ABENGOA SOLAR

Innovative Technology Solutions for Sustainability

Phase Change Material Tower

SunShot Concentrating Solar Power Program Review 2013

April 24, 2013

Luke Erickson

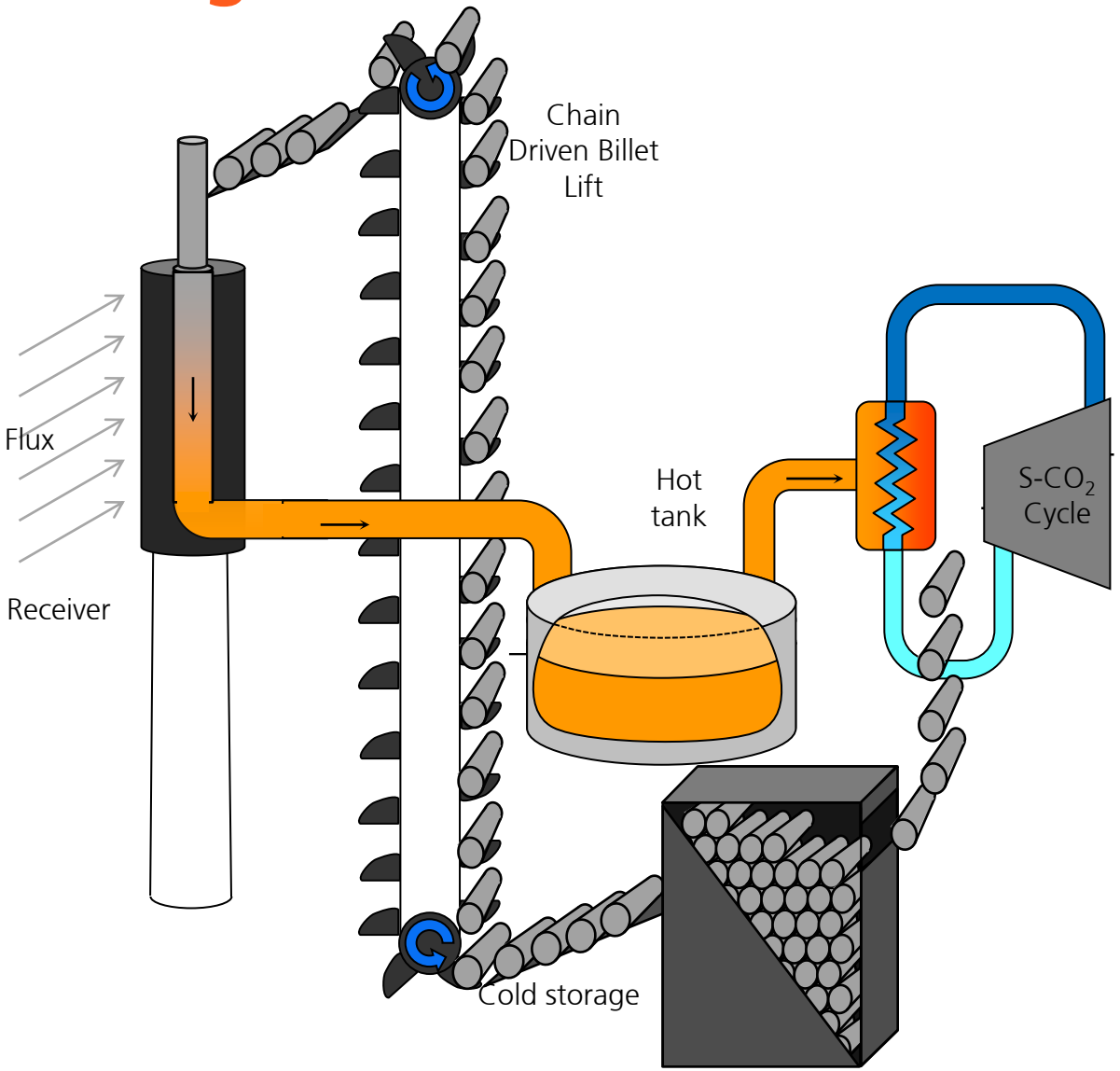
Project Details

- Title: “Conversion Tower for Dispatchable Solar Power”
- Award: $3,875,104 from ARPA-E HEATS Program
- Project Term: 1/11/2012 to 1/10/2015

- Project Plan:
  - 2012: Modeling and begin lab scale demonstration
  - 2013: Lab scale to prototype
  - 2014: Prototype demonstration

- Objectives:
  - Provide dispatchable solar thermal electricity at a significantly reduced cost compared to current state of the art

