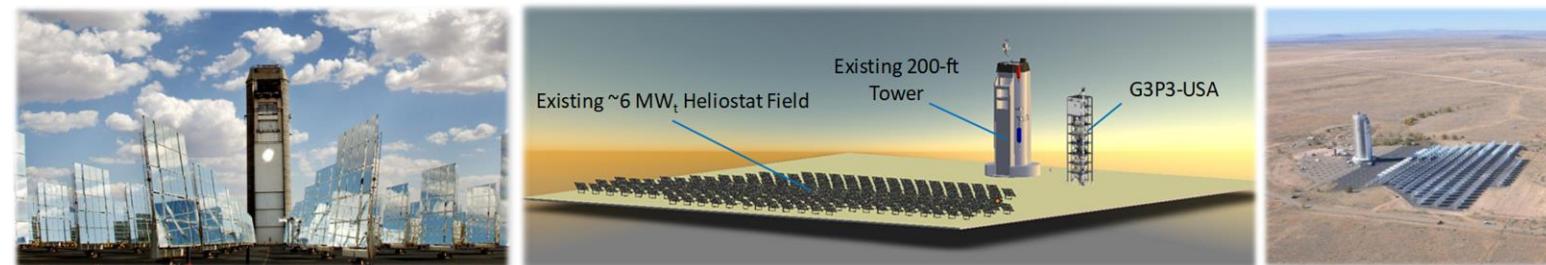




Sandia  
National  
Laboratories

# CSP Design Study for Sandia National Laboratories and Kirtland Air Force Base



*PRESENTED BY*

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# Motivation and Objectives

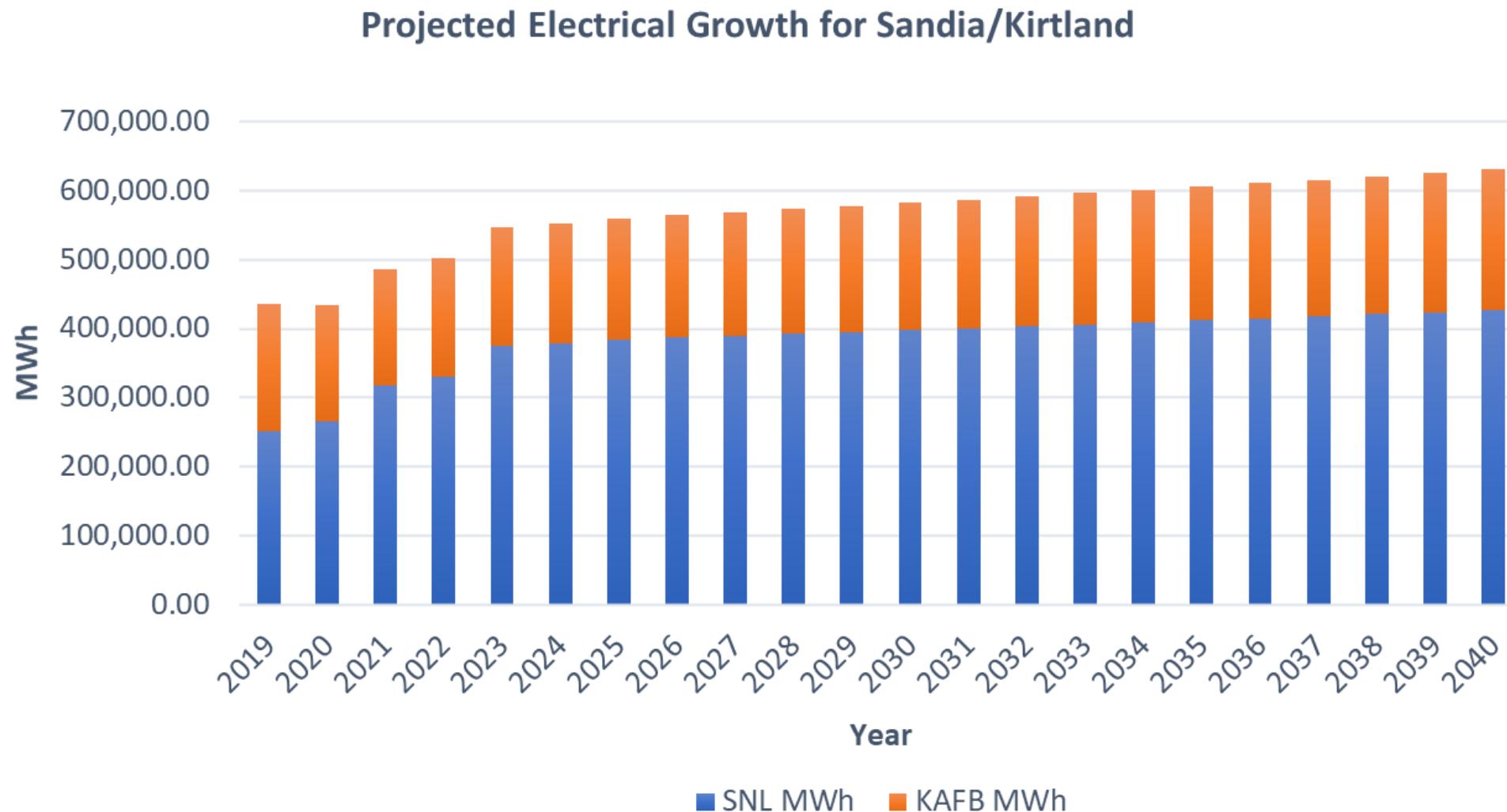


