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reshaping solar energy

NREL

PV Reliability Workshop

February 18, 2010

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Problem Statement:

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World annual energy consumption (2008):
474 exajoules (10^{18})(i.e.:15 terawatts (10^{12}) x 1 year)

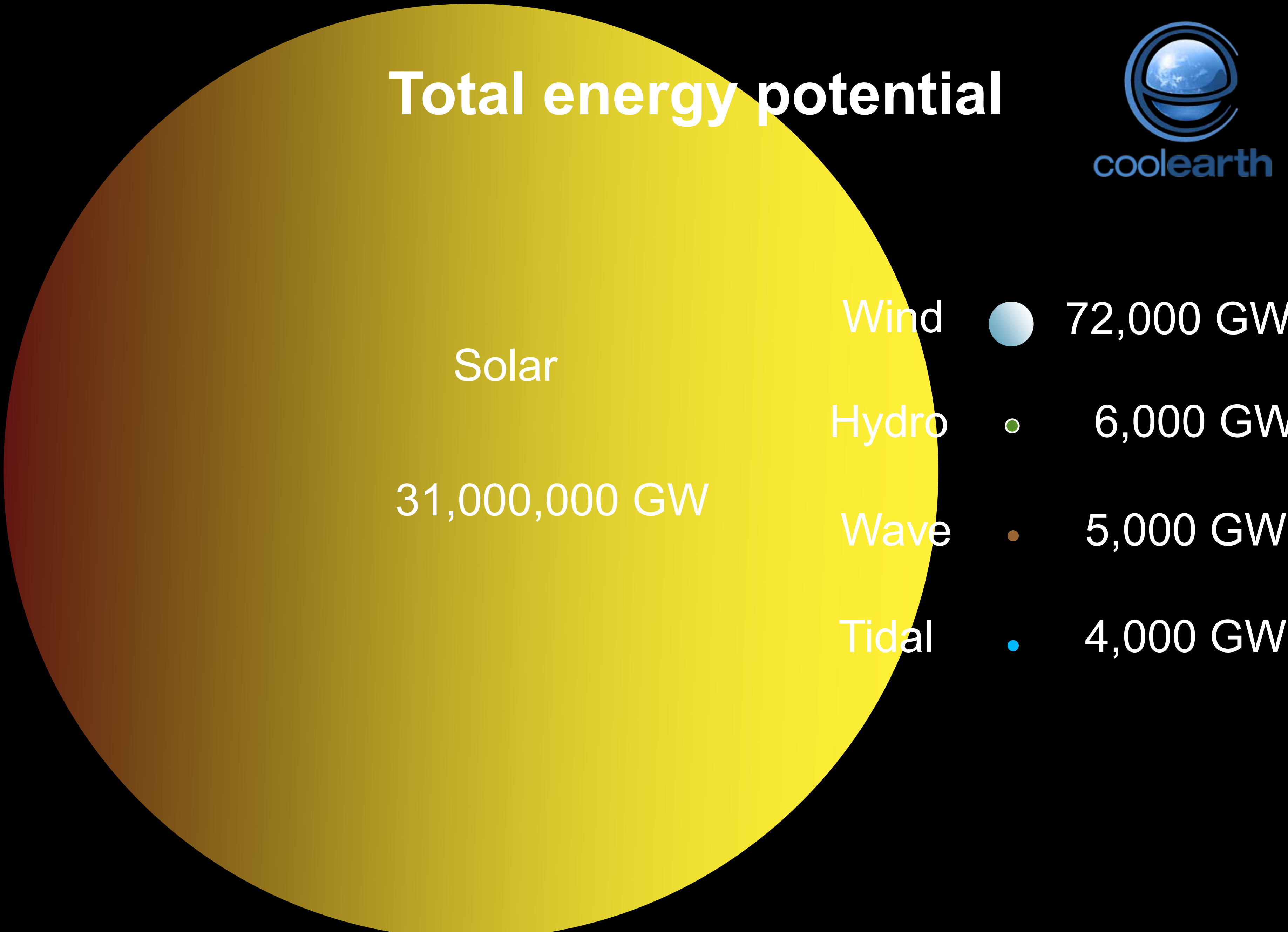
U.S. annual power consumption (2008):
105 exajoules (3.3 TW x 1 year)