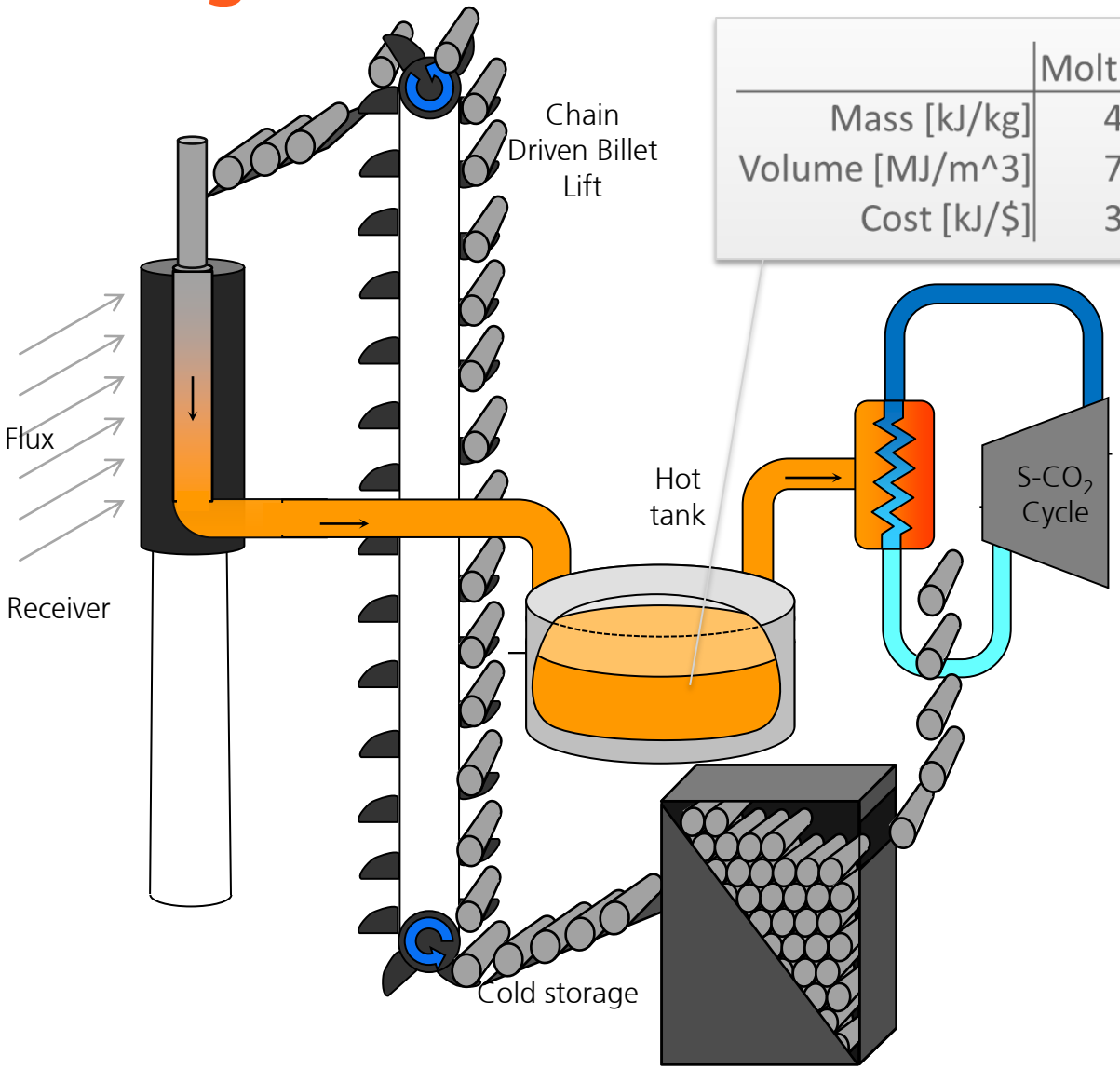
Phase Change Material Tower



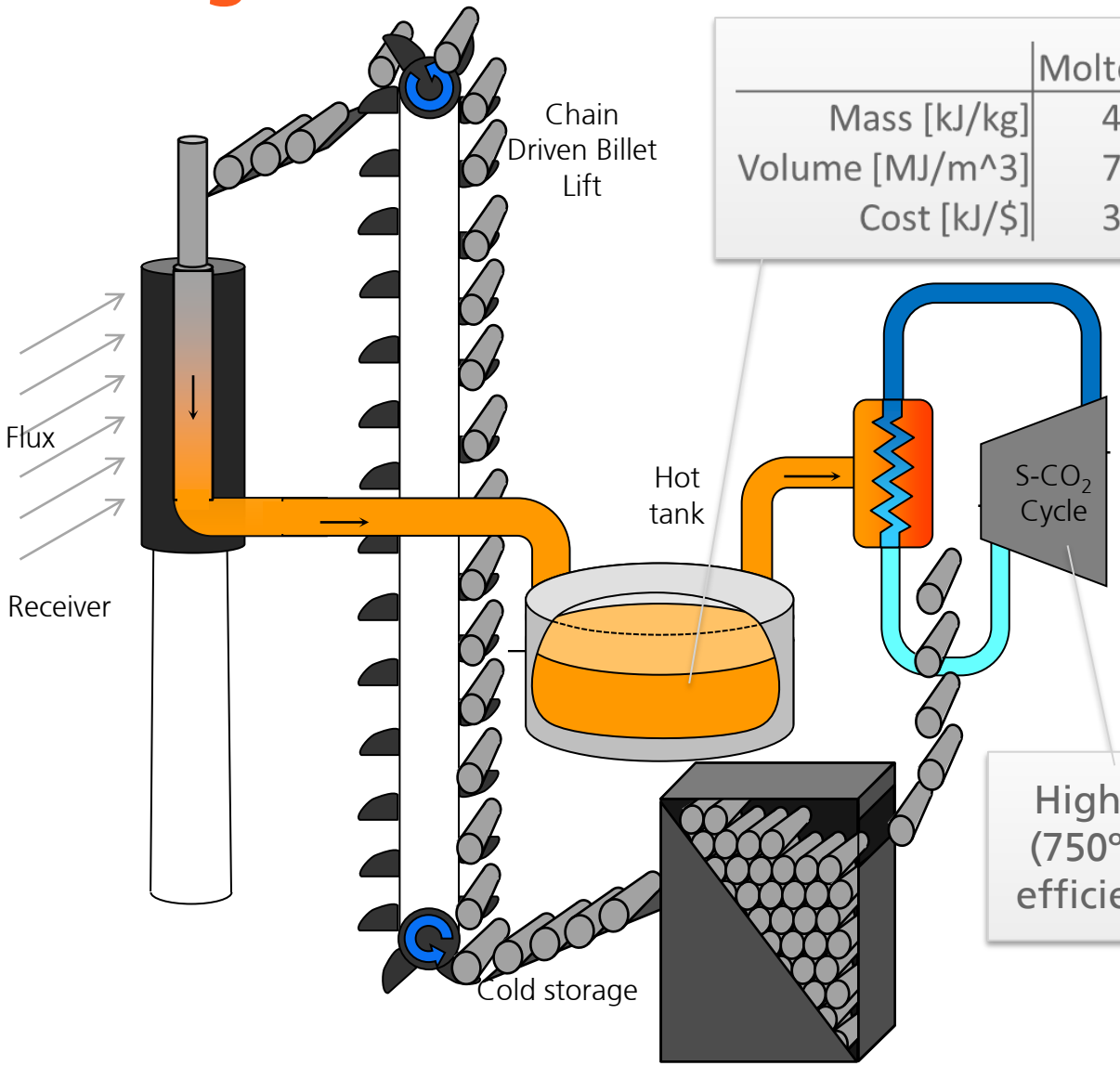
*Patent
Application
Filed

Phase Change Material Tower

	Molten Salt	PCMT
Mass [kJ/kg]	431	1008
Volume [MJ/m^3]	791	2420
Cost [kJ/$]	395	438



Phase Change Material Tower



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High temperatures (750°C+) allow very efficient power cycle

Phase Change Material Tower

Exception thermal conductivity (100x molten salt) allows high efficiency at high flux

