Impacts of Utility-Scale Solar Energy Development on Visual Resources

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Objectives of this Session

- Why visual impacts of solar technologies are unique
- Common impacts
- Technology-specific impacts and examples
- Mitigation measures

What Makes the Visual Impacts of Solar Facilities Unique?

- Large “visual footprints”
- Open and flat landscape settings
- Strong regular geometry
- Highly reflective surfaces

Large Solar Projects Have Large Visual Footprints

- Large projects can exceed 7 mi^2
- Structure heights range from 5 ft. for PV systems to 650 ft.+ for power towers
- Solar thermal plants have power plant, cooling towers, plumes and water handling facilities
- All plants have control buildings, a substation and transmission lines, fences, and lights
- Solar is often co-located with gas or other power plants
- Non-PV systems have thousands of highly polished mirrors subject to glare
- Power tower receivers are brilliant light sources hundreds of feet in the air

Flat, Open Desert Landscapes Are Preferred for Utility-Scale Solar Development

- Low **visual absorption capability**
  - Most good solar areas have very low relief
  - Very little screening from vegetation
  - Visually simple, uncluttered, relatively natural-appearing landscapes
- Most solar areas are in valleys with visibility from nearby roads and mountains (elevated viewpoints)
- Very good air quality, long sight lines, and elevated viewpoints make for high visibility of solar facilities, day and sometimes night

Ground-Level vs. Elevated Viewpoints

- **Ground-level**
  - Low profile
  - Less surface area visible
  - Repeats horizon line

- **Elevated**
  - More surface area visible
  - Hard geometry more apparent
  - No repetition of natural line

View from Mountain Peak at 10 Miles

Strong, Regular Geometry and Highly Reflective Surfaces

Credit: BrightSource Energy

Common Impacts

- All facilities have:
  - Collector array
  - Grid connection
  - Roads
  - Structures
    - O&M buildings
    - Fences
- Thermal CSP has:
  - Steam plant
  - Cooling towers and plumes
  - Pipes
- PV has:
  - Power Conversion units (inverters)

Plume at 8 miles

Technology-Specific Impacts: Parabolic Trough

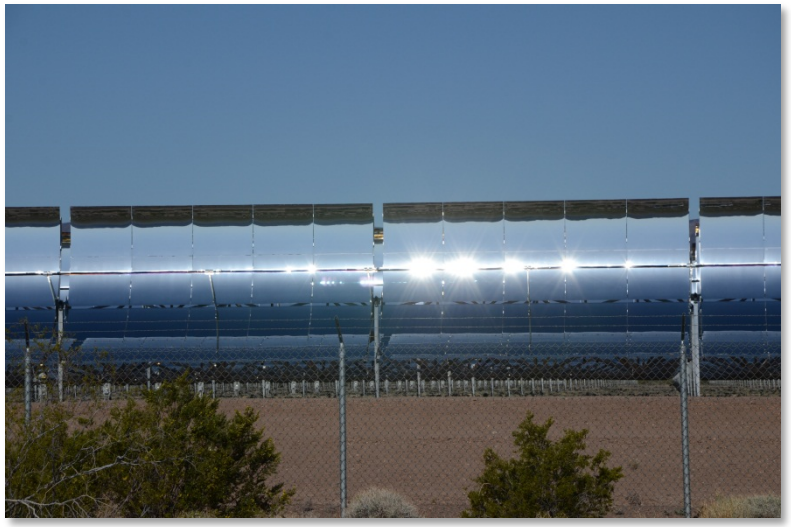
- Low profile, repeats horizon line when viewed at low angles
- Appearance can change dramatically with movement and over time
- Power plant, cooling tower, plumes, more water-related facilities
- Significant glare potential

Solar trough color and reflectivity varies widely throughout the day

Parabolic Trough Glare

Trough glare is an important aesthetic concern

- Not from mirrors; from absorber tube and/or associated components
- Can be intensely bright, impossible to look at in severe cases
- May be visible much of the day from some locations
- Moves as viewer moves
- Visible for at least four miles, could be much farther
- Potentially a real problem for trails and elevated viewpoints



