Direct s-CO_2 Receiver Development

National Renewable Energy Laboratory
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PROJECT OBJECTIVES

Goal: Develop a high-temperature (650°C), high-efficiency (>90%) power tower receiver using supercritical CO_2 directly as the heat transfer fluid

- *Direct interface with turbine enhances system performance*
- *Fluid stability simplifies receiver design*

Innovation: Advances in supercritical CO_2 power cycles have caused demand for new, higher-temperature receiver designs.

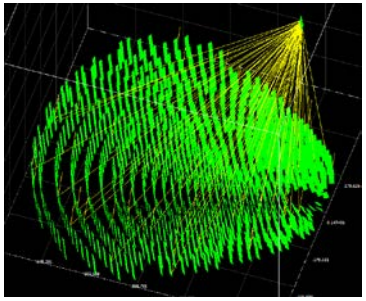
- *This project uses novel cycle configurations[1] and advances in heat exchanger technology[2] to meet the SunShot cost and performance targets*

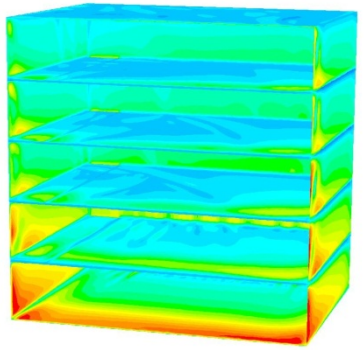
Milestones: Achieve 85% design point thermal efficiency

[1]Turchi, C. S., Ma, Z., Neises, T., & Wagner, M. J. (2012).
[2]Li, Q., Flamant, G., Yuan, X., Neveu, P., & Luo, L. (2011).

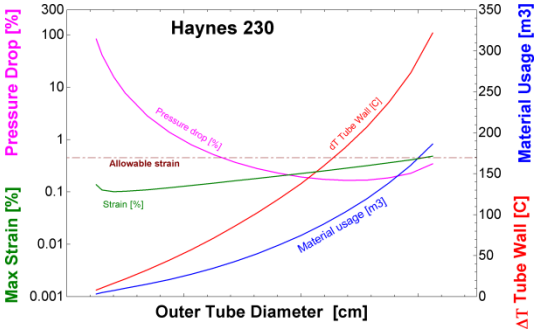
APPROACH

- Develop design and characterization tools using in-house and commercial software
- Optimize and characterize incident flux profile, absorber material strain, convective and emissive thermal losses
- Improve LCOE through system-level design optimization





KEY RESULTS AND OUTCOMES



Parameter	Value (%)
Thermal loss due to reflection	0.9- 2.7
Thermal loss due to convection	0.7 - 1.2
Thermal loss due to emission	3.2 - 3.6
Thermal efficiency	92.5 - 95.2

- High-temperature nickel alloys offer suitable operation window for 650°C operation. System-level optimization must balance peak strain and pressure drop with absorber surface temperature and material usage/cost.
- Simulation results predict NREL concept can achieve >90% thermal efficiency

NEXT MILESTONES

- *Down-select to single absorber technology*
- *Achieve 85% design point thermal efficiency (COMPLETE)*
- *Achieve 90% design point thermal efficiency (In Progress)*

- Work to date has demonstrated with high confidence that 85% thermal efficiency can be achieved and has identified a receiver design believed to exceed 92% in thermal efficiency.
- Continued work focused on:
  - Improve geometry optimization
  - Model system interactions with thermal storage, power cycle
  - Characterize off-design thermal performance
- Project risk is reduced through advanced analysis, novel application of standard heat absorber technology