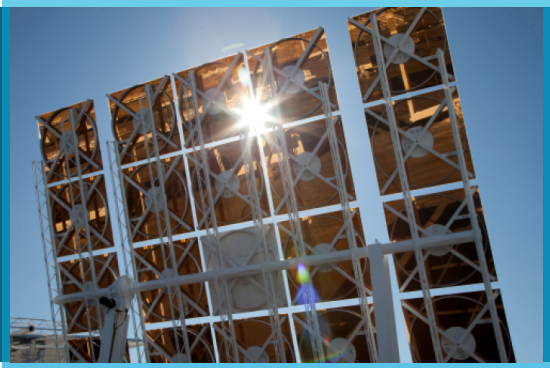
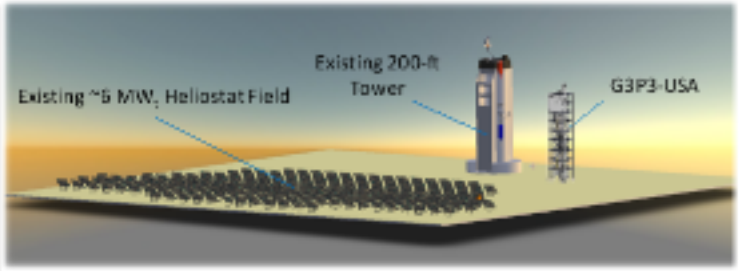
SAND2021-10301PE

Sandia National Laboratories

Overview of the Gen3 Particle Pilot Plant (G3P3)





PRESENTED BY

Clifford K. Ho

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Contributors:

SNL: Brantley Mills, Kevin J. Albrecht, Jeremy Sment, Nathan Schroeder, Henk Laubscher, Lindsey Yue, Org. 08923

Others: Georgia Tech, King Saud U., SEC, DLR, ANU, CSIRO, U. Adelaide, CNRS-PROMES, CAD-RC Ceramics, SolarDynamics, EPRI

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Gen 3 CSP Program (FY19 – FY24)

Achieve higher temperatures, higher power-cycle efficiencies, and lower LCOE

Brayton Energy	NREL	Sandia
Gas Phase Pathway	Liquid Phase Pathway	Solid Phase Pathway

18 months
FY19 – FY20

6 months
FY20

DOE Downselection (March 2021)

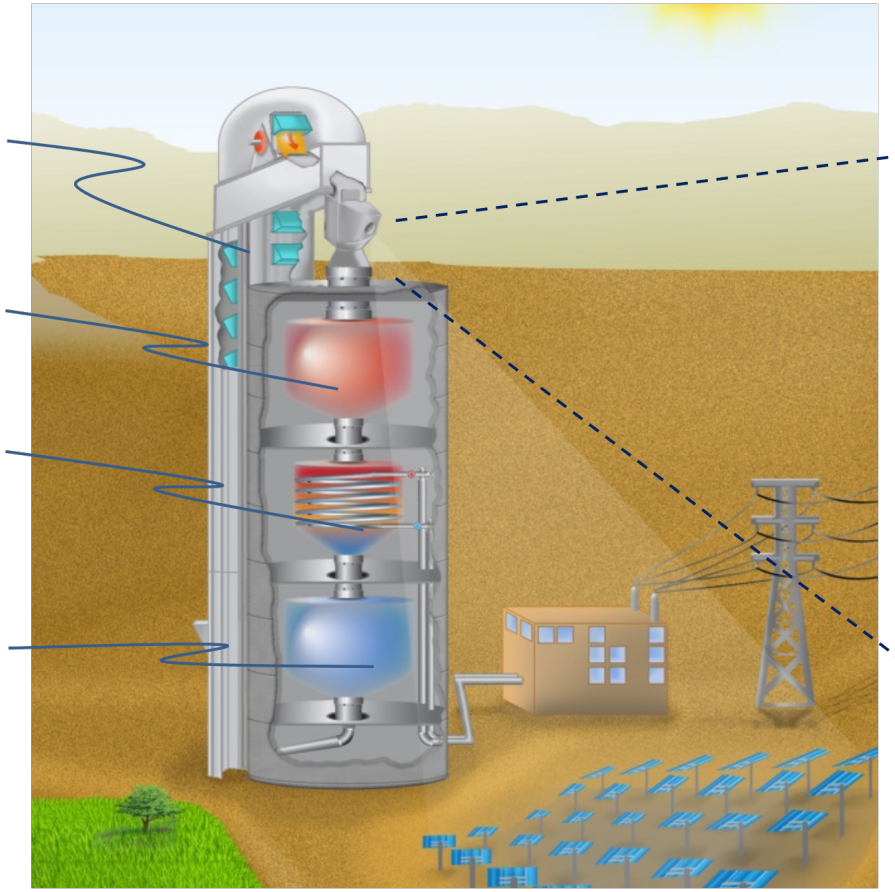
3 years
FY21 – FY23

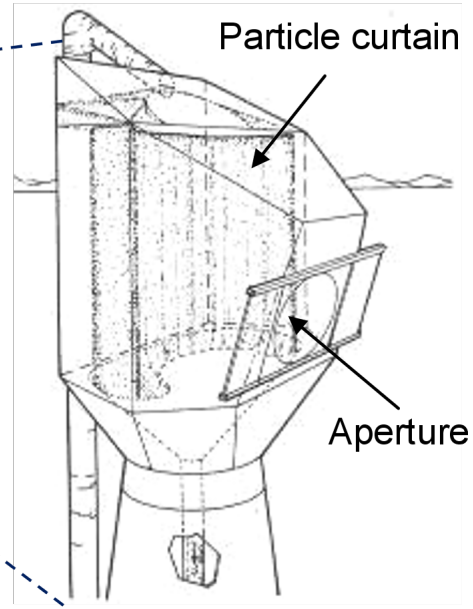
Introduction to the Team

Role	Team Members	
PI / Management	• Sandia National Labs (PI, PMP, financial, facilities)	
R&D / Engineering	• Sandia National Laboratories • Georgia Institute of Technology • King Saud University • German Aerospace Center	• CSIRO • U. Adelaide • Australian National University • CNRS-PROMES
Integrators / EPC	• EPRI • Bridgers & Paxton / Bohannan Huston	
CSP Developers	• SolarDynamics	
Component Developers / Industry	• Carbo Ceramics • Solex Thermal Science • Vacuum Process Engineering • FLSmidth	• Materials Handling Equipment • Allied Mineral Products • Matrix PDM
Utility	• Saudi Electric Company	