>90% from fossil fuels

Projected world annual power consumption by 2030:
1 zettajoule (10^{21} joules)
1,000,000,000,000,000,000,000 JOULES

Replace carbon based energy with clean renewable energy

Total energy potential



Information courtesy of Dr. Mark Jacobson, Stanford University

Area needed to meet US 2030 demand:

The Problem

What material is abundant enough to cover the surface area needed to supply all U.S. electricity?

Materials solution: Plastic

- Massively abundant - scales to 100%
- Inexpensive
- Easy to handle and ship

Scalable

Enough film produced globally each year to roll out to the Moon and back 28 times

We lower costs and get to scale by minimizing materials

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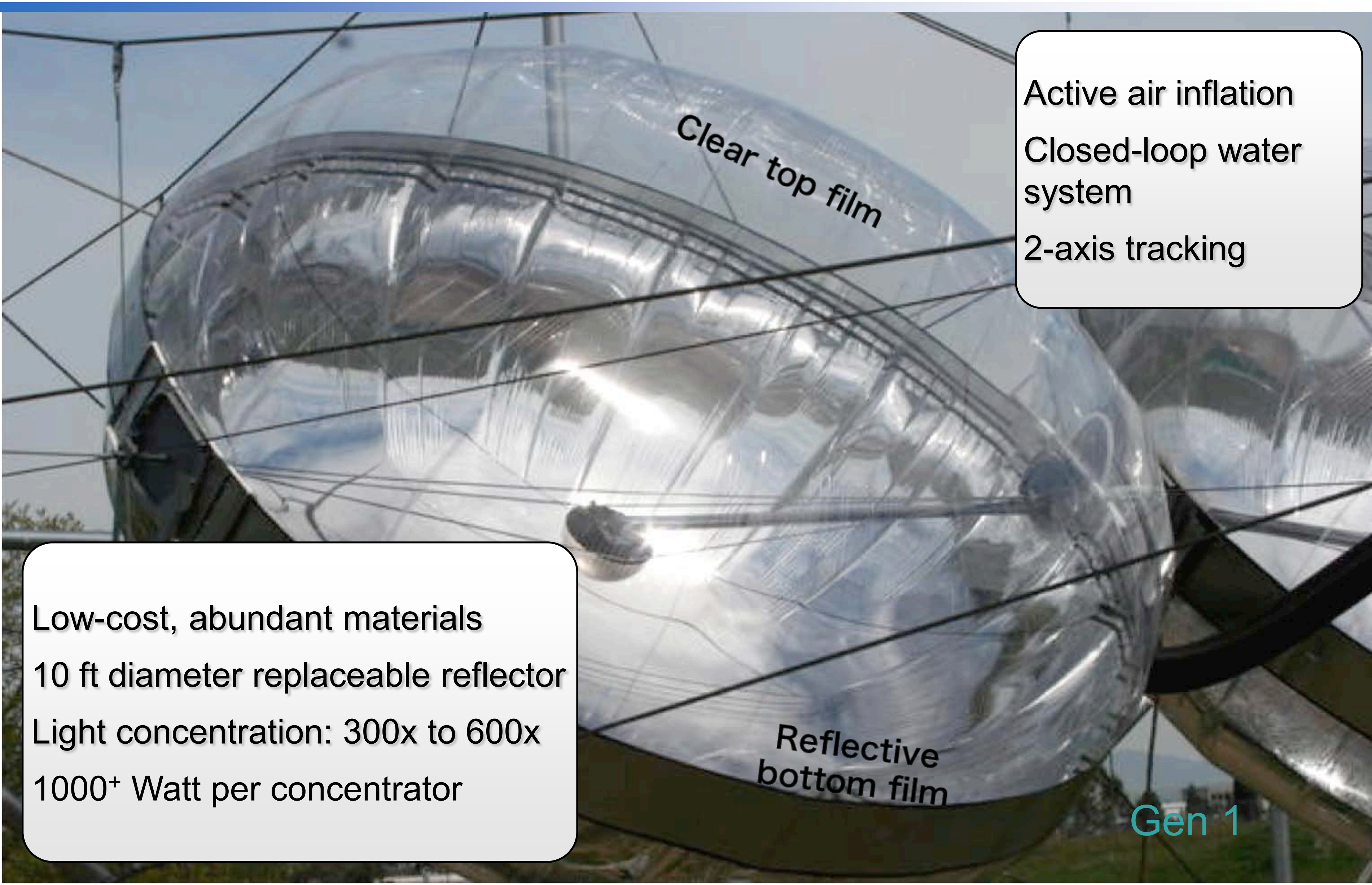