- **Provide 100% clean electricity** to Sandia NM and Kirtland AFB
- **Offset annual electrical costs** and potential future carbon costs
- Add **energy storage and resilience** to Sandia and KAFB

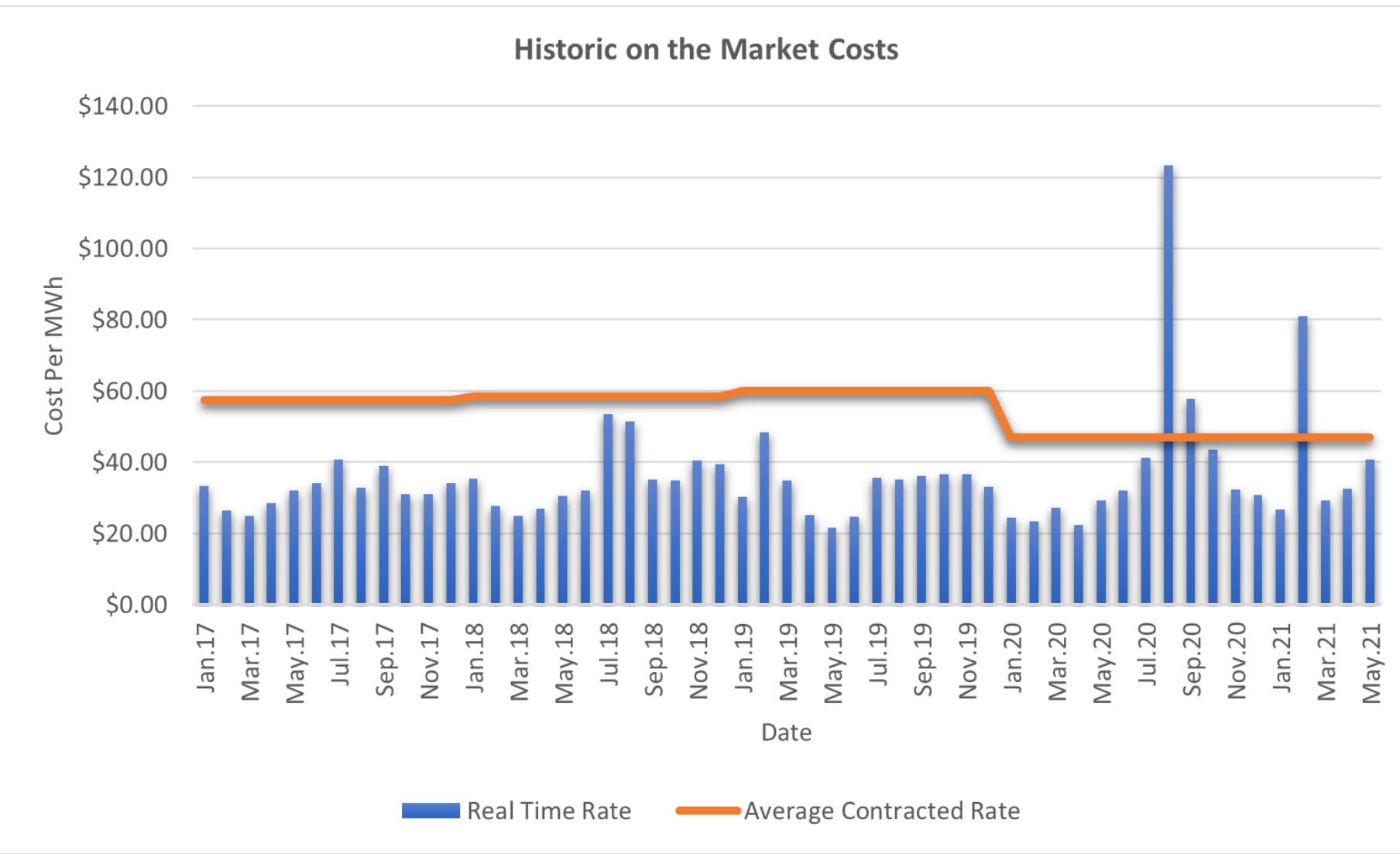
# Sandia NM and KAFB Energy Requirements



