SunShot
U.S. Department of Energy

CSP Program Summit 2016

CSP Systems Analysis

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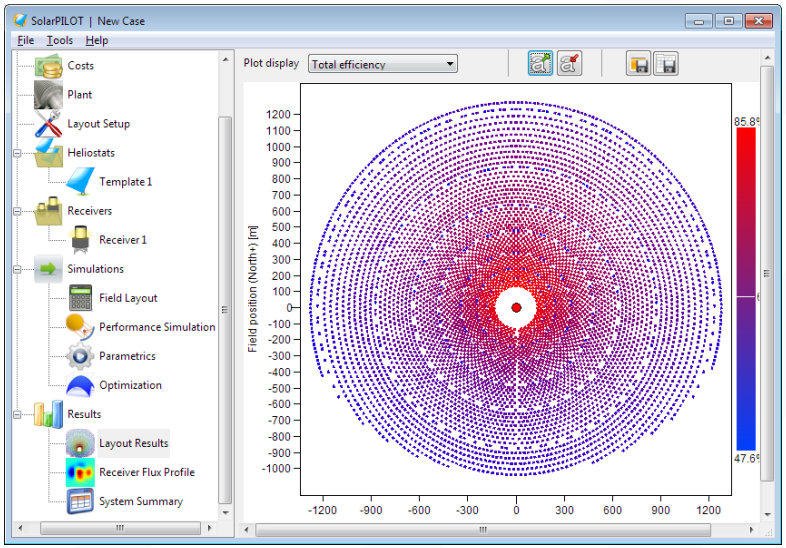
CSP Systems Analysis

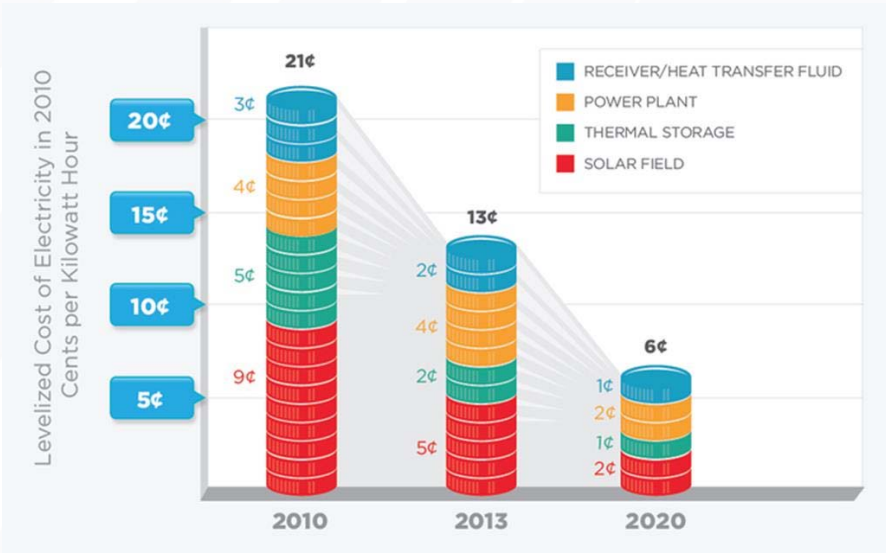
National Renewable Energy Laboratory

SuNLaMP Award NREL-1651

Total Budget $2,250,000

Period of Performance 10/1/2016 to 9/30/2018





Project Goal

- The role of the CSP Systems Analysis project is to evaluate CSP technologies in support of the DOE subprogram to assess progress toward DOE goals and guide the direction of DOE and NREL program resources.
- The project simulates CSP system performance and develops new and upgraded CSP tools for NREL's System Advisor Model (SAM).

This project is designated as a core NREL activity.

3-Year Project Objectives

Task 1. CSP Cost Tracking

- Track and assess CSP component and system costs as reported by the industry,
- Perform targeted cost validation on key subsystems, and
- Report CSP costs to DOE to serve as a benchmark for program metrics and progress.

Task 2. Supercritical CO_2 Power Cycle Modeling

- Increase simulation speed and accuracy to make sCO_2 cycle model codes compatible with NREL's SAM framework,
- Compare annual performance of the most common sCO_2 cycle configurations, recompression and partial-cooling, within a CSP system model,
- Validate performance estimates from an sCO_2 cycle model versus experimental data, and
- Make recommendations to industry related to the selection and operating mode of sCO_2 power cycles for CSP applications.