Background and Value Proposition

High-Temperature Particle-Based CSP

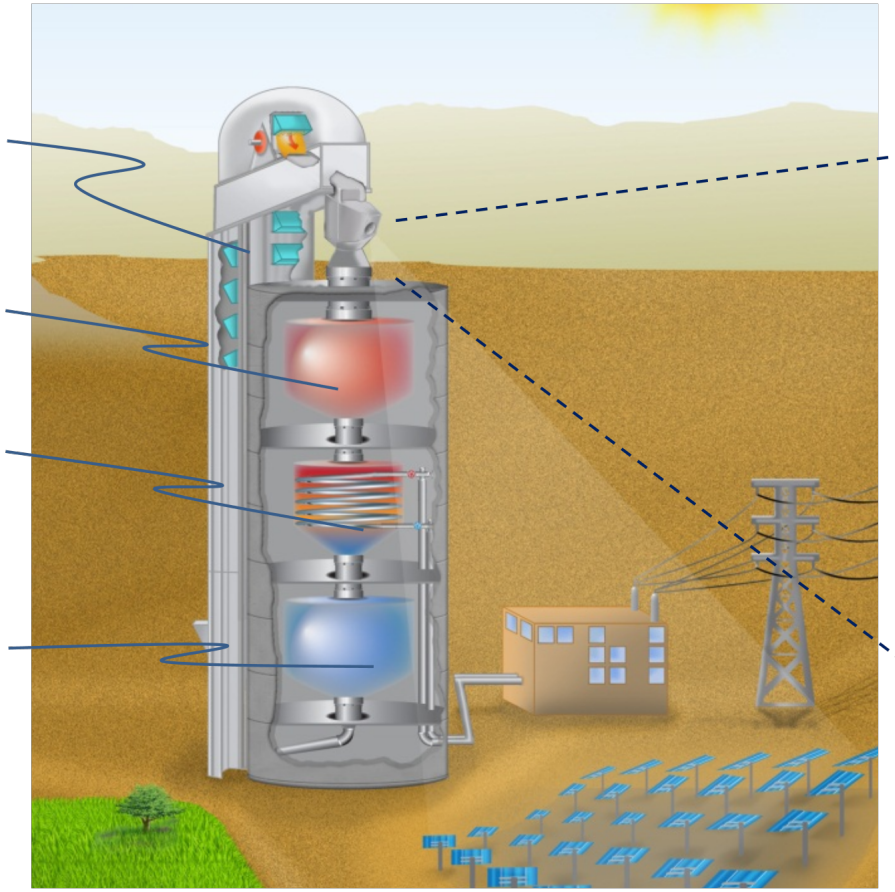


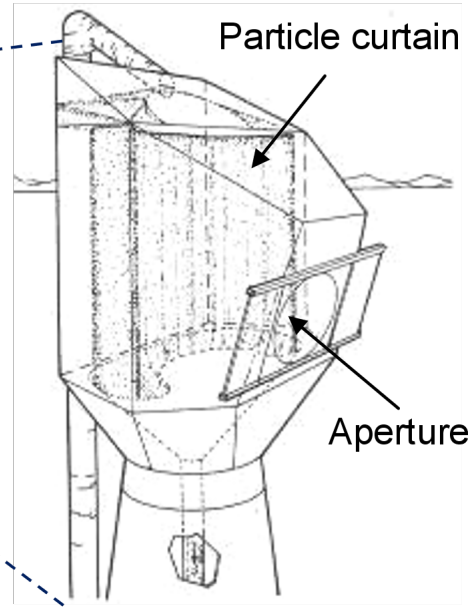


Falling particle receiver

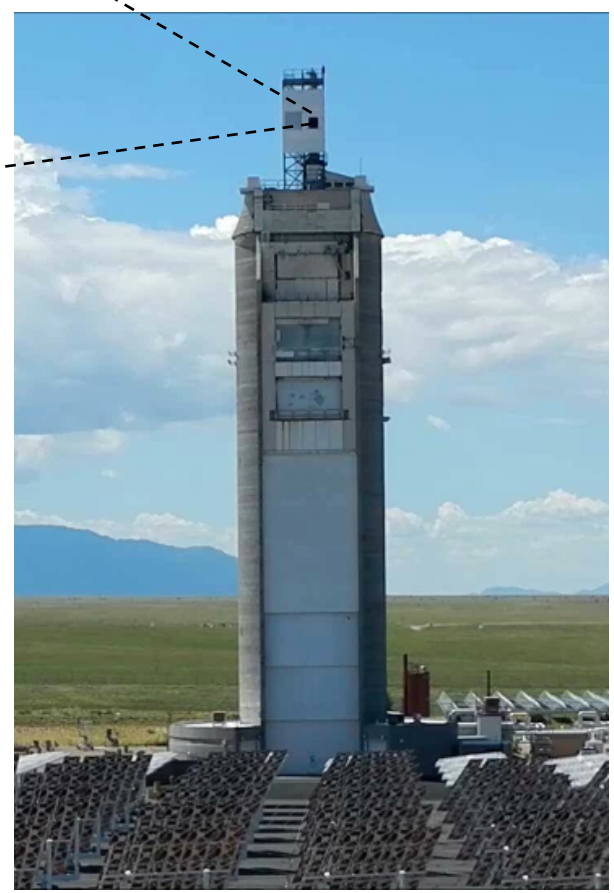
Background and Value Proposition

High-Temperature Particle-Based CSP





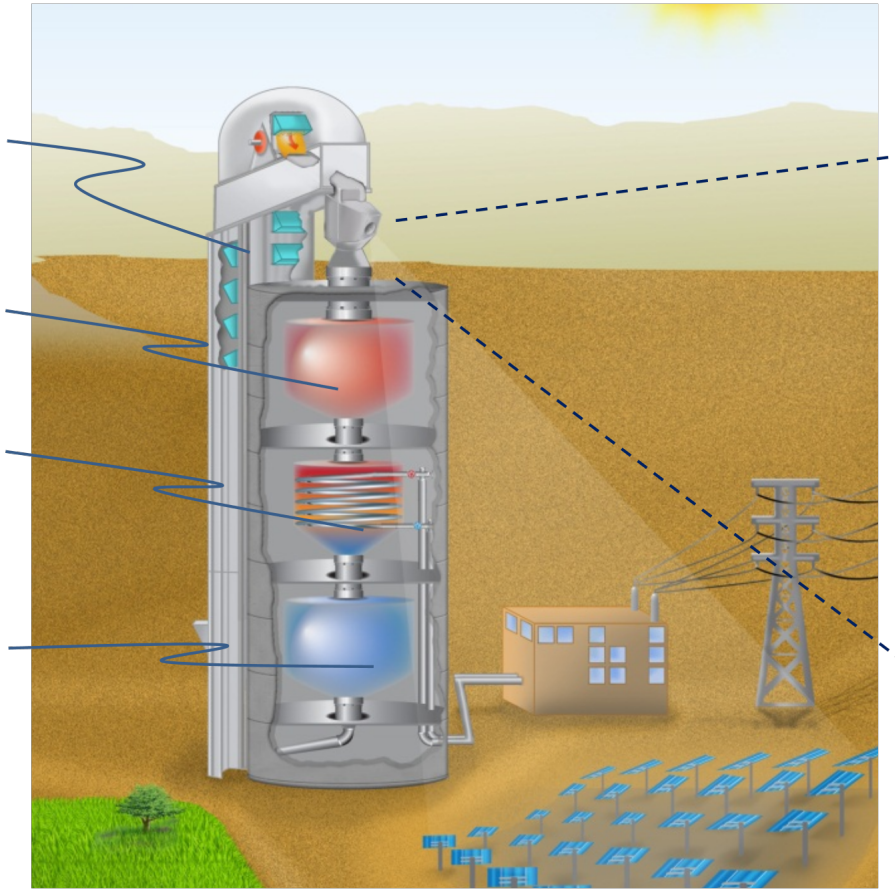
Falling particle receiver

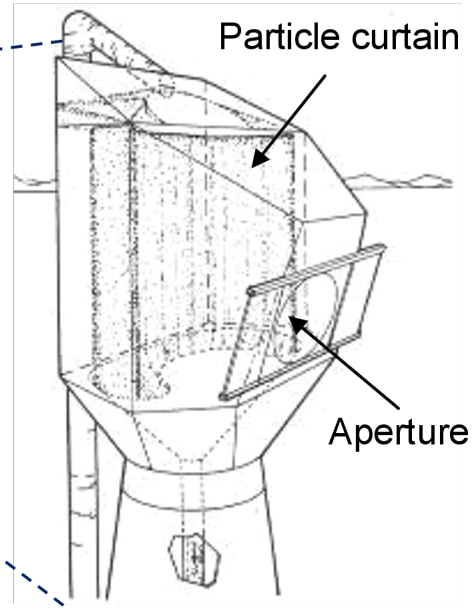


National Solar Thermal Test Facility