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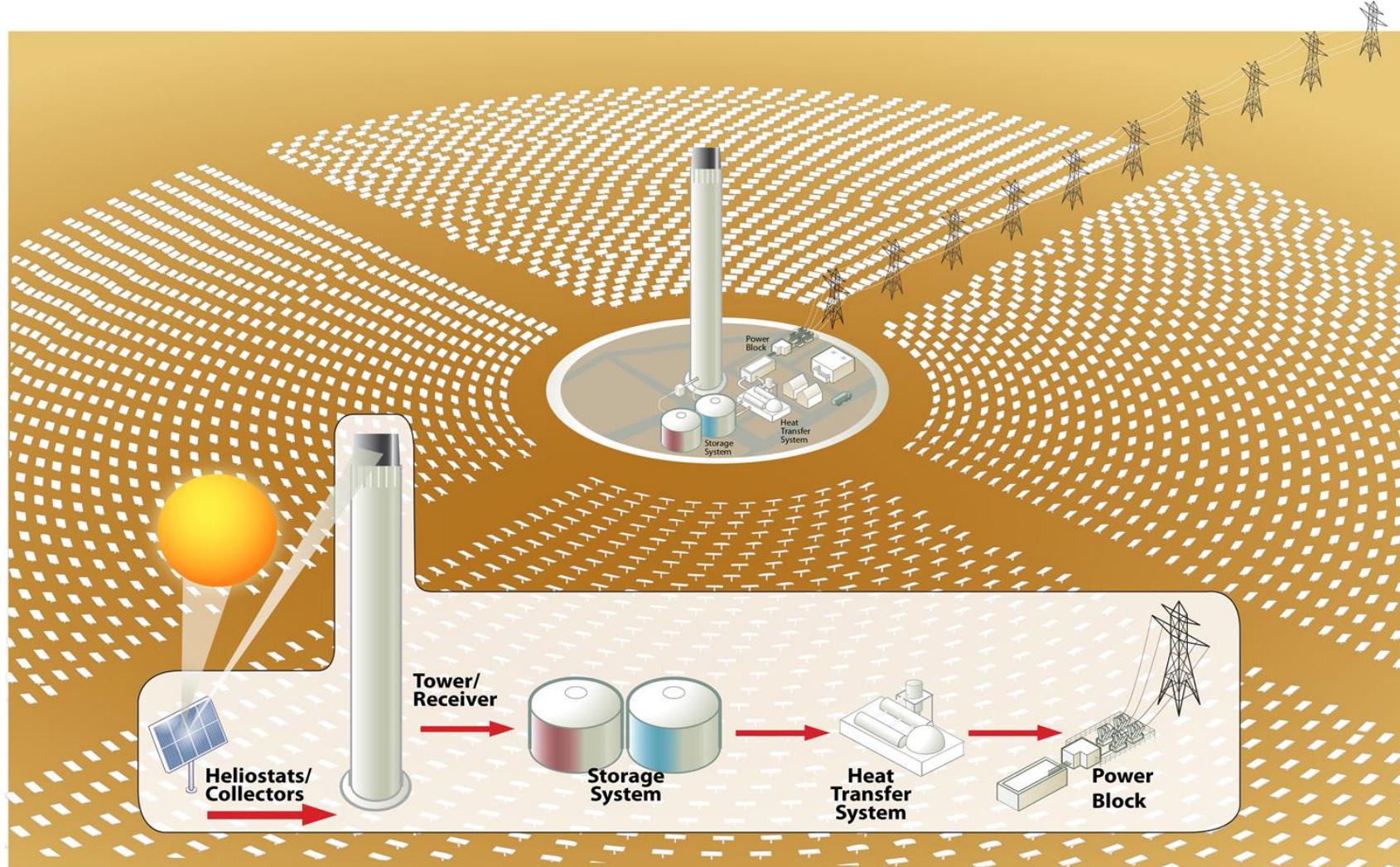
# Sandia/KAFB Electricity Costs



