

Photovoltaics II

Conversion of light to electricity

Energy 2013
ITP / NYU / Feddersen

Previously

For later:

Balance of system

Tracking methods

Concentrating systems

Solar lighting

Solar thermal

also:

Kardashev scale

Space based solar power

Dyson swarms

Balance of system

Tracking methods

Concentrating systems

Solar lighting

Solar thermal

also:

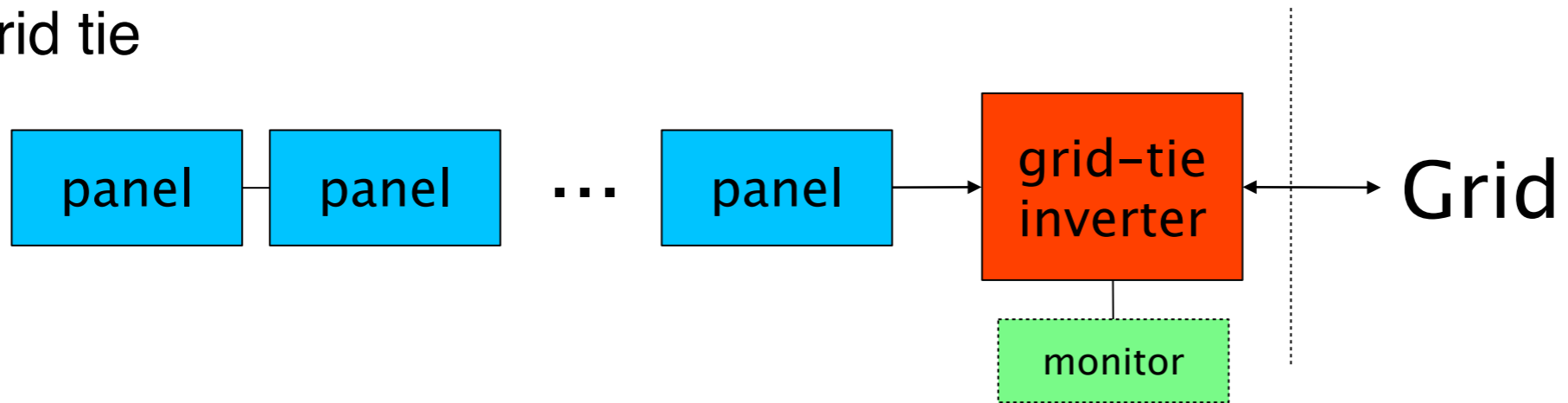
Kardashev scale

Space based solar power

Dyson swarms

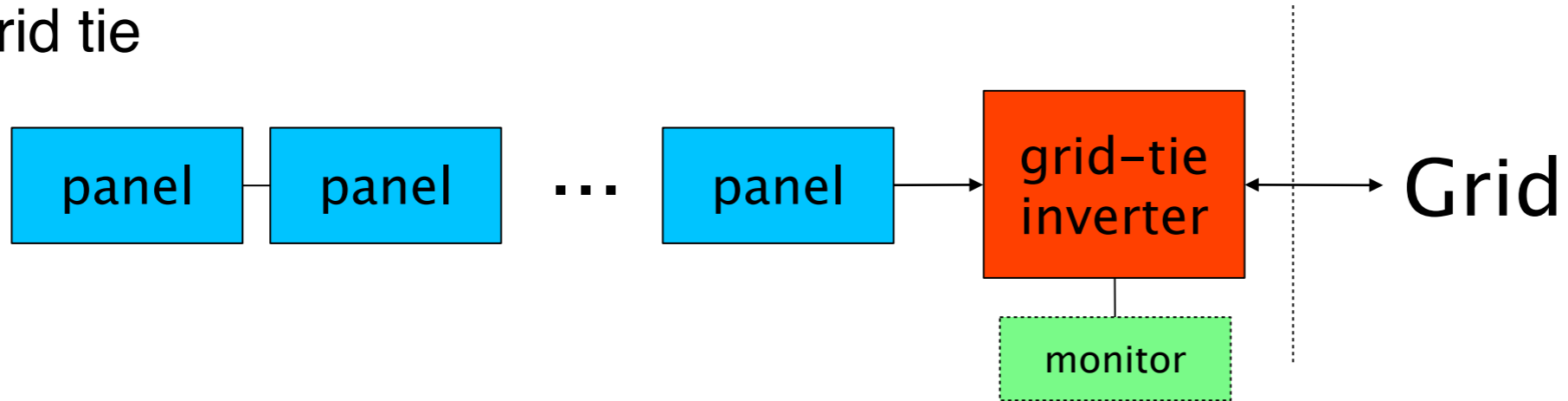
Balance of system:
grid tie

grid tie

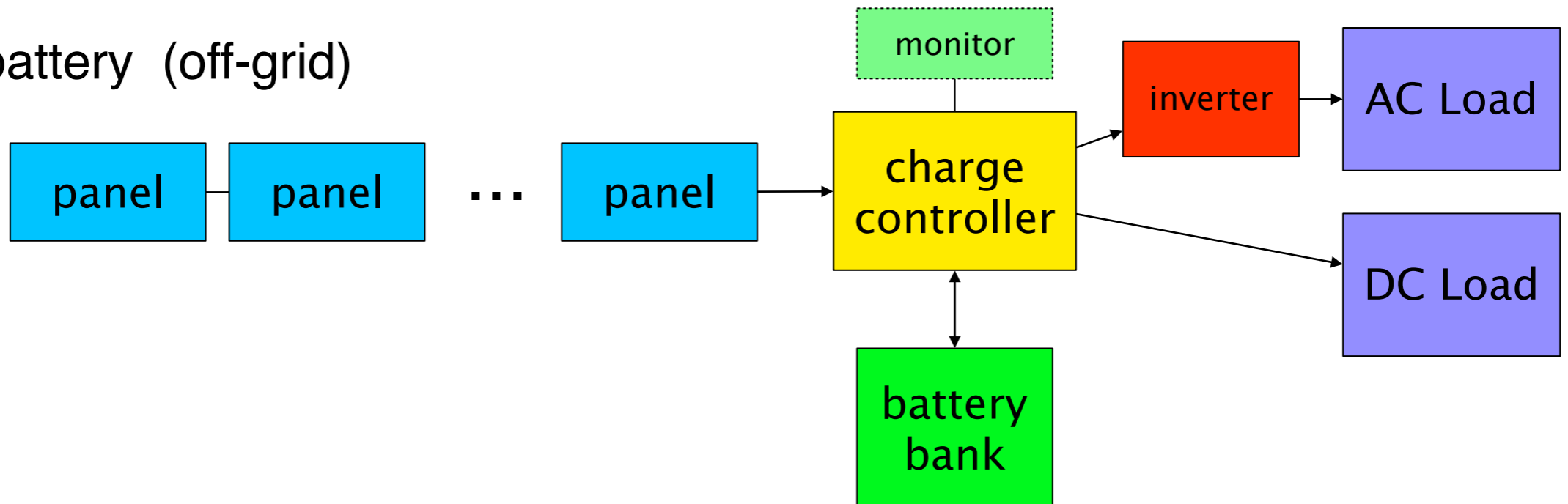


Balance of system: grid tie vs. battery

grid tie



battery (off-grid)



