The Development of a reciprocating steam engine for use in small-scale CSP Plants

UNDERTAKEN BY: BRADLEY DA SILVA

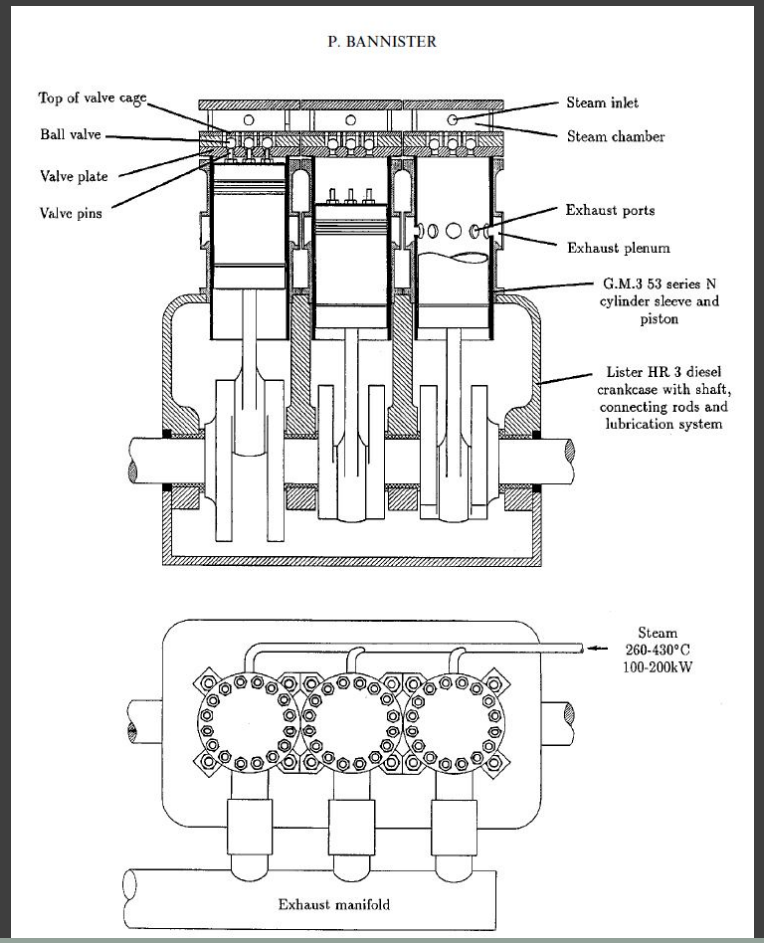
SUPERVISOR: PROF CJ MEYER

Introduction

- Micro gas turbines in small-scale CSP Plants
  - High cost
  - High level of technical skills required
- Reciprocating Steam engines as an alternative
  - Low cost and low maintenance devices
  - Basic automotive skills required
  - Remote location application