Active air inflation

Closed-loop water system

2-axis tracking

Low-cost, abundant materials

10 ft diameter replaceable reflector

Light concentration: 300x to 600x

1000+ Watt per concentrator

We will own and manage our own solar power plants

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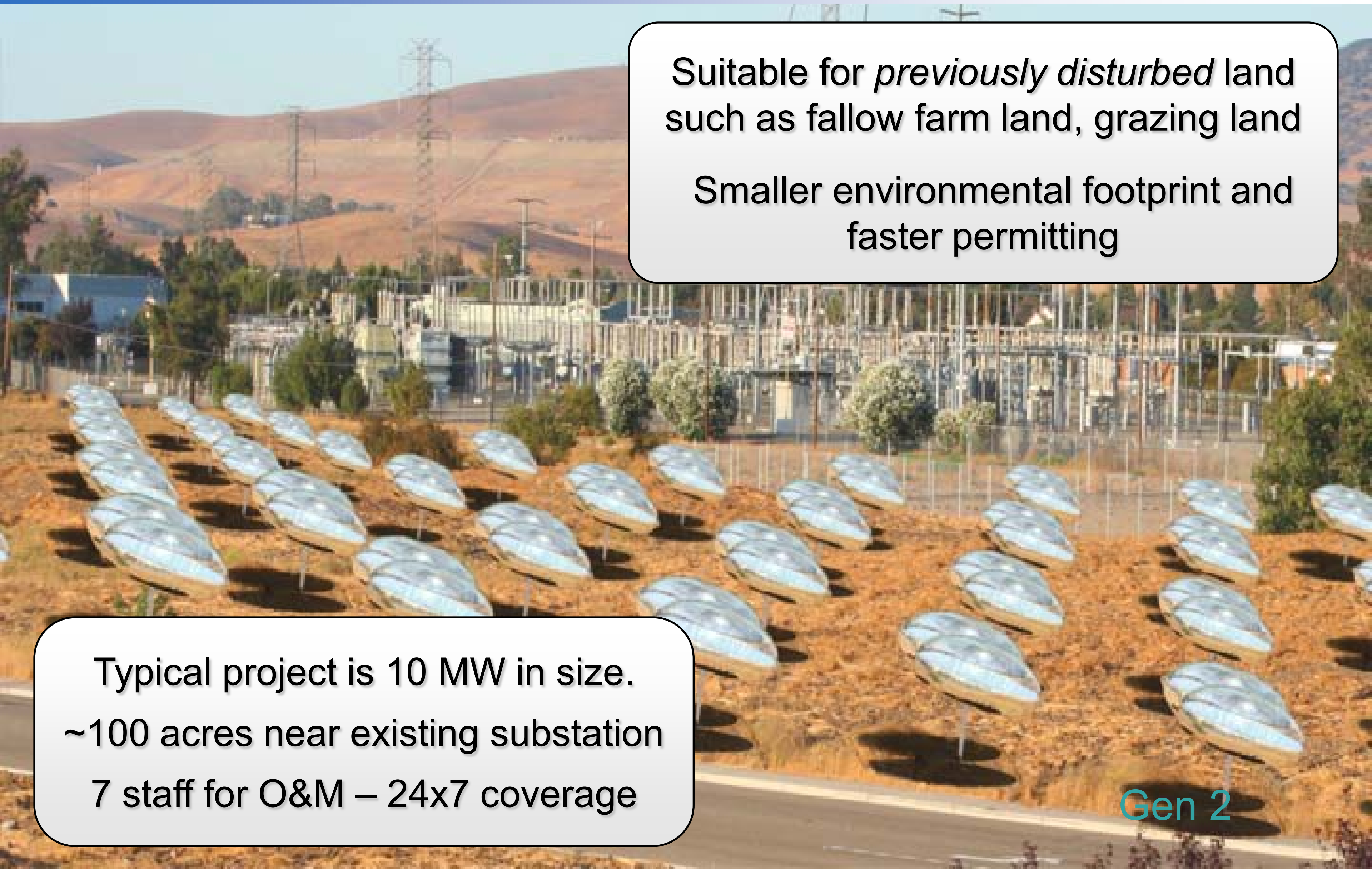