SEGS III-VII Parabolic Trough at ~4 Miles, Elevated

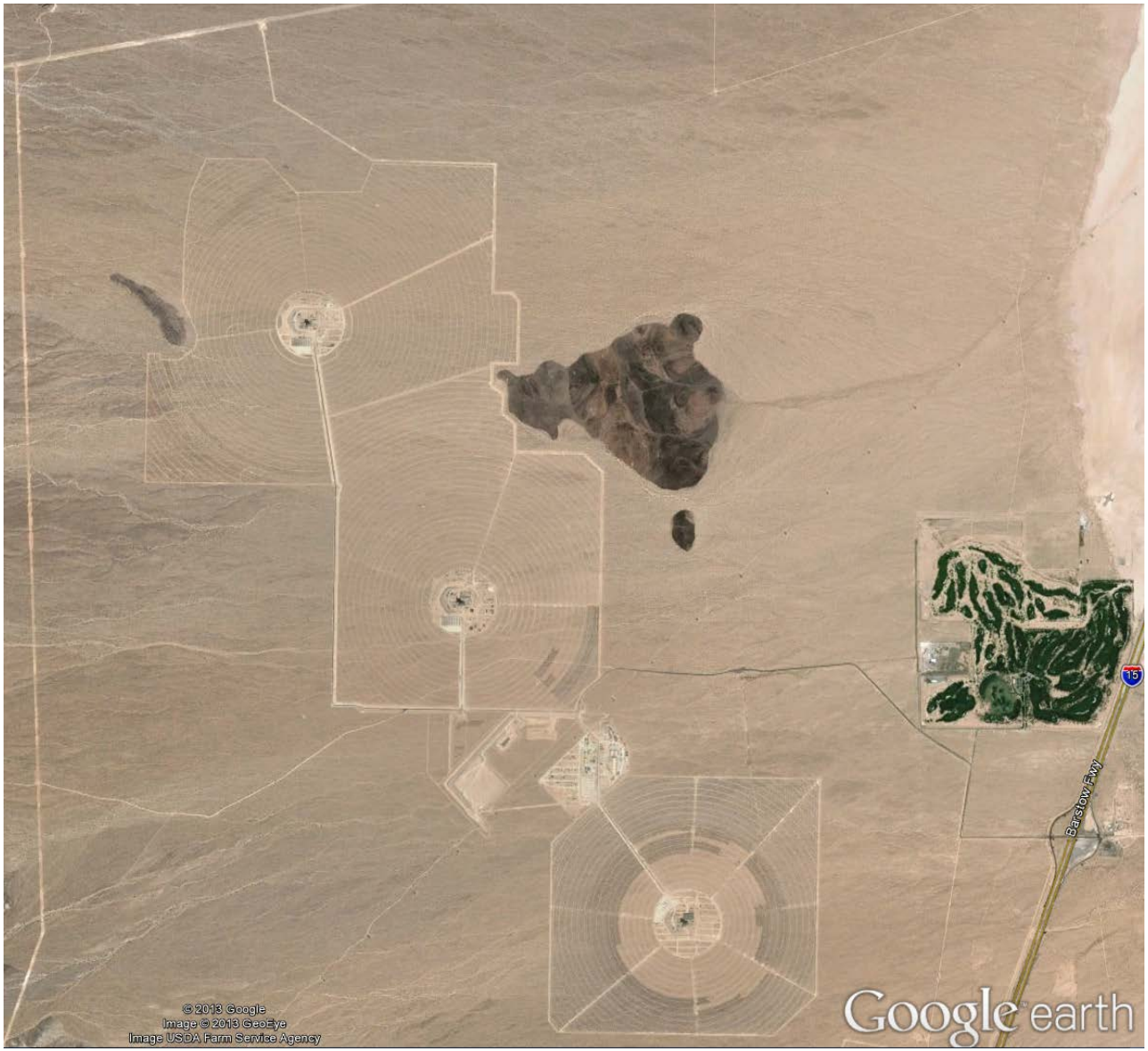
Nevada Solar One at 14 miles, Slightly Elevated

Power Tower

- By far, highest profile; 650 ft+
- May be multiple towers for one project
- Ivanpah EIS identified heliostat reflections as a major concern
- Some reflection potential, receiver “glow”
- Power plant, cooling tower, may have plumes, water-related facilities

Ivanpah Power Tower Facility Layout

- Project size: 3,600 acres (5.6 $mi^{2)}$
- 370 MW (nominal)
- 3 towers, 460 ft. tall
- Unlit tower visible beyond 35 mi
- 3 heliostat fields, each 1.67 mi^2
- 173,500 heliostats each about the size of a garage door
- Air cooled
- Left vegetation under heliostats



Ivanpah Tower 1 at 3.9 Miles

Power Tower Receiver "Glow"

- Special concern for power tower
- Reflected light from heliostats
- Some quotes:
  - "… it's painful to look at…" referring to Solucar
  - "I couldn't look at it." BLM staff member, referring to Solar One (Daggett)