ANU Solar Thermal Steam Engine

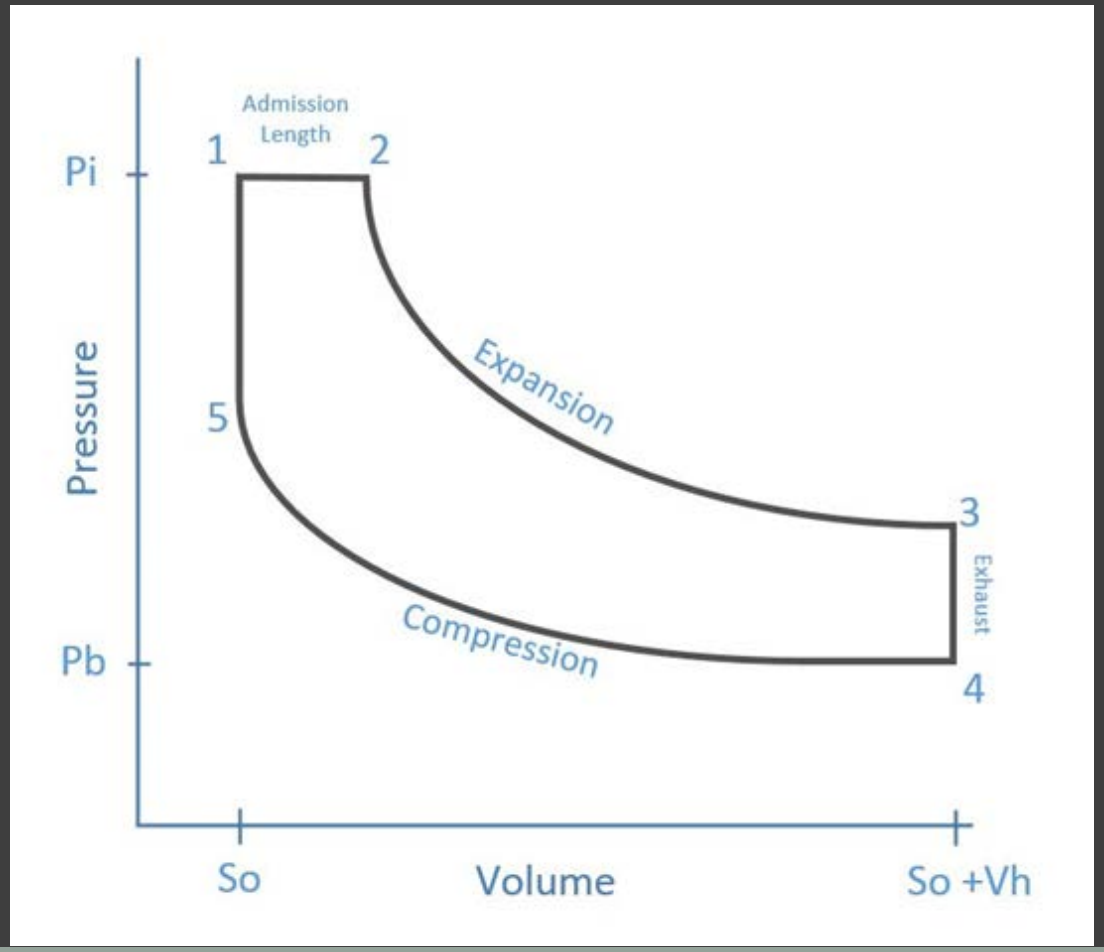
- White Cliffs Solar Thermal Power Plant
  - Produced 25kWe
  - 14 parabolic dishes
  - 24 hour battery storage
- Uniflow Steam Engine
  - Converted 3 cylinder Lister diesel engine
  - Bash valve system
    - Cheap and robust
    - Inefficiencies caused by throttling and incomplete filling
  - Machined exhaust ports
  - 21.9% measured efficiency at 6.9MPa, 415°C



Uniflow Steam Cycle

- Steam admission (5 – 1 – 2)
- Expansion (2 – 3)
- Exhaust (3 – 4)
- Compression (4 – 5)

- So – Clearance space
- Vh – Piston stroke volume
- Pi – Inlet pressure
- Pb – Exhaust pressure