Sandia National Laboratories

Background and Value Proposition

High-Temperature Particle-Based CSP

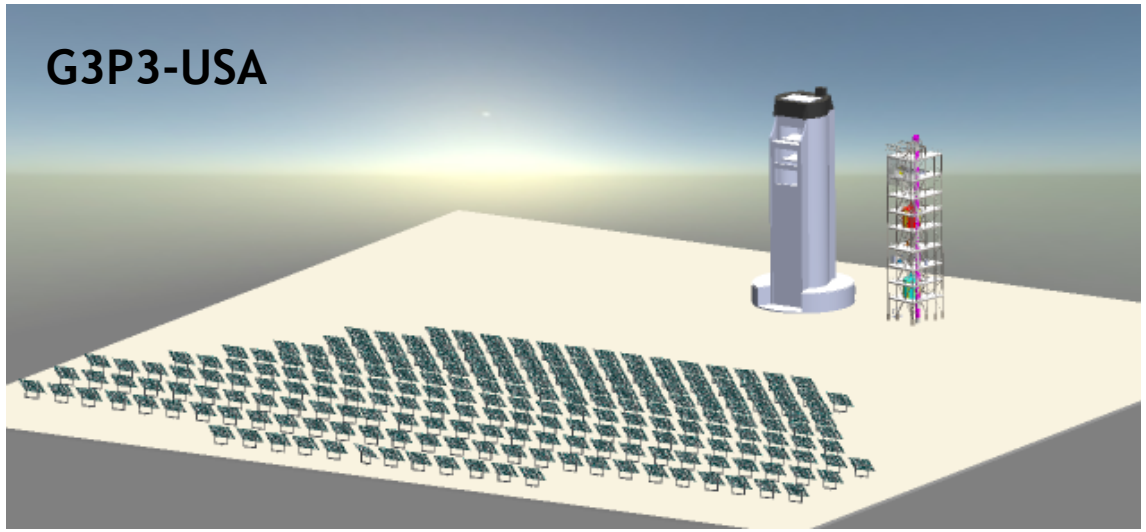


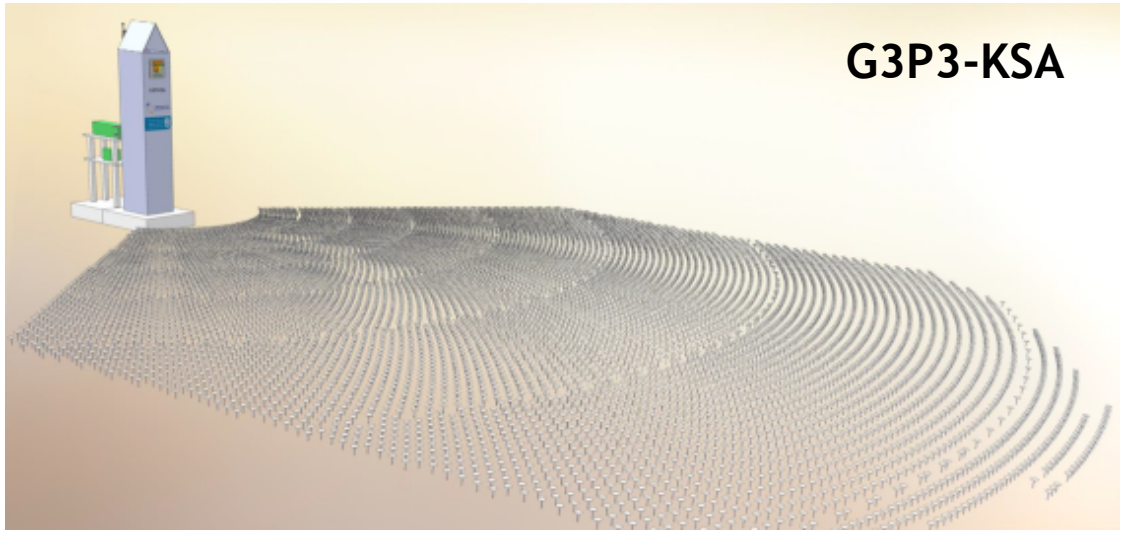


Falling particle receiver

- Higher temperatures (>1000 ˚C) than molten nitrate salts
- Direct heating of particles vs. indirect heating of tubes
- No freezing or decomposition
  - Avoids costly heat tracing
- Direct storage of hot particles