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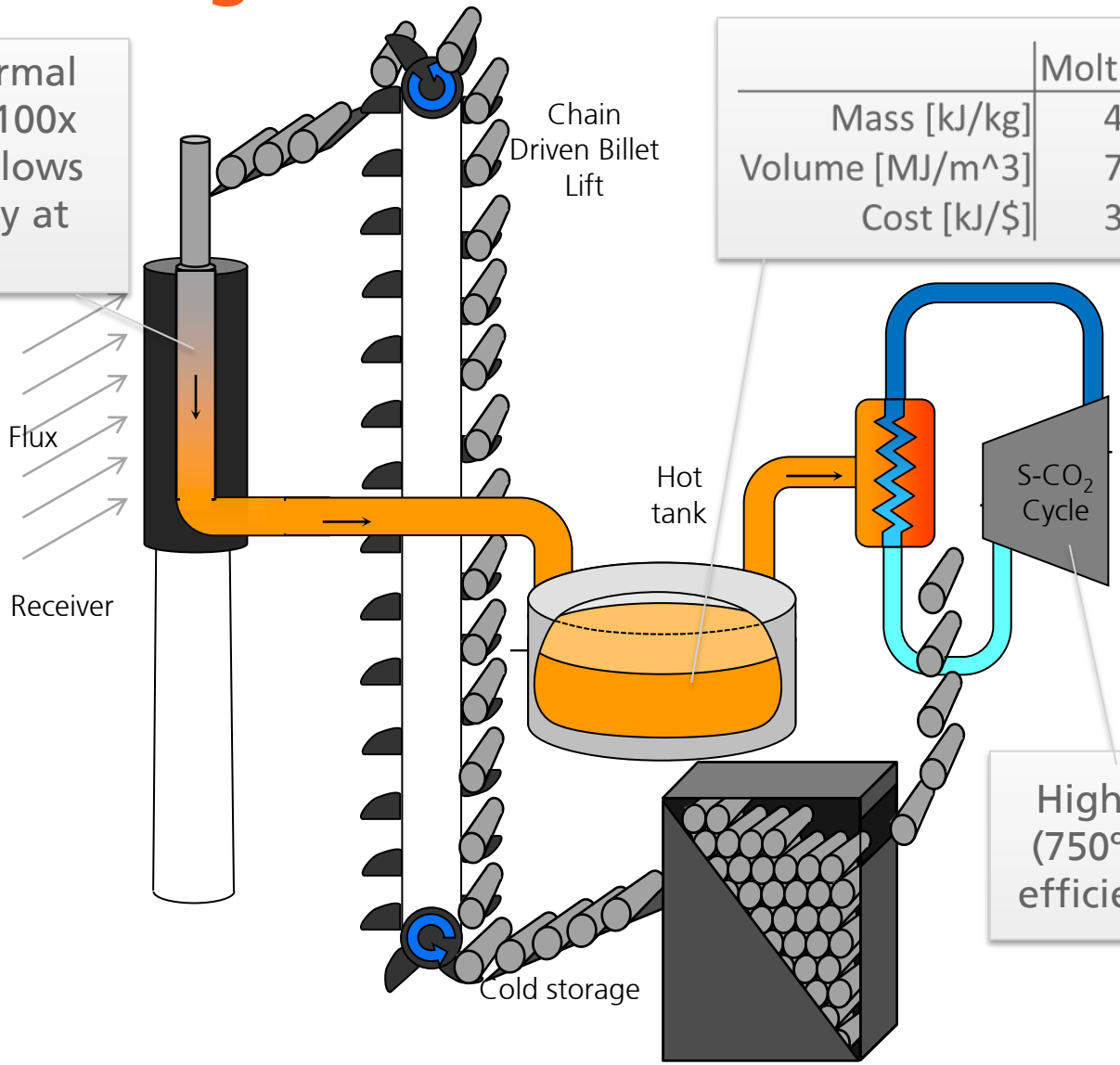

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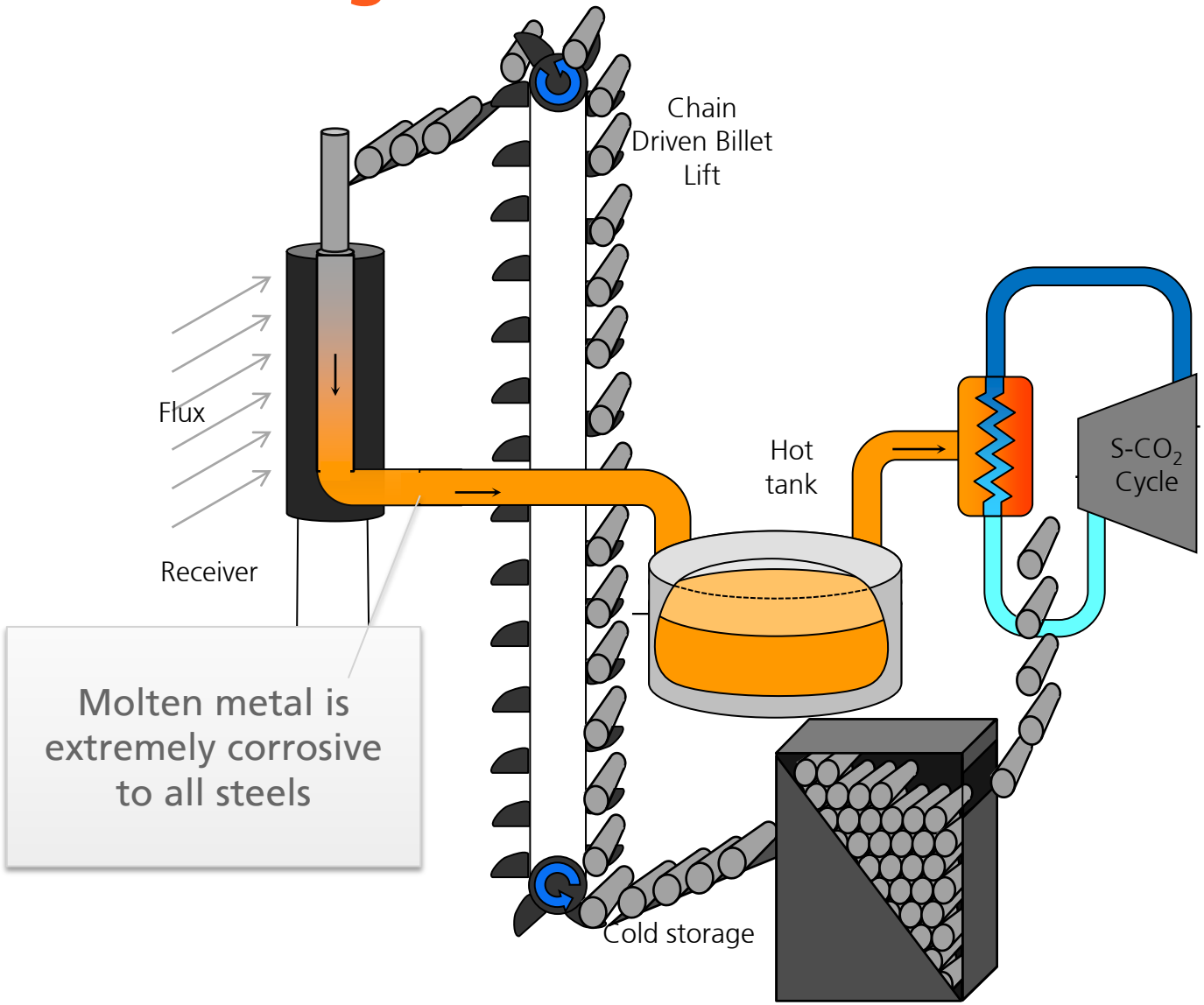
Phase Change Material Tower