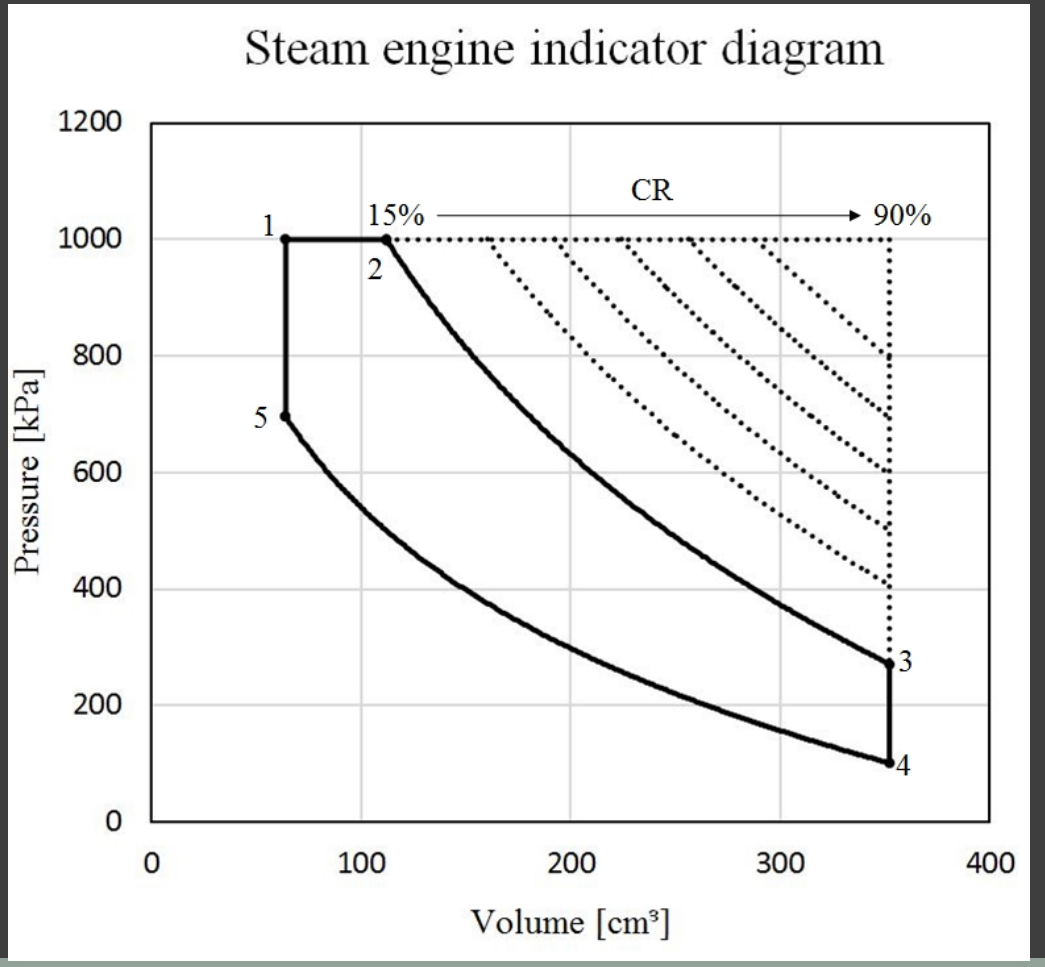


Objectives

- Design and manufacture a proof of concept reciprocating steam engine from an existing IC engine
- Develop a variable valve duration system for the engine to increase operating range
- Perform tests on the developed engine at various cut-off ratios
- Evaluate the performance of the constructed engine

Engine Thermodynamic model

- 20% Clearance space
- 10% exhaust port
- 15 – 90% cut-off ratio
- $Power = enclosed\ area \times engine\ speed[Hz]$