# Concentrating Solar Power Plant Design



# Conventional Molten Salt Tower



# CSP Molten-Salt Plant Design Parameters in SAM



Parameter	50 MW Baseline Value		100 MW Baseline Value	
Solar Multiple [-]	2.4	3.0	2.4	3.0
Receiver Thermal Power [MW <sub>t</sub> ]	297	371	594	743
Heat Transfer Fluid Max Temperature [ °C ]			574	
Total Land Area [acres]	965	1240	1892	2350
Total Heliostat Reflective Area [m <sup>2</sup> ]	562629	717254	1147635	1449523
Tower Height [m]	120	132	167	187
Storage Tank Volume [m <sup>3</sup> ]	9422		18844	
Annual Energy [GWh]	275 [233 - 318]	308 [259 - 338]	522 [414 - 608]	621 [521 - 678]

# Probabilistic Modeling in SAM

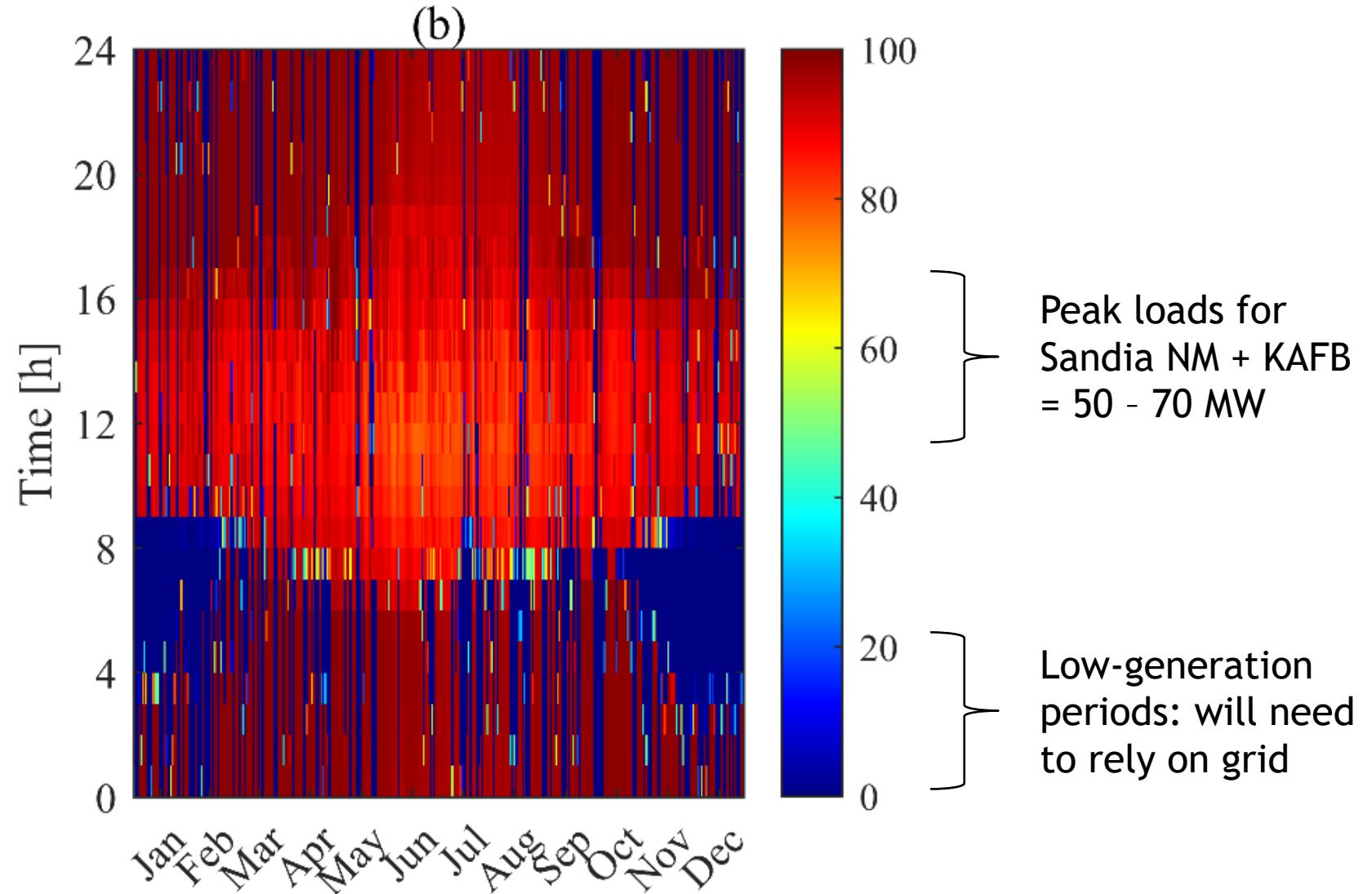


Parameter	Baseline Value	Uncertainty Distribution	Basis
<b>Heliostat Field Cost</b> [\$/m <sup>2</sup> ]	70.0	[50.0 - 167]	Range between 2017 baseline value and DOE 2030 cost target
<b>Fixed O&amp;M Cost</b> [\$/kW-yr]	66.0	[40.0 - 76.0]	Range between 2017 baseline value and DOE 2030 cost target, informed by JEDI model inputs for construction, O&M
<b>Power Cycle Cost</b> [\$]	1300	[900 - 1660]	Range between 2017 baseline value and DOE 2030 cost target
<b>Receiver Reference Cost</b> [\$]	10.0 E6	[6.67 - 11.5] E6	Range between 2017 baseline value and DOE 2030 cost target
<b>Thermal Energy Storage Cost</b> [\$/kWh <sub>t</sub> ]	30.0	[15.0 - 45.0]	Symmetric range about default value; lower limit based on DOE 2030 cost target
<b>Fixed Tower Cost</b> [\$]	8.00 E6	[5.33 - 9.20] E6	Range between 2017 baseline value and DOE 2030 cost target
<b>Cycle Thermal Efficiency</b> [%]	40.4	[35.0 - 50.0]	Range encompassing typical and state-of-the-art CSP power cycle performance [8]
<b>Receiver Heat Loss</b> [kW <sub>t</sub> /m <sup>2</sup> ]	30.0	[29.2 - 190]	Receiver efficiency range between 80% and 96% (blackbody efficiency) [9]