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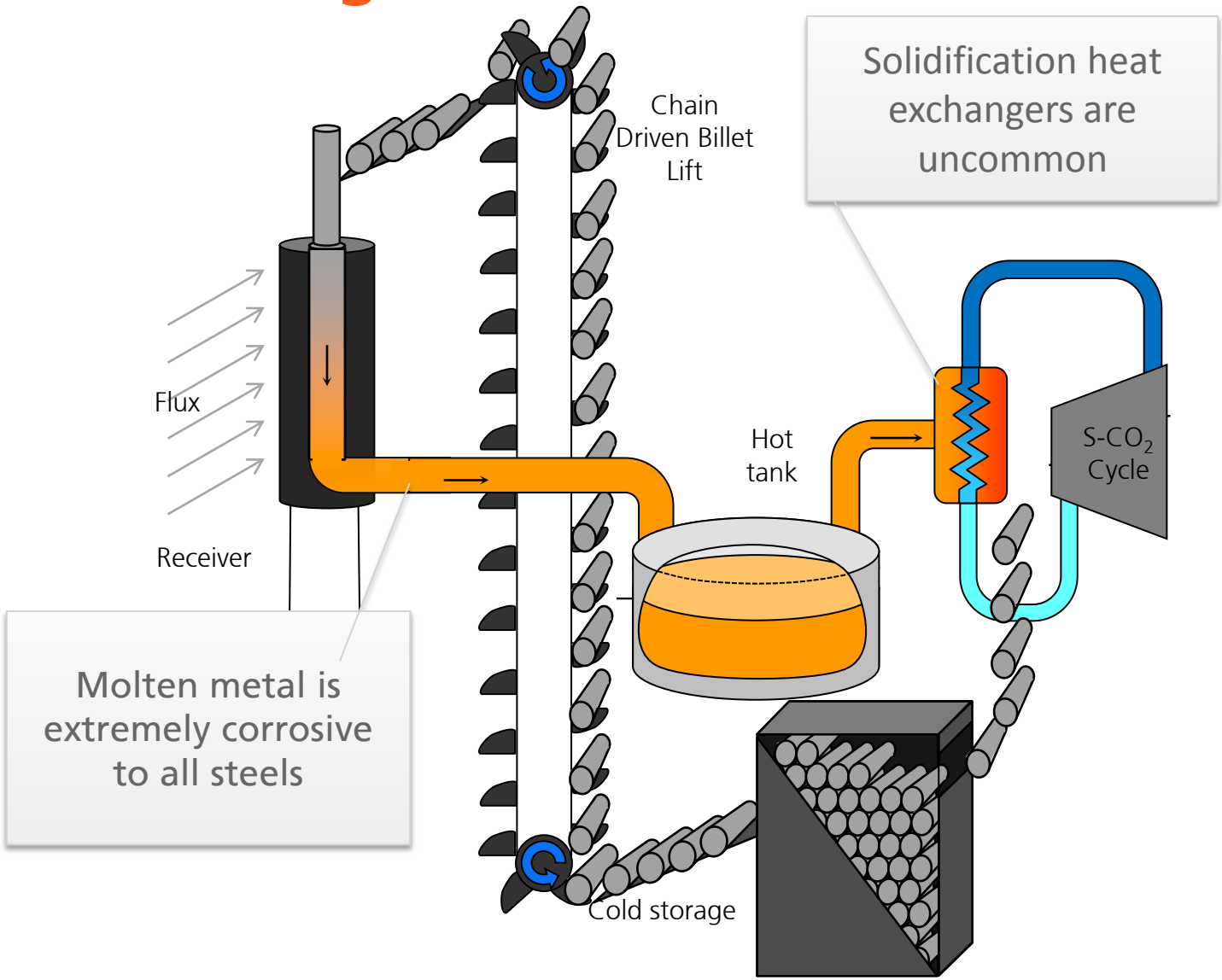