3-Year Project Objectives

Task 3. Optical Modeling of Power Tower Systems

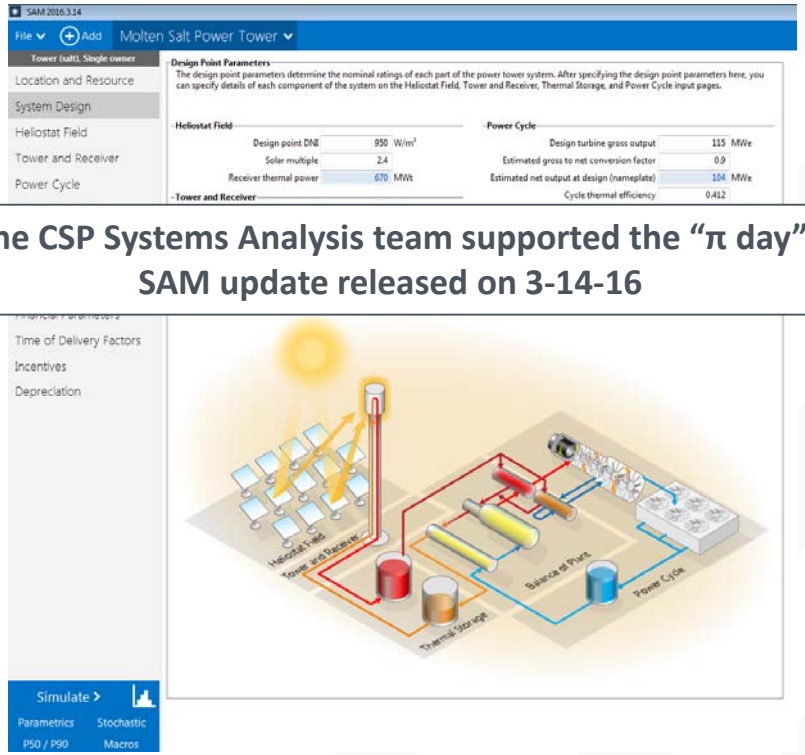
- Develop and implement SolTrace performance and interface enhancements, enabling new analysis capabilities, and transfer SolarPILOT and SolTrace model capabilities to industry and researchers via a SAM webinar.

Task 4. Thermal-Application Modeling Tools for SAM

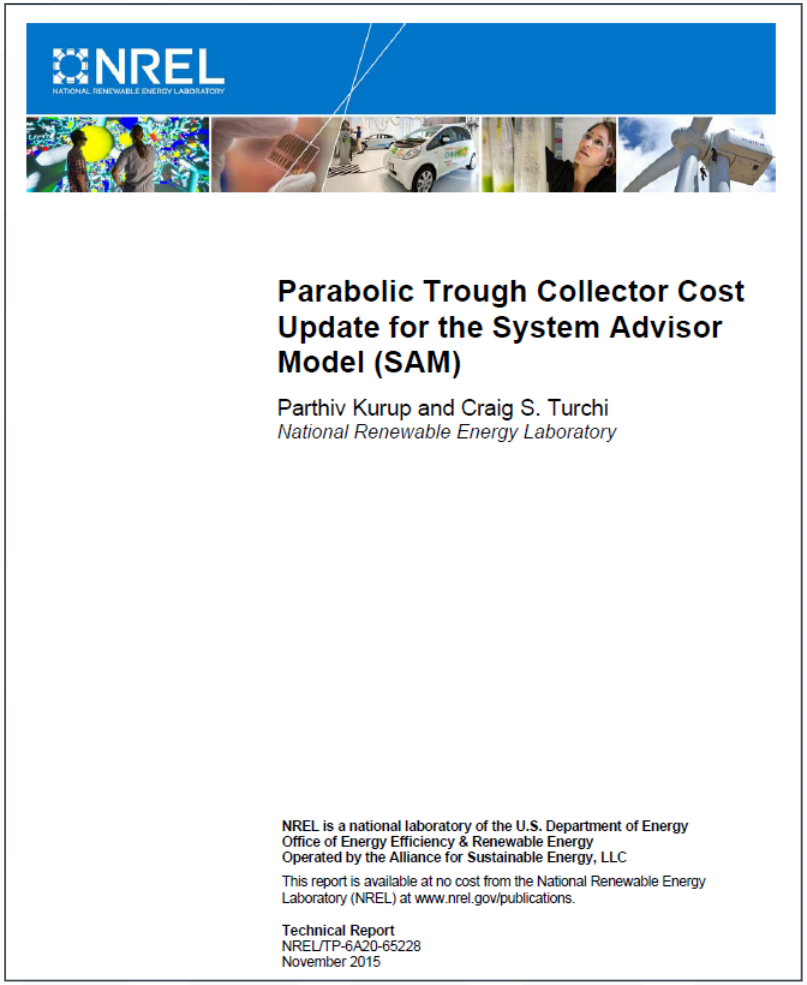
- Separate SAM's linear collector performance models from constraints associated with power conversion systems,
- Simplify and clarify SAM's user interface for simulations of thermal-only systems,
- Validate performance estimates from a SAM thermal-system model versus experimental data, and
- Perform a case study to highlight the potential of solar industrial process heat to promote early adopters