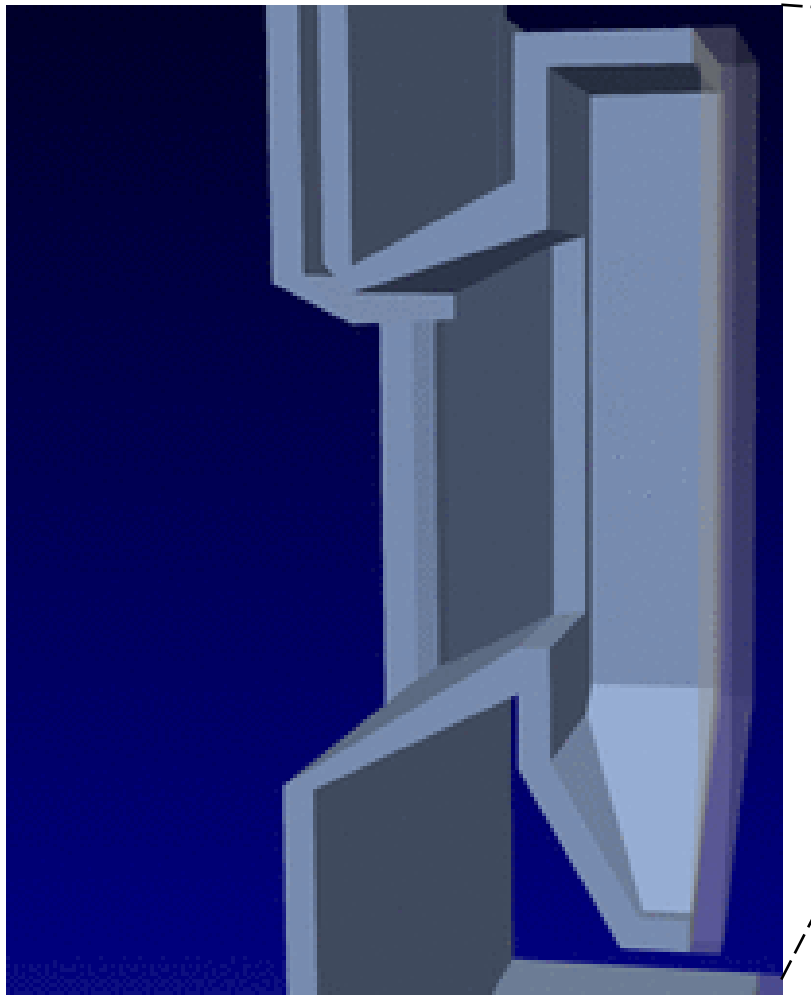
G3P3-USA and G3P3-KSA

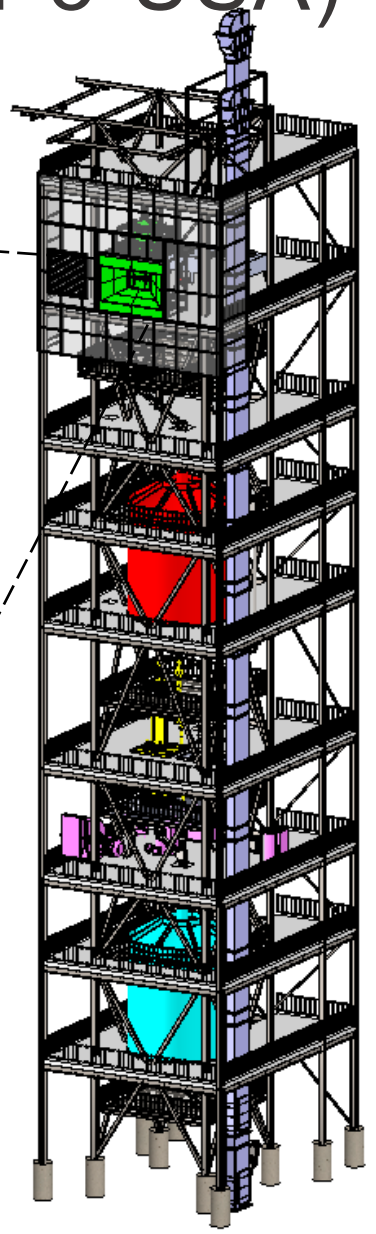




Gen3 Particle Pilot Plant (G3P3-USA)

Next-Generation High-Temperature Falling Particle Receiver





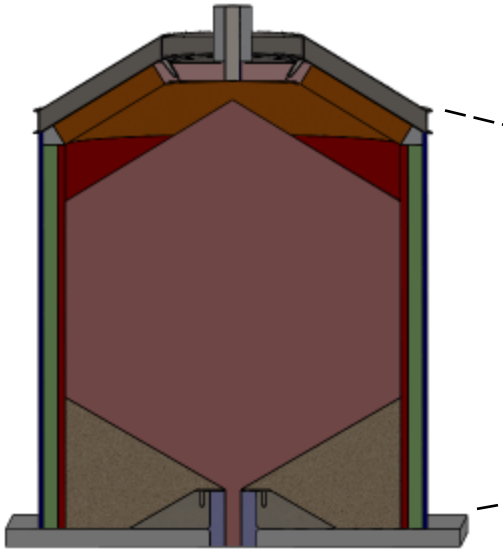
Gen 3 Particle Pilot Plant

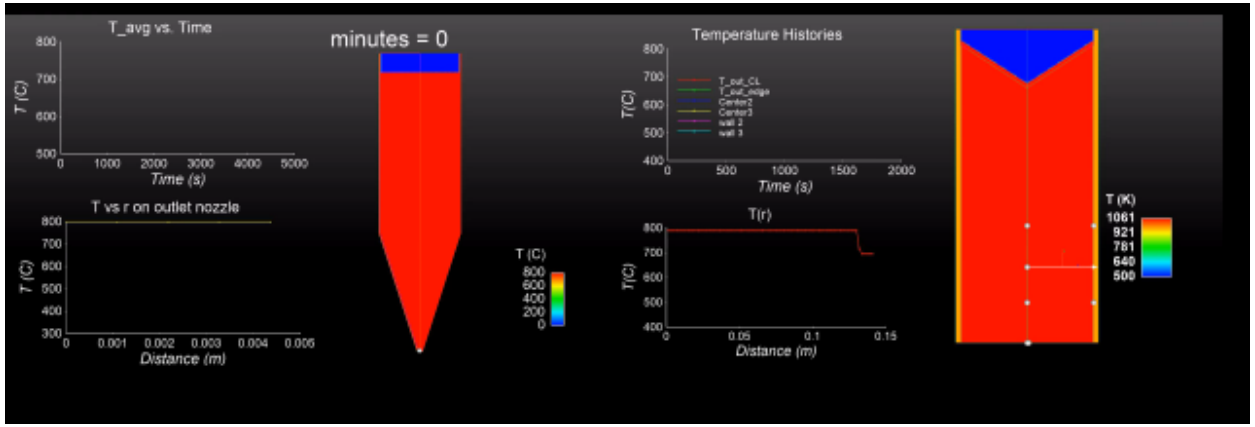
- ~1 – 2 MW_t receiver
- 6 MWh_t storage
- 1 MW_t particle-to-sCO_2 heat exchanger
- ~300 – 400 micron ceramic particles (CARBO HSP 40/70)

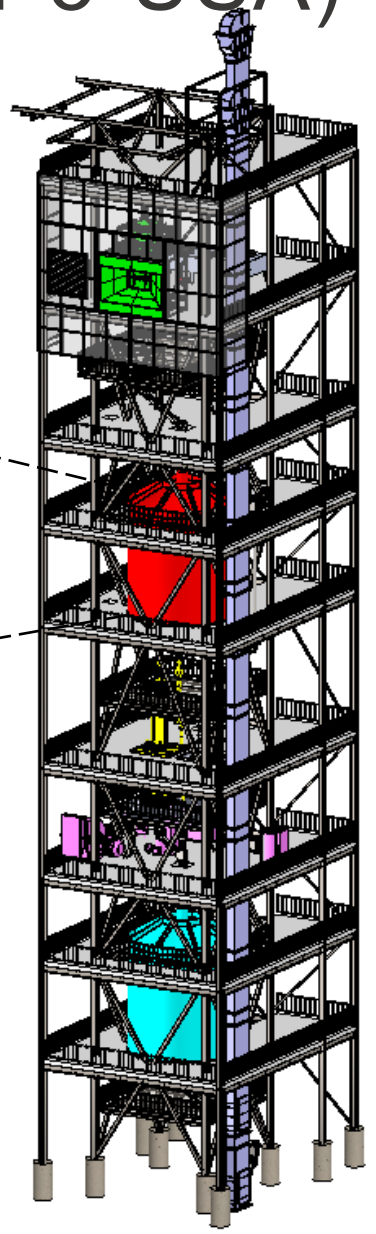
K. Albrecht, SNL

Gen3 Particle Pilot Plant (G3P3-USA)

High-Temperature Particle Storage Bin
(Allied Mineral Products, Matrix PDM, Sandia)