Balance of system:
grid-tie inverter



Inverters at "Riverhouse"
Battery Park City



charge controller

battery

inverter

AC load

Balance of system:
battery system



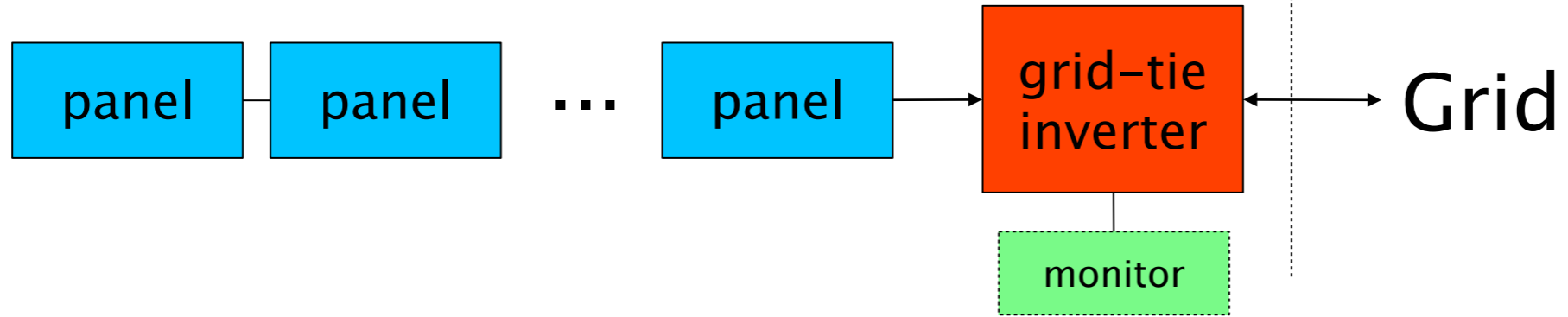
inverter
AC load

battery

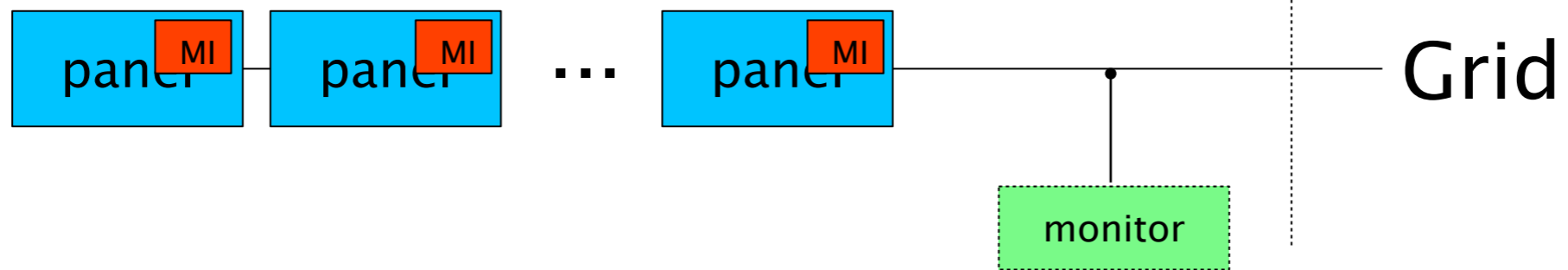
Balance of system:
battery system

Balance of system: grid tie (traditional) vs. micro inverter

grid tie



micro inverter



Balance of system:
micro inverter



Balance of system:
micro inverter



Balance of system:
micro inverter

40 MW goal

PSE&G Installed Solar Projects	Location	Size MW-dc	Service Date
Pole-attached solar units	Statewide	26.92	as of February 1, 2012
PSE&G Trenton Solar Farm	Trenton, NJ	1.26	September, 2010
Barringer High School	Newark, NJ	0.65	October, 2010
Central High School	Newark, NJ	0.50	October, 2010
Park Avenue Elementary School	Newark, NJ	0.51	October, 2010
PSE&G Silver Lake Solar Farm	Edison, NJ	2.02	November, 2010
Camden St. Schools	Newark, NJ	0.91	December, 2010
PSE&G Edison Training & Development	Edison, NJ	0.71	December, 2010
CenterPoint Properties	Bayonne, NJ	1.75	December, 2010
PSE&G Linden Solar Farm	Linden, NJ	3.20	December, 2010
PSE&G Central Division Headquarters	Somerset, NJ	0.92	December, 2010
PSE&G Yardville Solar Farm	Hamilton TWP, NJ	4.30	February, 2011
Matrix Realty Building A	Perth Amboy, NJ	1.69	February, 2011
Matrix Realty Building B	Perth Amboy, NJ	1.17	February, 2011
Matrix Realty	South Brunswick, NJ	2.98	June, 2011
Rider University	Lawrenceville, NJ	0.74	October, 2011
Mills Creek	Burlington TWP, NJ	3.82	November, 2011
Kearny Landfill Solar	Kearny, NJ	3.00	December, 2011
Thorofare Solar Farm	West Depford, NJ	0.72	December, 2011
Summit Associates	Edison, NJ	2.22	December, 2011
TOTAL PSE&G		59.99 MW-dc	
GRAND TOTAL Installed		86.60 MW-dc	



Balance of system:
micro inverter

40 MW goal, currently 36.5MW

PSE&G Installed Solar Projects	Location	Size MW-dc	Service Date
Pole-attached solar units	Statewide	26.92	as of February 1, 2012
PSE&G Trenton Solar Farm	Trenton, NJ	1.26	September, 2010
Barringer High School	Newark, NJ	0.65	October, 2010
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TOTAL PSE&G		59.99 MW-dc	
GRAND TOTAL Installed		86.60 MW-dc	

