



# **IVANPAH**

SOLAR ELECTRIC  
GENERATING SYSTEM

*IEA Technology  
Roadmaps*

*Solar Towers*

*Feb 2014*



**BrightSource**  
Limitless







# The World's Largest Solar Thermal Plant

- 3 x 130 MWe
- Direct steam @ 160 bar, 560°C
- 140m towers
- 173,500 heliostats, each 15m<sup>2</sup>



*Photo taken April 2013*





# Environmental Design

## Dry Cooling



## Low Impact Development







# Construction Complete – December 2013

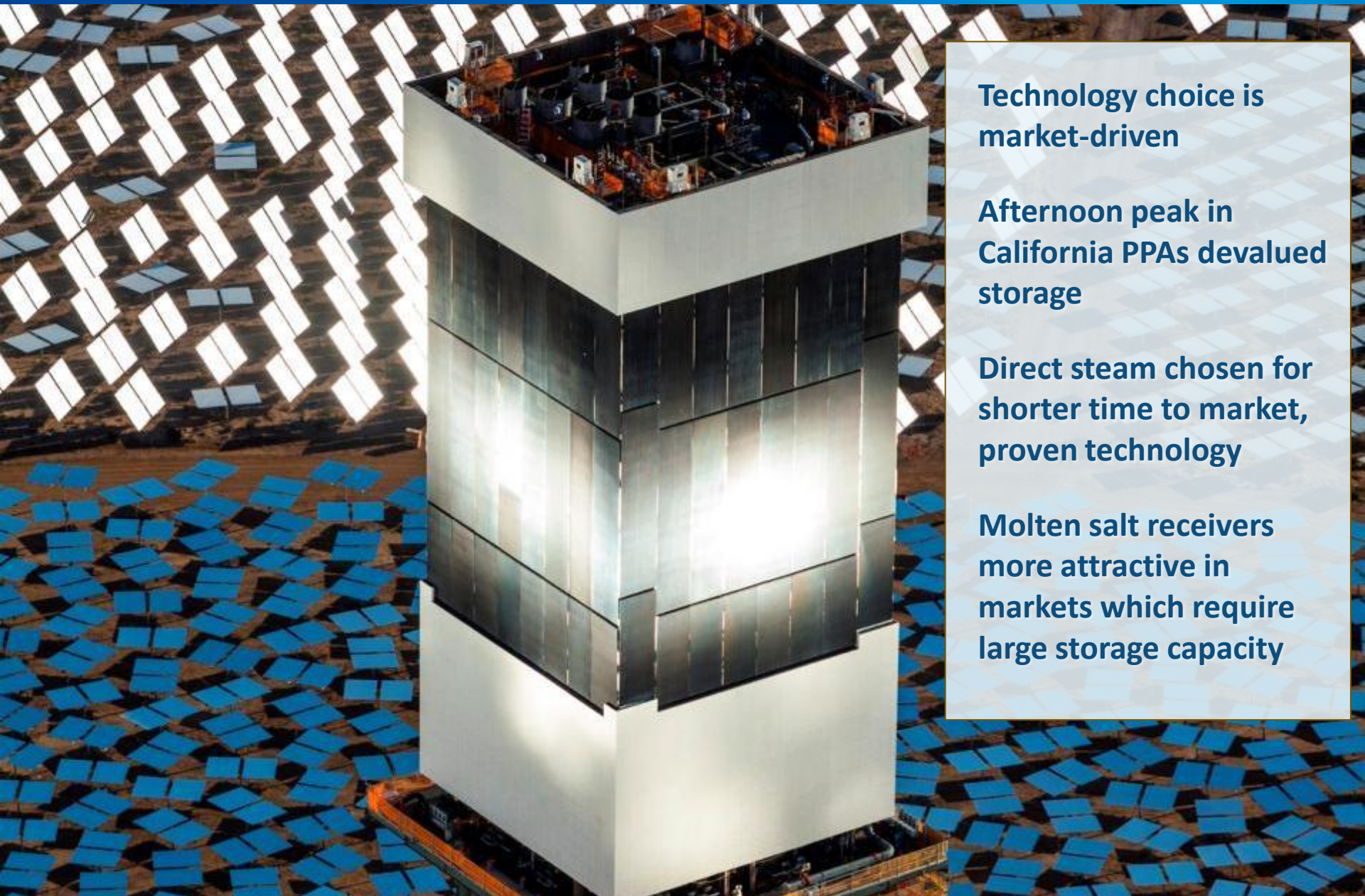


Screenshot from [www.vegashelicam.us/Pano\\_Tours/Ivanpah%20Solar%20Facility/IvanpahSolarFacility.html](http://www.vegashelicam.us/Pano_Tours/Ivanpah%20Solar%20Facility/IvanpahSolarFacility.html)  
Copyright © 2014 Vegas Helicam - Remote Piloted Aerial Photography.





