Carleton University Brayton Cycle Loop (CUBCL) Design

Mechanical and Aerospace Engineering
4th Year Project – 2022/23
sCO₂ Power Cycles

- Supercritical working fluids
  - P, T > critical values
  - Properties change dramatically near critical point
- High density near critical point
  - Reduced compressor work, compact turbomachinery
- Good efficiency potential
- Near-ambient critical temperature
  - Availability of sinks/sources

\[ \text{\text{P}}_{\text{crit}} = 7.37 \text{ MPa (1070 psi)} \]
\[ T_{\text{crit}} = 31^\circ \text{C (88}^\circ \text{F)} \]
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[Wilkes, 2013]

[Wright, 2011]
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sCO$_2$ Power Cycles

Solar

Military Fix Base & Marine

ARRA Geothermal

Waste Heat Bottoming Cycle to a Gas Turbine

Supercritical CO$_2$ Brayton Cycle

Nuclear (Gas, Sodium, Water)

SNL Solar Tower

DOE-NE Gen IV

Carbon Capture & Sequestration CCS+EOR Fossil Oxy-Combustion

SNL has Funding or Research Agreements with most Agencies Representing these Heat Sources

Clean Coal & Natural Gas Power Systems

Carleton University

[Wright, 2011]
CUBCL Project History

- 2006-11: 100 MW_e plant
- 2011-12: 10 MW_e plant
- 2012-16: 250 kW_th pilot-scale, 10 MW_e plant
- 2016-17: hiatus
- 2017-19: 250 kW_th pilot-scale, 10 MW_e plant, US DOE STEP Project Support
- 2019-: 100 MW_e plant, turbomachinery scaling (50-500 MW_e), US DOE STEP Project Support
2019- CUBCL Project

- 10 MW\textsubscript{e} US DOE STEP Project Support (GTI, SwRI, GE, NRCan, and others)
  - https://www.gti.energy/step-demo/
  - 2020-23: current tasks
    - Heat transfer modelling and experiments (4\textsuperscript{th} year/grad student)
    - Dynamic model and simulation (4\textsuperscript{th} year/grad student)

- 2022-23 4\textsuperscript{th} year project
  - Finalize design of 100 MW\textsubscript{e} plant based on STEP layout
  - Continue design of 50-500 MW\textsubscript{e} plants
    - Thermodynamics, aerodynamics, structural/mechanical design
2019- CUBCL Project

STEP facility initial cycle schematic [DOE]

CU “STEP” facility cycle schematic (100 MW_e)

STEP facility equipment layout [GTI]

CU “STEP” facility plant layout (100 MW_e)
ISABE 2022 Volunteers

- https://www.isabe.org/
- https://conference.isabe.org/
- Student volunteers (4th year and graduate students)
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