PSE&G Installed Solar Projects	Location	Size MW-dc	Service Date
Pole-attached solar units	Statewide	36.50	as of March 2013
PSE&G Trenton Solar Farm	Trenton, NJ	1.26	September, 2010
Barringer High School	Newark, NJ	0.65	October, 2010
Central High School	Newark, NJ	0.50	October, 2010
Park Avenue Elementary School	Newark, NJ	0.51	October, 2010
Silver Lake Solar Farm	Edison, NJ	2.02	November, 2010
Camden St. Schools	Newark, NJ	0.91	December, 2010
PSE&G Edison Training & Development	Edison, NJ	0.71	December, 2010
Center Point Properties	Bayonne, NJ	1.75	December, 2010
PSE&G Linden Solar Farm	Linden, NJ	3.20	December, 2010
PSE&G Central Division Headquarters	Somerset, NJ	0.92	December, 2010
PSE&G Yardville Solar Farm	Hamilton TWP, NJ	4.30	February, 2011
Matrix Realty Building A	Perth Amboy, NJ	1.69	February, 2011
Matrix Realty Building B	Perth Amboy, NJ	1.17	February, 2011
Matrix Realty	South Brunswick, NJ	2.98	June, 2011
Rider University	Lawrenceville, NJ	0.74	October, 2011
Mills Creek	Burlington TWP, NJ	3.82	November, 2011
Kearny Landfill Solar	Kearny, NJ	3.00	December, 2011
Thorofare Solar Farm	West Depford, NJ	0.72	December, 2011
Summit Associates	Edison, NJ	2.22	December, 2011
Black Rock/Matrix Realty	South Brunswick	2.97	March, 2012
PSE&G Metro Division Headquarters	Clifton, NJ	0.73	July 1, 2012
Community Food Bank of NJ	Hillside, NJ	1.07	August 2012
Hackensack Solar Farm	Hackensack, NJ	1.06	Winter 2012
TOTAL PSE&G		75.40 MW-dc	

Balance of system:
micro inverter

NJ total installed PV capacity surpassed 1GW in February 2013

<http://www.nj.gov/bpu/pdf/announcements/2013/20130319.pdf>

Text



Balance of system

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Solar thermal

also:

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Dyson swarms

Tracking



single axis
(elevation)

Tracking



~10kW

single axis
(azimuth)



Tracking

dual axis

~10kW

Tracking

dual axis

elevation axis

azimuth axis

~10kW



Tracking

dual axis - mixed
“Riverhouse” BPC

elevation
south side

azimuth
east and west sides

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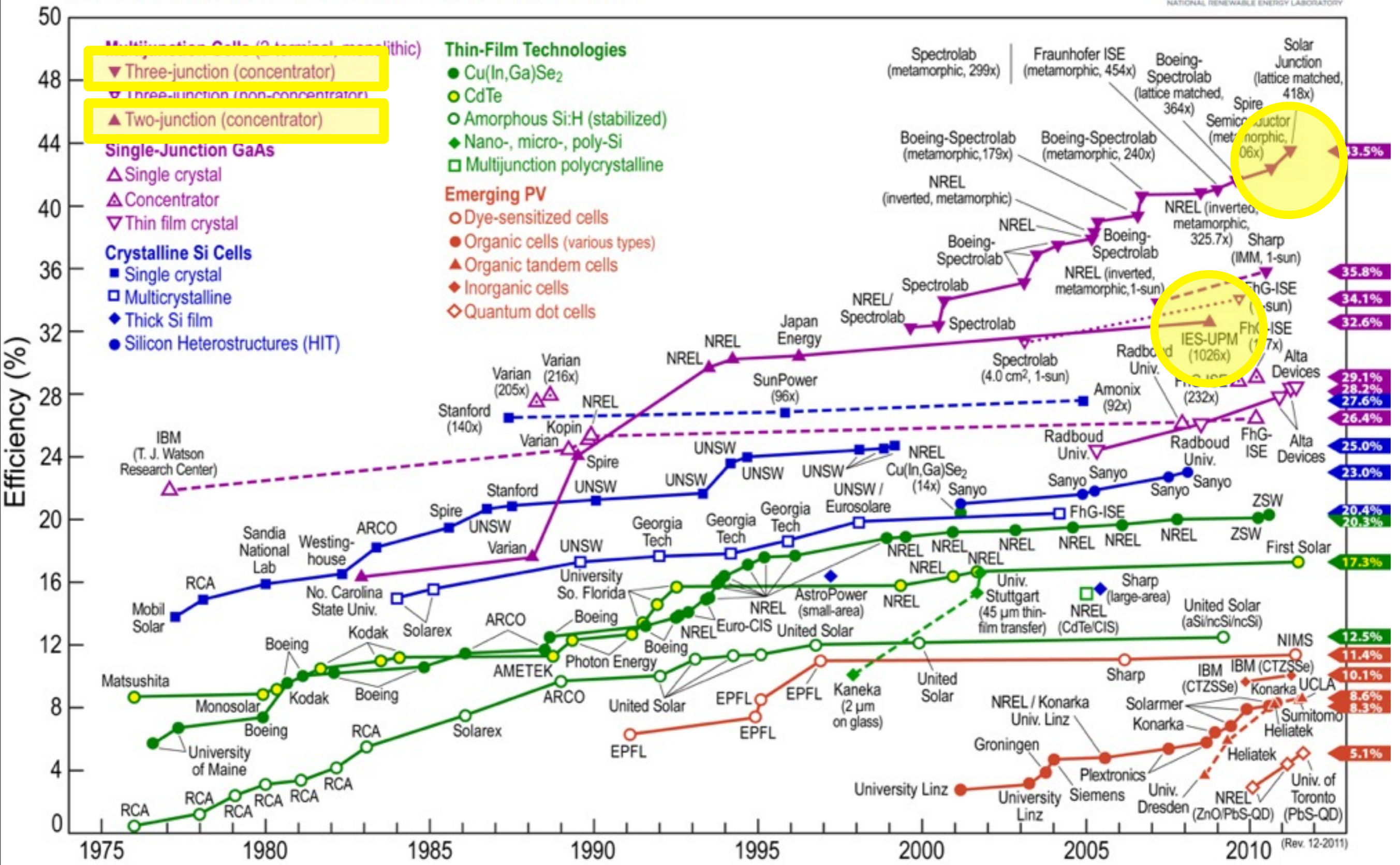
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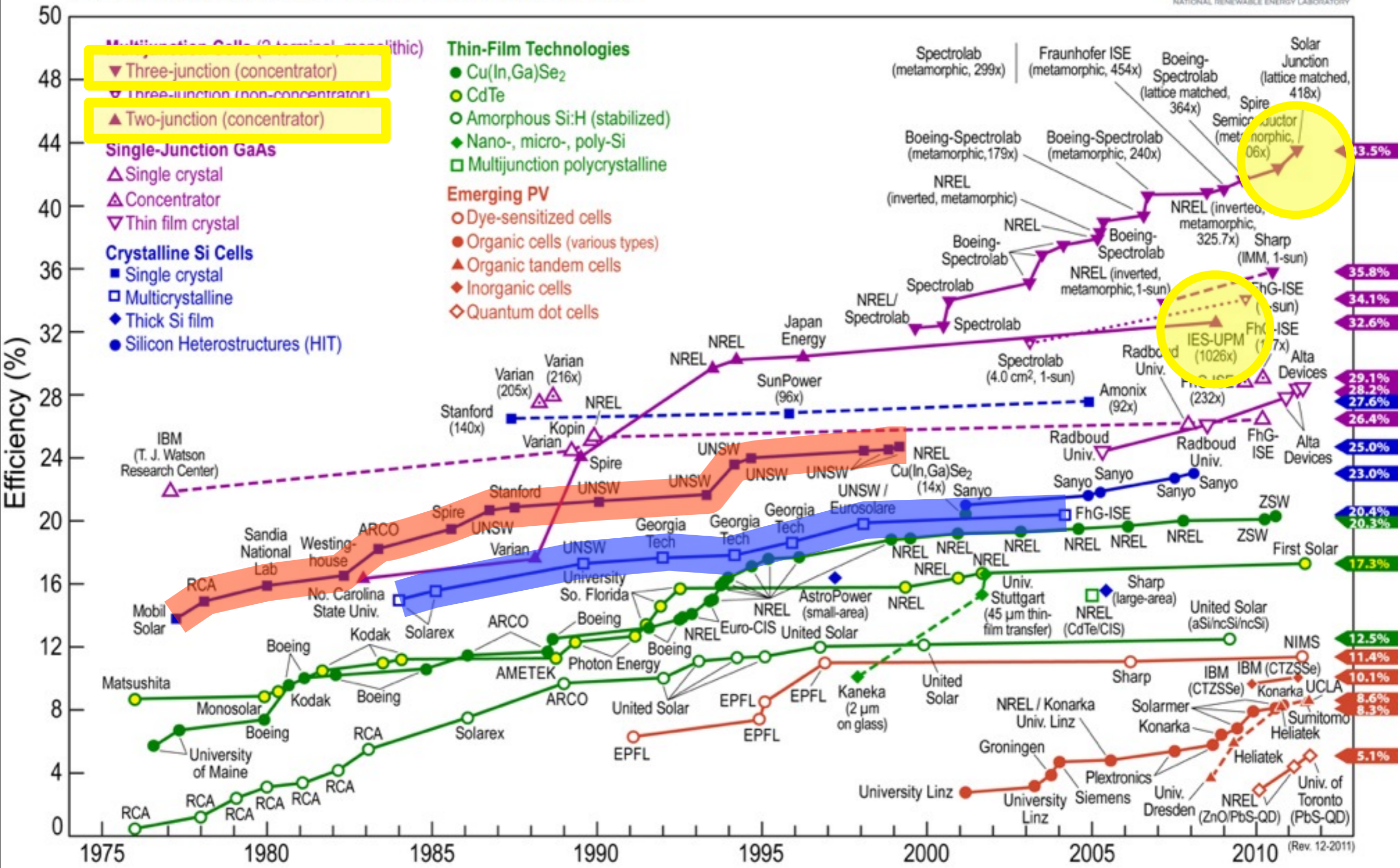
Best Research-Cell Efficiencies



