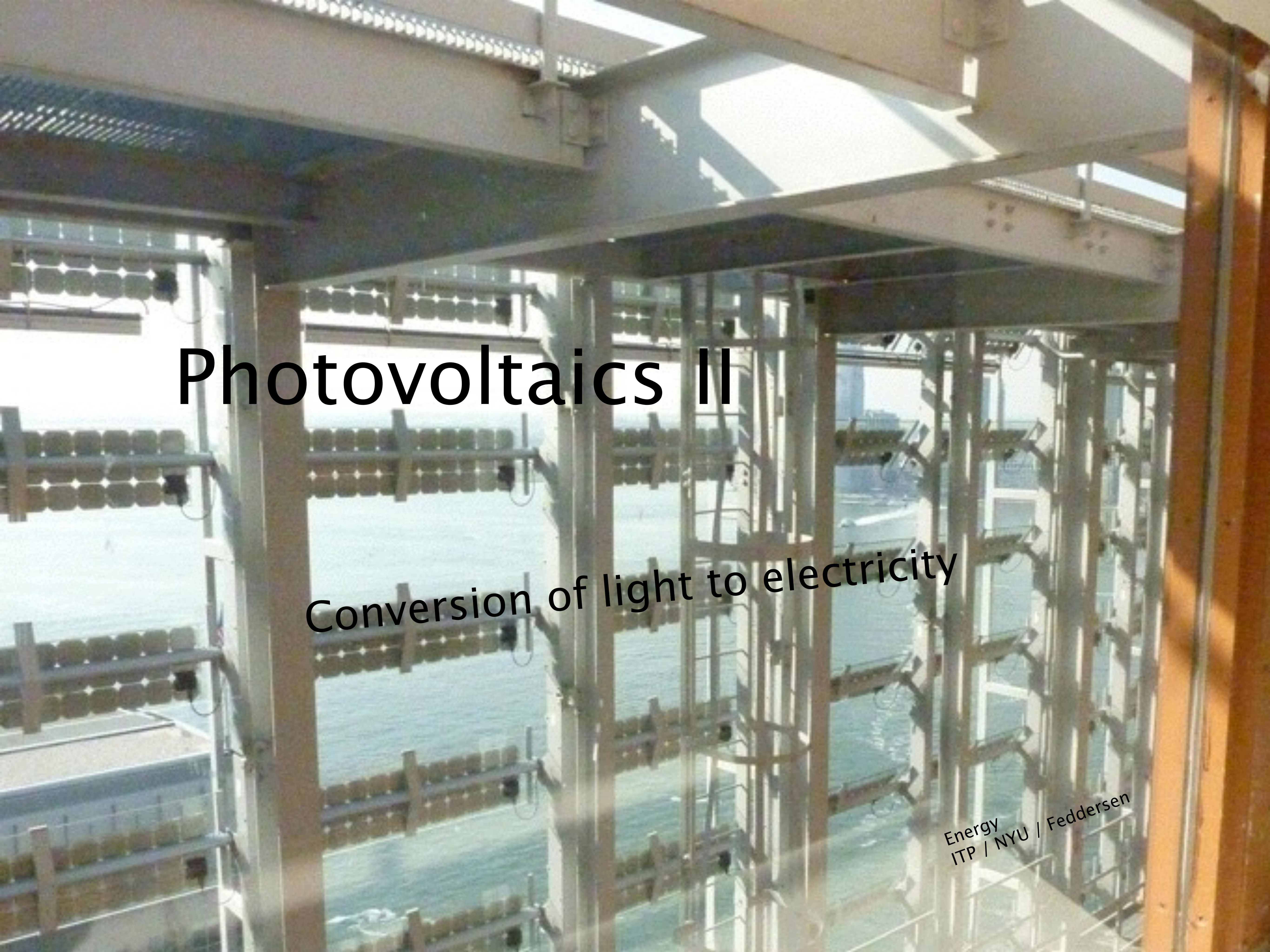


Photovoltaics II

Conversion of light to electricity

Energy
ITP / NYU / Feddersen

Previously

For later:

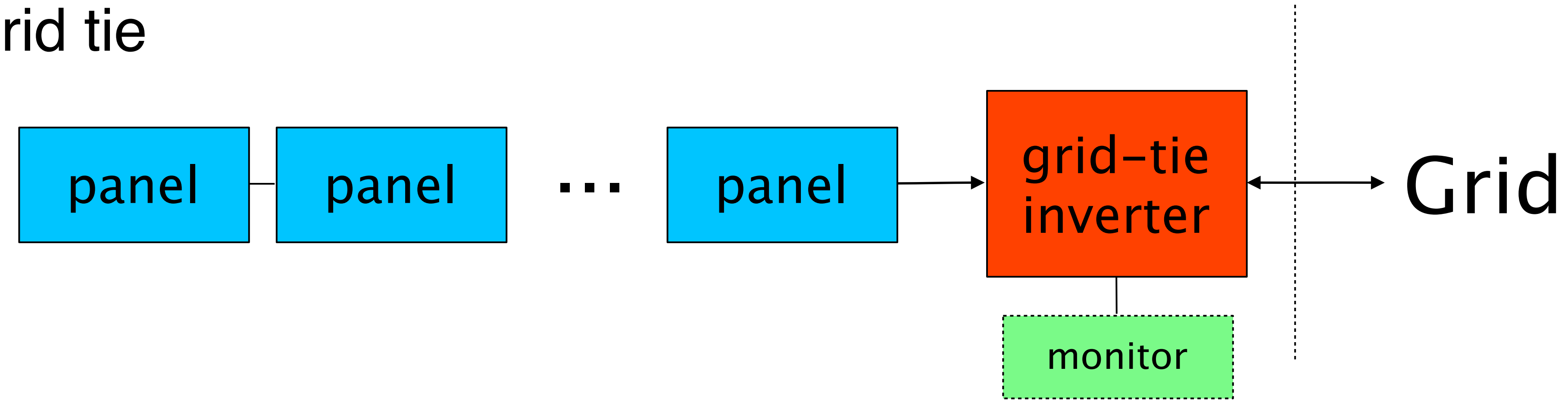
Balance of system
Tracking methods
Concentrating systems
Solar lighting
Solar thermal

also:
Kardashev scale
Space based solar power
Dyson swarms

Balance of system
Tracking methods
Concentrating systems
Solar lighting
Solar thermal

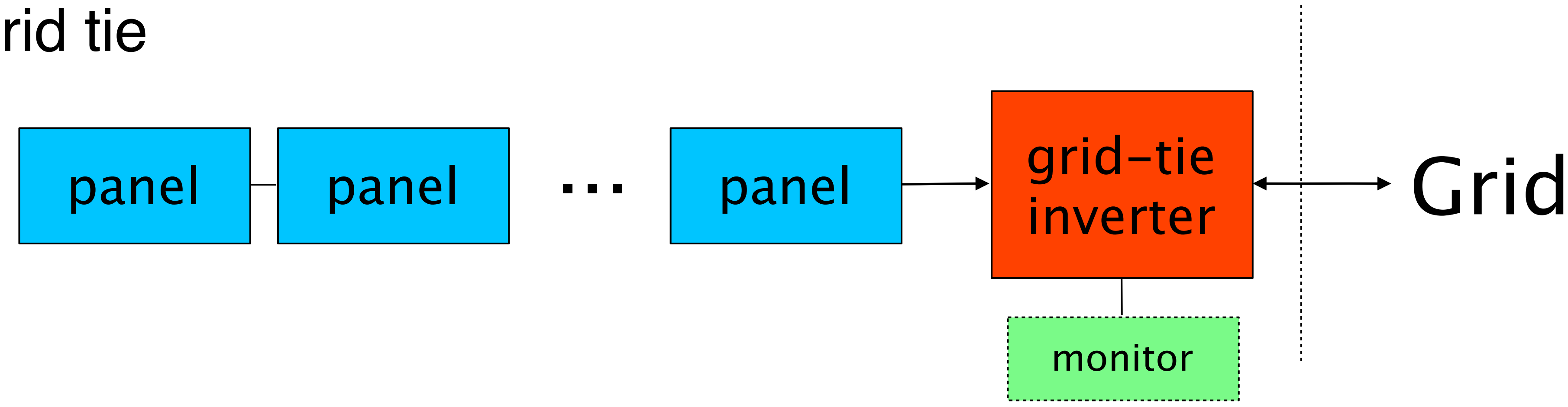
also:
Kardashev scale
Space based solar power
Dyson swarms

grid tie

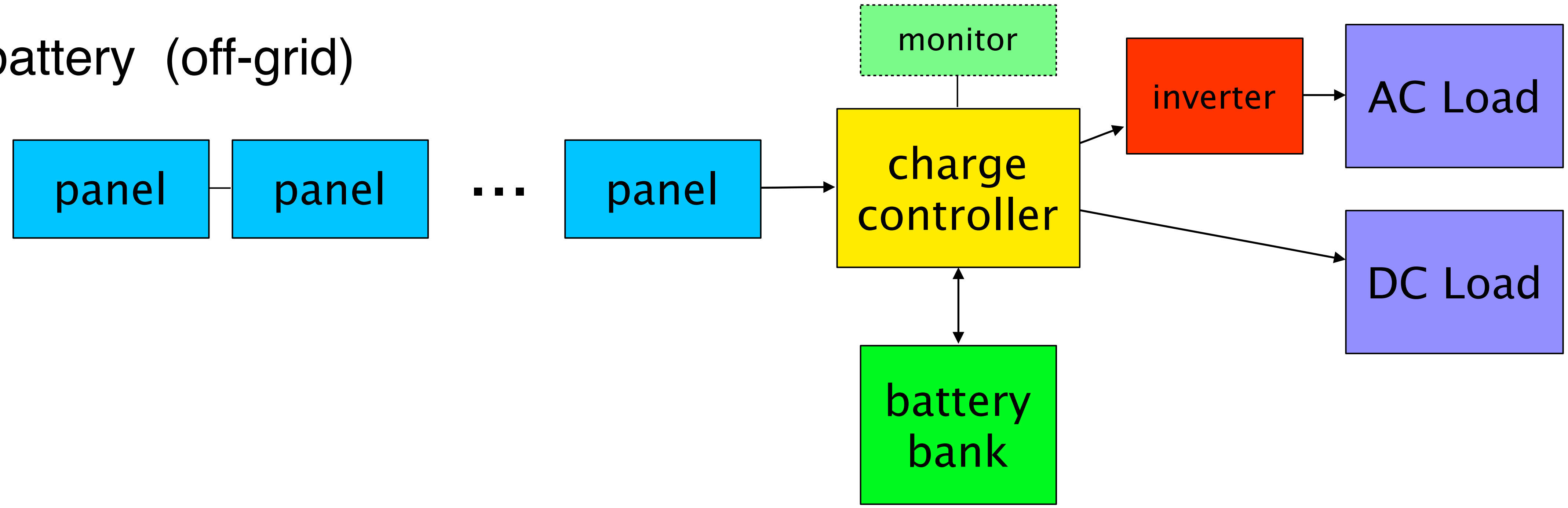


Balance of system: grid tie vs. battery

grid tie



battery (off-grid)



Balance of system: grid-tie inverter

Inverters at “Riverhouse”
Battery Park City

Balance of system: grid-tie inverter

SMA Solar Technology | SMA America | SMA Websites | Search

Home | Products | Service | News & Infos | SMA Solar Academy | Company | Contact

Home > Products > Grid-Tied Inverters > SUNNY BOY > SUNNY BOY 5000-US / 6000-US / 7000-US / 8000-US

SUNNY BOY 5000-US / 6000-US / 7000-US / 8000-US

Versatile performer with UL certification

The Sunny Boy 5000-US, 6000-US, 7000-US and 8000-US inverters are UL certified and feature excellent efficiency. Graduated power classes provide flexibility in system design. Automatic grid voltage detection* and an integrated DC disconnect switch simplify installation, ensuring safety as well as saving time. These models feature galvanic isolation and can be used with all types of modules-crystalline as well as thin-film.