Suitable for *previously disturbed* land such as fallow farm land, grazing land

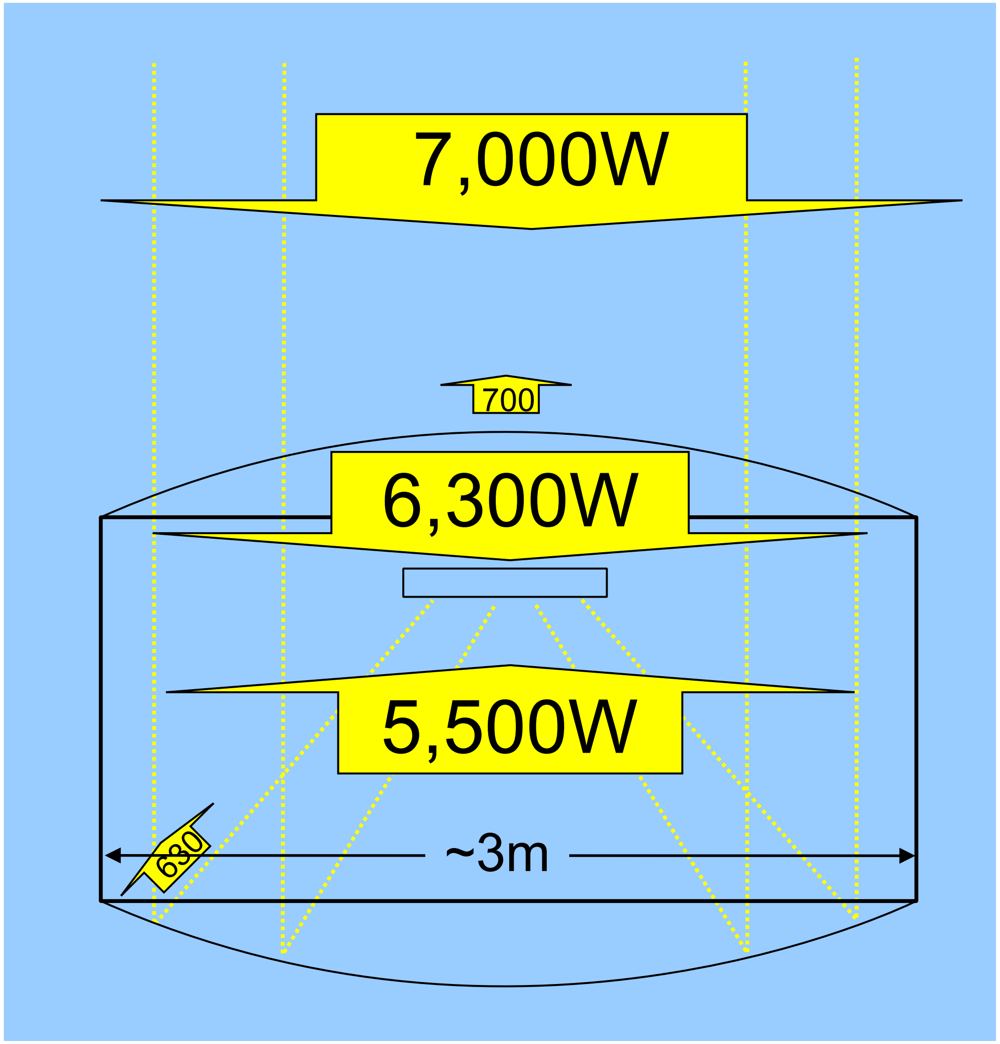
Smaller environmental footprint and faster permitting