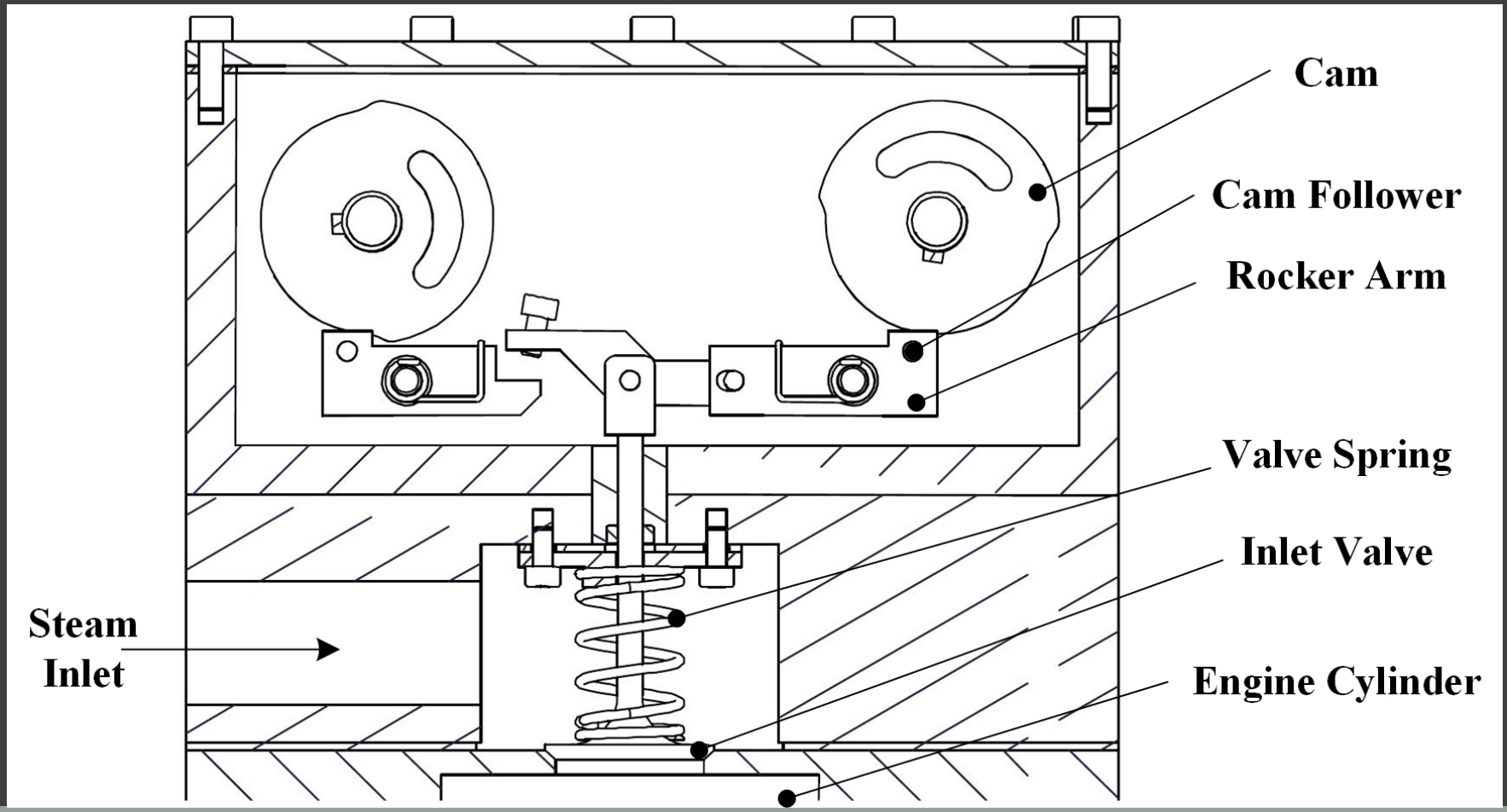


Single Cylinder 319cc Briggs and Stratton

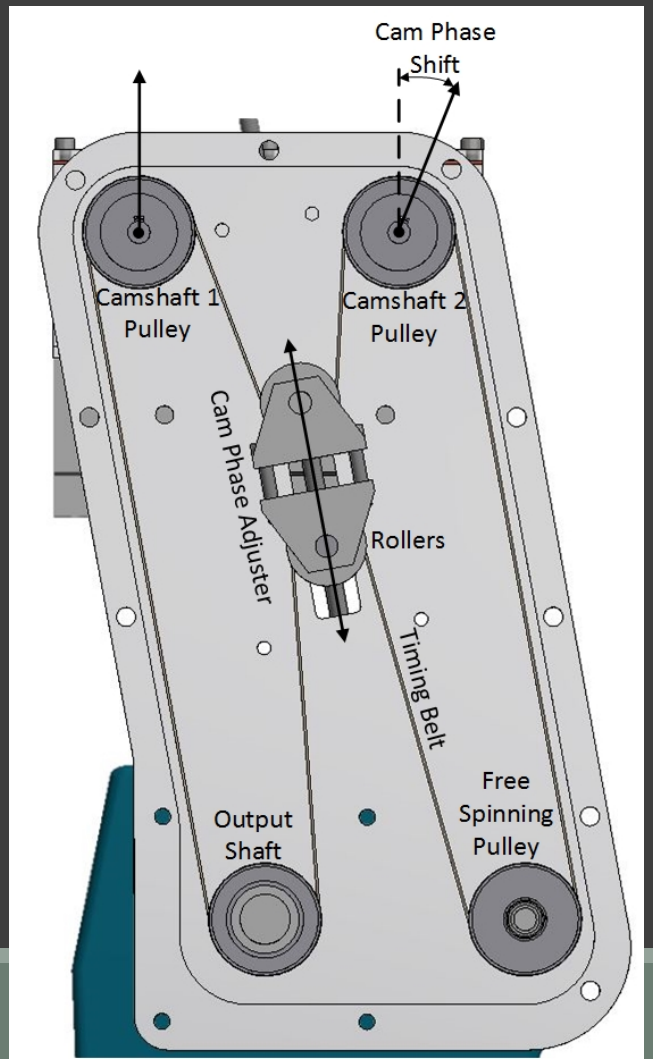
CMM Scanning