Extended operating temperature range to -40 °C available. Please specify when ordering.

* US Patent US7352549B1

INTEGRATED AFCI

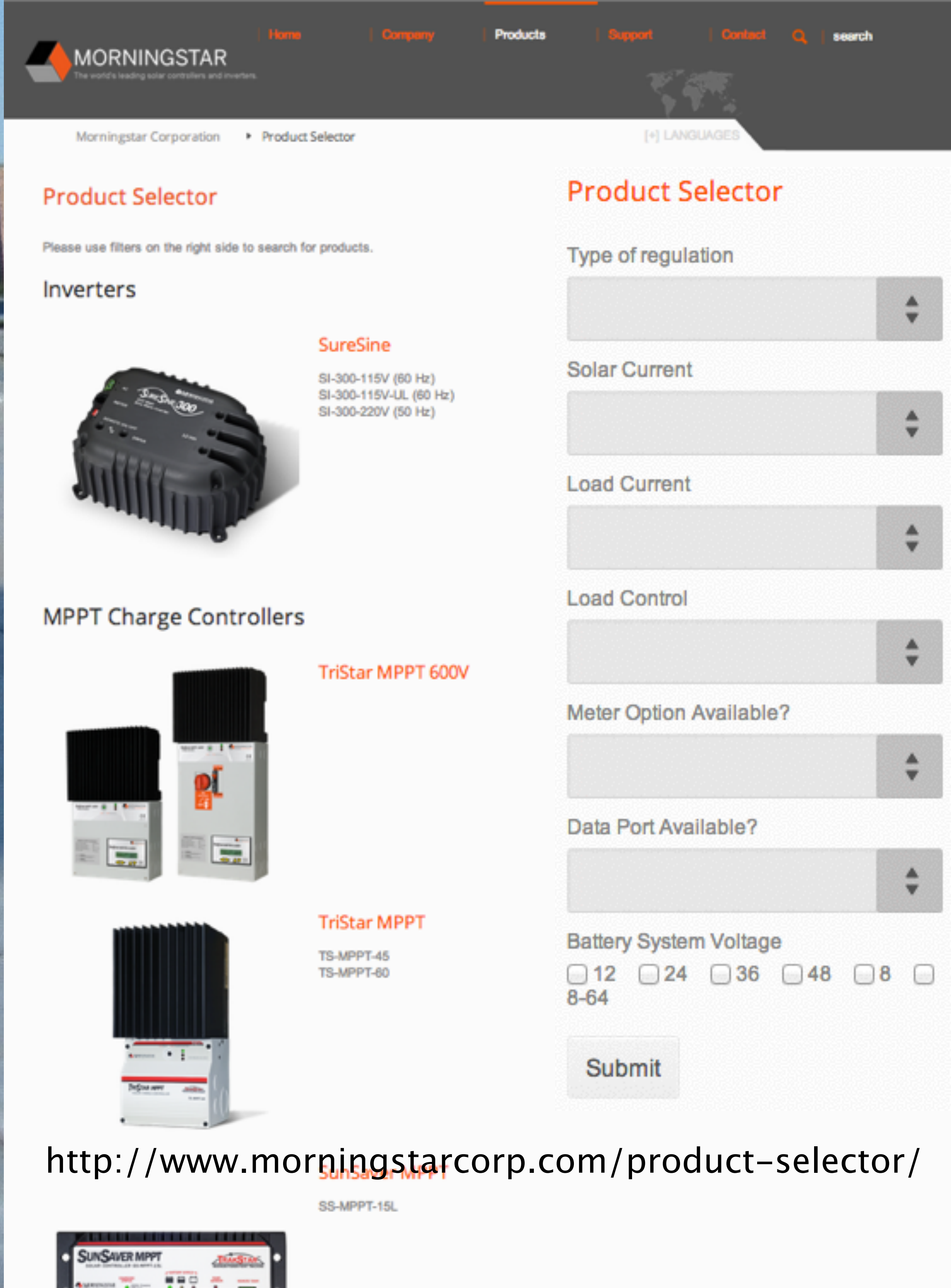
WHERE TO BUY

Overview | Technical data | Downloads

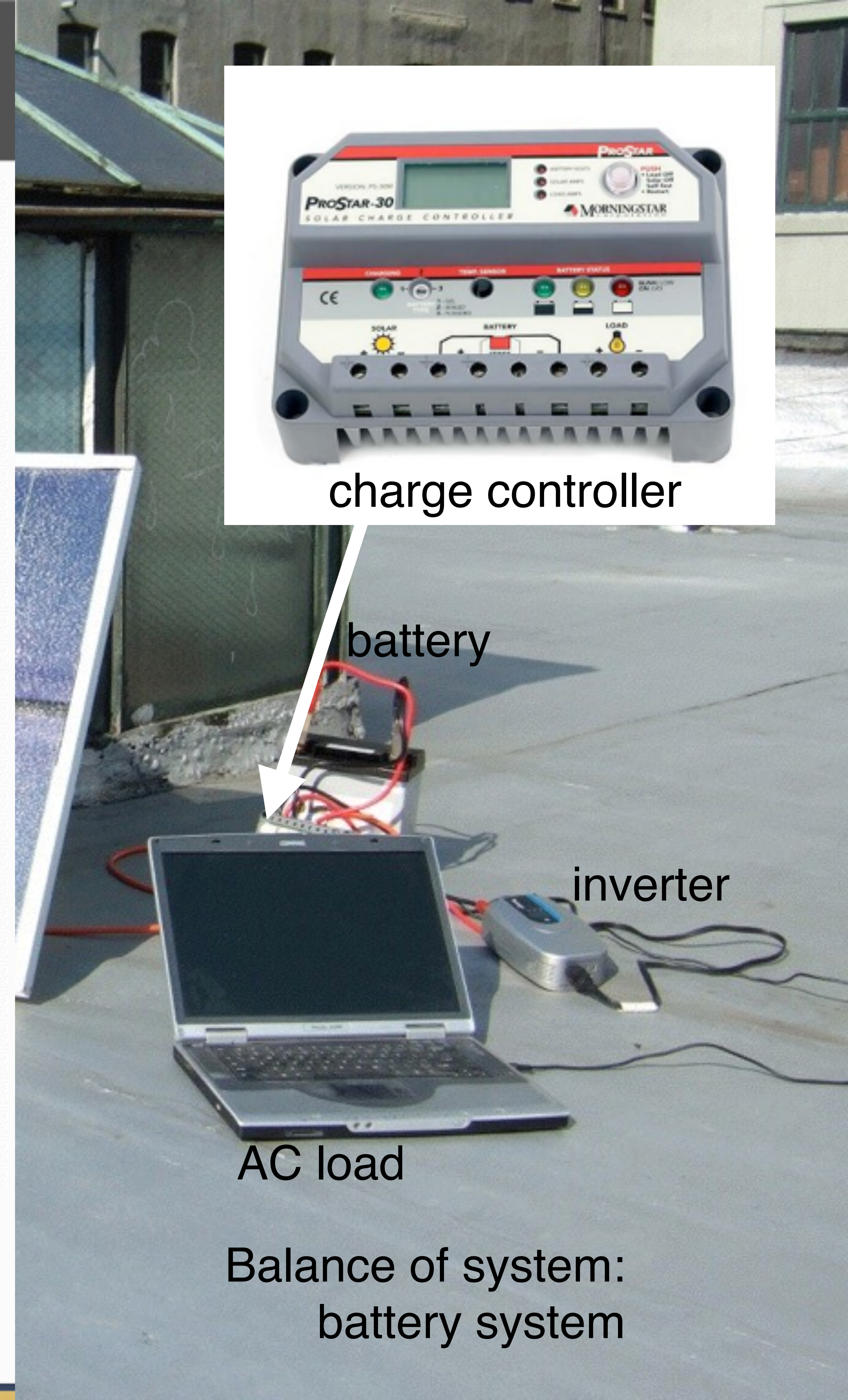
	Sunny Boy 5000-US	Sunny Boy 6000-US	Sunny Boy 7000-US	Sunny Boy 8000-US
	208 V AC 240 V AC 277 V AC	208 V AC 240 V AC 277 V AC	208 V AC 240 V AC 277 V AC	240 V AC 277 V AC
Input (DC)				
Max. recommended PV power (@ module STC)	6250 W	7500 W	8750 W	10000 W
Max. DC power (@ cos φ = 1)	5300 W	6350 W	7400 W	8600 W
Max. DC voltage	600 V	600 V	600 V	600 V
DC nominal voltage	310 V	310 V	310 V	345 V
MPP voltage range	250 V – 480 V	250 V – 480 V	250 V – 480 V	300 V – 480 V
Min. DC voltage / start voltage	250 V / 300 V	250 V / 300 V	250 V / 300 V	300 V / 365 V
Max. input current / per string (at DC disconnect)	21 A / 20 A 36 A @ combined terminal	25 A / 20 A 36 A @ combined terminal	30 A / 20 A 36 A @ combined terminal	30 A / 20 A 36 A @ combined terminal
Number of MPP trackers / fused strings per MPP tracker	1 / 4 (DC disconnect)	1 / 4 (DC disconnect)	1 / 4 (DC disconnect)	1 / 4 (DC disconnect)
Output (AC)				
AC nominal power	5000 W	6000 W	7000 W	7680 W 8000 W
Max. AC apparent power	5000 VA	6000 VA	7000 VA	7680 VA 8000 VA
Nominal AC voltage / adjustable	208 V / yes 240 V / yes 277 V / yes	208 V / yes 240 V / yes 277 V / yes	208 V / yes 240 V / yes 277 V / yes	240 V / yes 277 V / yes
AC voltage range	183 – 229 V 211 – 264 V 244 – 305 V	183 – 229 V 211 – 264 V 244 – 305 V	183 – 229 V 211 – 264 V 244 – 305 V	211 – 264 V 244 – 305 V

Inverters at “Riverhouse” Battery Park City


ProStar
ProStar-30
SOLAR CHARGE CONTROLLER
MORNINGSTAR
charge controller
battery
inverter
AC load
Balance of system:
battery system