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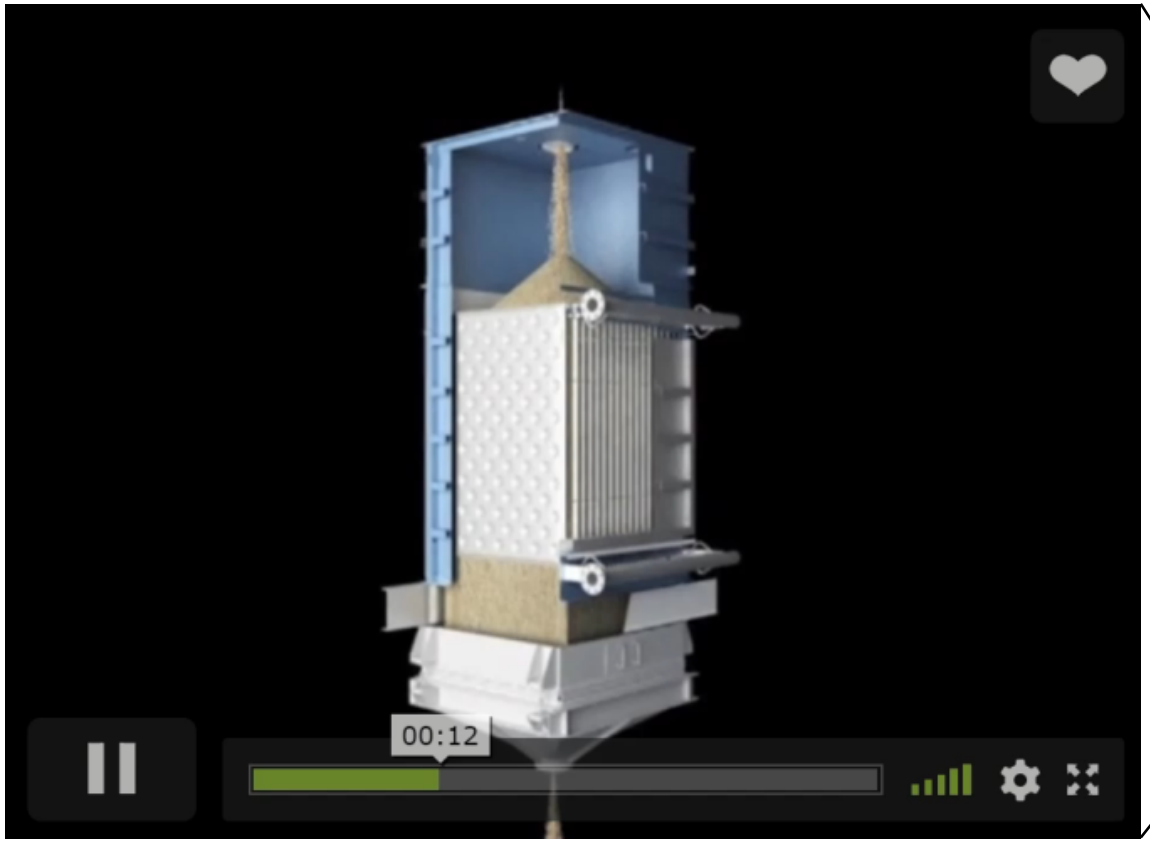
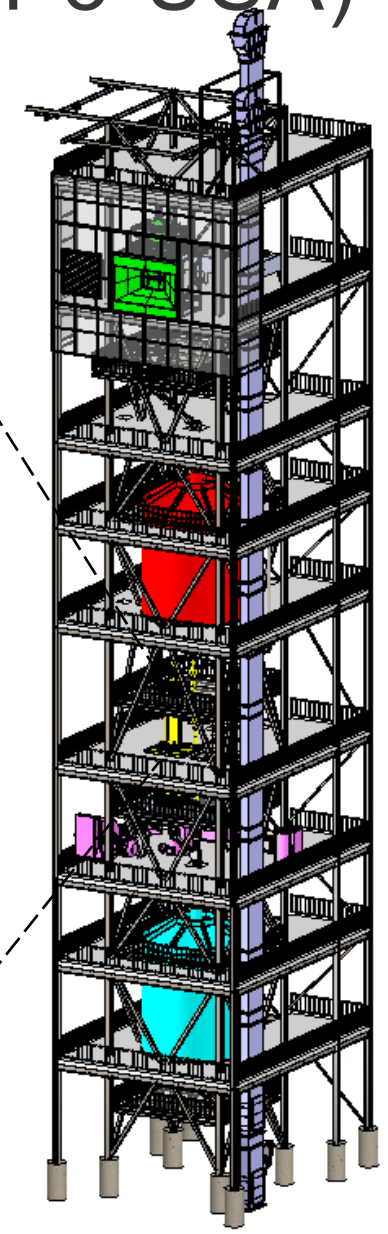
K. Albrecht, SNL

Gen3 Particle Pilot Plant (G3P3-USA)