Typical project is 10 MW in size.

~100 acres near existing substation

7 staff for O&M – 24x7 coverage

Technology Summary



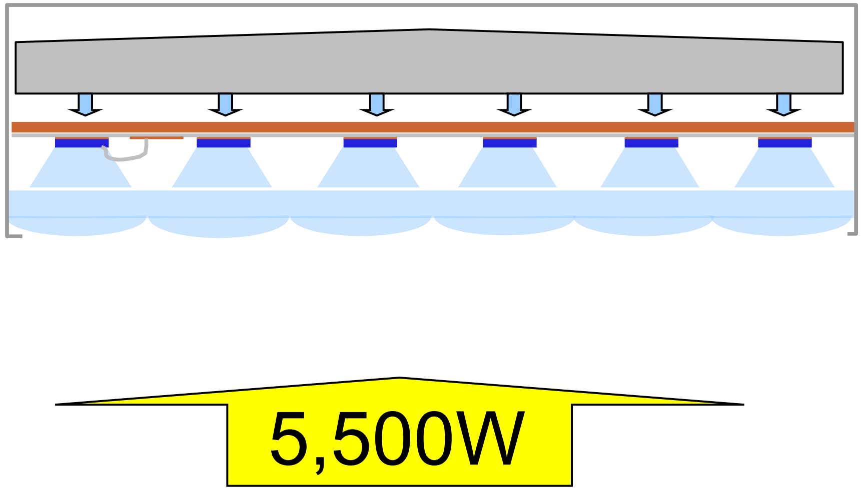
1,000 W/m^2
x 7 m^2

Fresnel and adsorption losses: front film (clear)

Scatter & adsorption losses: rear film (Al coated)