http://www.morningstarcorp.com/product-selector/

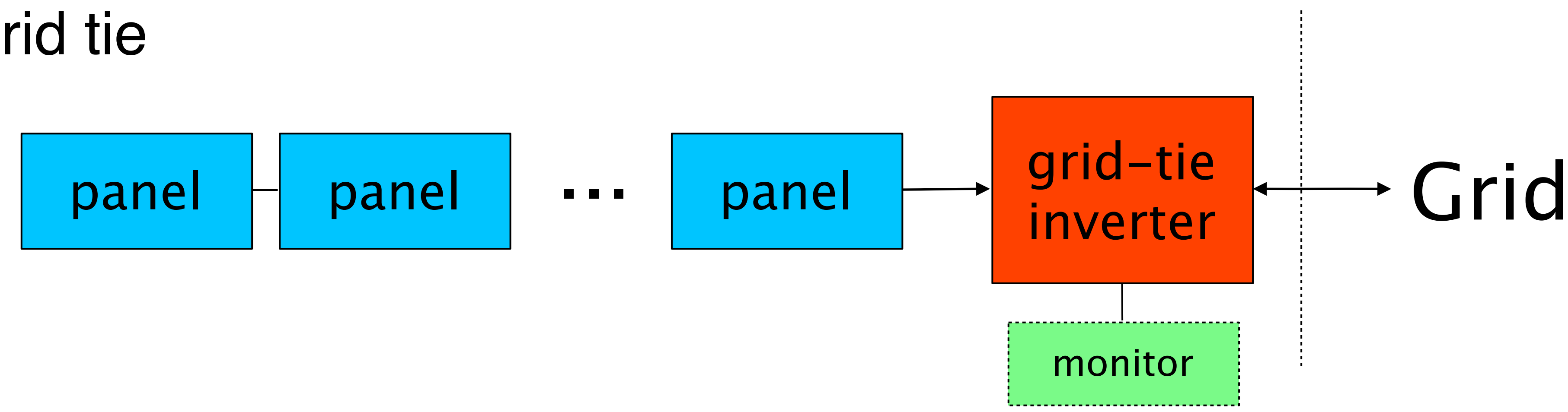


Balance of system:
battery system

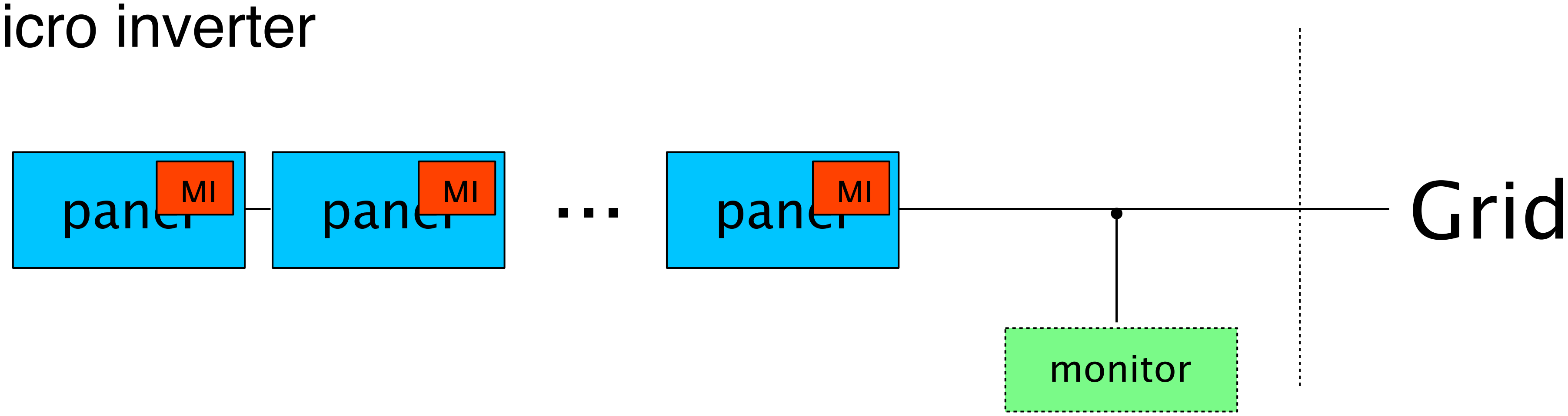
inverter
AC load
battery
Balance of system:
battery system
xPower 1500
Portable Household Power
XANTREX
AC OUTLETS
FAULT
POWER

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 39.75

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	
Barringer High School	Newark, NJ	0.65	
Central High School	Newark, NJ	0.50	
Park Avenue Elementary School	Newark, NJ	0.51	
PSE&G Silver Lake Solar Farm	Edison, NJ	2.02	
Camden St. Schools	Newark, NJ	0.91	
PSE&G Edison Training & Development	Edison, NJ	0.71	
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PSE&G Yardville Solar Farm	Hamilton TWP, NJ	4.30	
Matrix Realty Building A	Perth Amboy, NJ	1.69	
Matrix Realty Building B	Perth Amboy, NJ	1.17	
Matrix Realty	South Brunswick, NJ	2.98	
Rider University	Lawrenceville, NJ	0.74	
Mills Creek	Burlington TWP, NJ	3.82	
Kearny Landfill Solar	Kearny, NJ	3.00	
Thorofare Solar Farm	West Depford, NJ	0.72	
Summit Associates	Edison, NJ	2.22	
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
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
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	

PSE&G Installed Solar Projects	Location	Size MW-dc	Service Date
Pole-attached solar units	Statewide	39.75	as of January 2014
Trenton Solar Farm	Trenton, NJ	1.26	September, 2010
Barringer High School	Newark, NJ	0.65	October, 2010


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
Tracking methods
Concentrating systems
Solar lighting
Solar thermal

also:
Kardashev scale
Space based solar power
Dyson swarms


FOR 37°-43° N LAT.
SOLAR TIME
SOLAR PATHFINDER
"THE ENERGY EVALUATOR"


Tracking
single axis
(elevation)


Tracking
~10kW
single axis
(azimuth)


Tracking
dual axis
~10kW


Tracking
dual axis
elevation axis
~10kW
azimuth axis


Tracking
dual axis - mixed
“Riverhouse” BPC
azimuth
east and west sides
elevation
south side

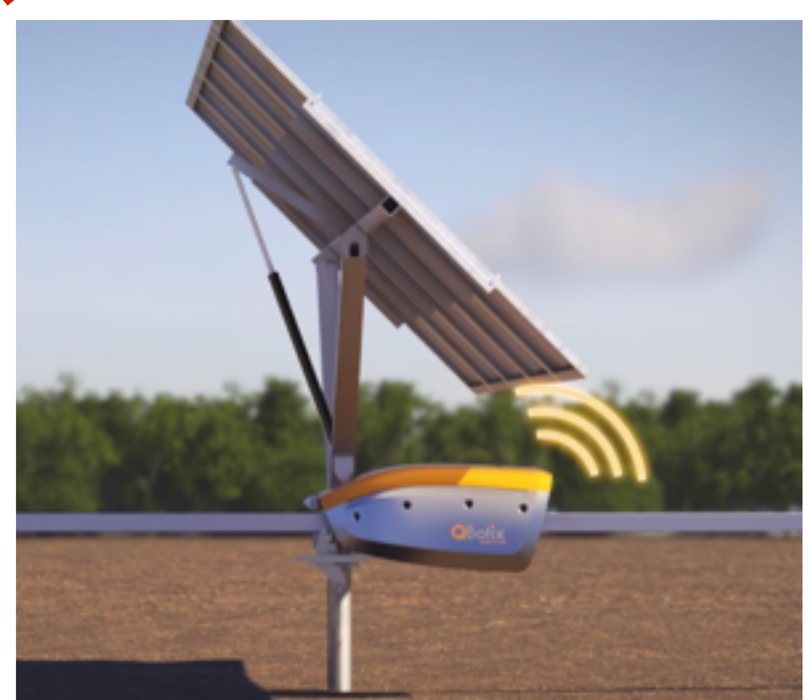
Challenge:

Tracking systems 1) require **space between arrays** and 2) introduce **mechanical parts** that require energy and maintenance.

Cost of tracking system must compete with cost of simply adding more fixed panels.

Ways to simplify mechanics or minimize number of actuators are interesting.

QBotix RIP 2015



Balance of system
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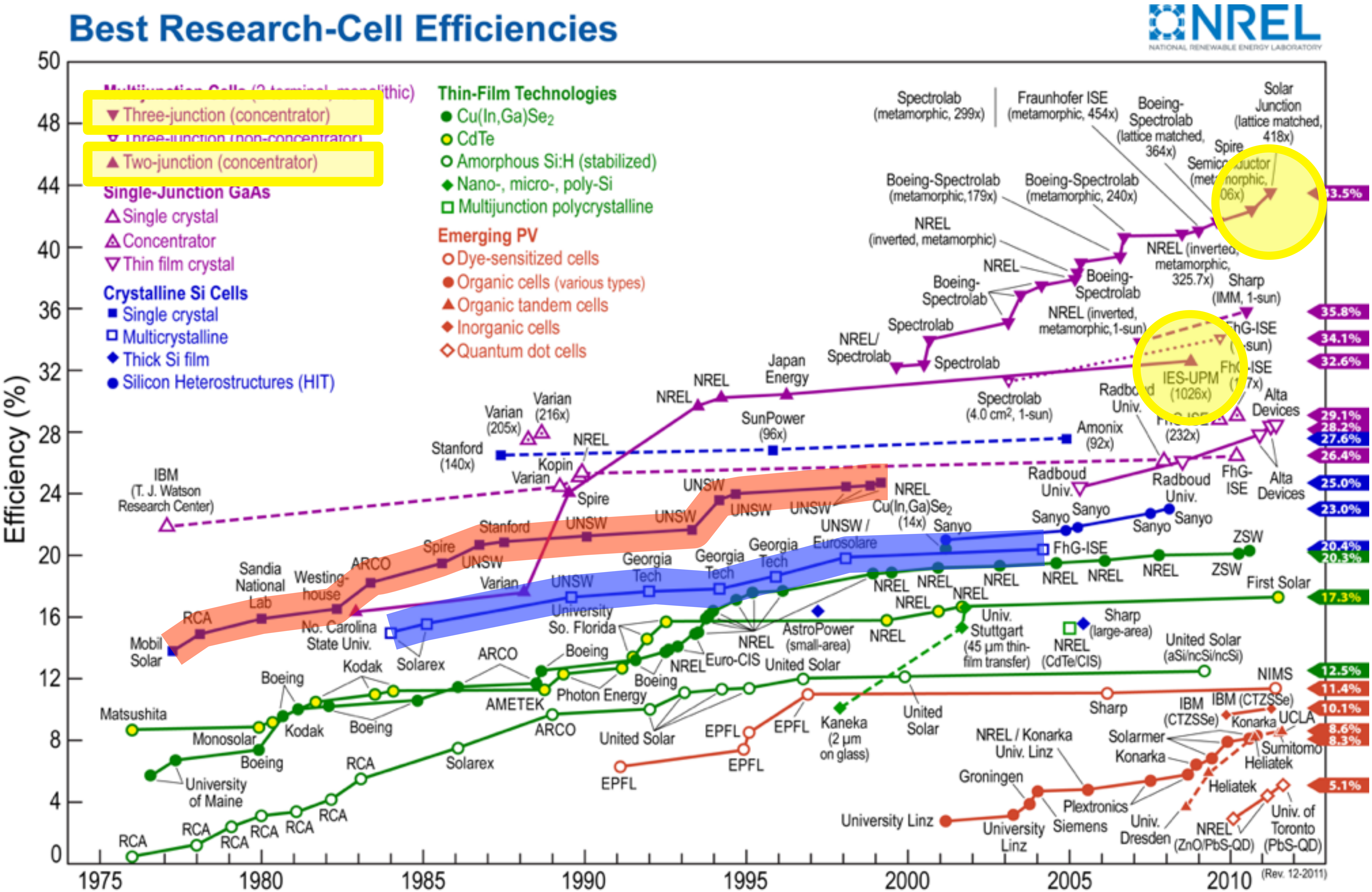
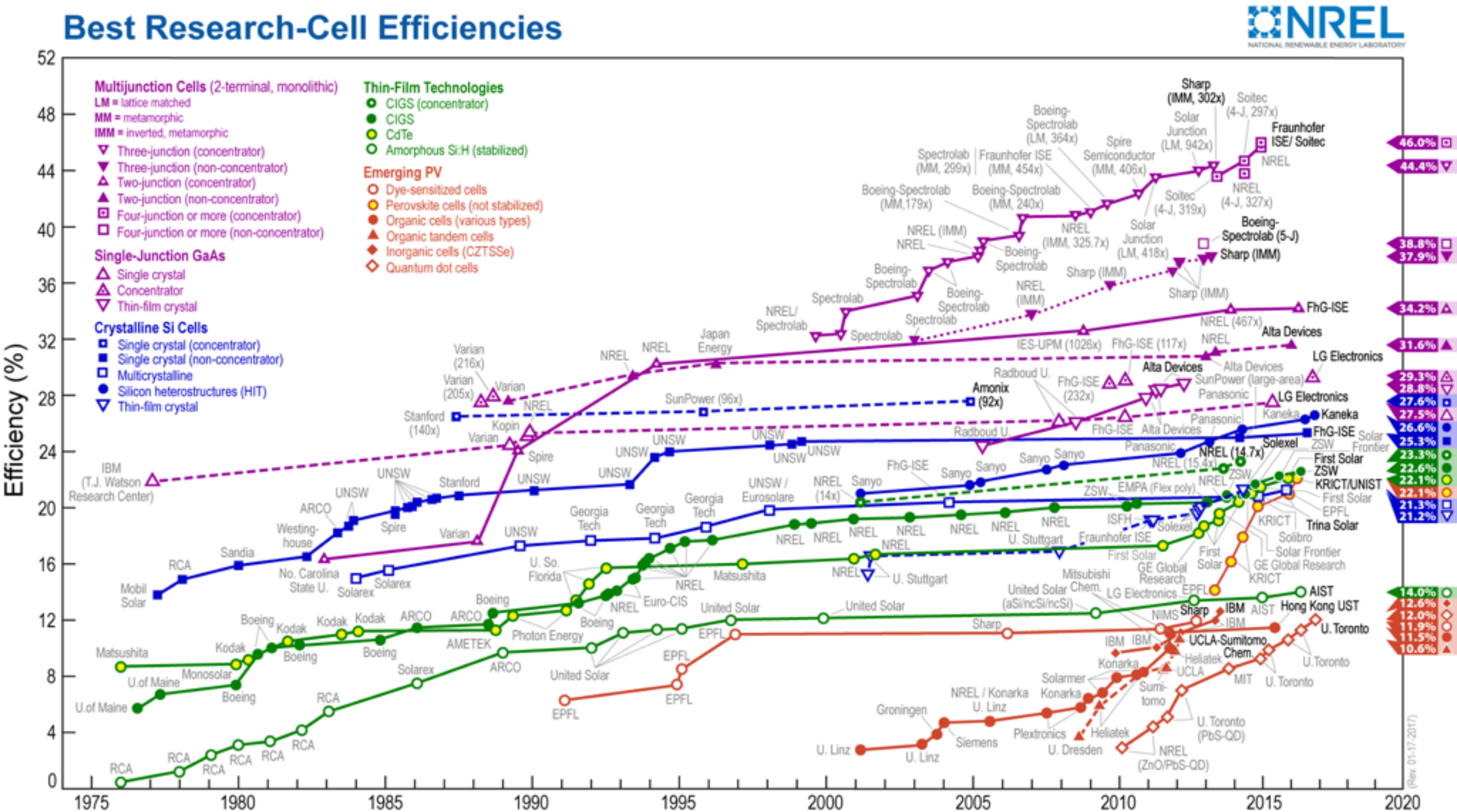


