

Escuela Oficial de Idiomas
de Gijón

JORNADA POR UN MUNDO SOSTENIBLE

14 DE MARZO DE 2017

PROYECTO ERASMUS+ ACCIÓN KA 1
HORIZONTE 2020.

FUTURE ENERGY TODAY

John K. White

1. World energy use

2. What's a watt?

3. The sun and the wind

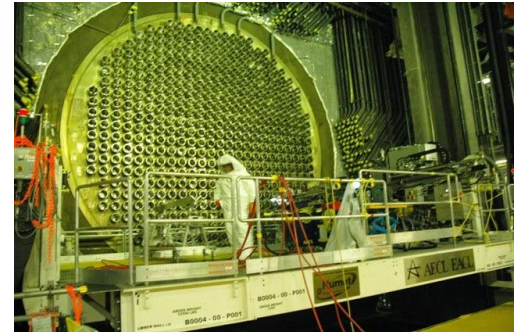
4. Spain and the world

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4. Spain and the world



Solar

Coal

Oil

Wind

Gas

Hydro

Nuclear



Coal

Oil

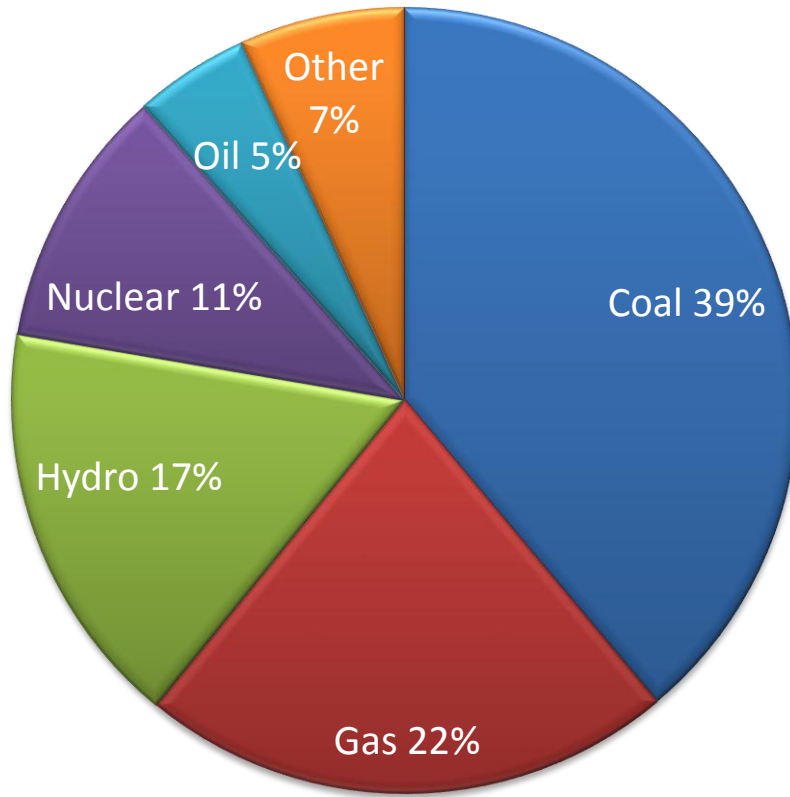
Gas

Nuclear

Hydro

Wind





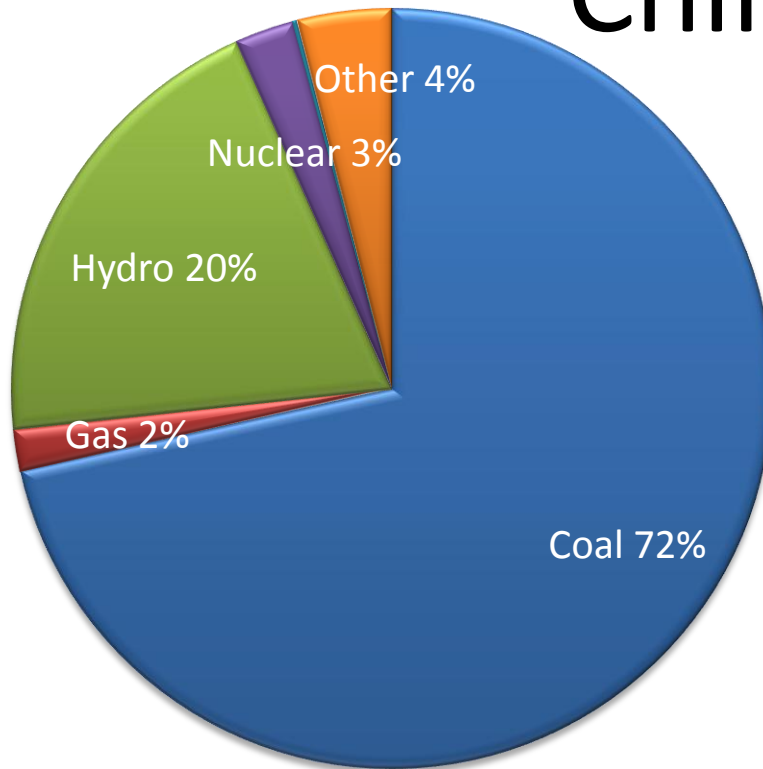
World Electricity (TWh)