Technology Summary

Monolithic water-cooled receiver module

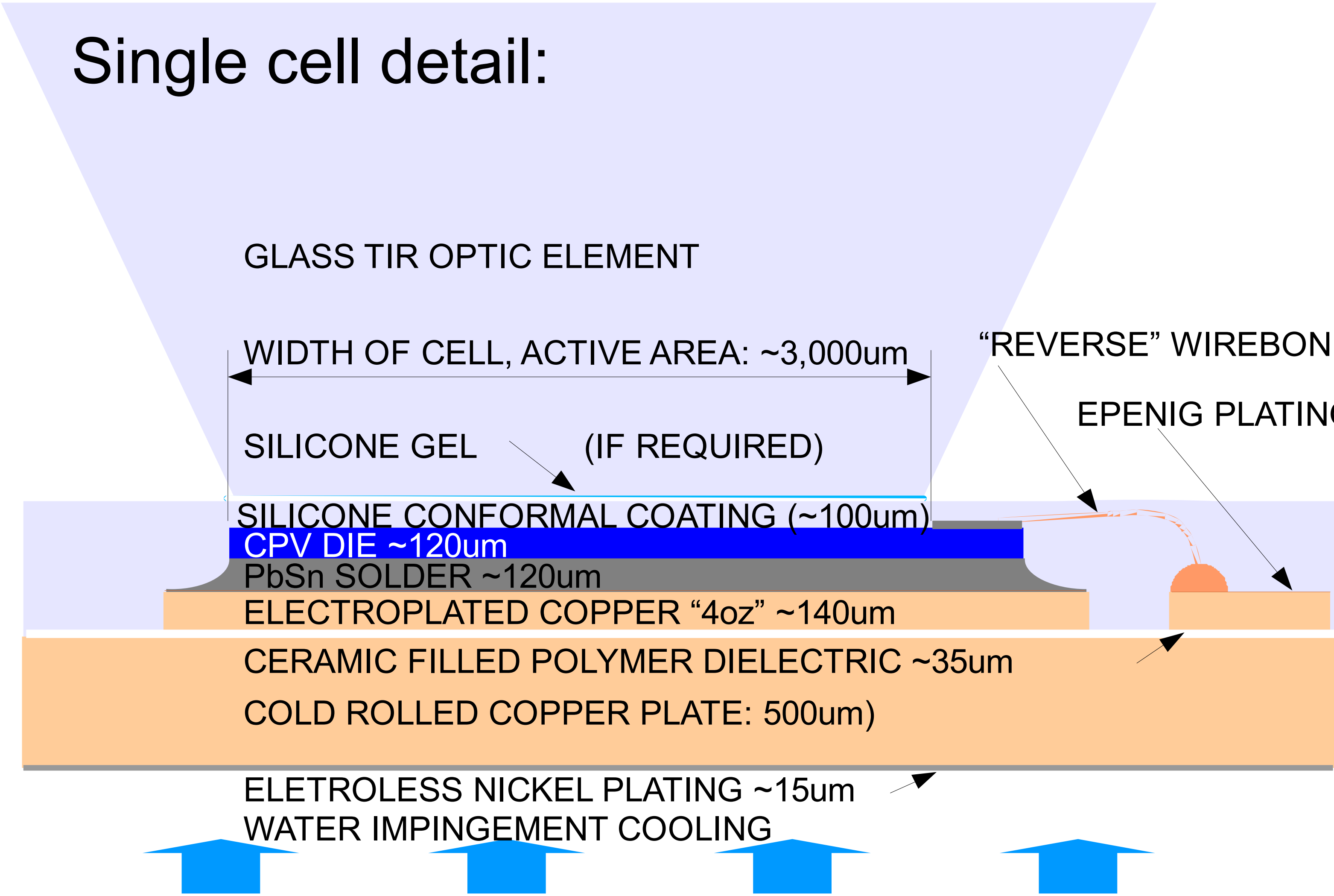


Average irradiance on receiver: $68kW/m^2$

Average irradiance per cell: $350kW/m^2$

Technology Summary

Single cell detail:



Technology Challenges

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Front film degradation in UV:
~1.5 suns max (direct + backscattered)
Incorporate commercial UV inhibitors
Transmit <10% of UV
Require ~12 month lifetime
Well understood problem with commercial solutions

Rear film degradation:
~1 sun visible & ~0.1 sun UV
Protected by >99% opaque aluminum
Require ~12 month lifetime

Technology Challenges

Secondary optic degradation:
~100 suns IR & visible
~10 suns UV exposure
Dry and clean environment (inside balloon)
Requires 25 year lifetime.
Some solarization may occur
(greater attenuation of UVA)
Low risk item

Technology Challenges

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Silicone based optical coupling agents:
Up to 500 suns visible exposure
Up to 50 suns UVA exposure
UVB and UVC attenuated by glass
Requires 25 year lifetime:
- Clarity
- Resilience
- Glass optical contact

Data exists for PV, less for CPV
Must accommodate CTE mismatch between glass lens array and CPV cell array
High risk item

Technology Challenges

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Die attachment to substrate:
Silver-filled epoxy or soft (PbSn) solder
Prefer soft solder
Must isolate CPV die from strain due to CTE mismatch between die and substrate
Must maintain electrical and thermal contact.
Requires 25 year lifetime
High risk item
Some helpful background in both aerospace and automotive industries


Thank you
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