High-Temperature Particle-to-sCO_2 Heat Exchanger
(VPE, Solex, Sandia)



https://www.solexthermal.com/our-technology/cooling/



K. Albrecht, SNL

Gen 3 Particle Pilot Plant

- ~1 – 2 MW_t receiver
- 6 MWh_t storage
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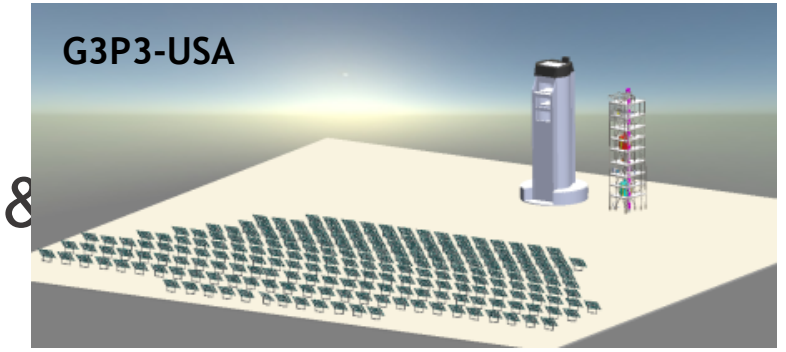
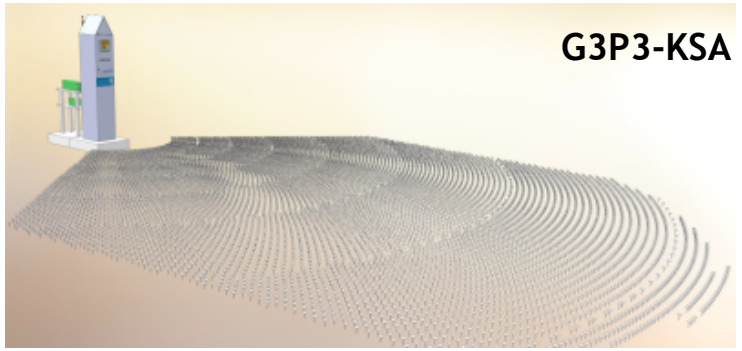
Summary

Summary

- G3P3-USA and G3P3-KSA being developed
- Key components evaluated in G3P3 Phases 1 &
  - Receiver
  - Particle-to-sCO2 heat exchanger
  - Storage
- Key risks of G3P3
  - Particle and heat loss from open-aperture receiver
  - Heat loss from storage and bucket elevator
  - Low particle-side heat-transfer coefficients in heat exchanger
  - High cost of diffusion-bonded heat exchanger
- Contingencies
  - Fluidized-bed heat exchanger (Babcock & Wilcox, SandTES TU Wien)
  - Skip hoist for particle lift
  - Tower-integrated particle storage bins