Coal	8 726
Gas	4 933
Hydro	3 769
Nuclear	2 417
Oil	1 068
Other	1 520

Total 22 433

Total: 22 PWh

China



Electricity (TWh)

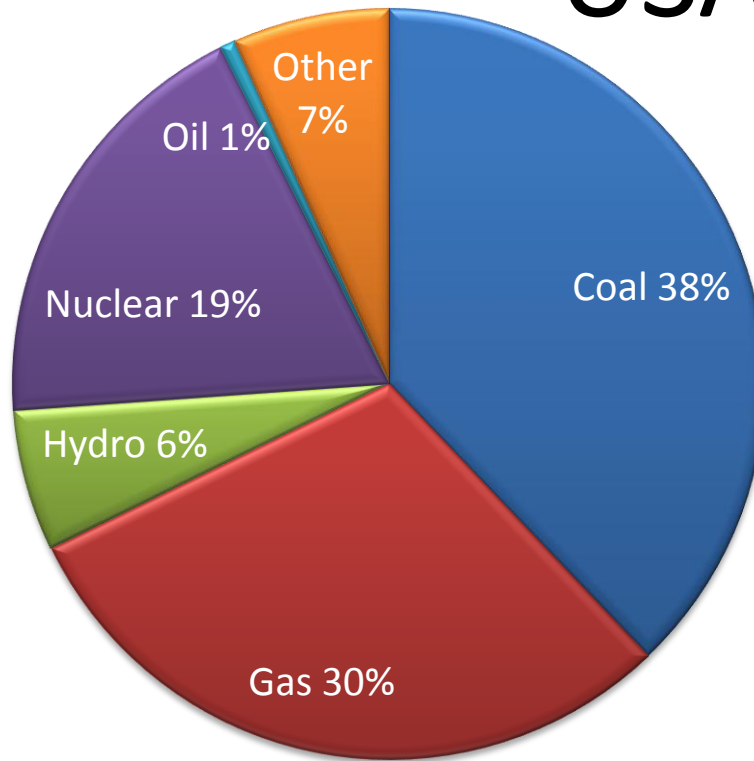
Coal	3 681
Gas	91
Hydro	1 039
Nuclear	131
Oil	9
Other	204

Total 5 145 (23%)

Middle
Kingdom



USA



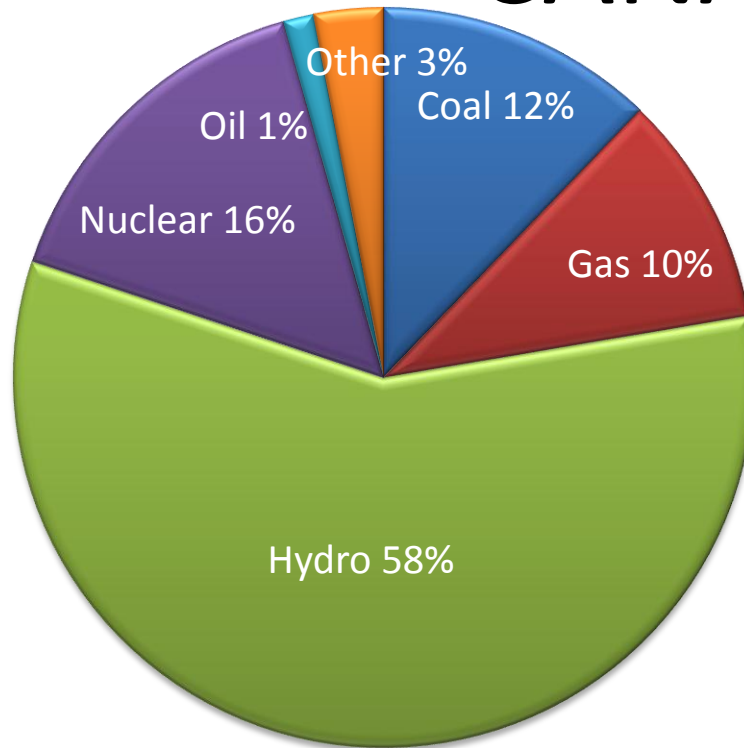
Electricity (TWh)

