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# An Integrated Techno-economic Modeling Tool for sCO2 Brayton Cycles


Thomas Drennen, Ph.D. (Hobart and William Smith Colleges)
Blake Lance, Ph.D. (Sandia National Laboratories)


Sandia National Laboratories

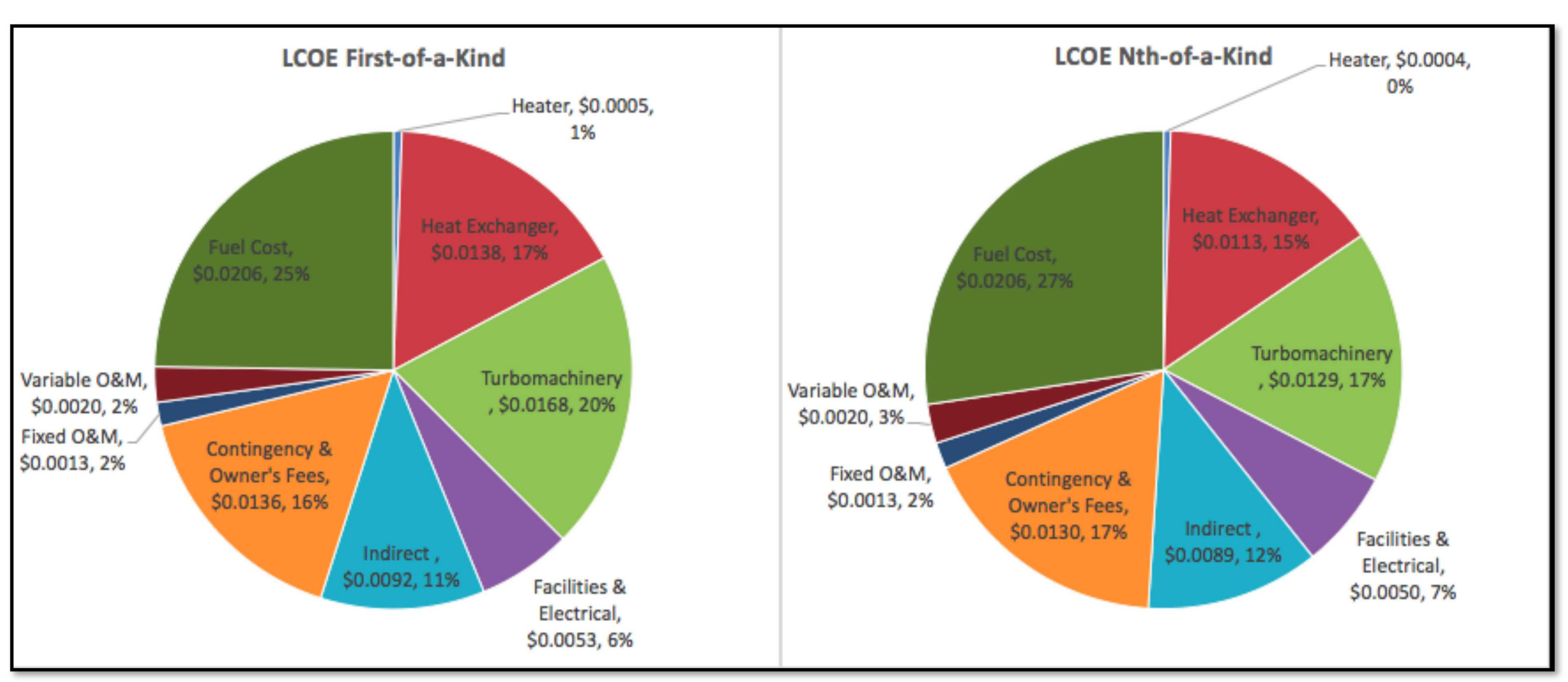
## Model Overview

- Estimates the levelized cost of energy (LCOE) for recompression closed Brayton cycle (RCBC) systems.
- Integrated with Sandia's RCBC Evaluation and Trade Studies Model (RETs), which calculates system performance based on user-defined input on key inputs such as: system size, recuperator effectiveness, turbine inlet temperatures, etc.
- Costing information for various components from a variety of sources, including internal Sandia estimates, vendor estimates, and other published estimates.
