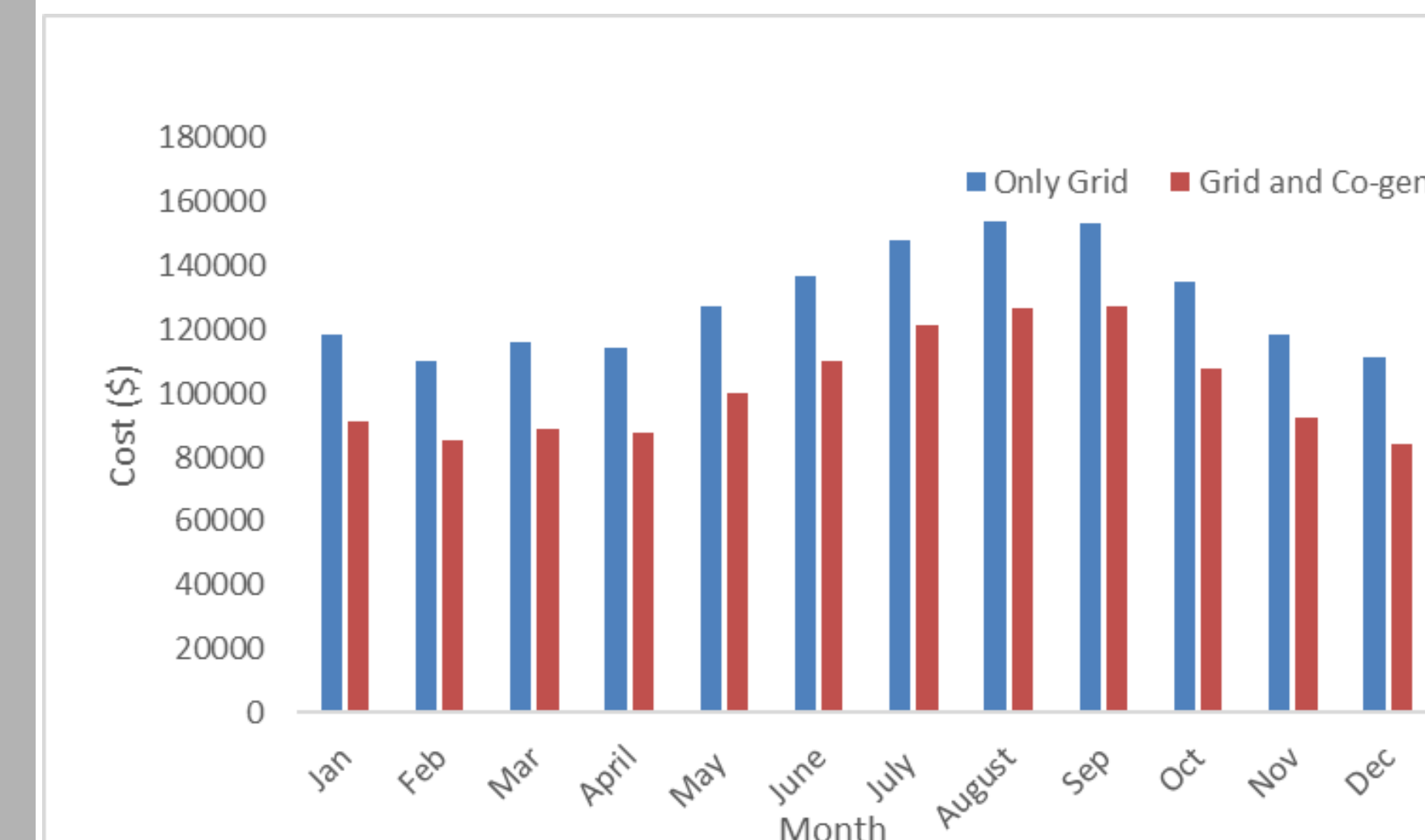


Figure 3. The Monthly Electricity Costs

Figure 3. shows the financial benefit of having a co-gen system versus having to purchase all electricity from the grid