# Predicted CSP Hourly Power Generation “Heat Map”



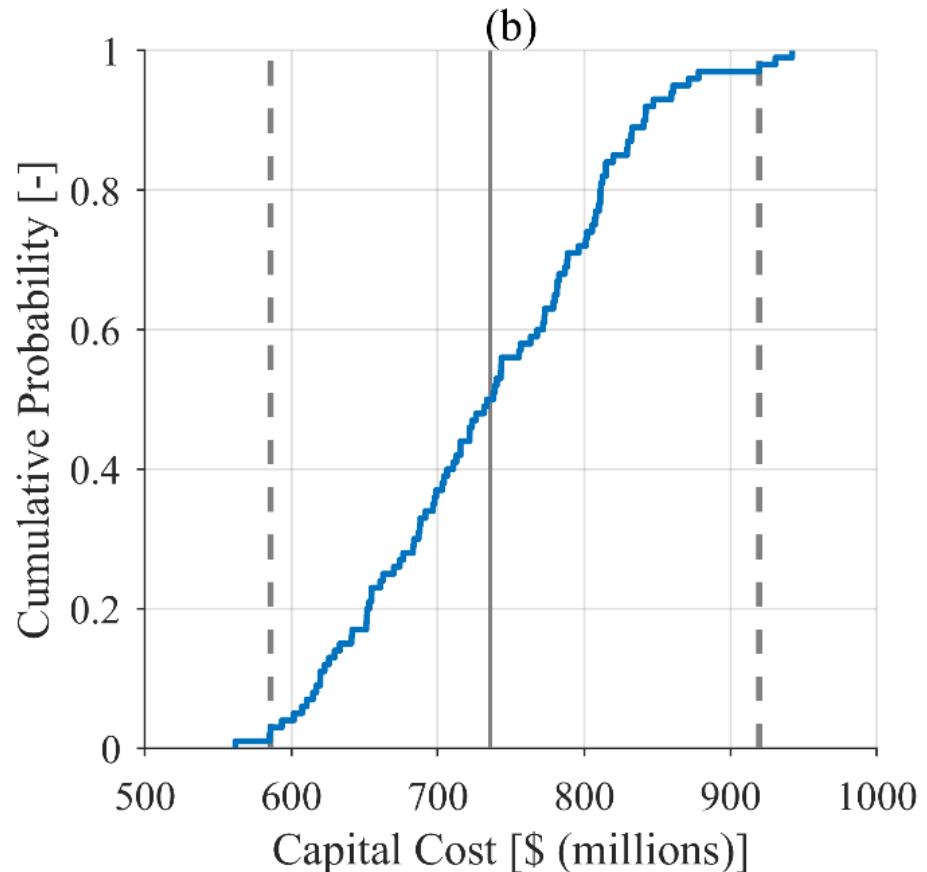
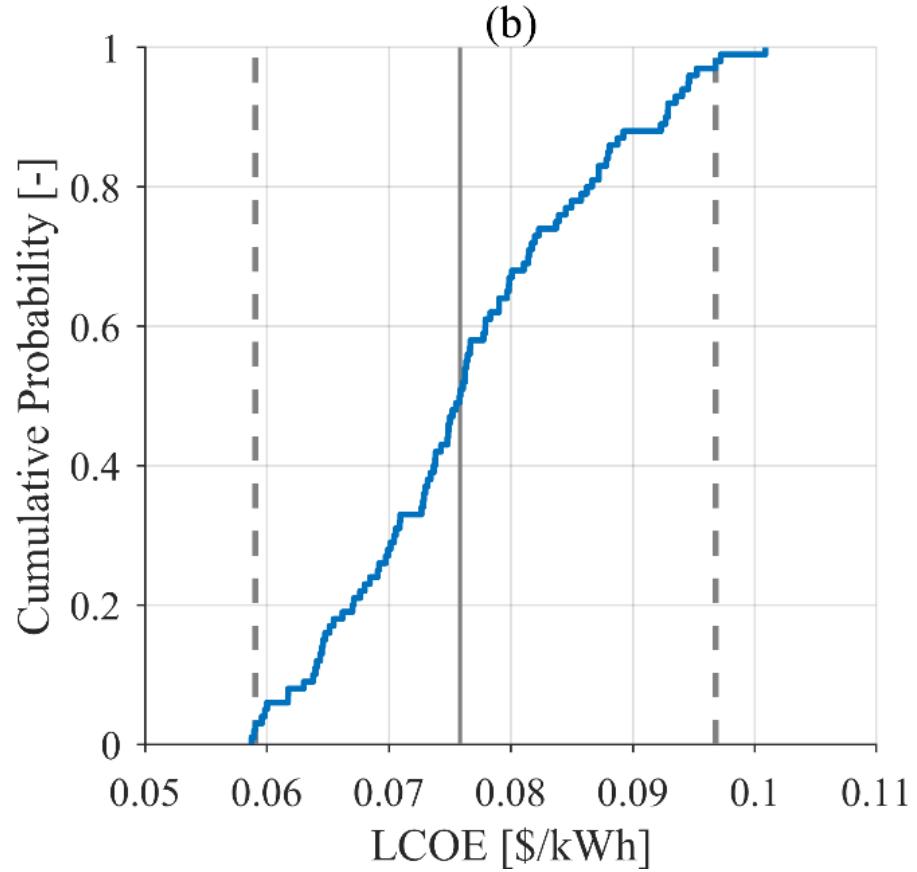
100 MW CSP Plant  
Solar Multiple = 3



