# GHG Emissions and Electricity Demand Reduction due to Combined Heat and Power in Alberta



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## Introduction

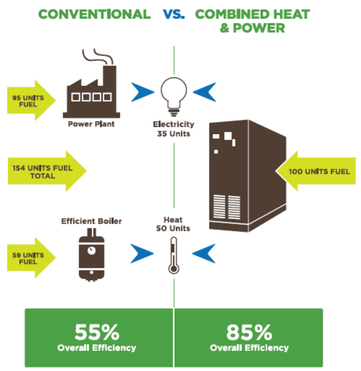
Combined Heat and Power, or Cogeneration, refers to the generation of heat and power from a single fuel source. Thermal power plants lose about 60% of input energy as heat. CHP captures the waste heat for use in building heating [1].

CHP systems offer numerous benefits:

- fuel savings, energy diversity, reliability, transmission avoidance, reduction in pollution and GHG emissions, reductions in capital expenditure [2],[3]

CHP technology is very well suited to:

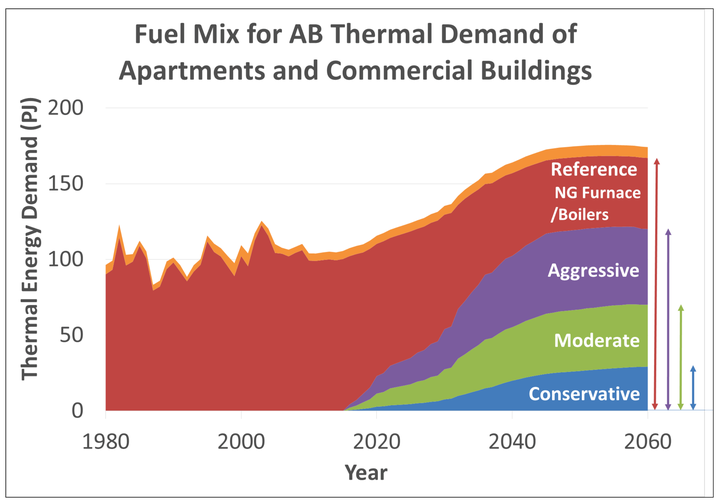
- recreation centers, hotels, apartments, universities, & hospitals




**Convention vs CHP system [1]**

## Methodology

- The mix of heating systems meeting thermal demands for commercial buildings and apartments was manipulated as the lever in multiple scenarios
- For alternate scenarios, CHP is introduced to the mix at 2015 onwards with varying rates of adoption for both new build and retrofits (the entire building stock). The rates of adoption depend on future market development for CHP

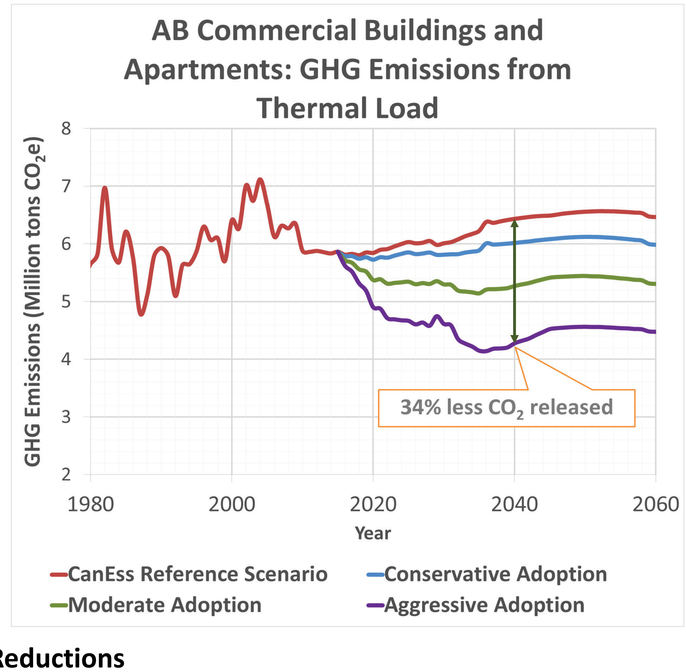



- Emissions from meeting thermal demand are calculated using emission factors compiled from academic sources
- Fuel is compared in terms of equivalent $CO_2$ emissions
- A CHP unit with a heat-to-power ratio of 1.5 is assumed for calculating the generated electricity