  ...but these are for close-up views
- Large commercial towers much brighter and taller
- Power towers also subject to "dust glow"
- Little hard data, further research needed

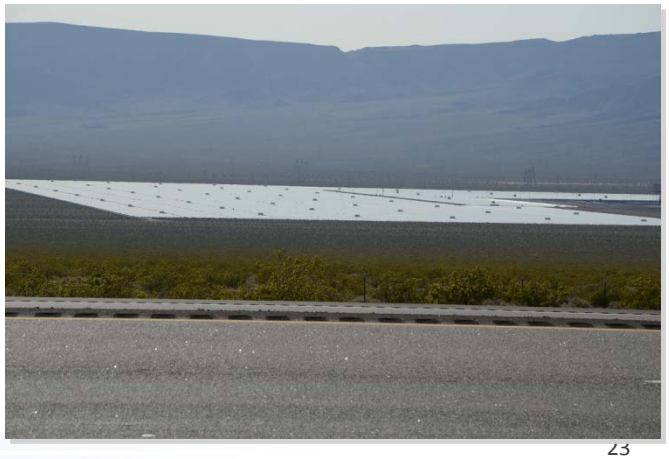
19.9 MW Torresol Gemasolar

Torresol Gemasolar at ~5 miles

Torresol Gemasolar at ~25 Miles

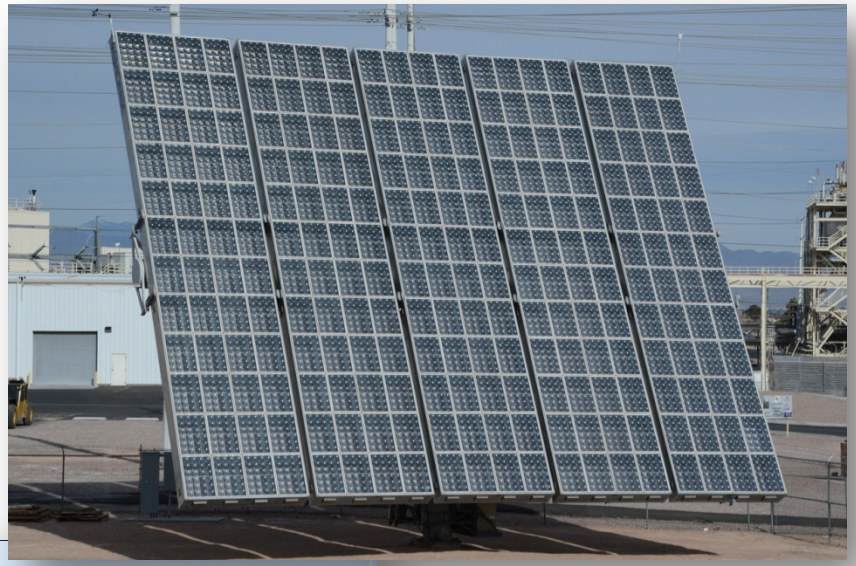
Photovoltaic

- Lowest profile, lowest reflection potential
- Several different technologies
- No power plant, cooling towers, or plumes, few lights, and low worker activity
- Panels still surprisingly reflective
- Can appear black, blue, gray, or white
- Facilities can be visible for long distances (20+ mi)
- Power conversion units can cause large contrasts as well



PV Technologies

Crystalline Silicon



Concentrating PV

Thin Film

Reflections from Panels at Silver State Thin-Film PV

Silver State Thin Film PV at 11 Miles

Visual Mitigation Measures for Solar

Effective mitigation a real challenge

- Consider visual concerns early in project planning
- Encourage low-profile technologies and components
- Locate as far from sensitive areas as possible
- Use non-reflective coatings
- Enforce strict lighting standards
- Use slight variations in topography to screen solar collectors
- Blend arrays with contours to harmonize where concealment is impossible
- Move mirrors, adjust mirrors, or screen to reduce glare

Mitigation: “Organic” shape avoids regular geometry – would be better with treated road surface.

Mitigation: Color-Treated Trough Mirror Backs

Mitigation: Painting Power Conversion Units (Shadow Gray)

Research and Related Activities

- Conducted field-based investigation of visual characteristics of solar facilities for NPS
- Funded to assist NPS to identify visual impact risks on lands near selected NPS units
- Funded to characterize impacts and develop mitigation measures for solar facilities (DOE)
- Developing visual impact BMP handbook for renewable energy for BLM – available Spring 2013

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