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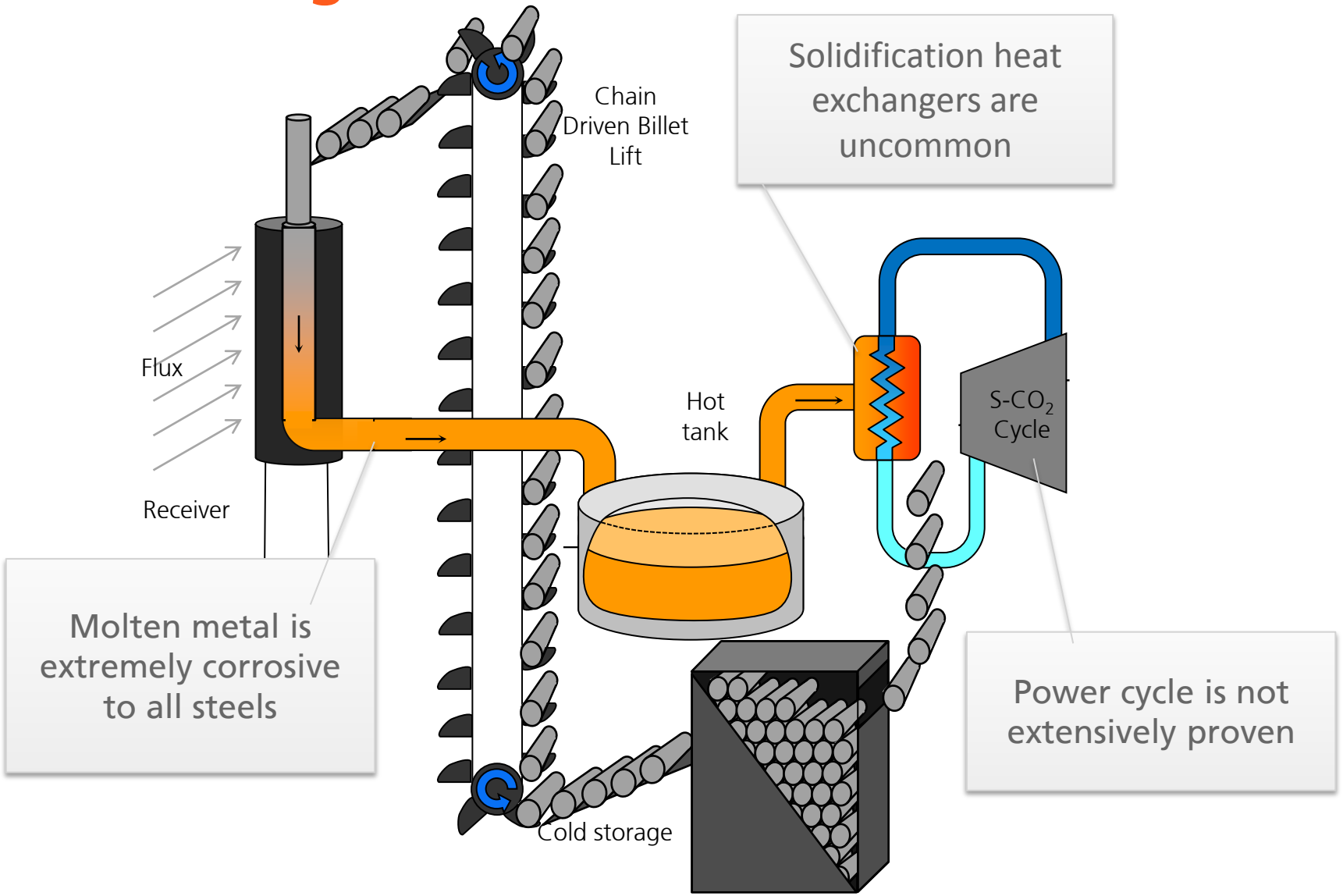
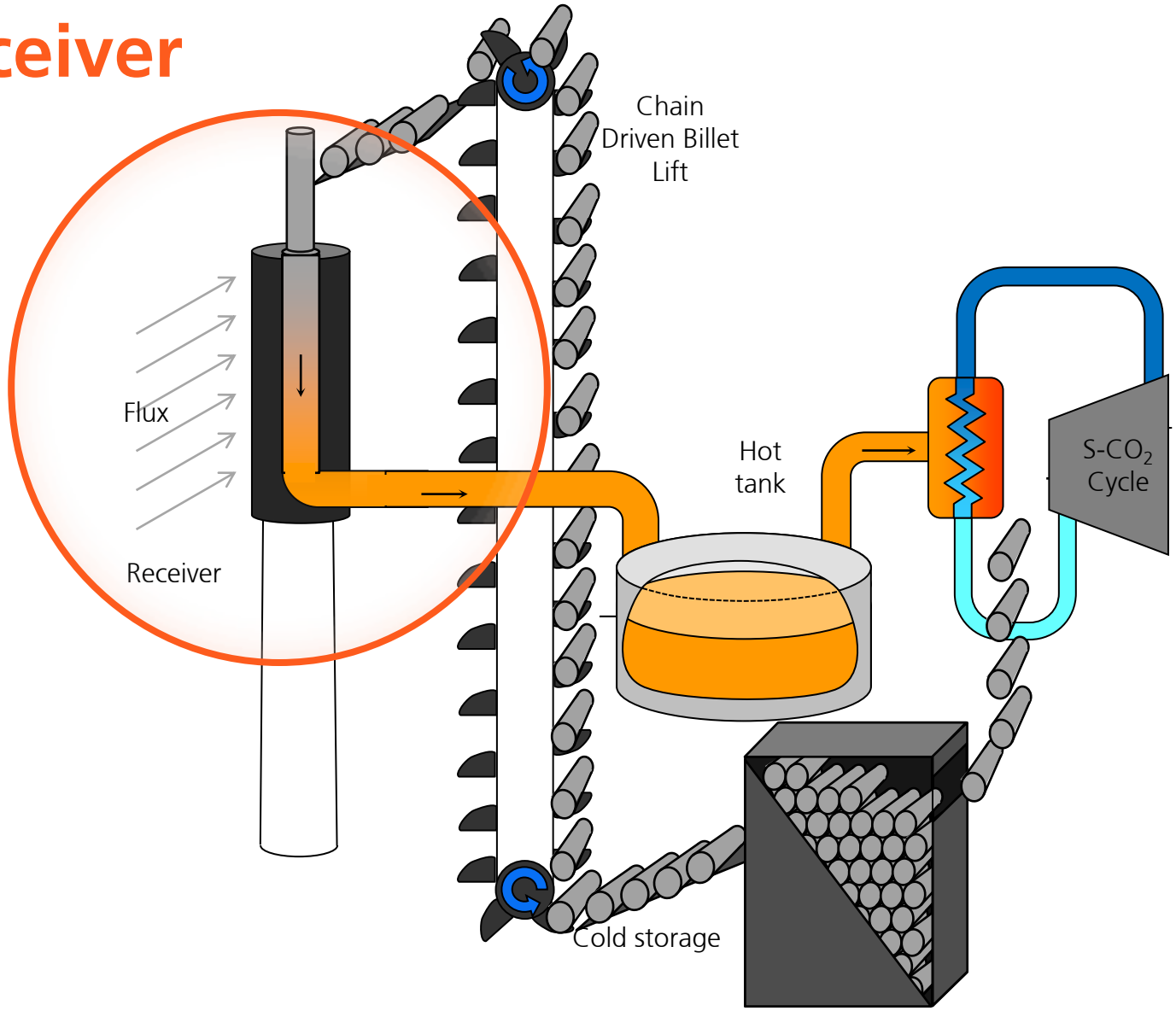
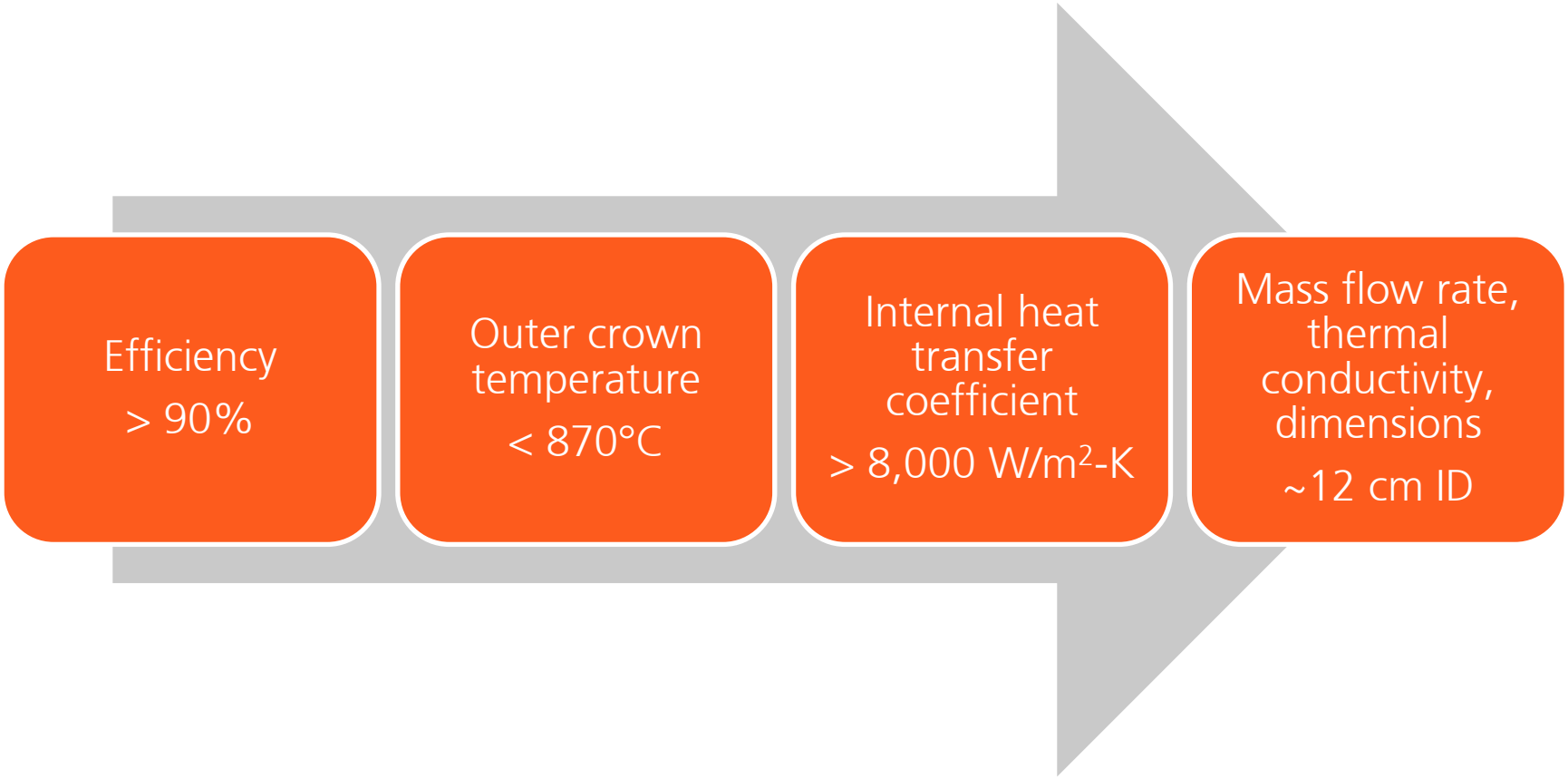