## Results

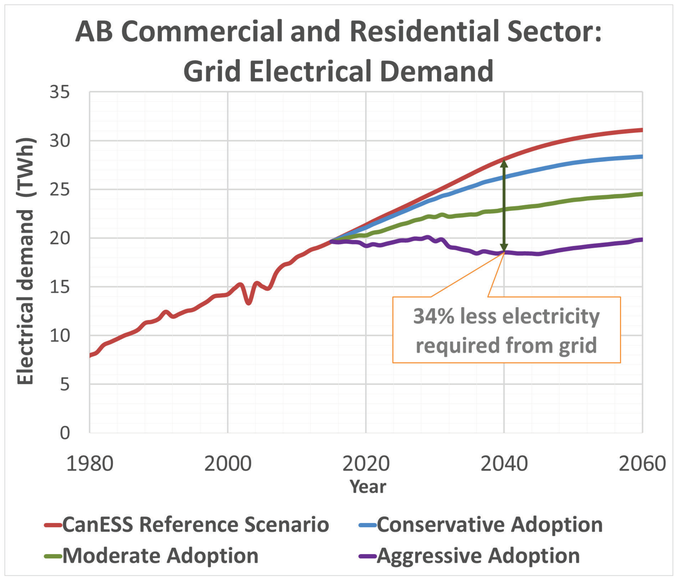
### Greenhouse Gas Emission Reductions

- Installation of CHP in apartments and commercial buildings always results to a reduction in GHG emissions
- Greatest change in reductions are observed in the first few years after 2015
- A maximum of 34% emission reduction from the reference scenario is observed in the year 2040, amounting to 2 million tons of emissions avoided




### Grid Electrical Demand Reductions

- The corresponding electricity generated by installed CHP units locally offsets a significant portion of electricity otherwise provided by the grid (Alberta Interconnected Electrical System)
- A 34% reduction is observed in the year 2040. This amounts to 10 TWh of locally generated electricity.




## Discussion

- Figure 3 clearly shows that CHP adoption in apartments and commercial buildings will reduce GHG emissions in Alberta.
- Higher adoption rate = higher emissions reduction
- Figure 4 shows that distributed generation with CHP results in decreased electrical demand, reducing demand for new electrical infrastructure [4] (such as transmission lines and large, centralized generators)
- Locally generated electricity also avoids transmission costs and offers increased reliability [4], especially in extreme weather
- Results suggest that it is worthwhile to facilitate CHP adoption in Alberta in the future. Efforts can be directed to address the following challenges to CHP adoption:
  - Lack of awareness on CHP technology
  - Lack of interconnection standards for distributed generation [5]
  - Lengthy permitting process reduces economic benefit [5]
- Corresponding cost benefits of CHP adoption is limited to qualitative analysis. It was found that an average cost benefit for a typical building is difficult to quantify due to the following factors [4]:
  - Varying sizes and thermal demands of apartments and commercial buildings
  - Volatile electricity and natural gas prices
  - Wide range of applicable CHP technology
- With current low natural gas prices, the 4 of projects we studied that were implemented in Alberta saw payback periods ranging from 2-7 years (over the last 20 years)

## Conclusion

The adoption of CHP technology in apartments and commercial buildings provides a host of benefits.

Widespread adoption would help Alberta:

- meet GHG reduction targets, reduce harmful toxic NOx, SO2, and particulate emissions, reduce transmission tariffs and infrastructure, and increase the reliability of the electrical system

An increase in the adoption of CHP will require:

- increased awareness of CHP systems among engineers, building owners, policy makers and the public, and a streamlining of the current permitting process.

## References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- [2] M. Klein, “Cogeneration and district energy in Canada,” *Cogener. On-Site Power Prod.*, pp. 37–40, 2001.
- [3] M. Klein, “Cogeneration: A Primer,” 2013.
- [4] Personal Communication – M. Klein.
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- [6] http://www2.cieedac.sfu.ca/media/publications/Cogeneration_Report_2014_Final.pdf
- [7] Straatman, B., 2014, *The Canadian Energy Systems Simulator (CanESS): A Reference Scenario to 2060 for Exploring Alternatives for Canada’s Energy Future*. Perspectives on Canada's Energy Future: Scenarios to 2060. University of Calgary, December 1, 2014.


## Acknowledgements


We would like to thank the following individuals for lending their expertise to this project:
Manfred Klein, Dr. David Layzell, Dr. Hassan Hamza
Dr. Bastiaan Straatman, Dr. Gilles Jean

This poster produced as part of University of Calgary course Scie529 in Fall 2014. For info: dlayzell@ucalgary.ca