# Estimated Costs of 100 MW CSP Plant



Solar Multiple = 3

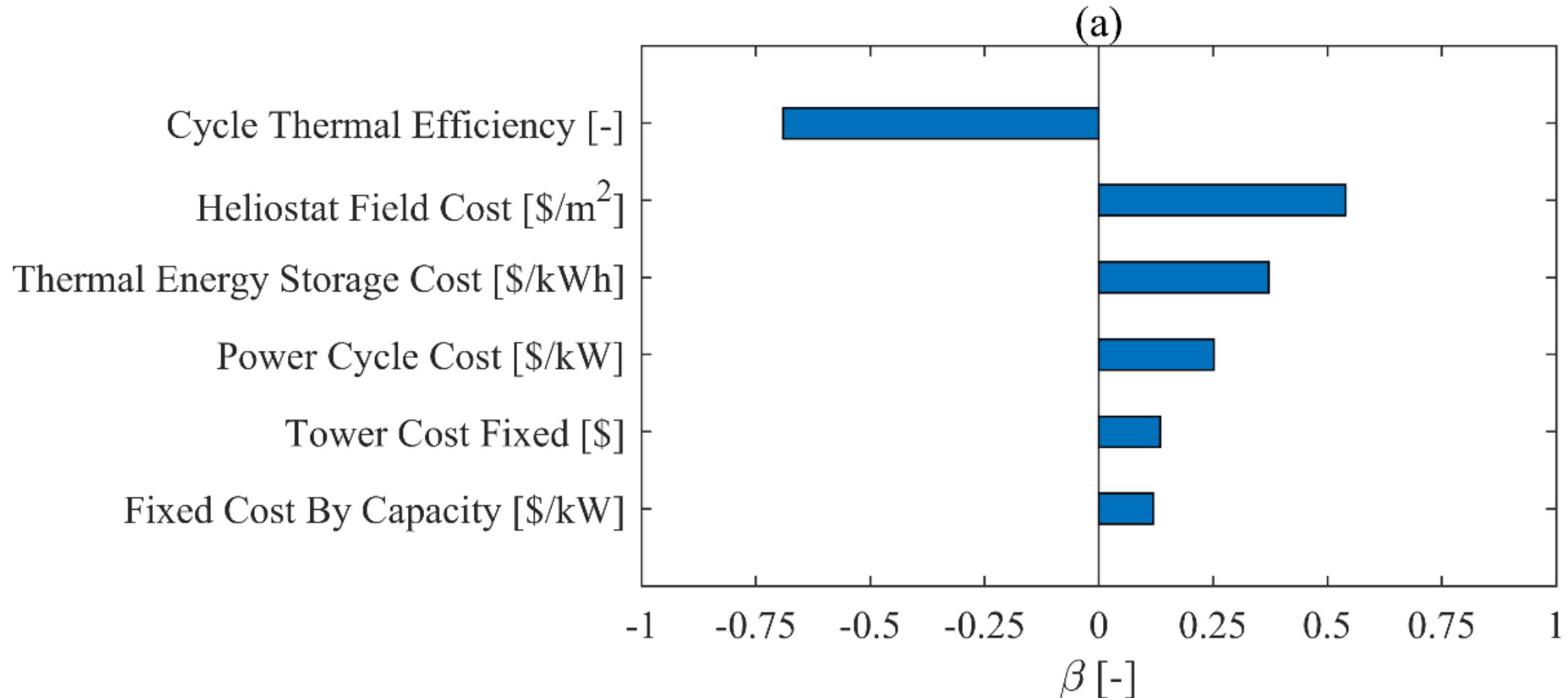


Includes financing and upfront fees

# Rank Regression Analysis



100 MW CSP Plant, Solar Multiple = 3



# Payback Analysis

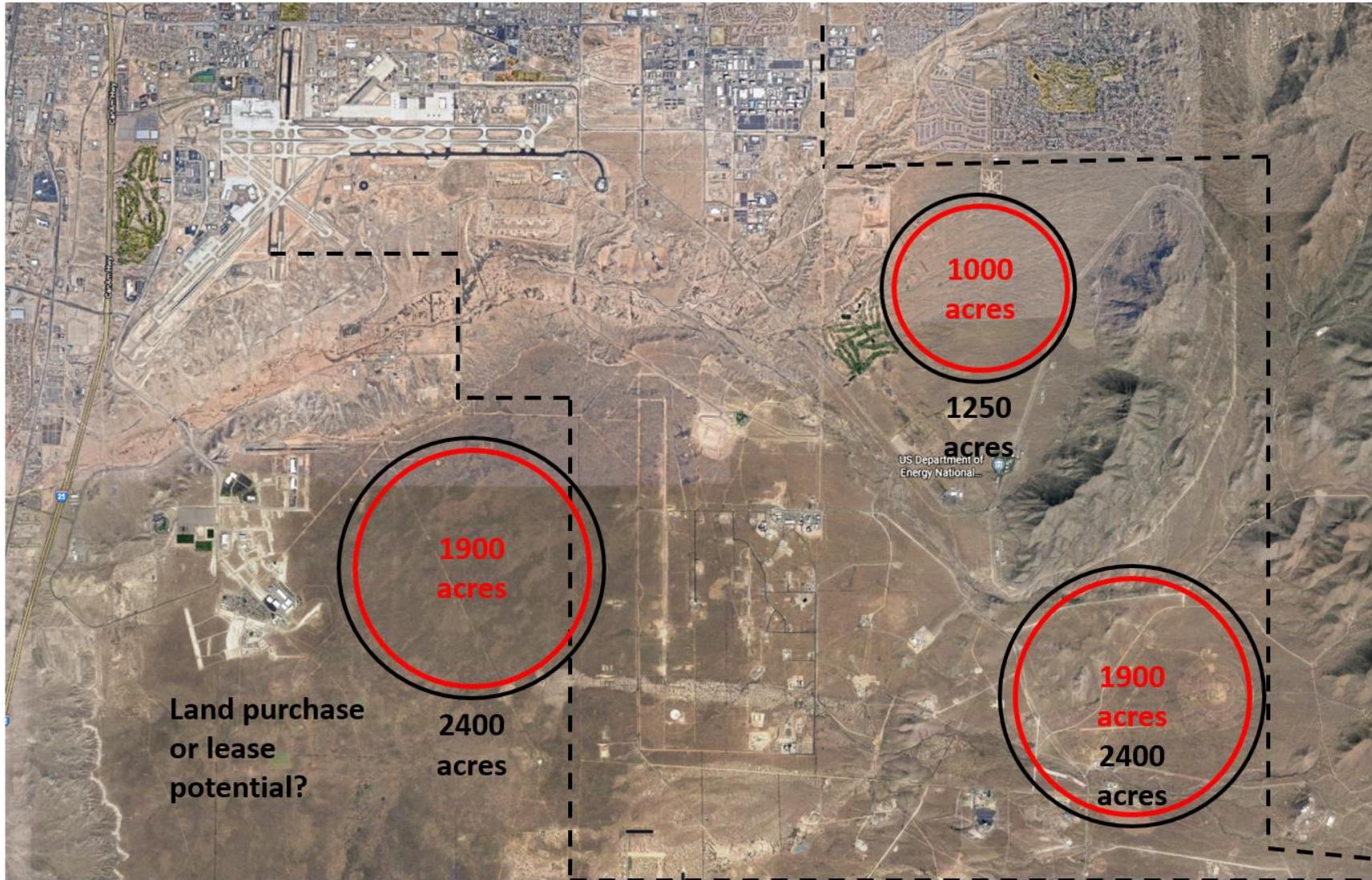


Parameter	50 MW			100 MW		
	Best Case (with carbon tax)	Best Case (no carbon tax)	Worst Case (no carbon tax)	Best Case (with carbon tax)	Best Case (no carbon tax)	Worst Case (no carbon tax)
Overnight Construction Cost (\$M)	263	263	416	479	479	833
O&M Costs (\$M/yr)	0	0	3.8	0	0	7.6
Avoided Energy Costs (\$M/yr)	14	14	14	24	24	24
Avoided Carbon Tax (\$M/yr)	10.8 (182,400 tons/year avoided at \$59/ton)	0	0	21.7 (376,800 tons/year avoided at \$59/ton)	0	0
Payback period at 4% IRR (yr)	14.1	35	$\infty$	13.9	41	$\infty$

# Siting Considerations



# Land Availability



# Potential ~2000 acre site (100 MW) looking SW



# Potential ~2000 acre site (100 MW) looking SE



# Potential ~1000 acre site (50 MW) looking east



# Summary



# Summary



- Conceptual design for a concentrating solar power plant to generate clean electricity for Sandia NM and KAFB
- 50 MW and 100 MW CSP plants were designed and evaluated
- **Advantages**
  - 100% clean electricity; reduction of up to ~300,000 tons of CO<sub>2</sub>/year
  - Avoidance of annual electricity payments (~\$24M/year)
  - Avoidance of future carbon costs
  - Added energy storage and resilience

# Challenges



- **Large up-front costs**
  - Up to ~\$800M overnight construction costs for 100 MW plant
- **Siting**
  - ~2000 acres of land required for 100 MW plant
  - Usable land on Kirtland Air Force Base (KAFB) is limited
- **Construction and Permitting**
  - Requires coordination among Sandia, NNSA/SFO, KAFB, PNM, WAPA, FAA and EPC

# Questions?

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# Backup Slides



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