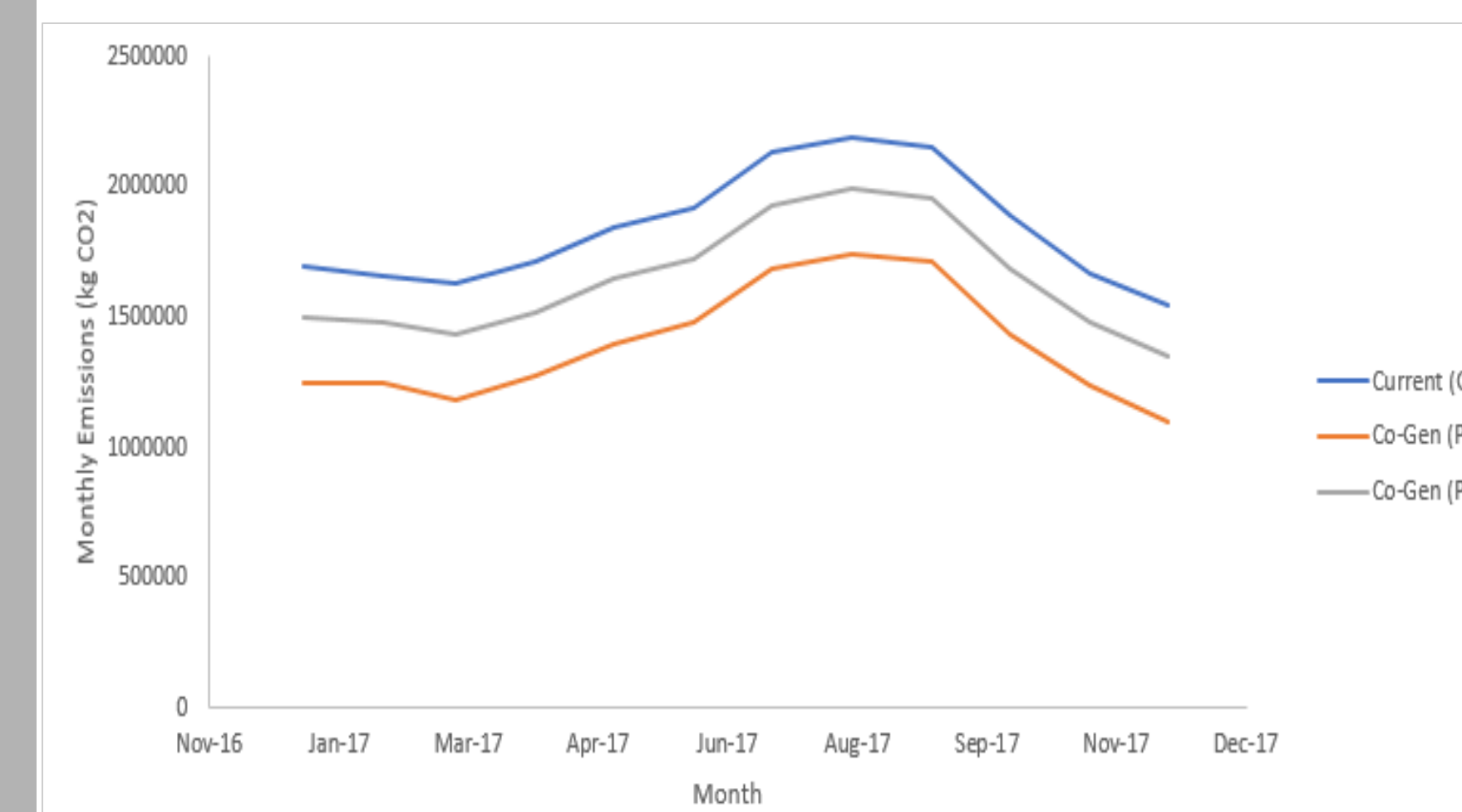


Figure 4. CO₂ Savings over the Year

Figure 4. shows how much CO₂ (about 2 million kg per year) can be saved by installing the co-gen system

Table 1. Savings with the Co-gen System

Finances per year	
Current spending	\$1,550,000
Cost with co-gen plant	\$1,230,000
Pay back period	10 yrs
First 10 yrs savings	\$111,517
Second 10 yrs savings	\$318,724
CO ₂ Savings	
Grid Emissions	0.984 kg-CO ₂ /kWh
Co-gen Emissions	0.7738 kg CO ₂ /kWh

Conclusions

The class determined that Calvin College should invest in a GE Genbacher 4 J416 engine. This co-gen system would provide the college with \$111,000 in savings per year for the first 10 years while the loan is being paid, and \$320,000 for the next 10 years of the engine's life. It would also reduce CO₂ emissions.