Source: DOE NREL

Best Research-Cell Efficiencies



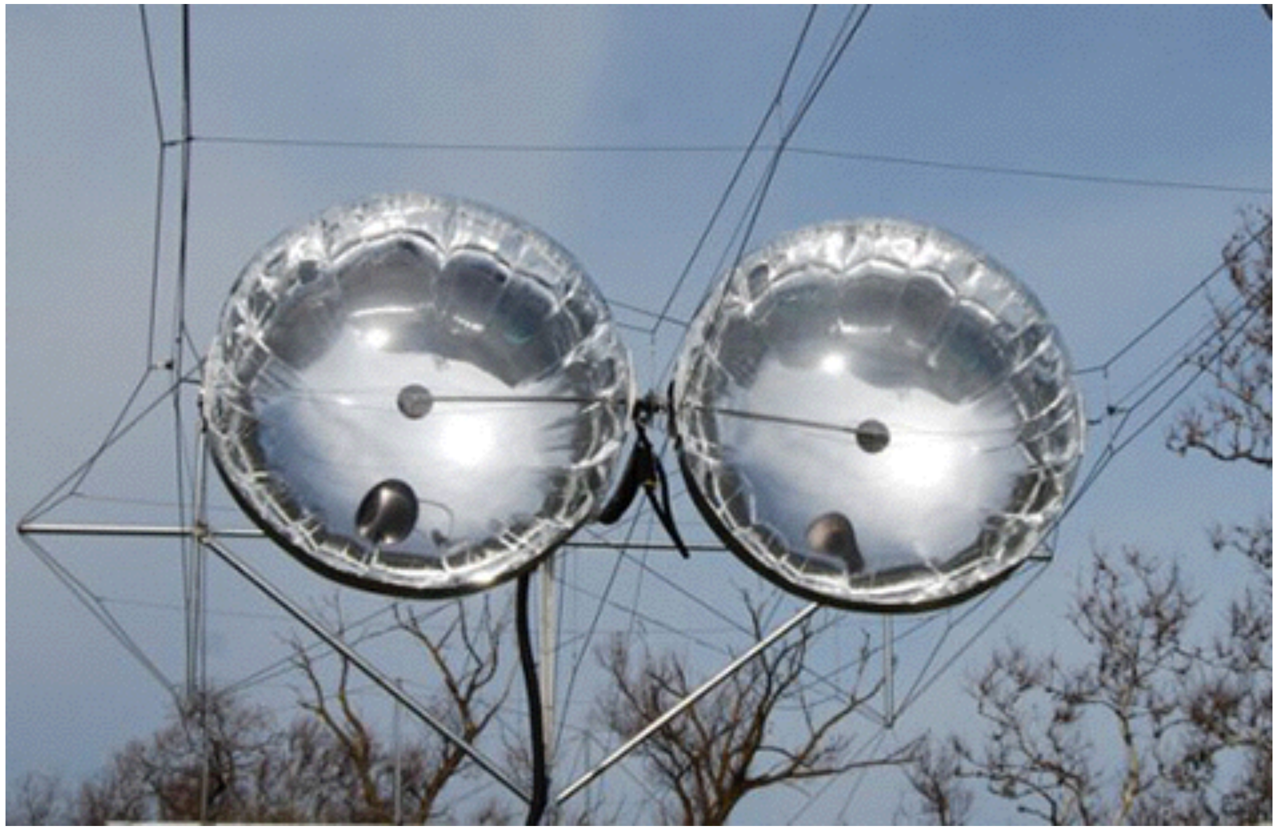
2017

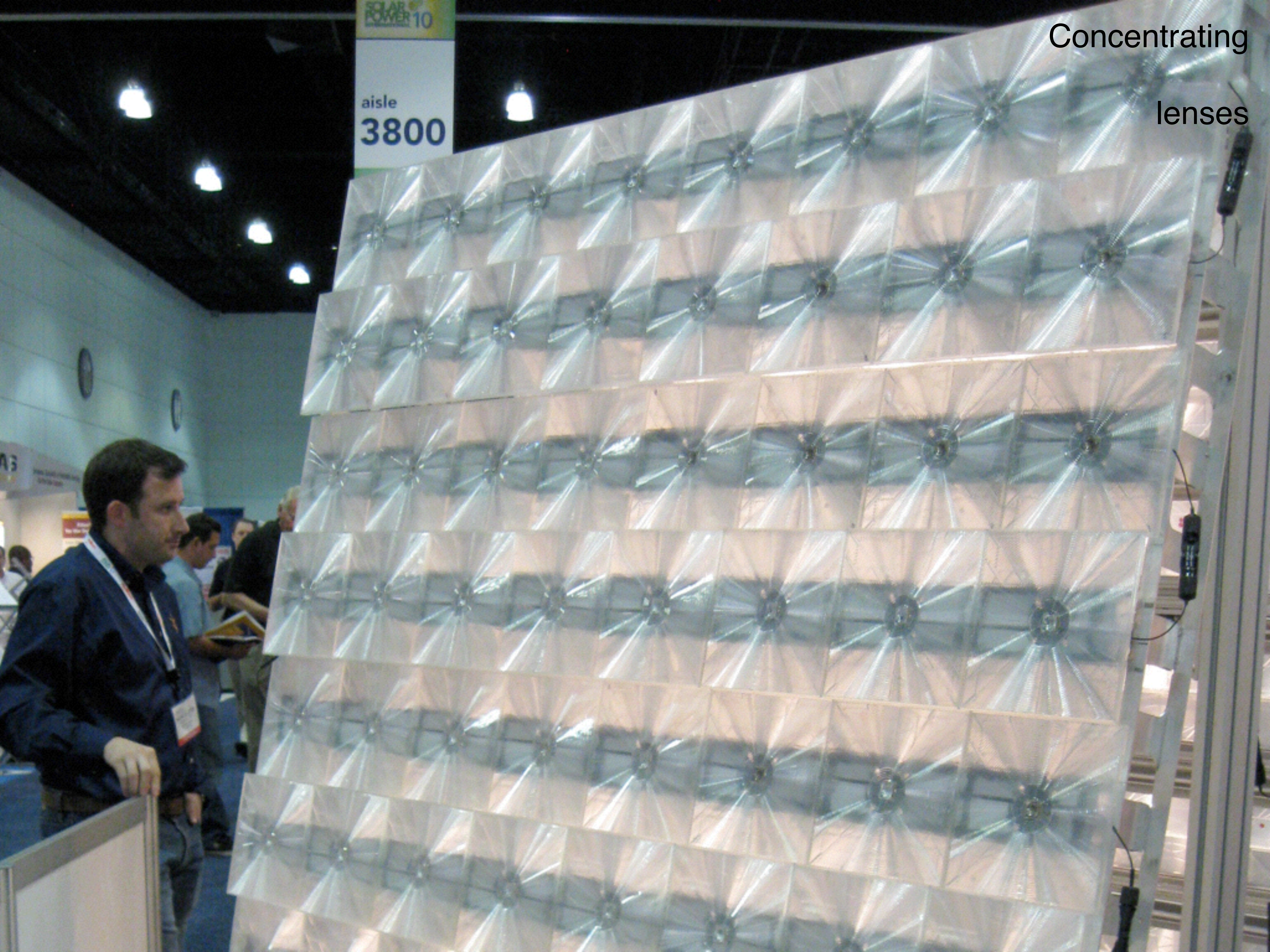
Source: DOE NREL


Concentrating
mirrors
Energy Innovations
RIP 2015
WOOD & JONES

Concentrating

cheap mirrors

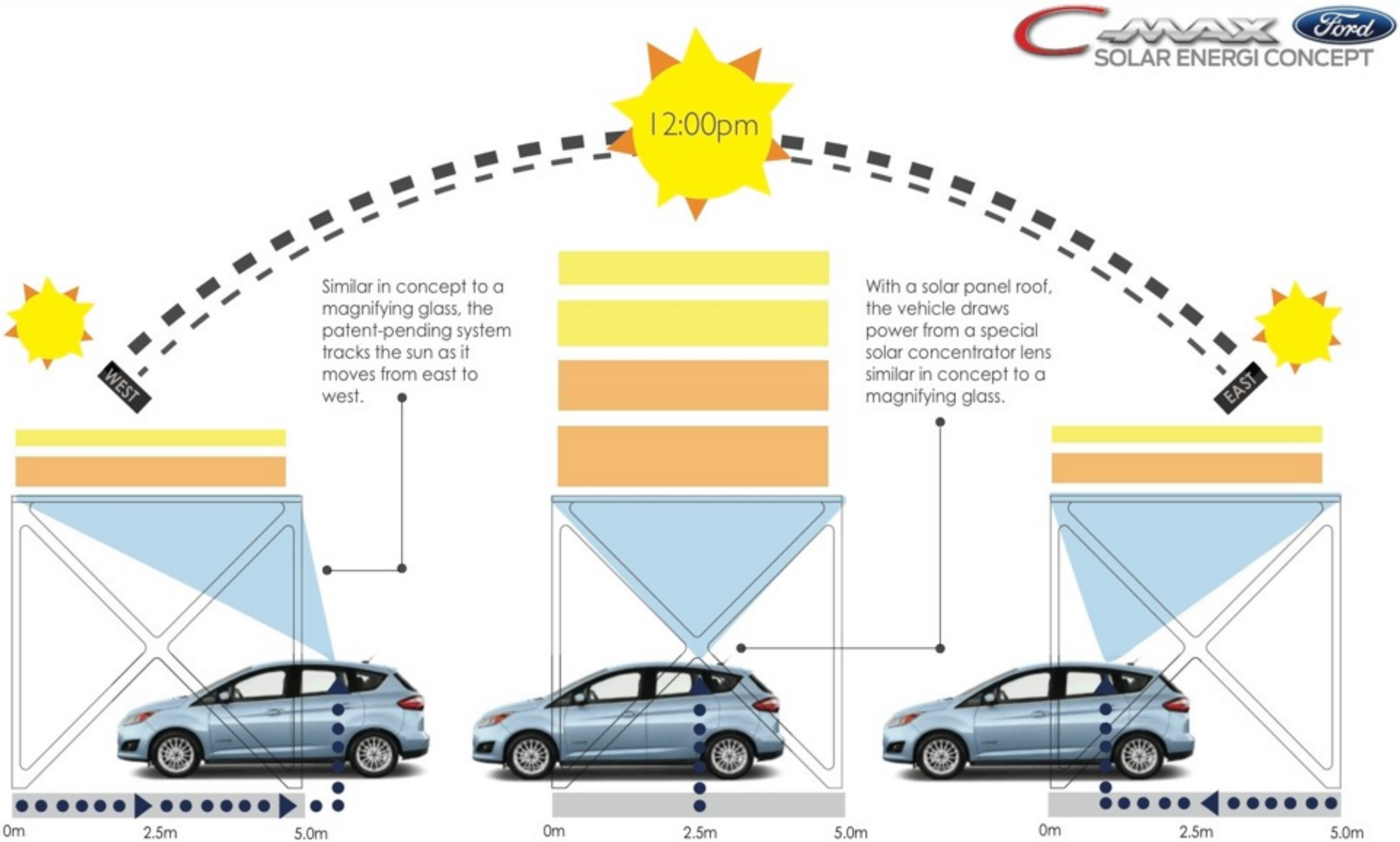



Concentrating
lenses
aisle
3800

Concentrating
Fresnel Lens

How it Works

The C-MAX Solar Energi optimizes the intake of solar power through a Fresnel lens concentrator by autonomously moving in the direct path of the sun's rays.