- Production costs are estimated using a levelized cost of energy (LCOE) approach. LCOE calculations estimate the per unit ($/kWh) cost of production over the economic lifetime of the technology. Specifically, this calculation takes the capital costs, associated financing costs, O&M, fuel costs, and any externality costs (such as $CO_2$) and calculates a per unit production cost.

***LCOE is often used as an economic measure of energy costs as it allows for comparison of technologies with different capital and operating costs, construction times, and plant load factors.***

## Results

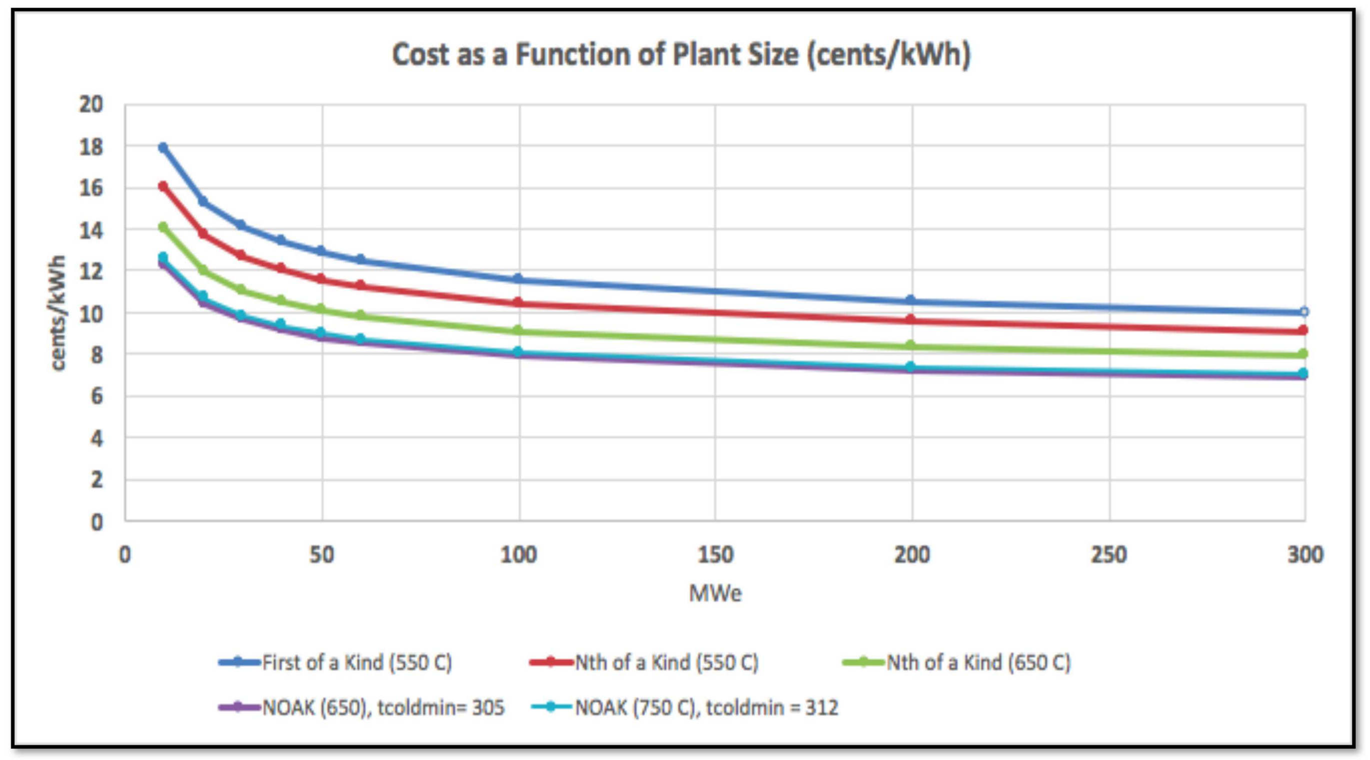
The estimated LCOE for a 100 MWe Brayton system operating with an inlet turbine temperature of 700 degrees C with dry cooling are **0.832 $/kWh and 0.754 $/kWh for a first-of-a-kind and n$^{th}$-of-a-kind plant, respectively.**