Source: DOE NREL

Differences

Best Research-Cell Efficiencies



Source: DOE NREL

Differences

Concentrating
mirrors

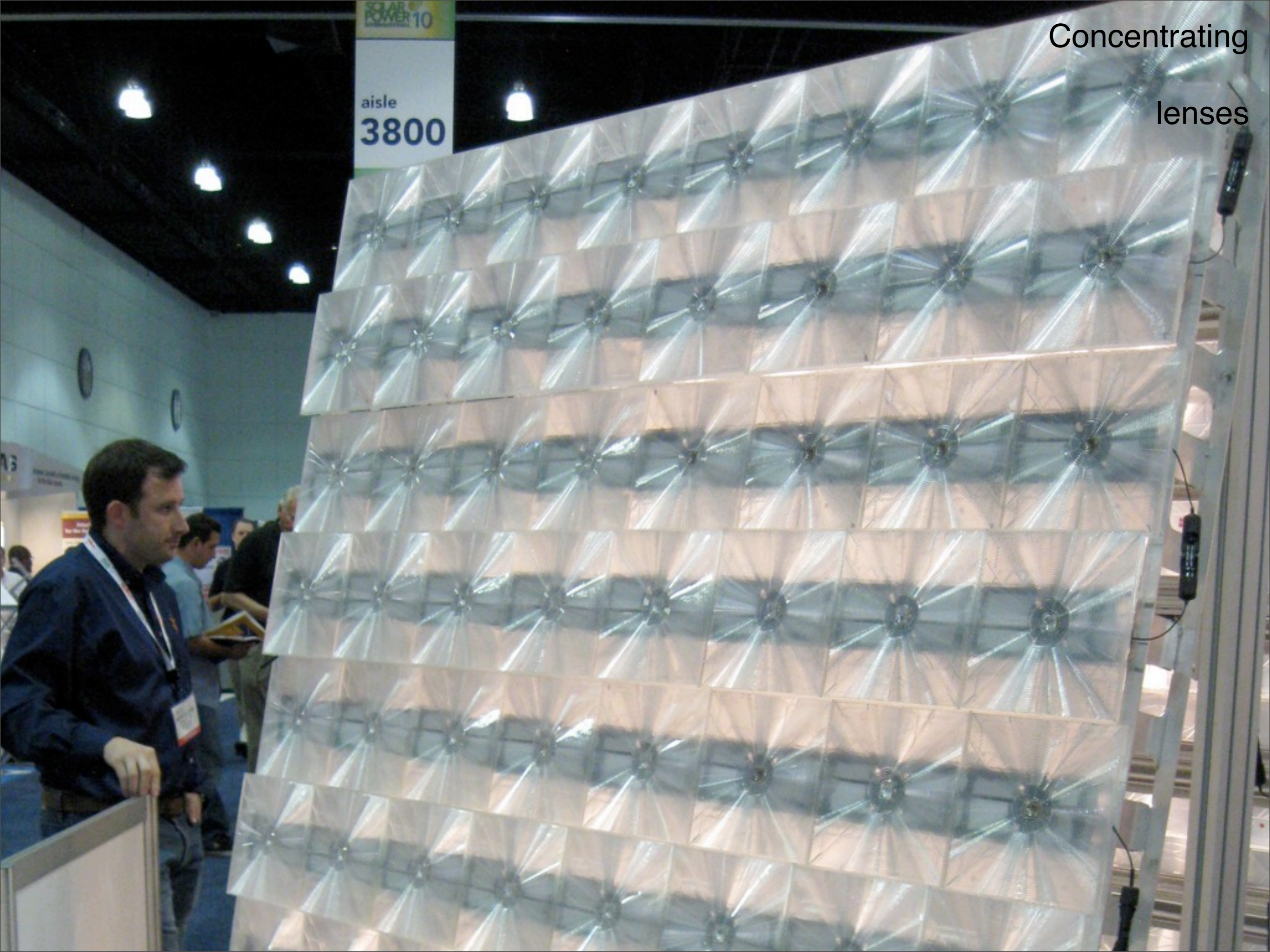


Concentrating cheap mirrors



Concentrating
lenses

SOLAR
POWER 10
aisle
3800



Concentrating
(sort of...)