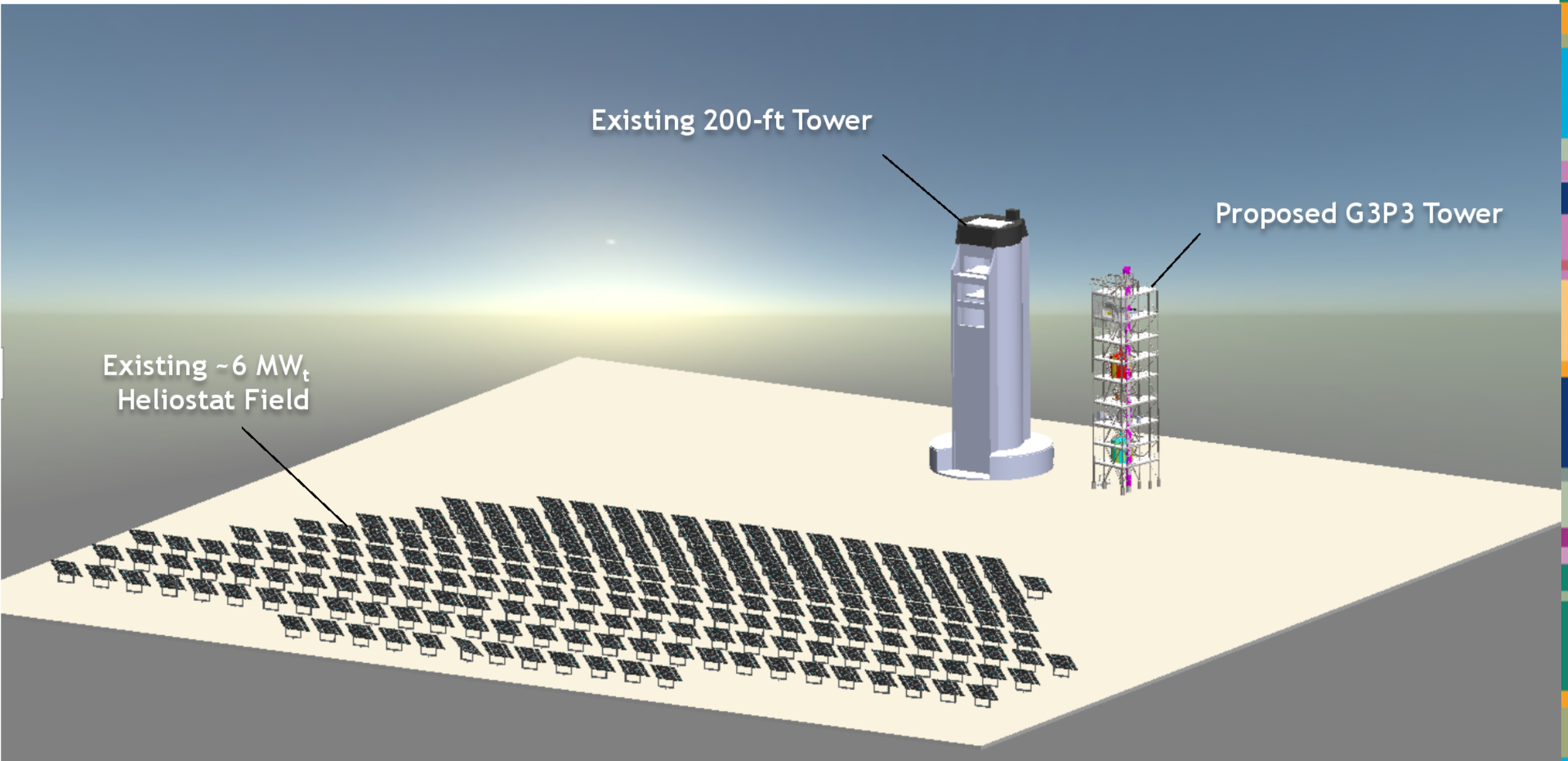




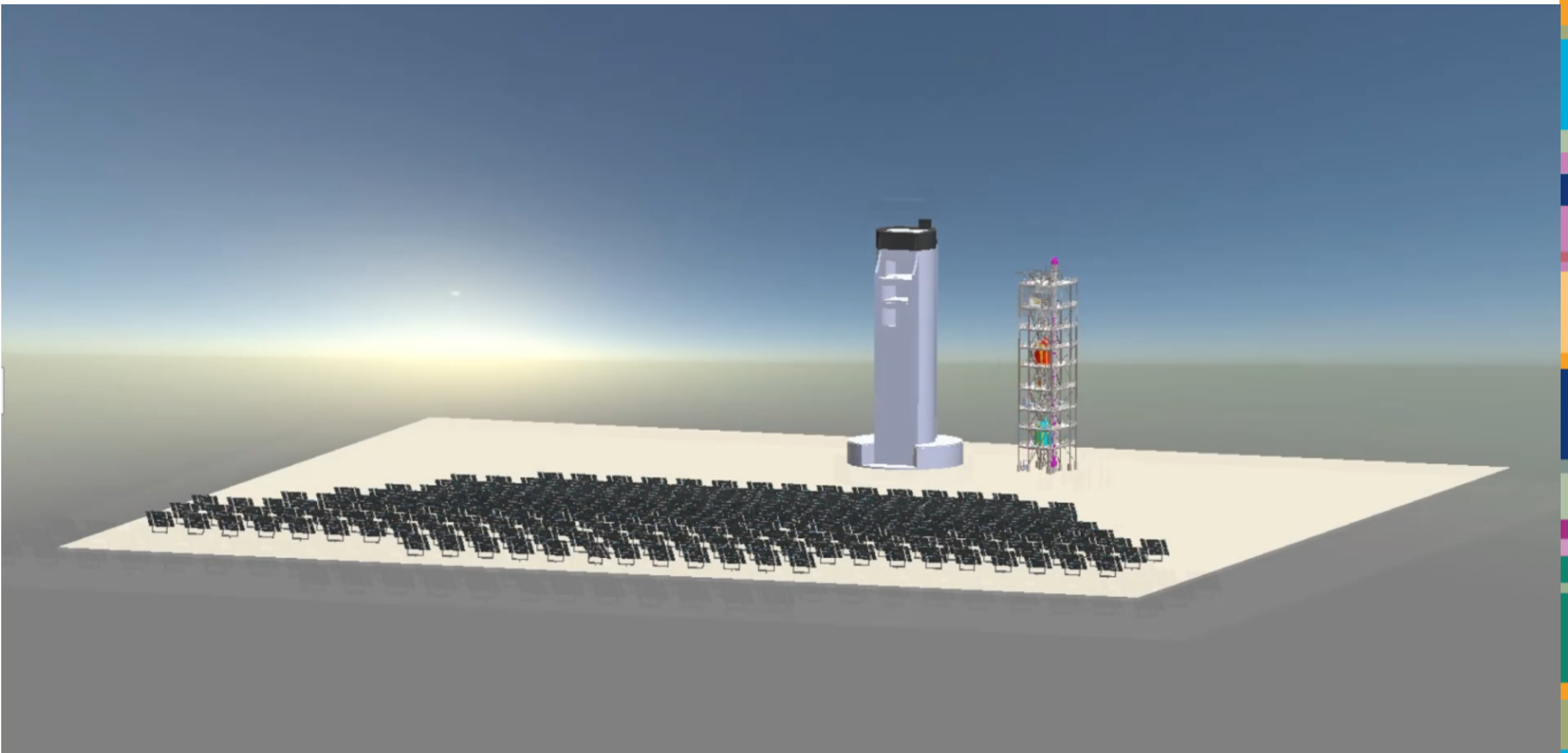
Acknowledgments

- This work is funded in part or whole by the U.S. Department of Energy Solar Energy Technologies Office under Award Number 34211
  - DOE Project Managers: Matthew Bauer, Shane Powers, Vijay Rajgopal, Levi Irwin, Andru Prescod, Mark Lausten, Avi Shultz

G3P3-USA
National Solar Thermal Test Facility (NSTTF), Albuquerque, NM