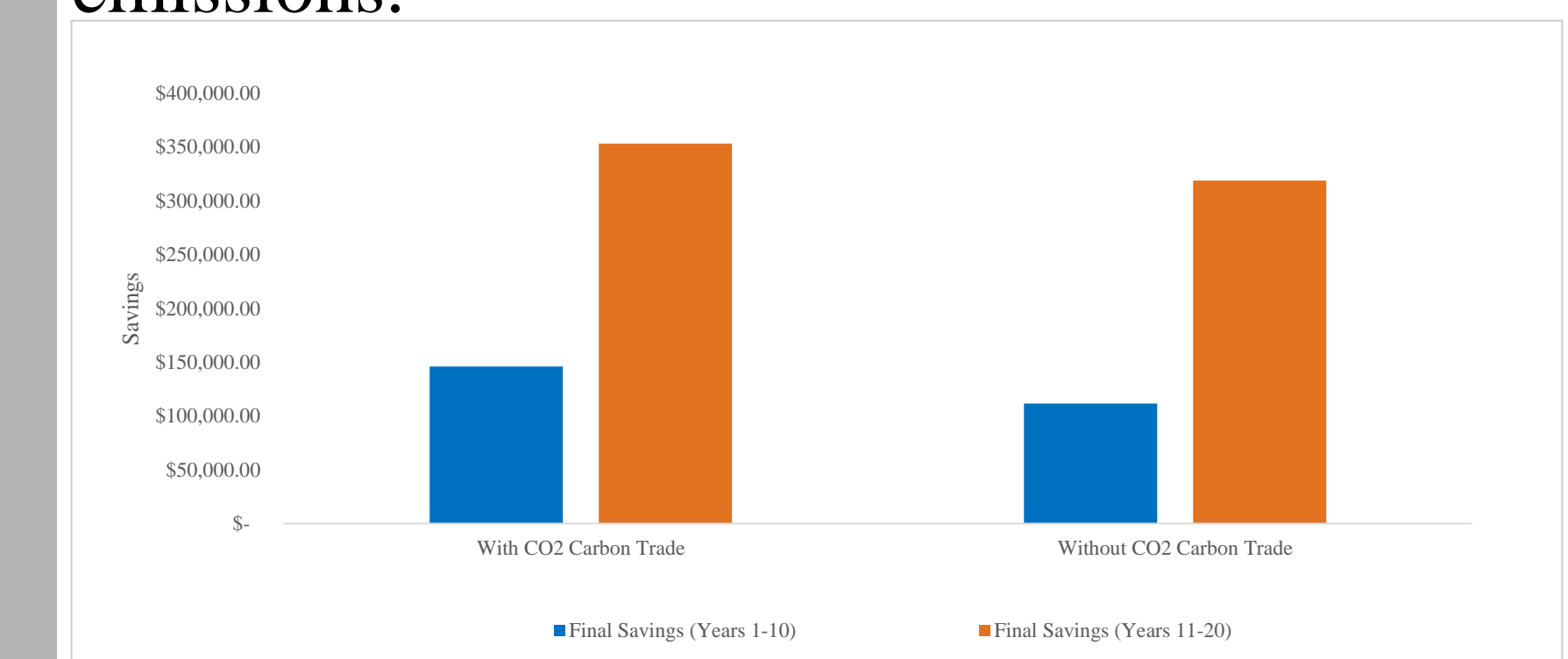


Figure 4. Final Savings

Figure 4. shows the final savings per year for operation with CO₂ carbon trade and without carbon trade

References

Special Thanks to:

- General Electric
- Jared Cherni, GE Sales Manager
- Jack Phillips, Mechanical Assistant Director Calvin College
- Phil Beezhold, Director of Physical Plant Calvin College
- Matthew Heun, Engr-333 Professor