Solyndra



☀ **Diffused Sunlight**
Enhanced collection from all angles

☀ **Direct Sunlight**
Same cross-section at all angles

☀ **Reflected Light**
From the roof surface

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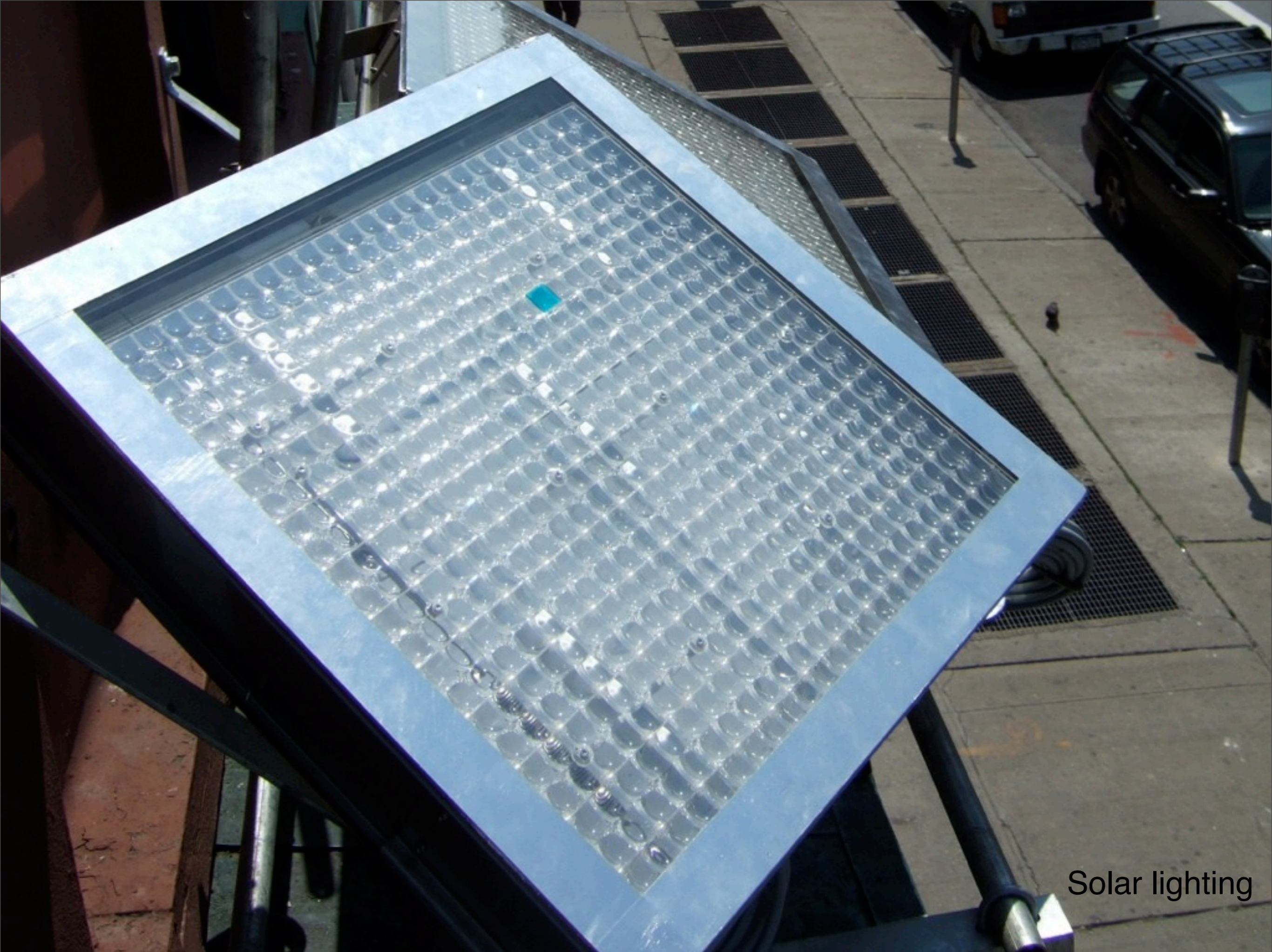
Solar thermal

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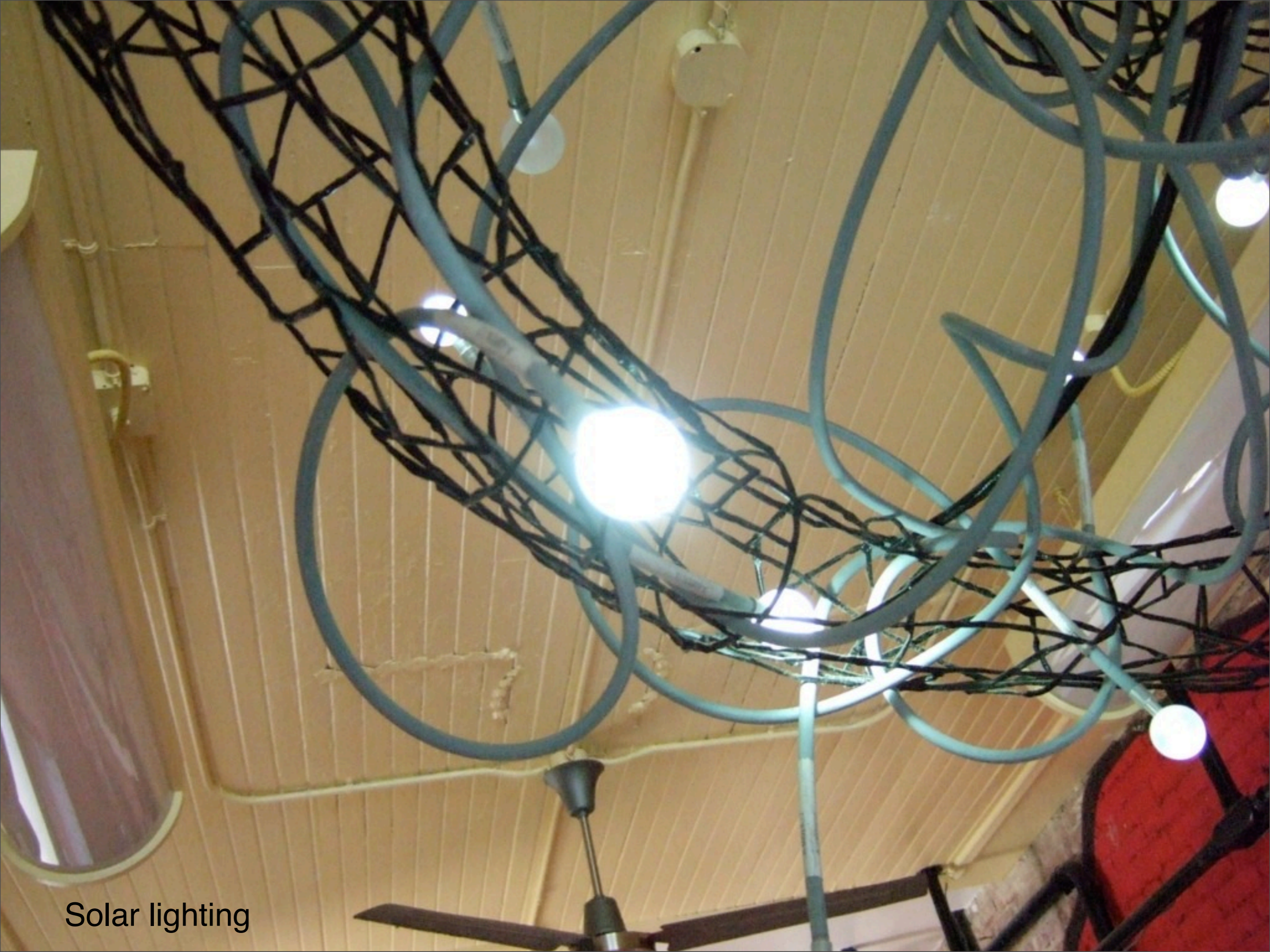
Dyson swarms