Receiver


Chain
Driven Billet
Lift
Flux
Receiver
Hot
tank
S-CO2
Cycle
Cold storage

Receiver Performance Modeling

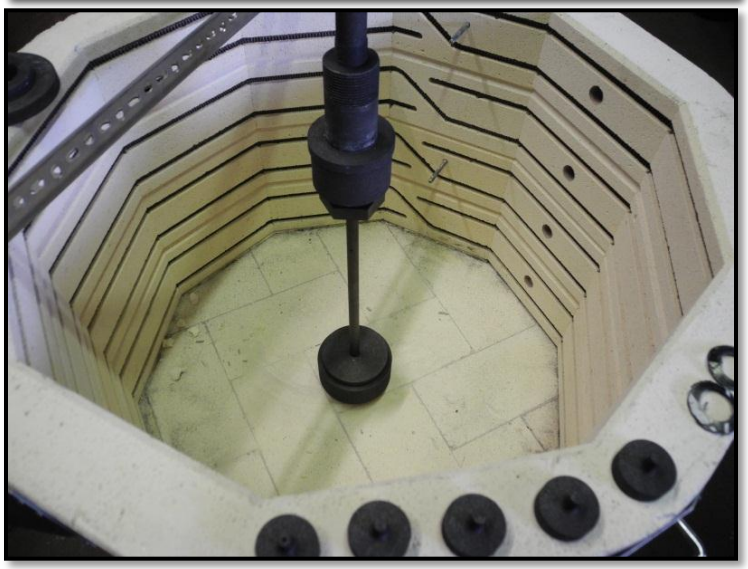


Conclusion: Ideal tube size is ~12 cm ID

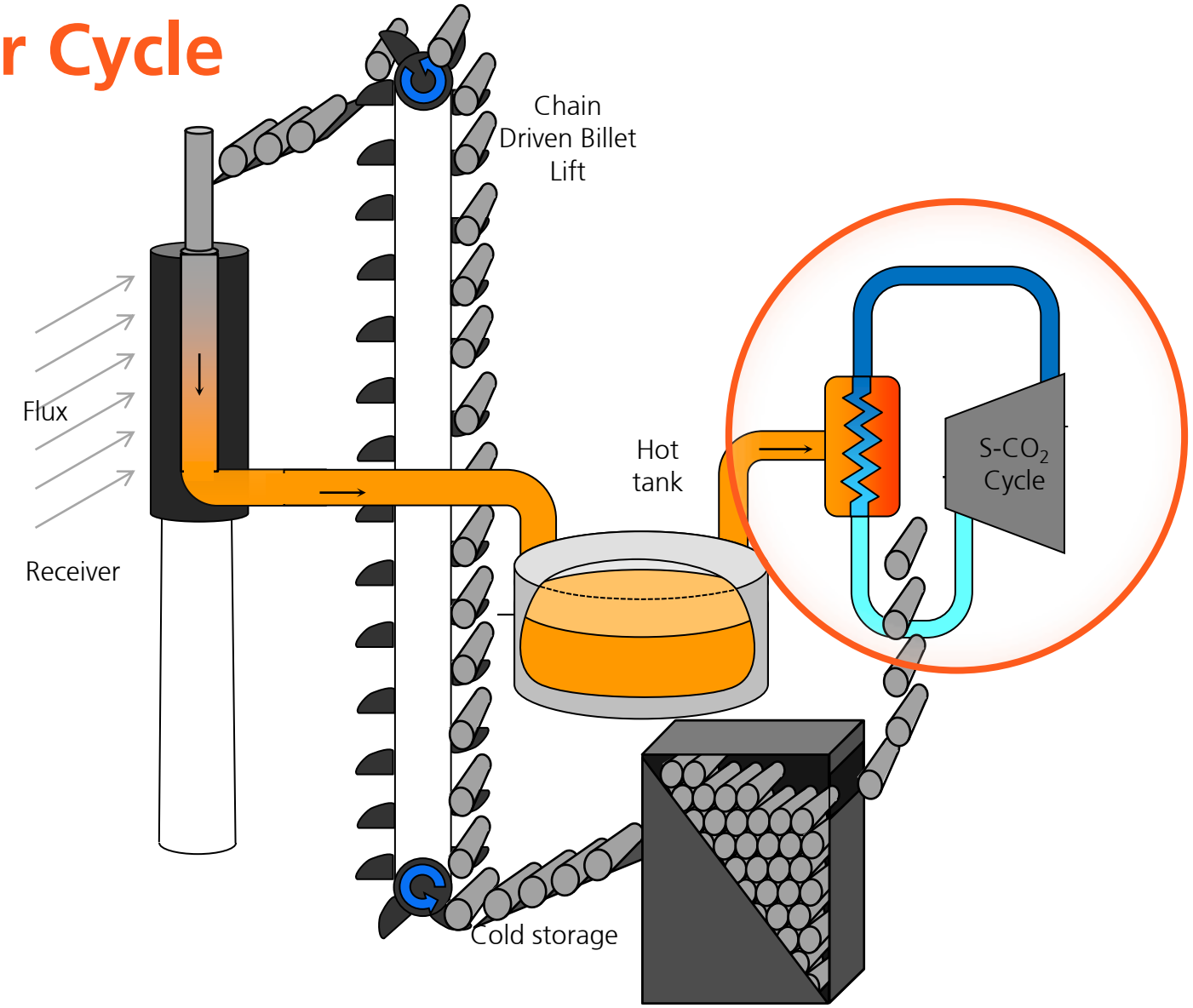
maximizes performance at low cost without sacrificing strength