CAD Model Assembly

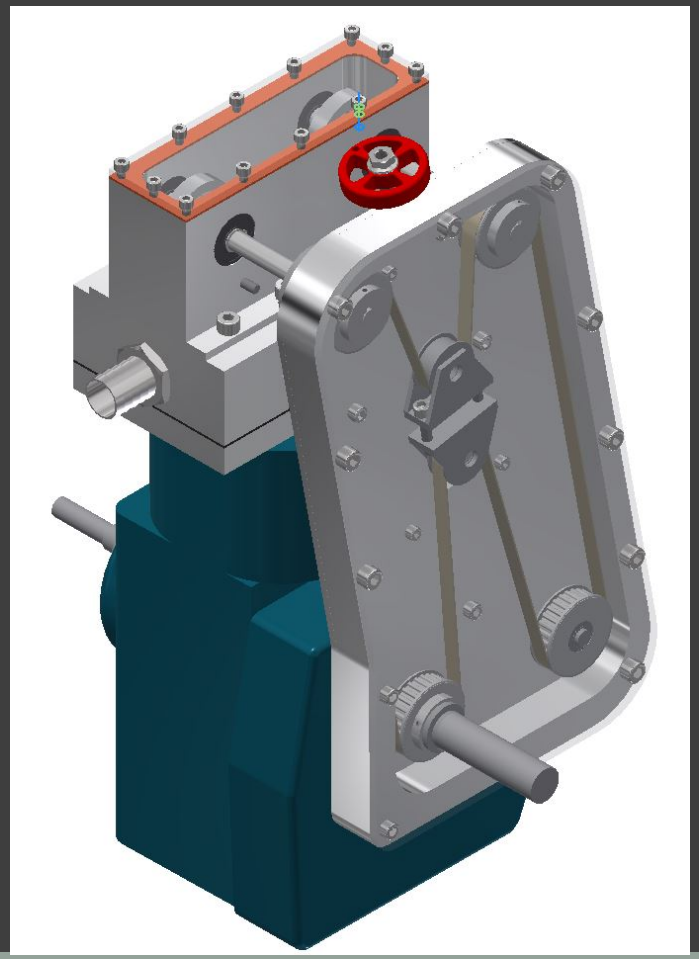
Inlet Valve Design

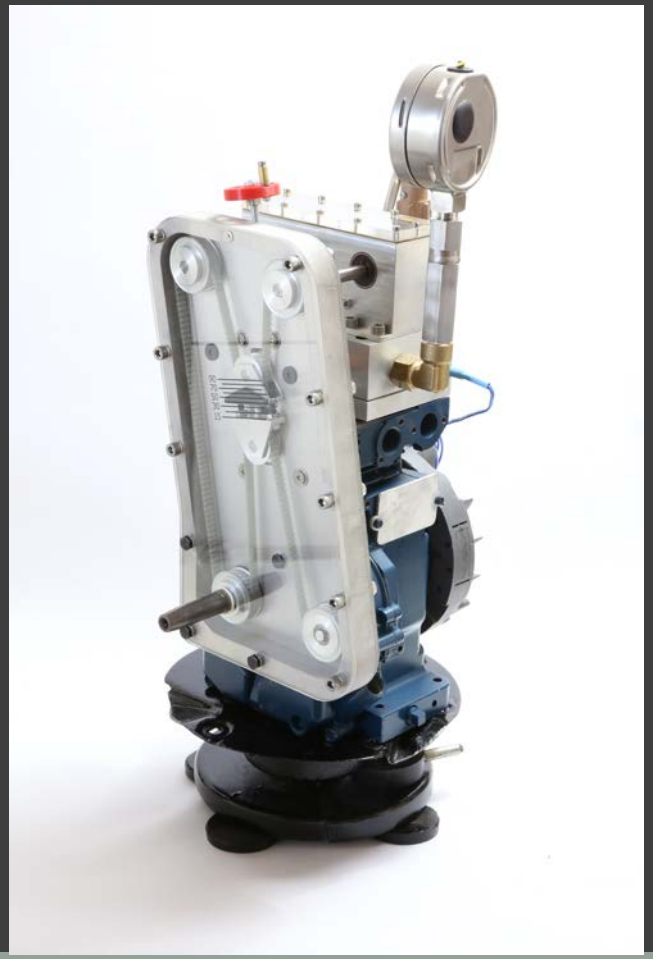


Cam Phasing Design