# Receiver Technology



**Technology choice is market-driven**

**Afternoon peak in California PPAs devalued storage**

**Direct steam chosen for shorter time to market, proven technology**

**Molten salt receivers more attractive in markets which require large storage capacity**





# Heliostat Technology

**Lowest installed cost/m<sup>2</sup>**

**Mass production**

**Low environmental impact**

**New generation: wireless/autonomous**



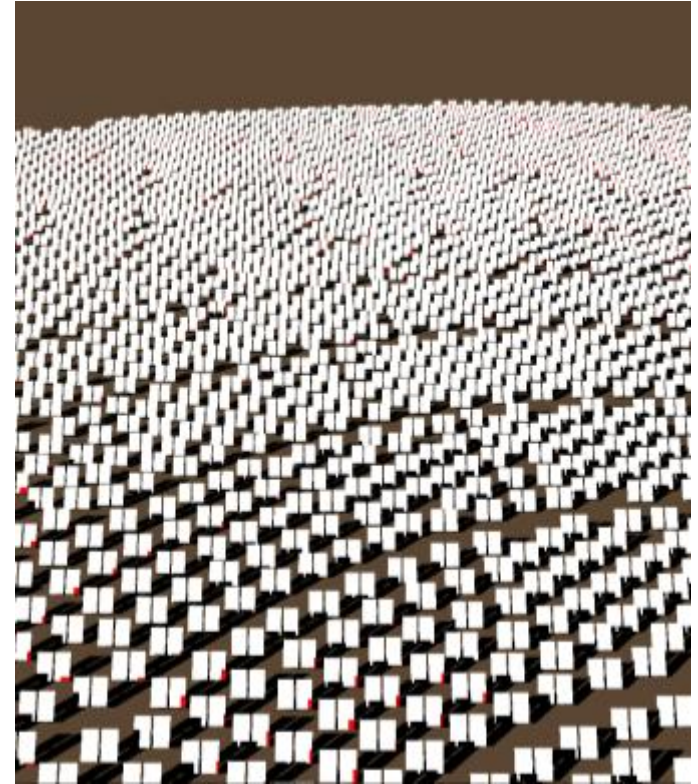
*Photo taken April 2013*



# Solar Field Layout Optimization

Algorithmic optimization to maximize annual output/revenue

- Receiver sees 'maximum glass, minimum dirt'
- optimized use of available land
- complete adaptation of technology to site constraints
- low environmental impacts



*Computer simulation*





# Solar Field Layout Optimization



*Photo taken October 2012*

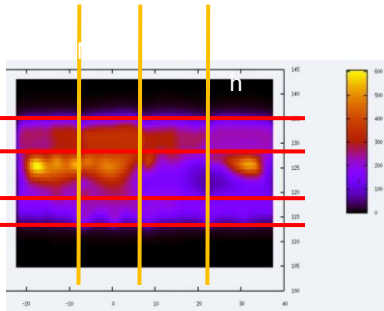




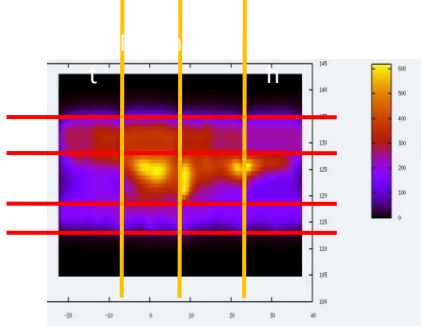
# Control Systems Based on Real-time Dynamic Optimization

## Solar Boiler Management System

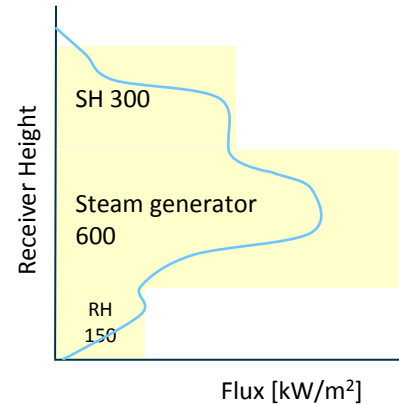
Morning (8:30)



Evening (16:00)



## Flux Limits



## Real-time Site Weather Data



- Visual and infrared cameras in the solar field monitor **SRS** status
- Cameras on the tower are used to calibrate **heliostat aiming accuracy**







## And what about storage and DSG

- No storage => best direct
- CSP storage advantageous
- Storage => best receiver with storage medium as HTF
- Direct 10 hours average sun + storage hours
- Ultimate – 400MW DSG tower + second tower with storage media







Thank you



*Photos on Slides 1-3, 5-6, 8-10 courtesy of Bechtel*