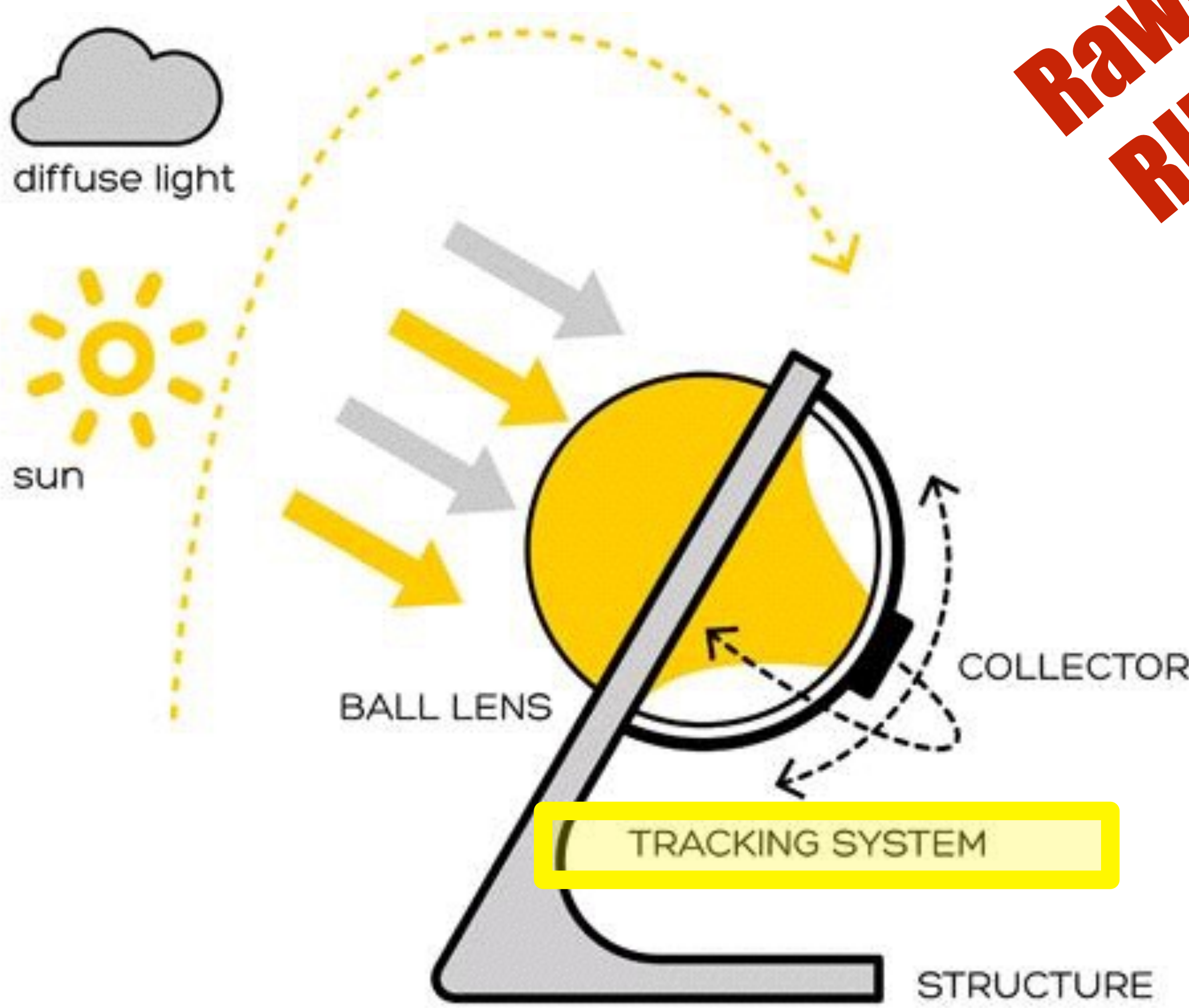
Concentrating

spherical lenses

Challenge:

Concentrating systems also require tracking systems, so same issues (**space between arrays** and **mechanical parts**) apply. Concentrated sunlight can reach very high temperatures and could focus on surrounding structures if tracking system fails.

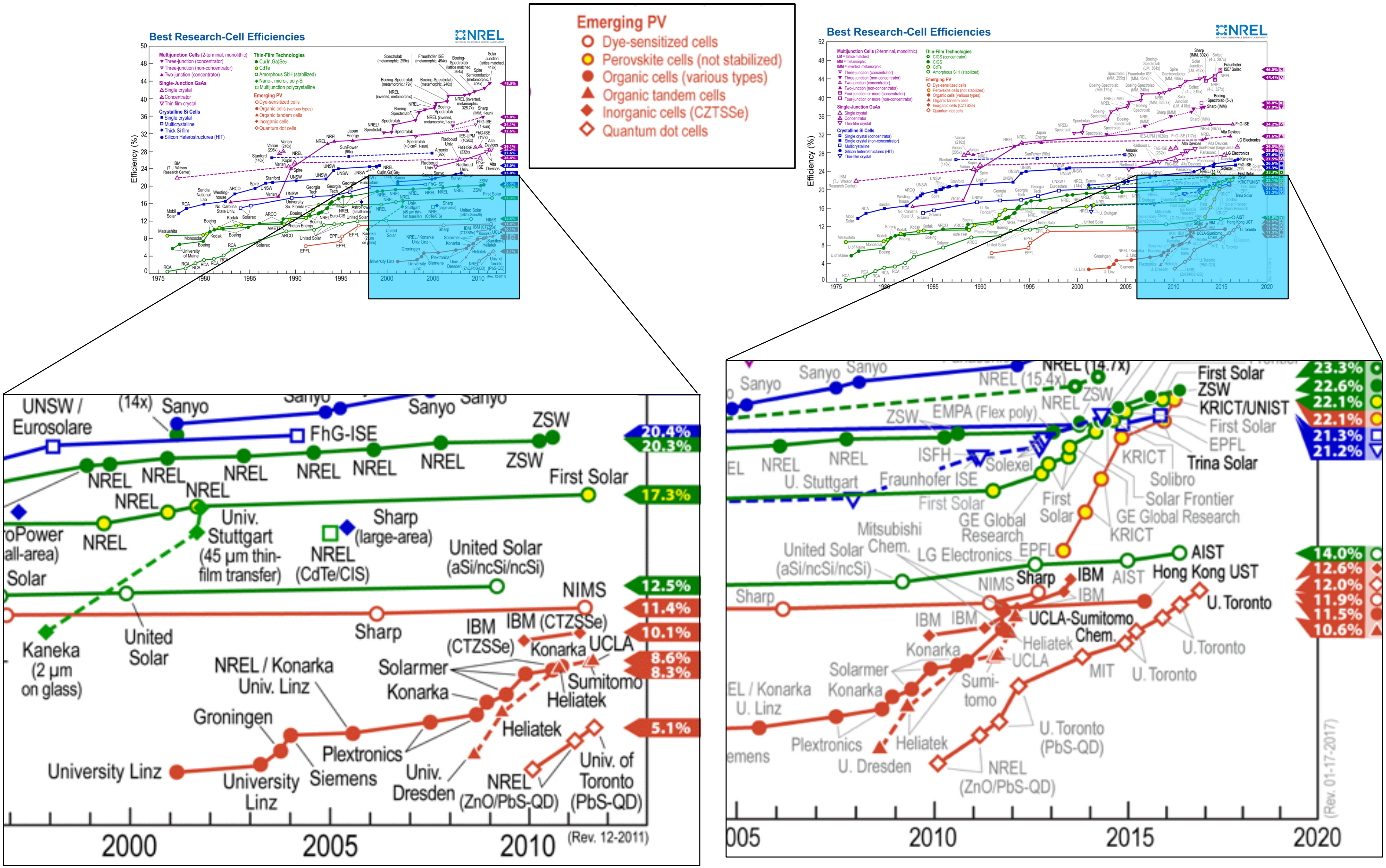
Rawlemon
RIP 2017?



Concentrating
(sort of...)

Solyndra

2012 2017



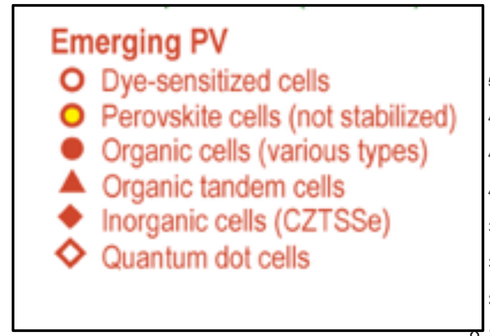
Source: DOE NREL

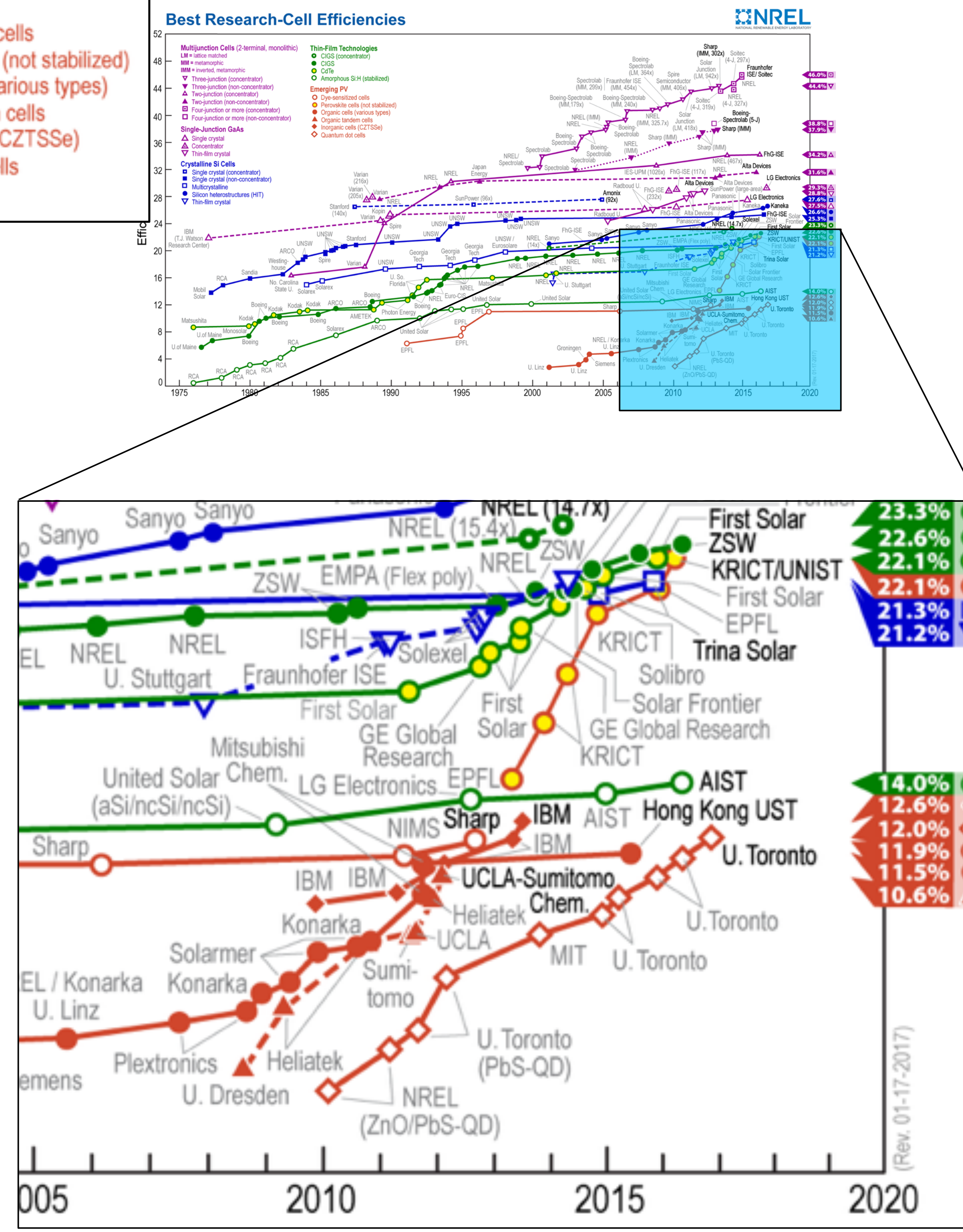
“**Quantum dots** (QD) are very small semiconductor particles, only several nanometres in size, so small that their optical and electronic properties differ from those of larger particles… The tunable absorption spectrum and high extinction coefficients of quantum dots make them attractive for light harvesting technologies such as photovoltaics” – Wikipedia