Experimental Validation

- Objective: Validate heat transfer model used to design receiver
- Method: Heat kiln to very high temperature to radiatively heat a silicon carbide tube and measure temperatures along the length and flow rate to calculate heat transfer coefficients



Power Cycle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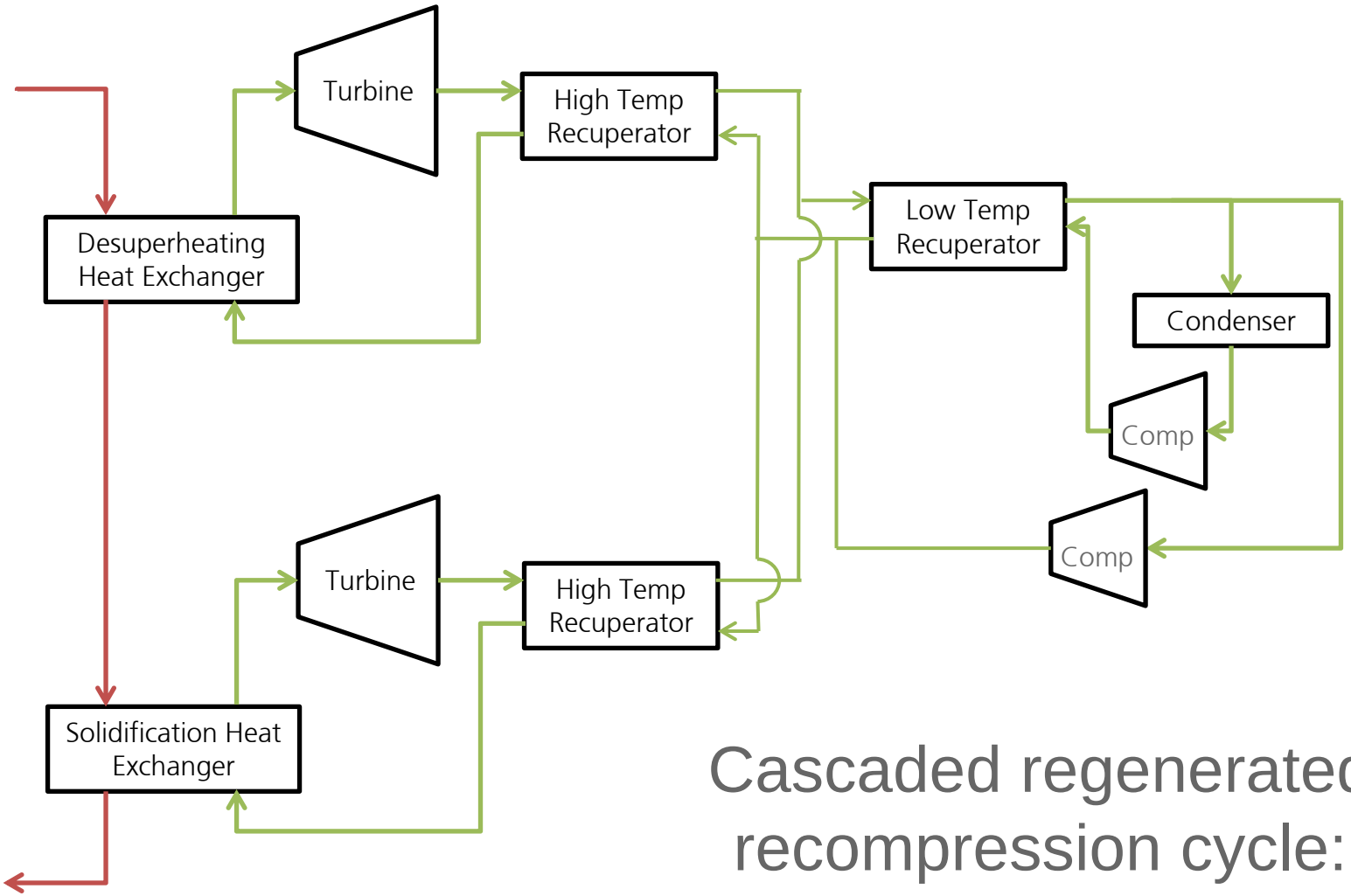
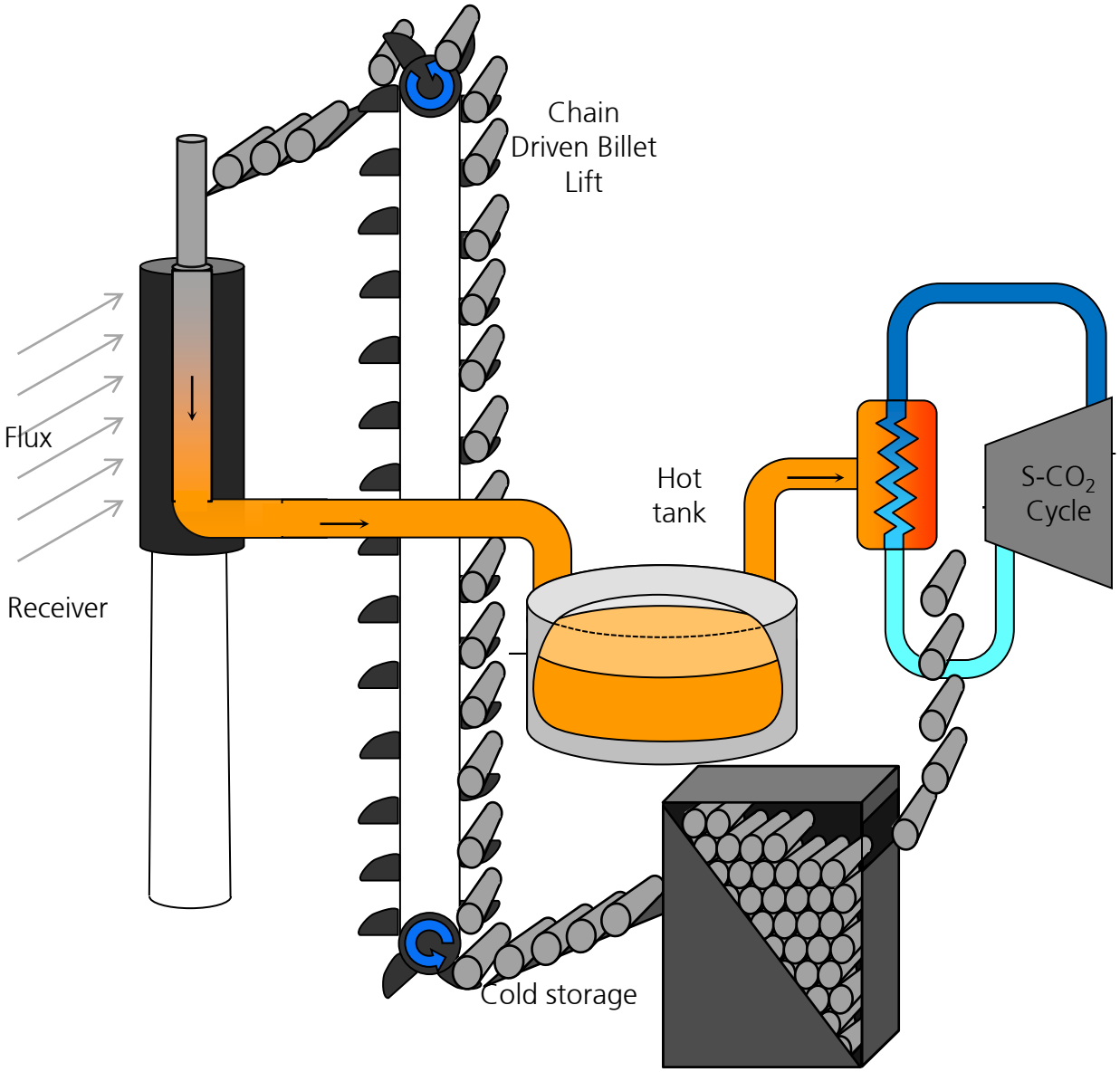
Cycle Layout