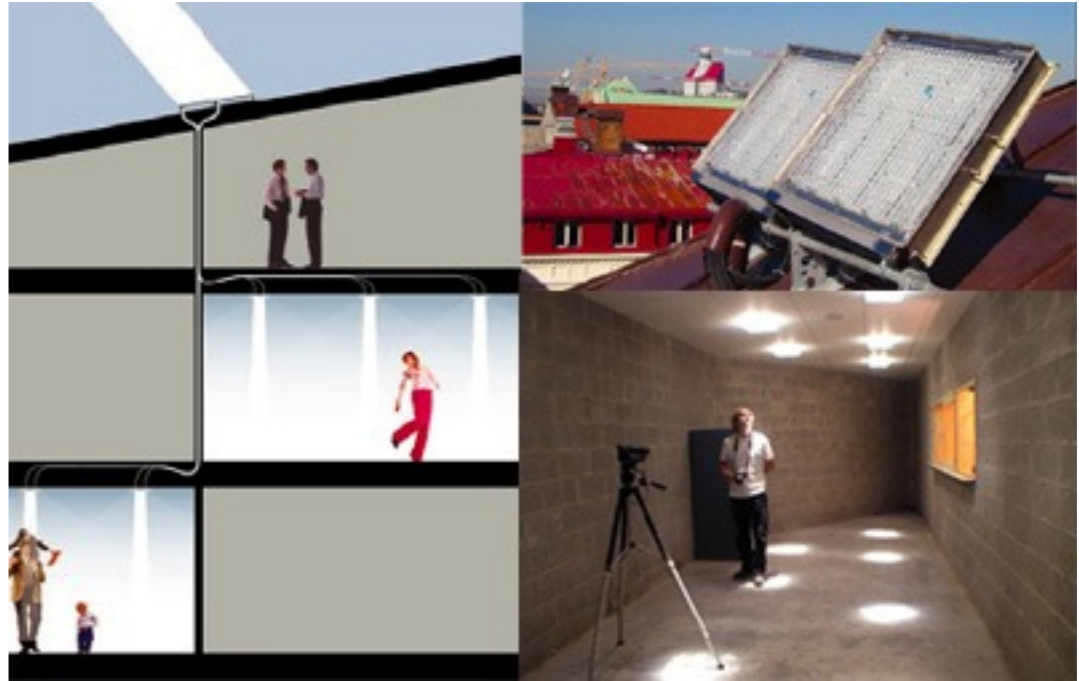
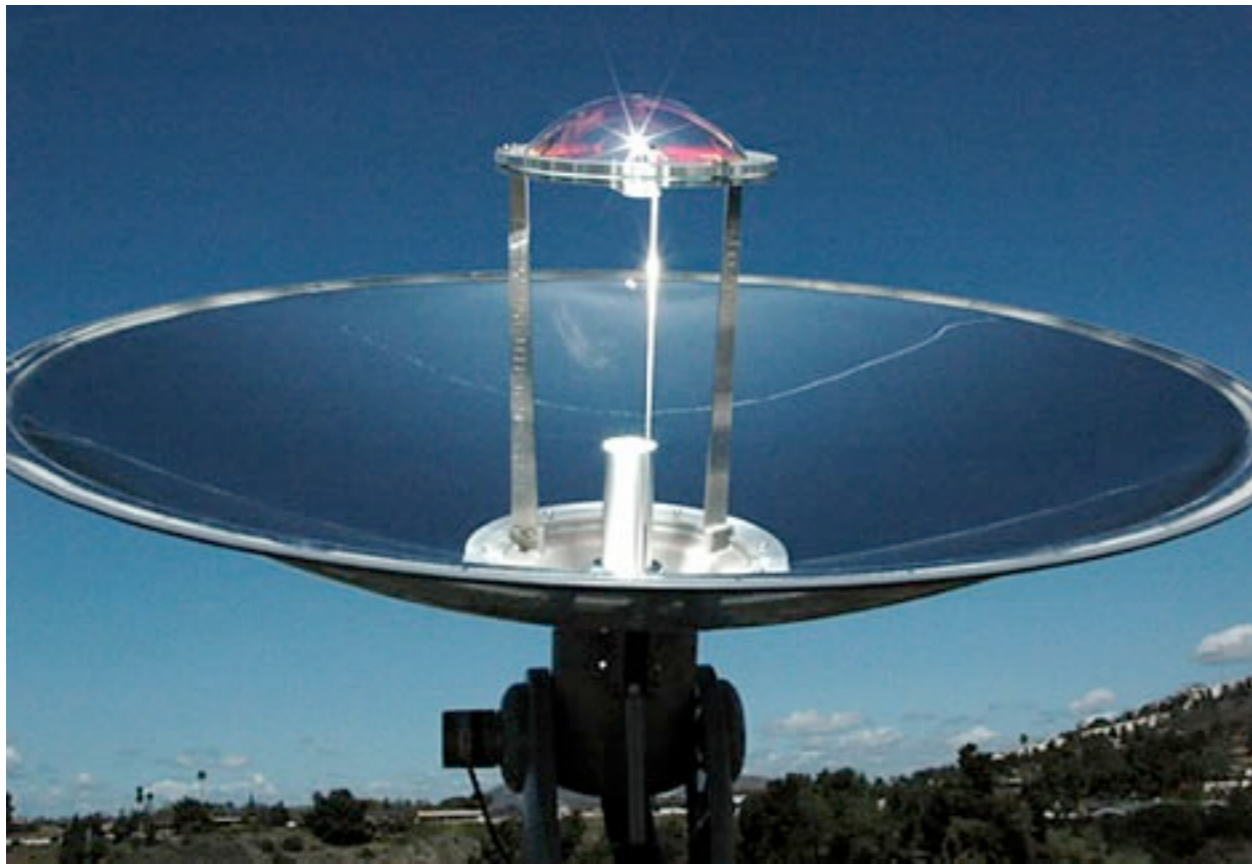
Solar lighting