“A **perovskite solar** cell is a type of solar cell which includes a perovskite structured compound… Perovskite materials such as methylammonium lead halides are **cheap to produce and simple to manufacture**….Solar cell efficiencies of devices using these materials have increased from 3.8% in 2009 to 22.1% in early 2016, making this the **fastest-advancing** solar technology to date… One big challenge for PSCs is the aspect of short-term and long-term **stability.**” — Wikipedia

“The **DSSC** has a number of attractive features; it is **simple** to make using conventional roll-printing techniques, is semi-flexible and semi-transparent which offers a variety of uses not applicable to glass-based systems, and most of the materials used are **low-cost**… it has proven difficult to eliminate a number of expensive materials…and the liquid electrolyte presents a serious challenge… its price/performance ratio should be good enough to allow them to… [achieve] grid parity. Commercial applications… were held up due to chemical stability problems.” — Wikipedia

2017

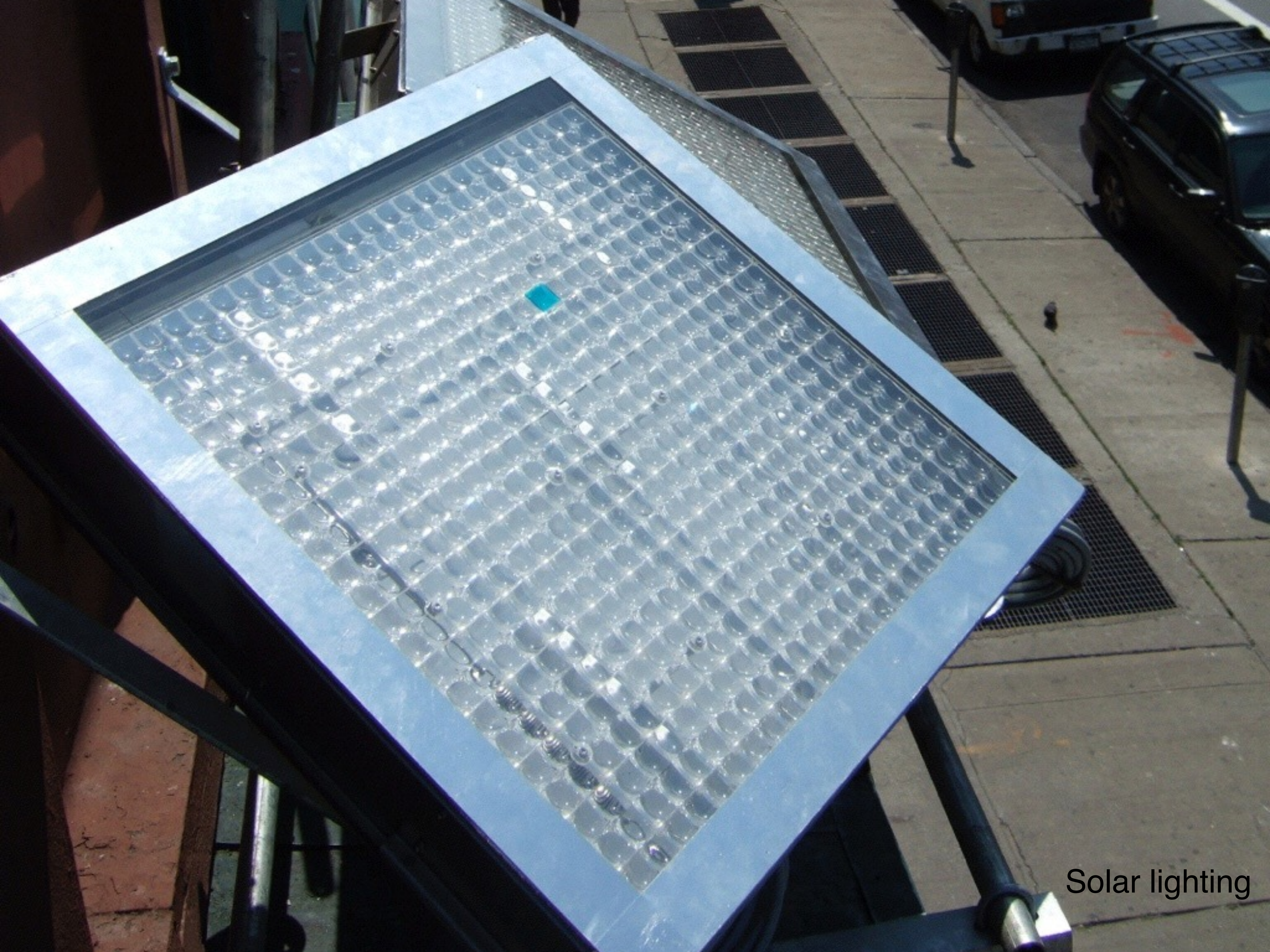




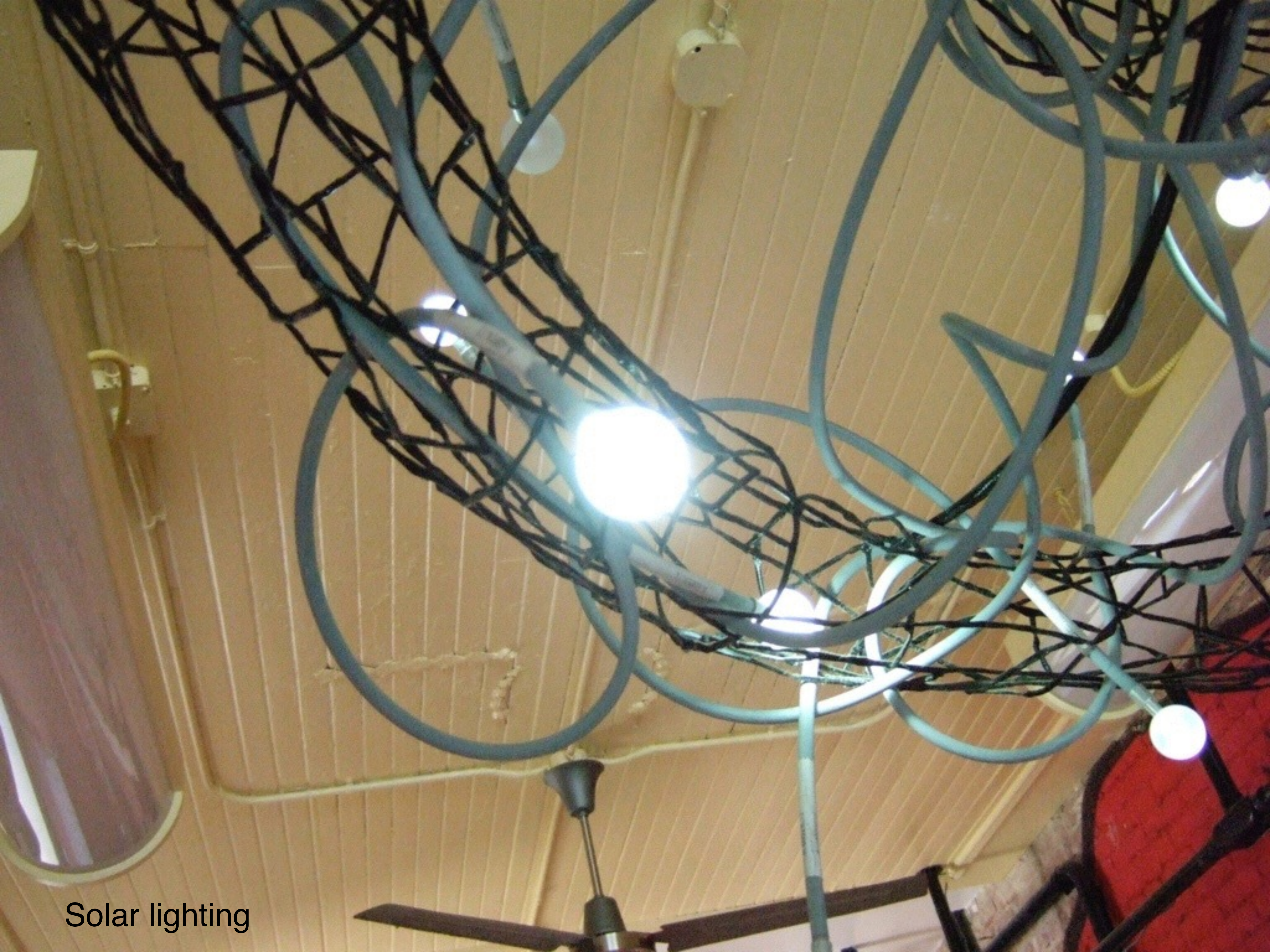
Source: DOE NREL

Balance of system
Tracking methods
Concentrating systems
Solar lighting
Solar thermal