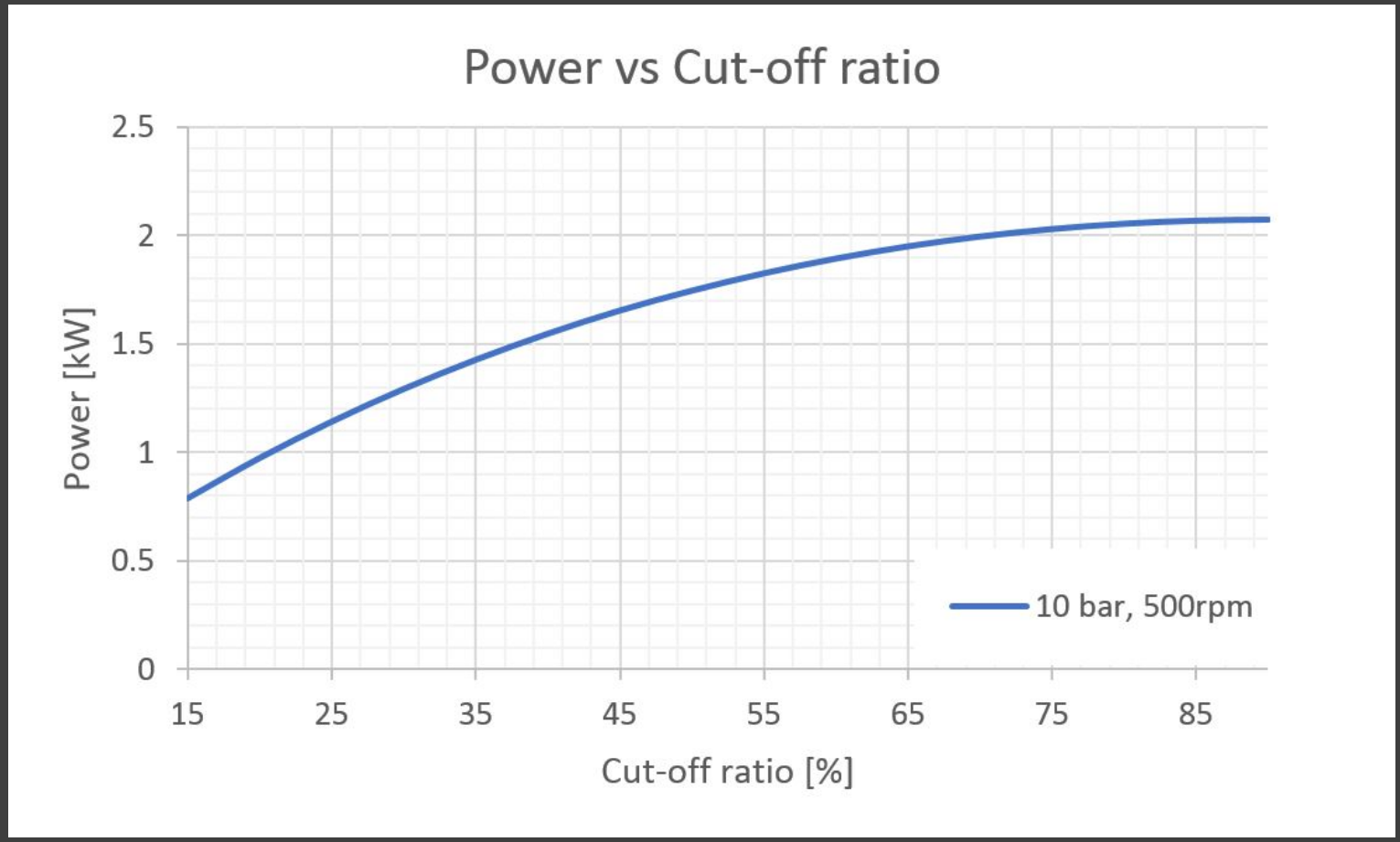
Complete Assembly



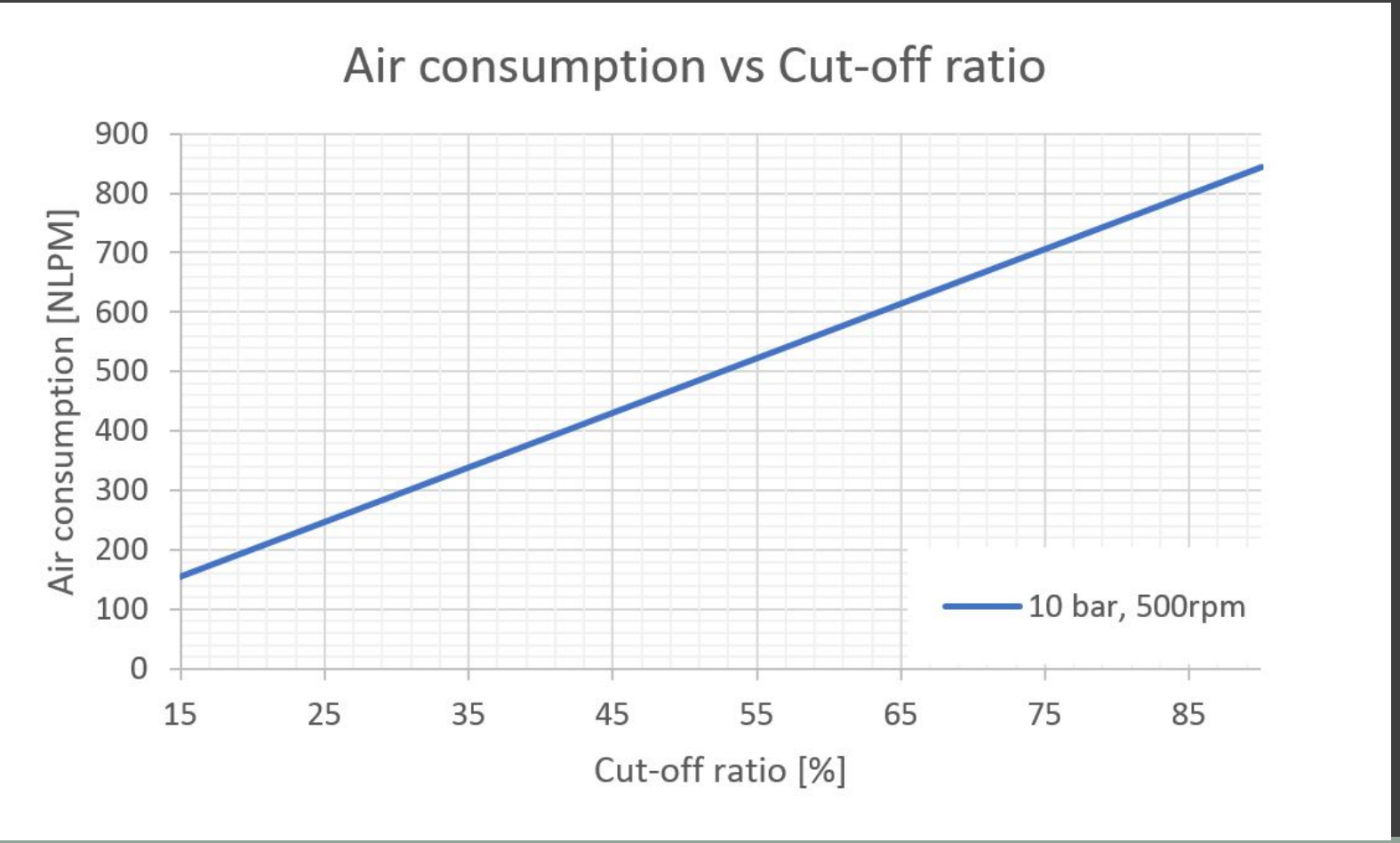


Preliminary Operation on Air

Air engine model



Air engine model



Potential application

- Small-scale CSP Plants
- Waste heat recovery
- Generation from thermal storage