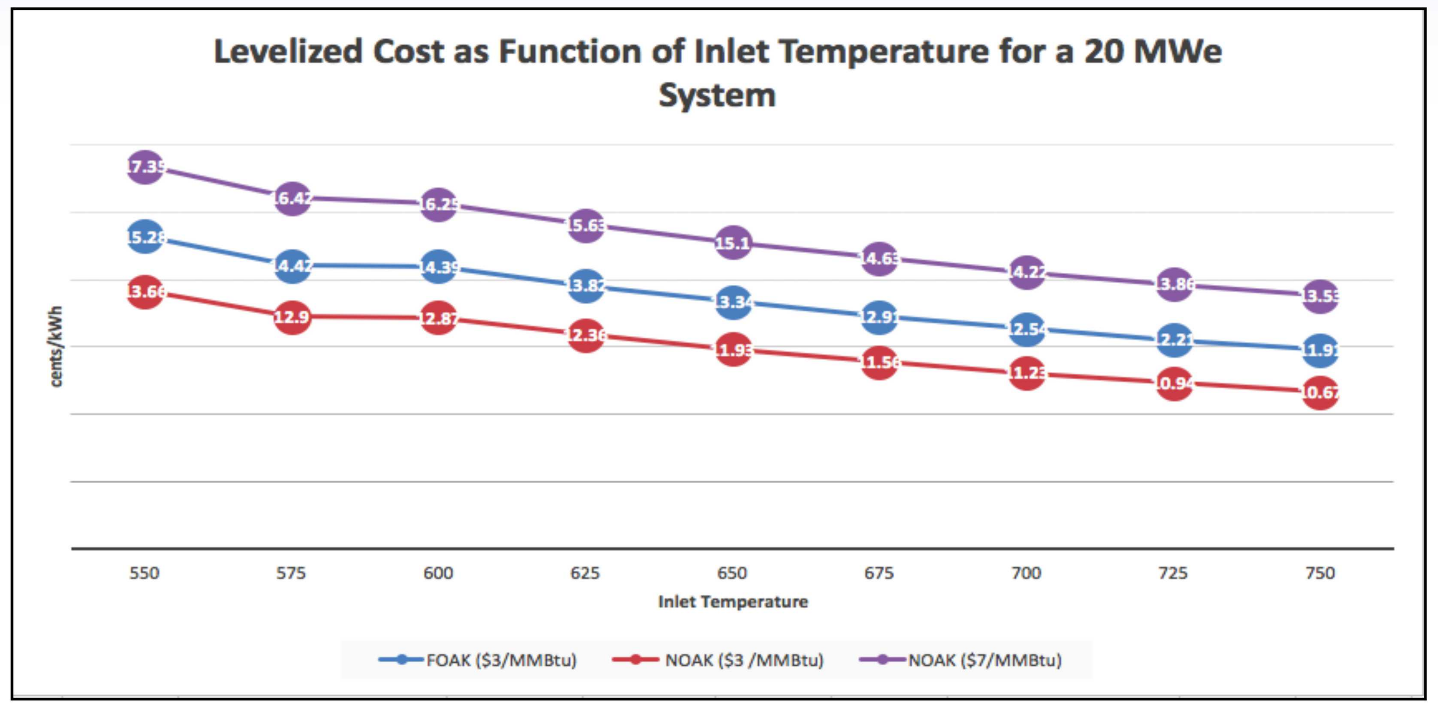

For the 100 MWe facility, the various heat exchangers and turbomachinery account for 15% and 17% of the total costs for the nth-of-a-kind plant, respectively. The non-component costs, ranging from fuel costs, project indirect, owner's costs, and contingency costs account for the majority of costs. Worth noting is that many of these costs are often overlooked in initial analysis of new technology costs.

