A Sea of Mirrors: An Overview on Ivanpah Solar Power Plant

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Solar Power:
- Photovoltaic (PV): DC
- Solar thermal: concentrating solar power (CSP) - AC
CSP Systems

**Single Mirror**
- Parabolic dish (PSA, Spain)

**Multiple Mirrors**
- Power tower (Ivanpah, USA)

**Linear Receiver**
- Parabolic trough (Torresol Energy, Spain)
- Fresnel linear mirror (Novatec Solar, Germany)
Ivanpah at A Glance

- **Location:** Ivanpah Dry Lake, CA
- **Size:** Approx. 3,500 acres (14.2 km²)
- **3** plants
- **173,500** computer-controlled heliostats
  - 2 mirrors on each heliostat
- **Cost:** $2.4 Billion
  - NRG Energy
  - BrightSource Energy
  - Google
- **Power Production:** 377 MW
- **Homes Served Annually:** 140,000 (California, USA)
Ivanpah Solar Thermal System

- Solar receiver/boiler
- Heliostats/mirrors
- Air-cooled condenser
- Turbine
Solar Receiver/Boiler

Steel hollow tubes with absorptive coating

High-pressure steam

Concentrated sunlight

Water

- 460 foot tall
- No thermal storage facility

Insulation material

3 infrared cameras monitoring temperature
173,500 heliostats track the sun in two dimensions.

Controlled by a central server

- Positions of all heliostats were measured by high-resolution GPS.
- Angle of each mirror is calculated, distributed, and adjusted by a motor on a 10s period.
- No sun-tracking sensors on the heliostats.

http://photo.sf.co.ua/id356
Heliostats/Mirrors

- Mirrors are slightly curved (no actuators)
  - Initially flat
  - Bended when assembled to the supporting frames.
  - Curvature controlled by the length of bolts.
  - Three different focal length
  - Cleaned twice a year.
Air-Cooled Condenser

An air-cooled condenser housing giant fans

- Dry-cooling system.
- The steam production cycle is a closed-loop system.
- 0.03 Gal/KWh
  - Nuclear: 0.72 Gal/KWh
  - Coal: 0.5 Gal/KWh

Top view of the condenser

http://photo.sf.co.ua/id356
http://www.freerepublic.com/focus/news/3122781/posts
Ivanpah Project Facts, BrightSource