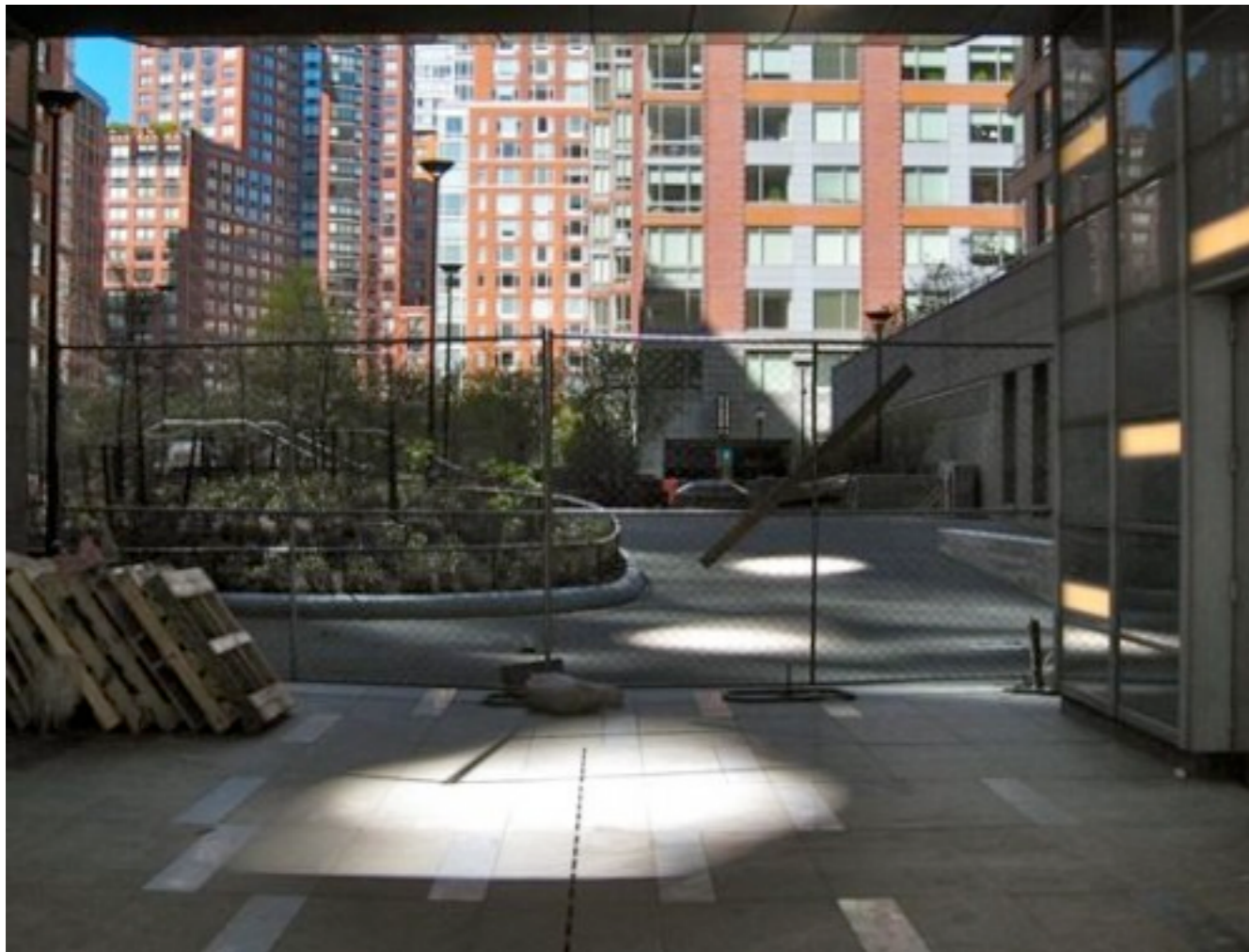
Solar lighting



Solar lighting



Solar lighting



Solar lighting: Teardrop park heliostats
Carpenter Norris Consulting Inc.



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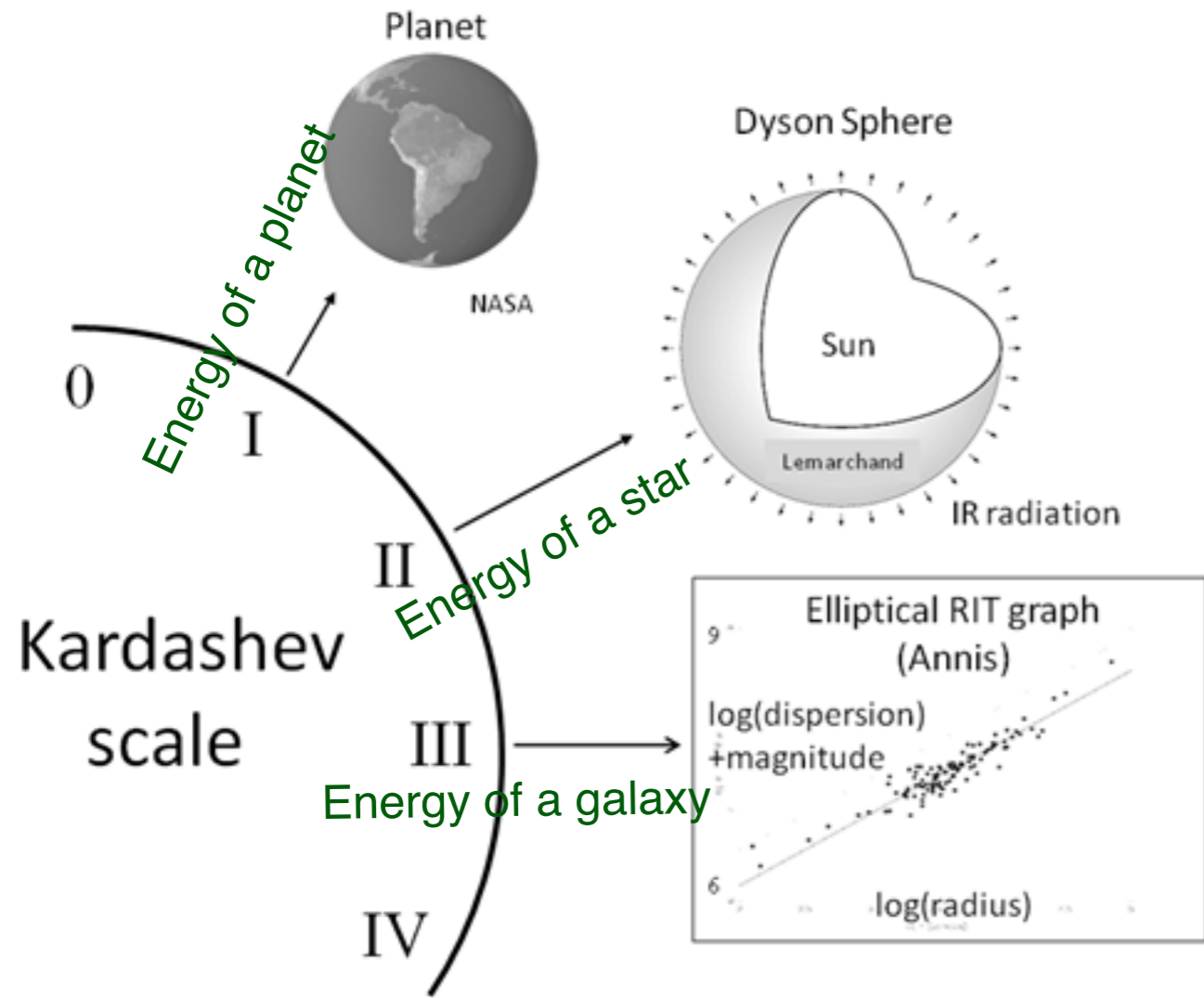