## Sensitivity Analysis

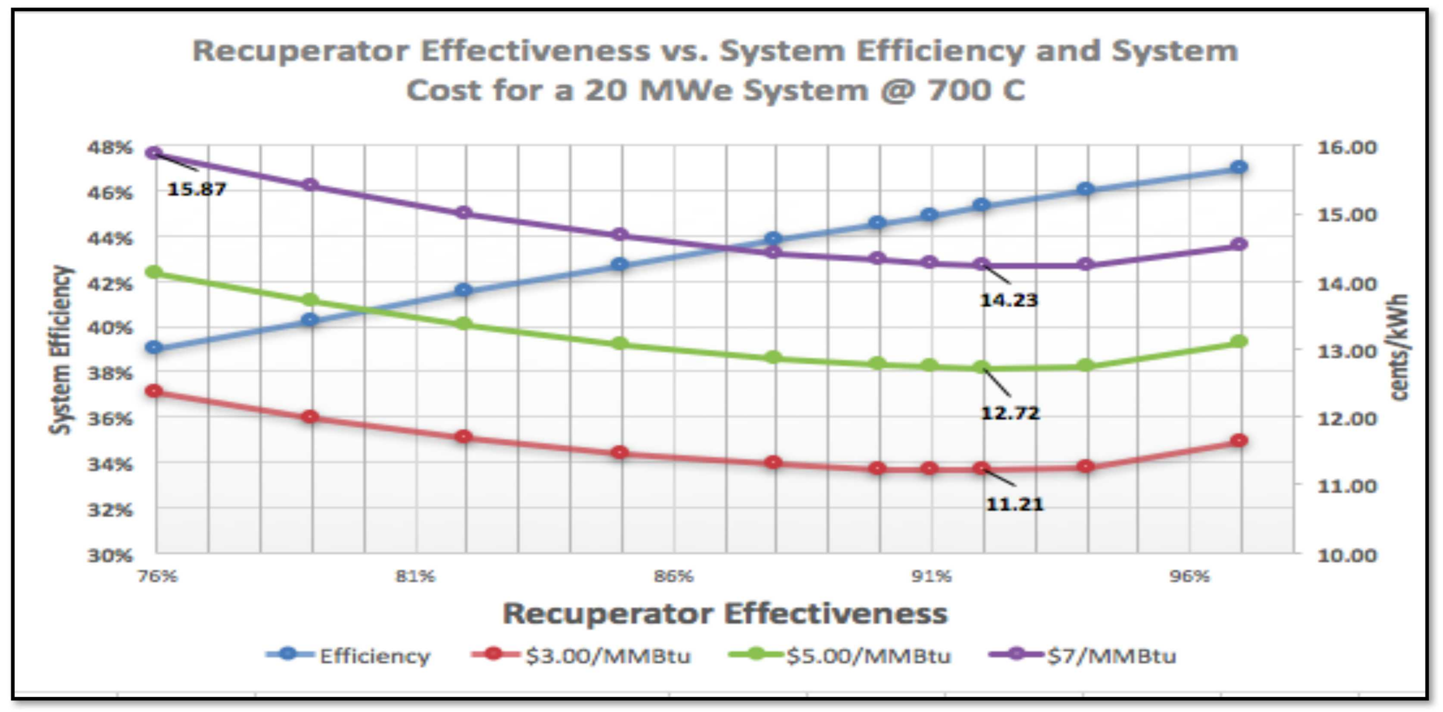
This integrated tool allows for the testing of key sensitivities related to plant size, turbine inlet temperatures, and recuperator effectiveness.