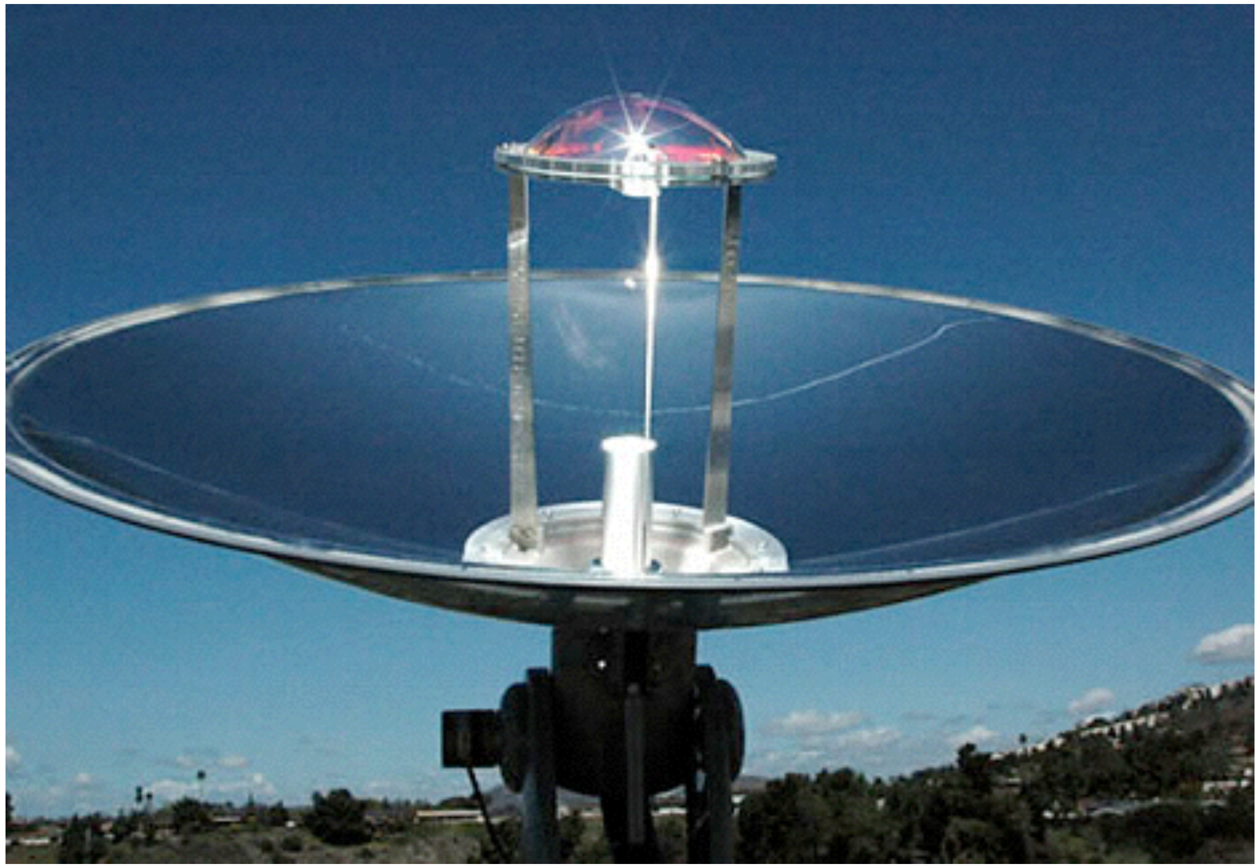
also:
Kardashev scale
Space based solar power
Dyson swarms


Solar lighting

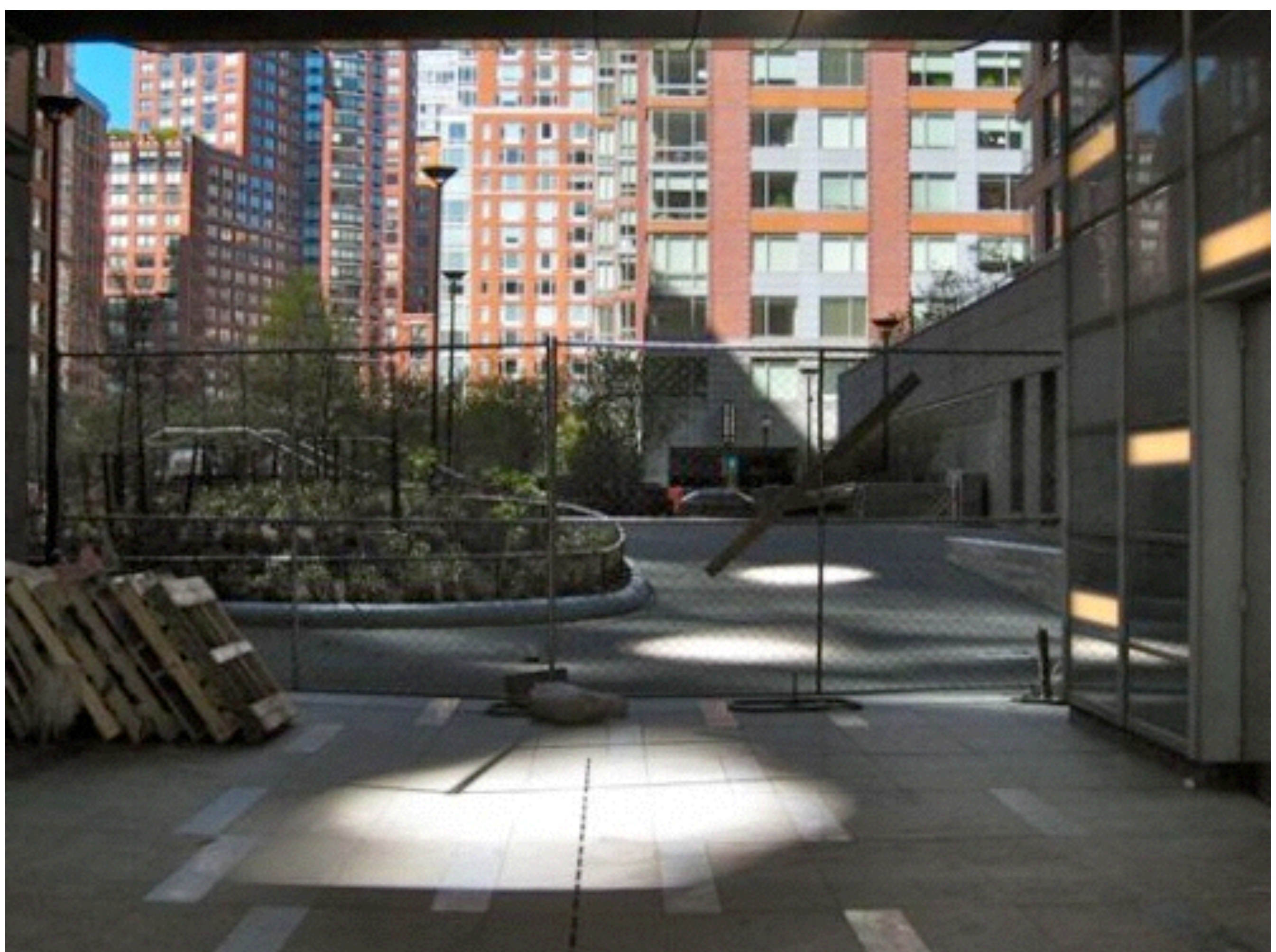
Solar lighting



Solar lighting



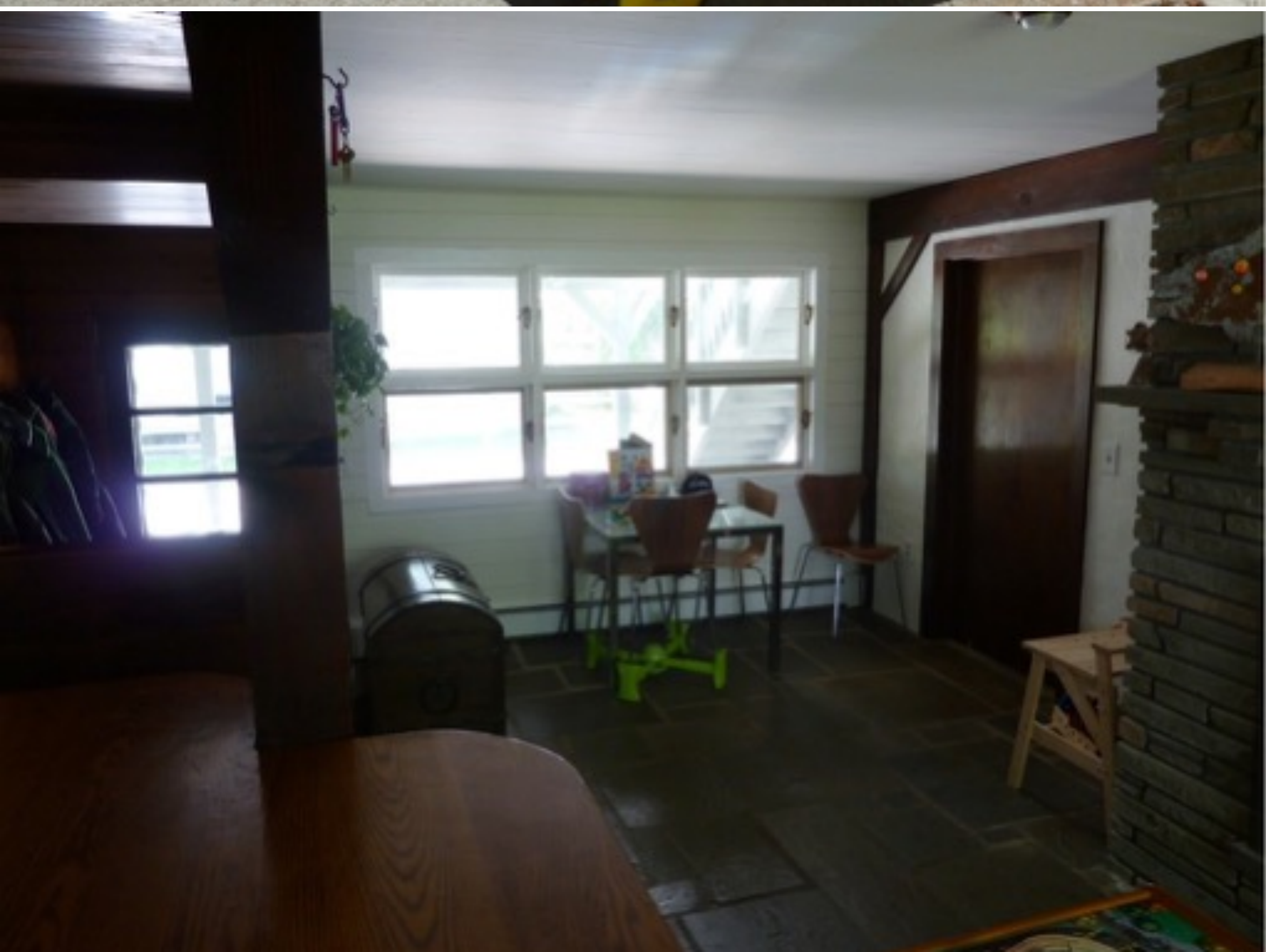

Solar lighting



Solar lighting: Teardrop park heliostats

Carpenter Norris Consulting Inc.