Solar thermal

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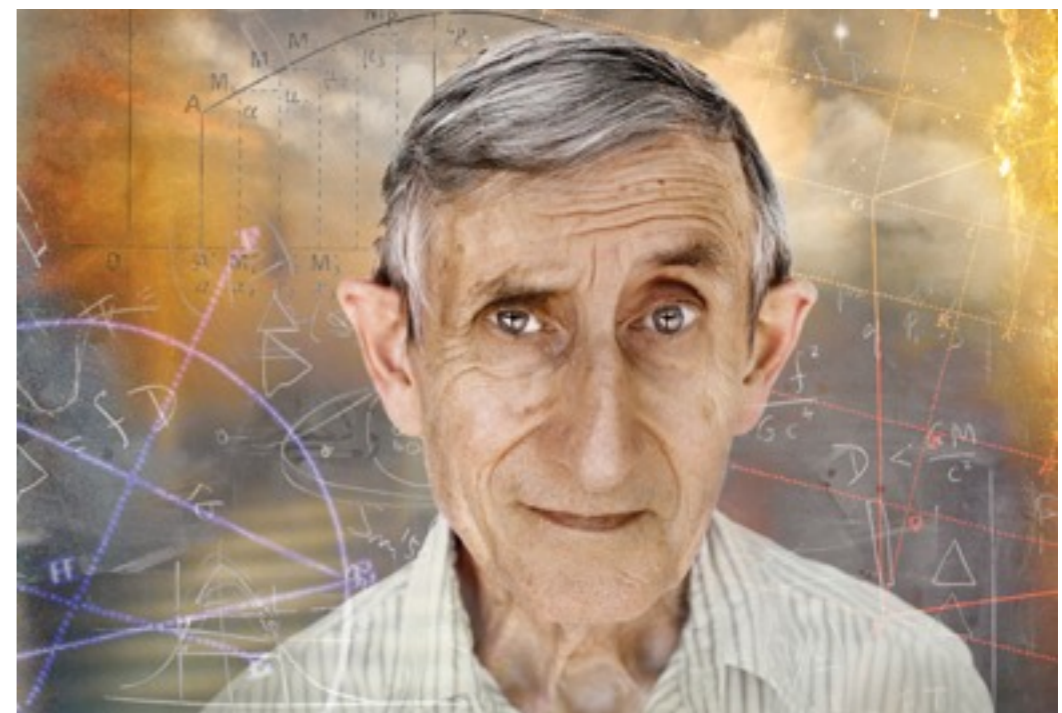
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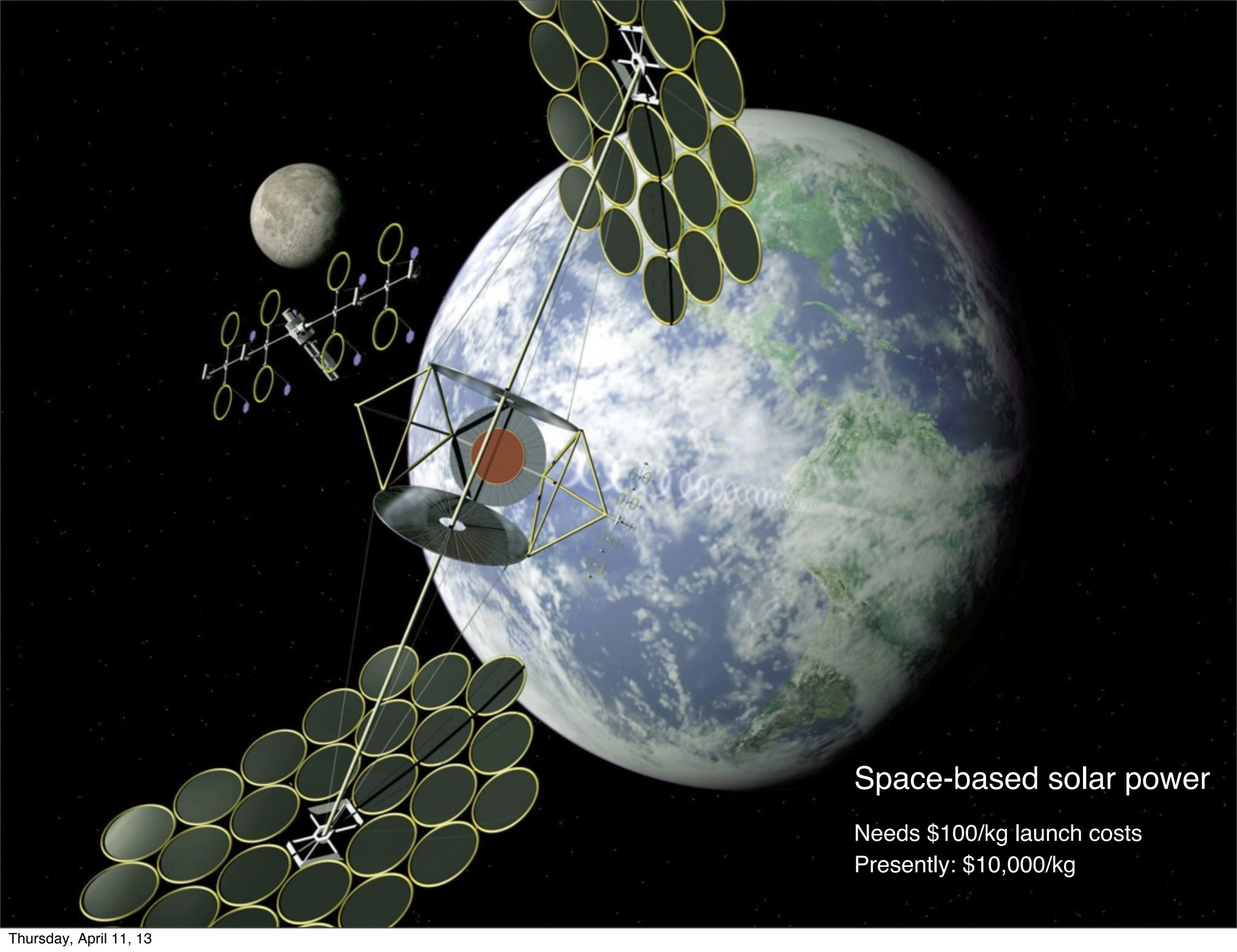
Nikolai Kardashev



Kardashev scale, Dyson swarms (or rings or spheres)



Freeman Dyson



Space-based solar power

Needs \$100/kg launch costs

Presently: \$10,000/kg