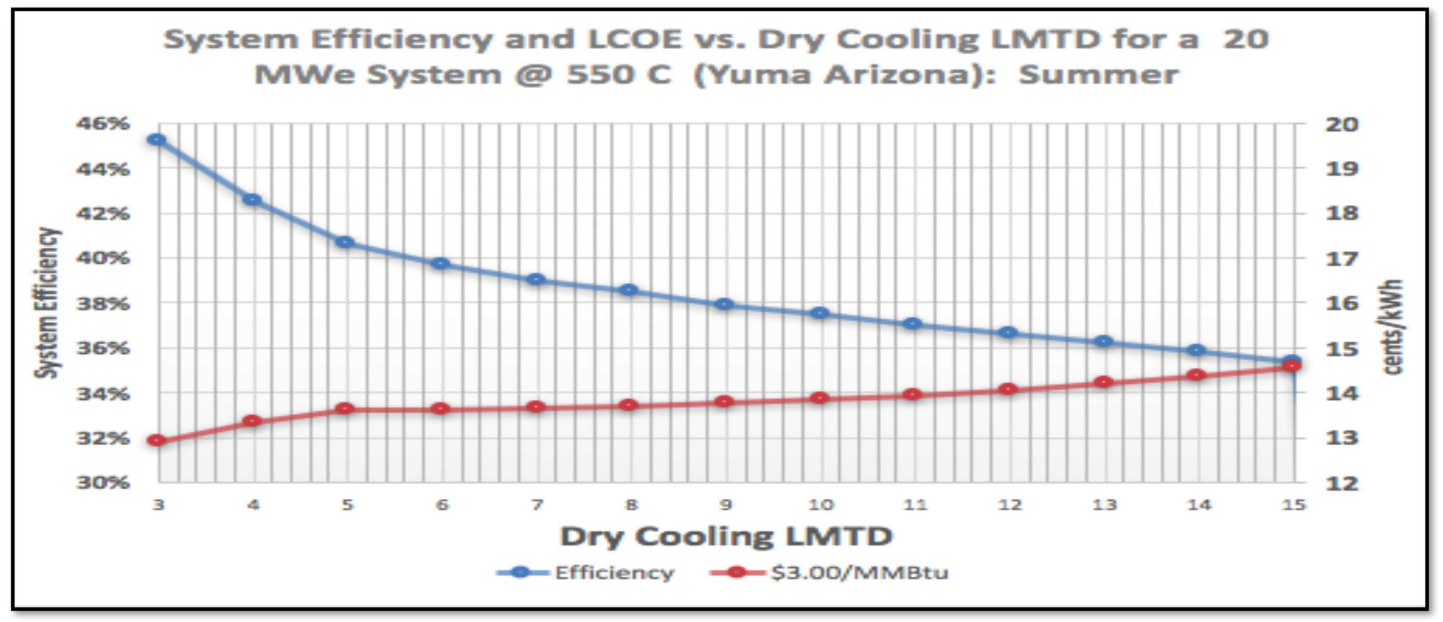

The figure above shows the projected LCOE costs for systems from 10 to 300 MWe for several cases, varying turbine and minimum system temperatures. The results show that **costs decline rapidly as size increases** from 10 to 50 MWe, before slowly leveling off. They also show that **costs are lower for higher turbine inlet temperatures** (approximately 0.02 $/kWh when going from 550 to 650 degrees C).




As turbine inlet temperature increases, certain individual system components require higher-quality alloys. The results (above) show that the **higher costs are offset by the increase in overall system efficiency**.




Increasing recuperator effectiveness translates into higher system efficiency and system costs. **LCOE is minimized for recuperator effectiveness of 92%.**




System efficiency – and hence LCOE – are highly sensitive to assumptions about design of cooling systems and physical location.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