Cascaded regenerated recompression cycle: 47% efficient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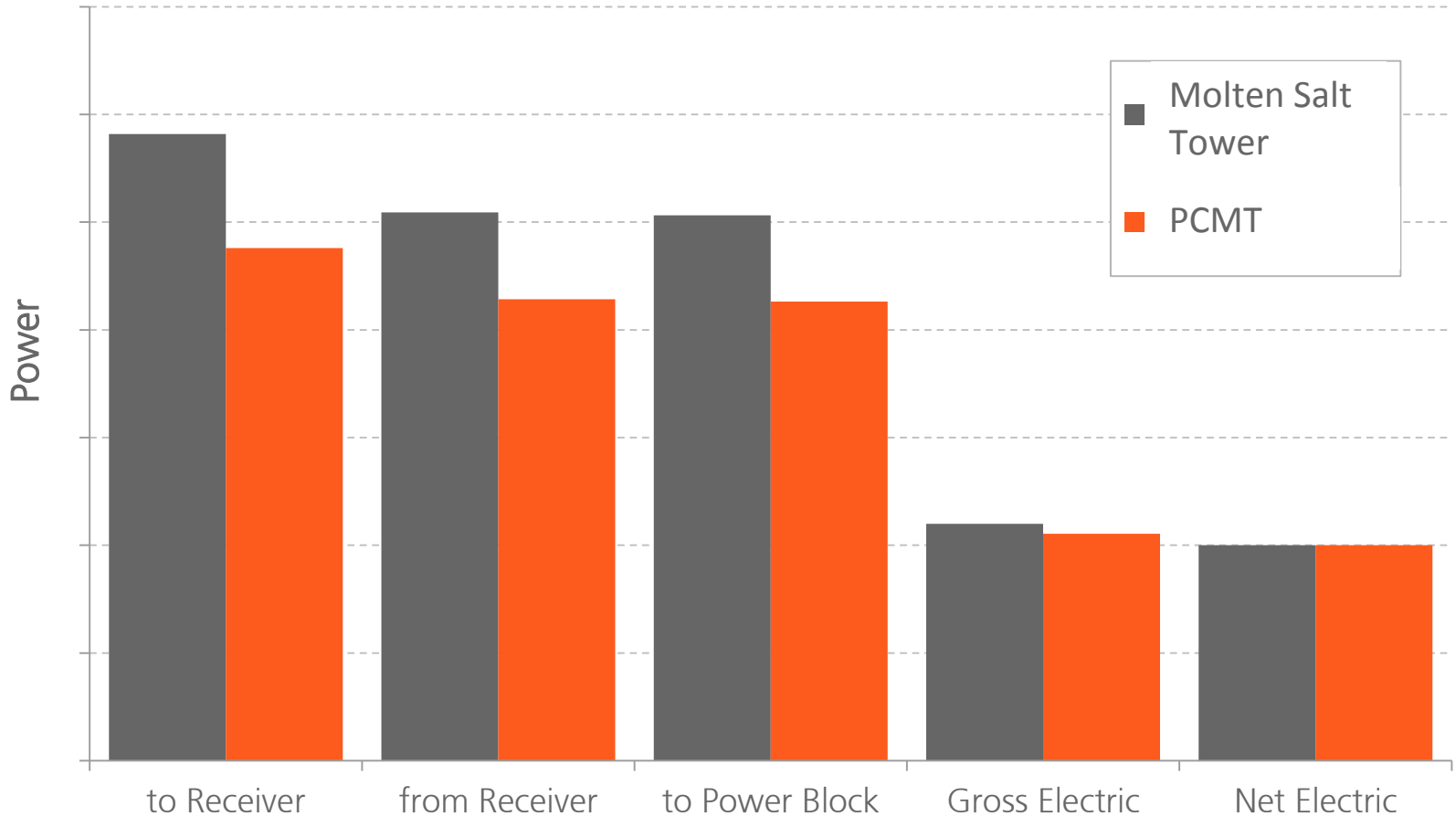
Projected Performance



Acknowledgements

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Questions?

Thank You

Supplemental Slides

Piping

- Refractory lined piping is a commercially available product
- Uses included: molten metal transfer piping, transportation of sand tailings, and transfer of pulverized coal
- Assortment of available fabrication methods (shrink fit, adhesive, casting) & liner materials (i.e. alumina, SiC, etc.)

Pyrotek molten metal transfer piping

Cera System's alumina lined elbow

Hot Storage Tank

- Alumina brick lined steel tank
- Just 13% of molten salt storage volume for an equivalent oil trough plant
- Used for aluminum smelting facilities