G3P3-USA
National Solar Thermal Test Facility (NSTTF), Albuquerque, NM

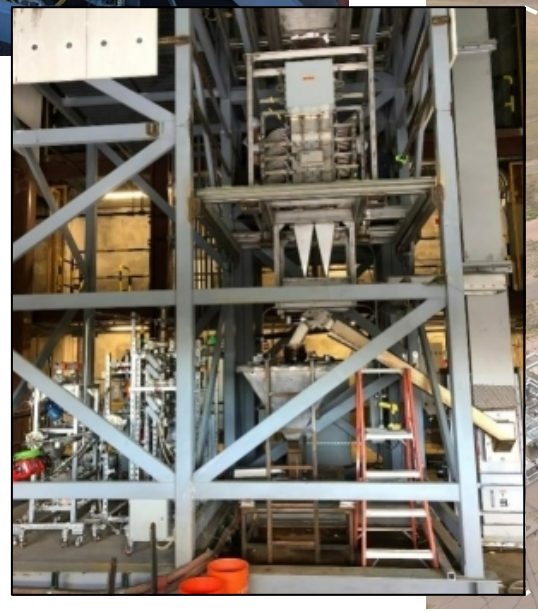


Backup Slides

High-T, High-P Particle-to-sCO2 Heat Exchanger

100 kW particle-to-sCO2 heat exchanger

~100 kW sCO2 flow loop



Integration of heat exchanger and sCO2 flow loop in tower

On-sun testing of integrated system with falling particle receiver