Year 1 Accomplishments: Task 1

- Updated costs for SAM
- Industry cost survey drafted



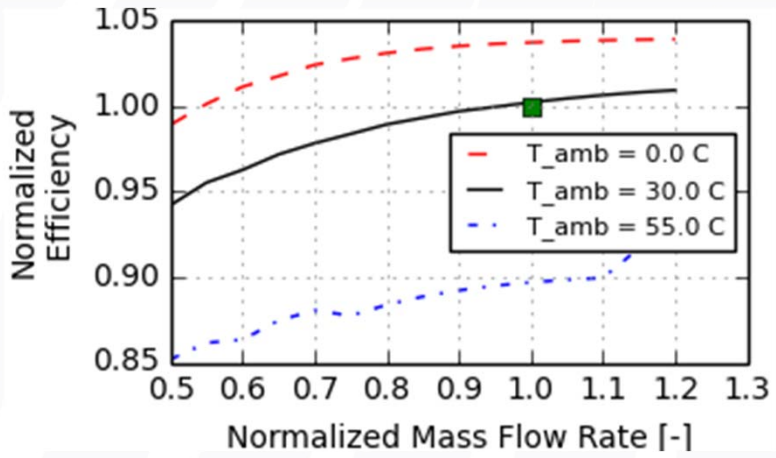
The CSP Systems Analysis team supported the "π day" SAM update released on 3-14-16



Year 1 Accomplishments: Task 2

Supercritical CO_2 Power Cycles

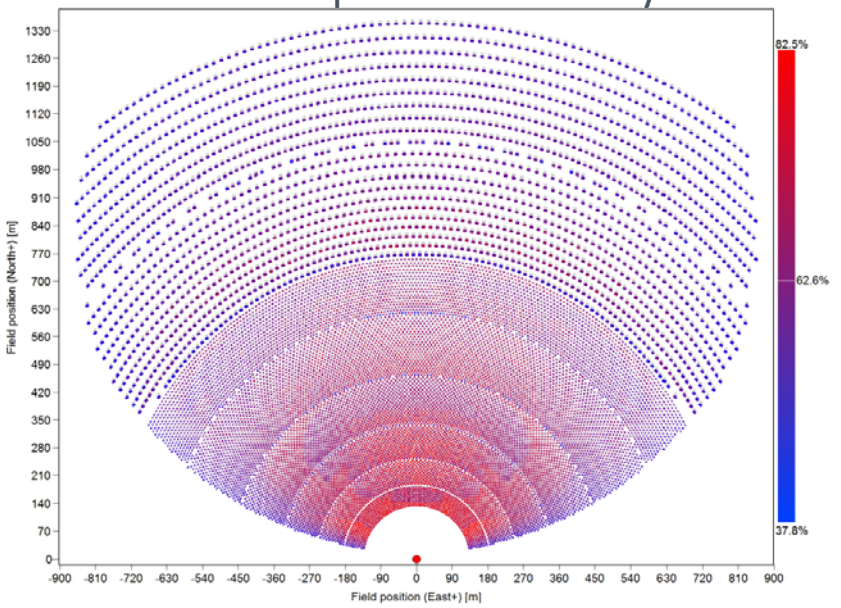
- Established framework for sCO_2 power cycle modeling in SAM
- Developing off-design performance maps of the recompression sCO_2 power cycle
  - Performance under part-load and varying ambient temperatures is essential for CSP applications



Year 1 Accomplishments: Task 3

Demonstrated computation speed enhancement for SolTrace ray-tracing tool of over 300x. This public tool aids in solar field and receiver optimization.

Case 6: Example solar field layout



Case	# Elements	Description	Base [s]	Time [s]	Factor
1	100,512	Default SolarPILOT case, 500MWt	11,672	6.7	1,742×
2	100,512	Same as case 1, afternoon sun position, $\theta = 23°$, $\alpha = 253°$	8,325	6.4	1,300×
3	6,282	Default case with single-facet heliostats	926.9	2.5	370×
4	95,174	Ivanpah-like facility	6,531	9.6	680×
5	34,188	Hexagonal field with regular layout	5,447	6.1	893×
6	79,812	North field, mixed heliostat templates (small inner, large outer)	6,683	6.2	1,078×

Year 1 Accomplishments: Task 4

- Ported new code structure for data transfer between SAM interface and parabolic trough code
- Harmonized variable names in new code
- Confirmed agreement between old format and new code structure
- Acquired field data to test/validate models

Ongoing Work in FY16

- Update SAM cost defaults based on with industry feedback
- Demonstrate accuracy and increased robustness and speed of sCO_2 recompression cycle model convergence
- Demonstrate improvements in computational speed and flexibility of SolTrace
- Complete new thermal-application model options for SAM: liquid-HTF trough, steam trough, and steam linear Fresnel

Thank you!

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