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Solar thermal

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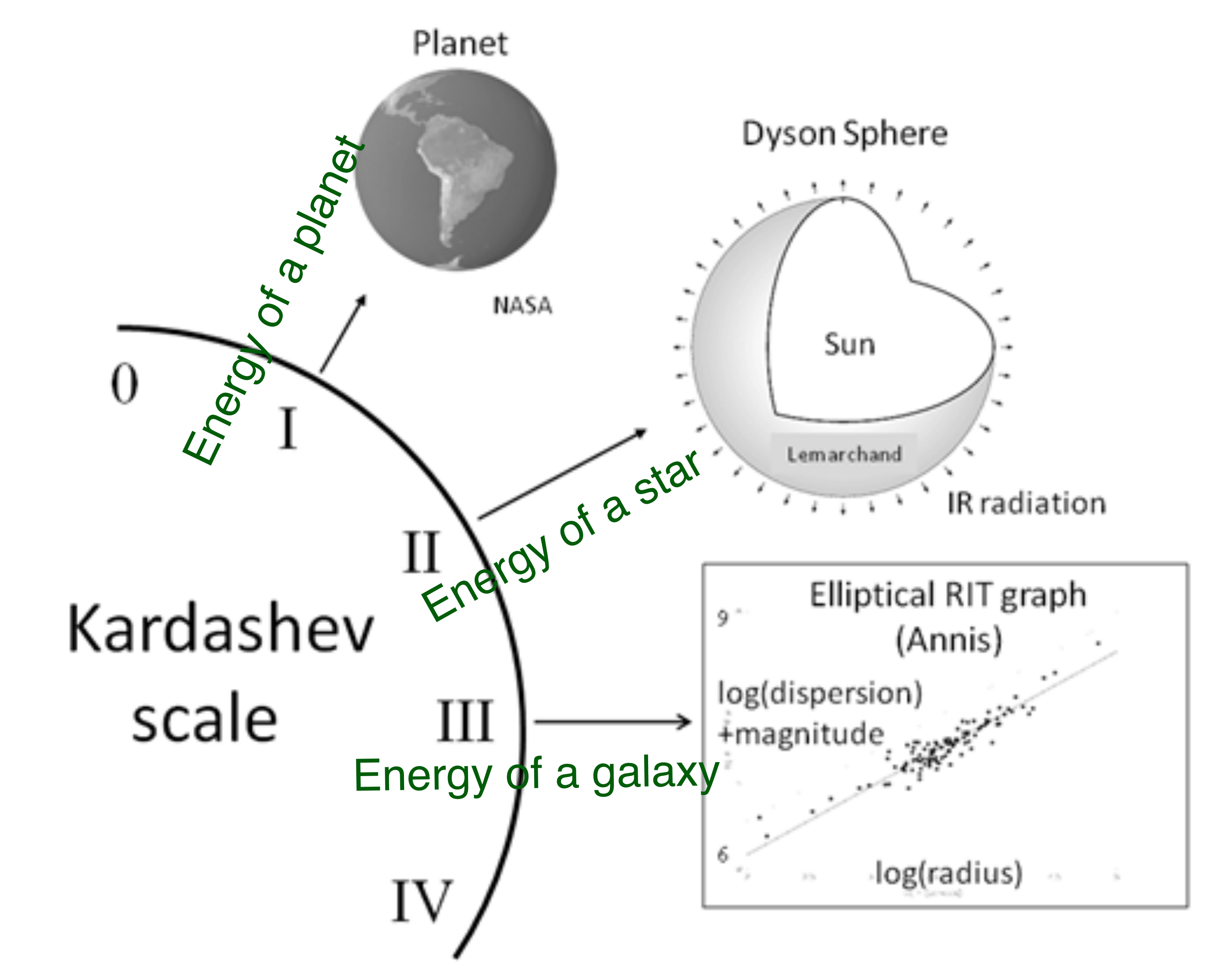
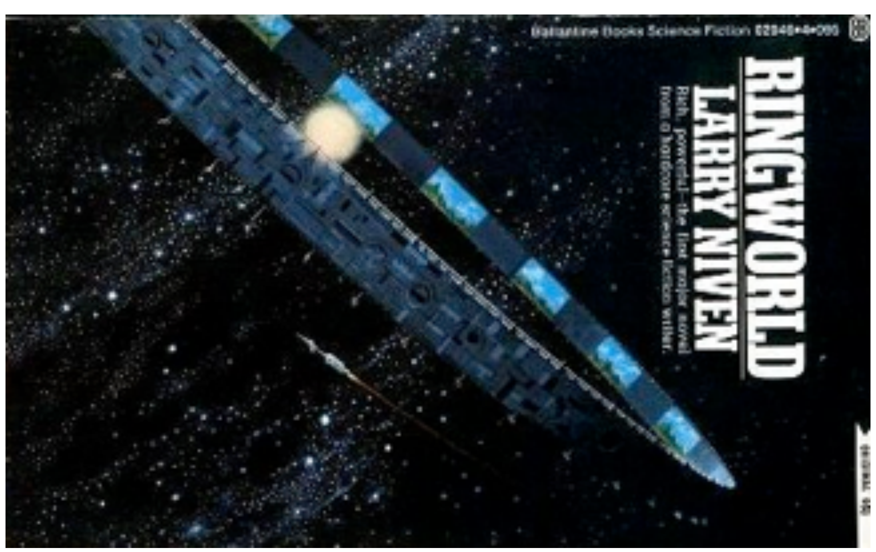
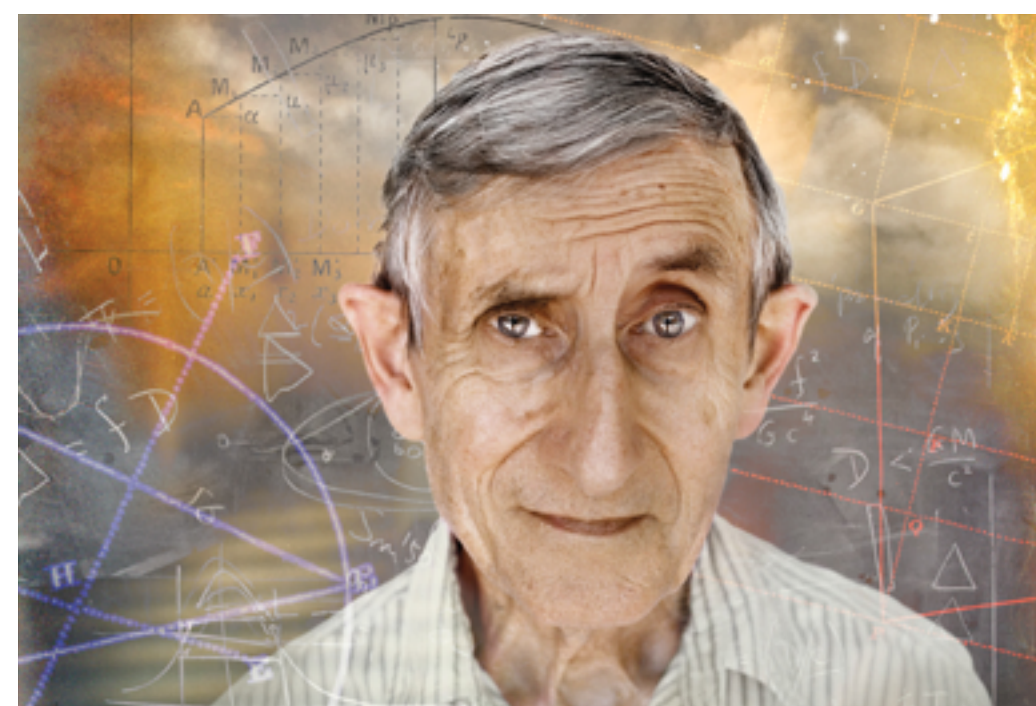


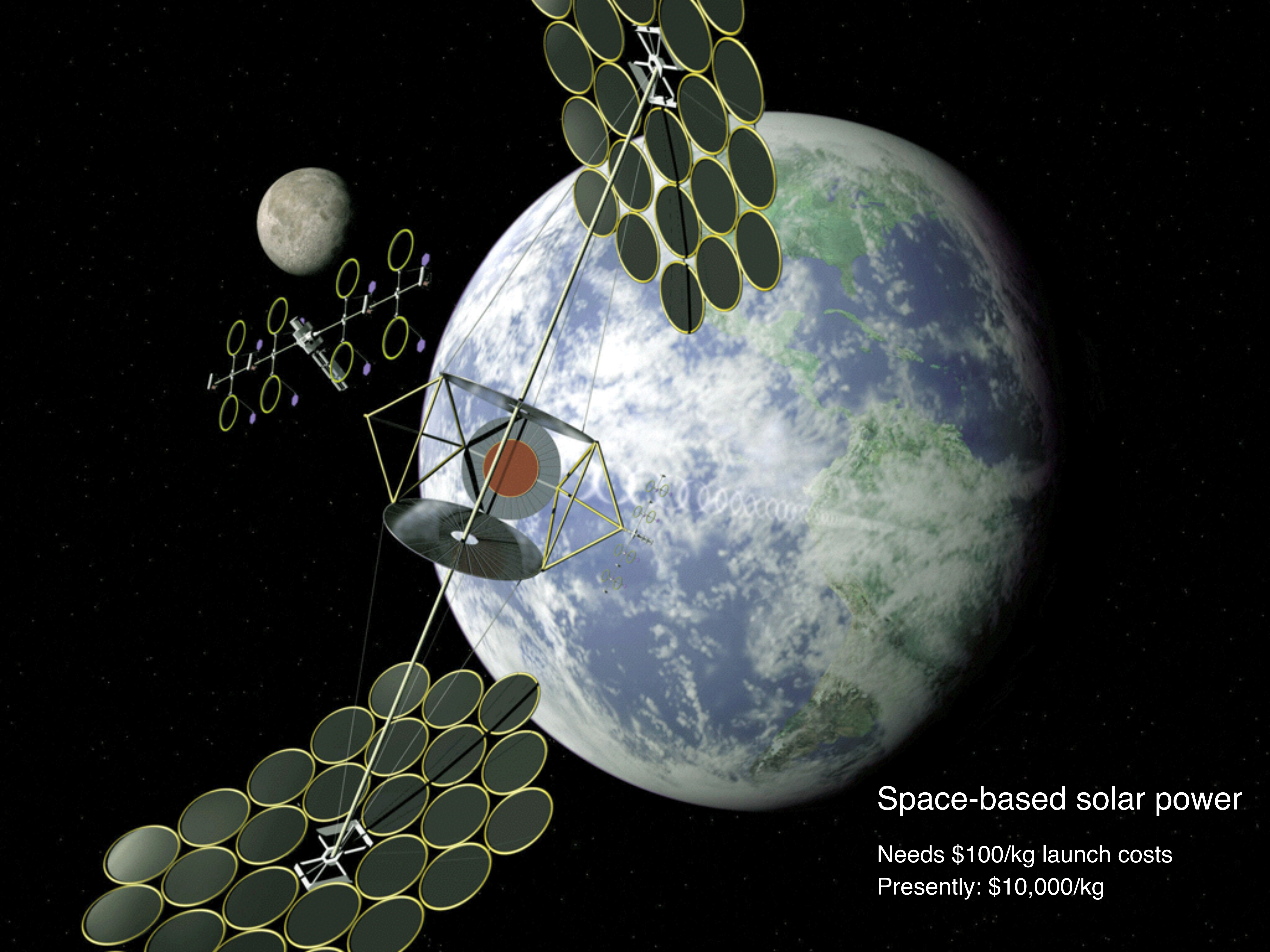
Nikolai Kardashev





Freeman Dyson

Kardashev scale, Dyson swarms (or rings or spheres)



Space-based solar power

Needs $100/kg launch costs
Presently: $10,000/kg

Space-based solar power

Needs $100/kg launch costs

CAPABILITIES & SERVICES

SpaceX offers open and fixed pricing for its launch services. Modest discounts are available for contractually committed, multi-launch purchases. Prices shown below are paid in full standard launch prices for 2013. SpaceX can also offer crew transportation services to commercial customers seeking to transport astronauts to alternate LEO destinations. Please contact sales@spacex.com for details.

FALCON 9 →

FALCON HEAVY →

PRIVATE CREW PROGRAM →

PRICE	FALCON 9	FALCON HEAVY	
PAID IN FULL STANDARD LAUNCH PRICES (2013)	$56.5M	$77.1M Up to 6.4 ton to GTO	$135M Greater than 6.4 ton to GTO

PERFORMANCE	FALCON 9 INCLINATION	FALCON 9 PERFORMANCE	FALCON HEAVY INCLINATION	FALCON HEAVY PERFORMANCE
LOW EARTH ORBIT (LEO)	28.5°	13,150 kg 28,991 lb	28.5°	53,000 kg 116,845 lb
GEOSYNCHRONOUS TRANSFER ORBIT (GTO)	27°	4,850 kg 10,692 lb	27°	21,200 kg 46,738 lb

$11,700/kg

$6,370/kg

From “**Do the Math**”

I sense that people have a tendency to think space is easy… Once in space, failures cannot be serviced. The usual mitigation strategy is redundancy, adding weight and cost. A space-based solar power system might sound very cool and futuristic, and it may seem at first blush an obvious answer to intermittency, but this comes at a big cost. Among the possibly unanticipated challenges:

- **The gain over the a good location on the ground is only a factor of 3 (2.4× in summer, 4.2× in winter at 35° latitude).**
- It’s almost as hard to get energy back to the ground as it is to get the equipment into space in the first place.
- The microwave link faces problems with transmission through the atmosphere, and also flirts with roasting ducks on the wing.
- Diffraction of the downlink beam, together with energy density limits, means that very large areas of the ground still need to be dedicated to energy collection.

- See more at: http://physics.ucsd.edu/do-the-math/2012/03/space-based-solar-power/#sthash.k4Wv6o77.dpuf