Coal	1 612
Gas	1 272
Hydro	259
Nuclear	797
Oil	29
Other	285
Total	4 256 (19%)

Stars and
Stripes



CANADA



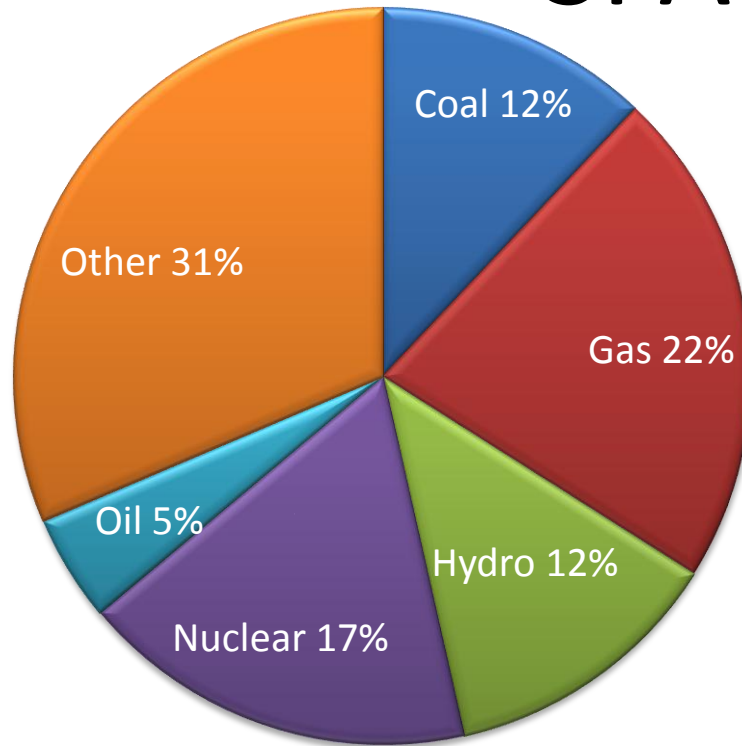
Electricity (TWh)

Coal	79
Gas	66
Hydro	375
Nuclear	101
Oil	9
Other	20
Total	650 (3%)

*A mari usque
ad mare*



SPAIN



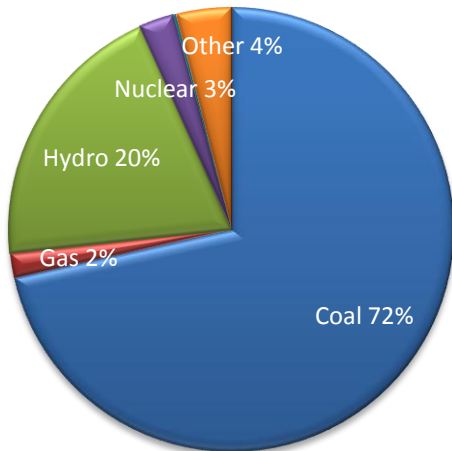
Electricity (TWh)

Coal	38
Gas	69
Hydro	40
Nuclear	55
Oil	15
Other	99
Total	314 (1%)

Plus ultra



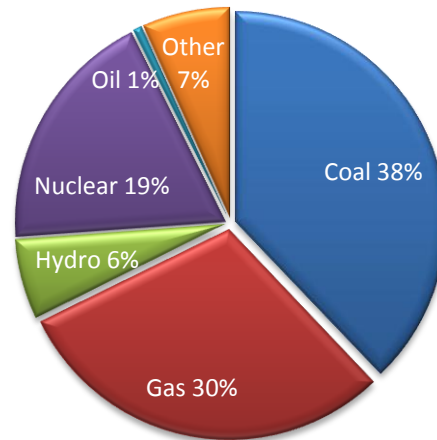
China



Electricity (TWh)

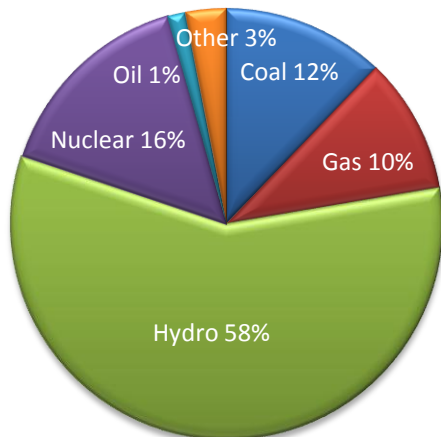
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Electricity (TWh)

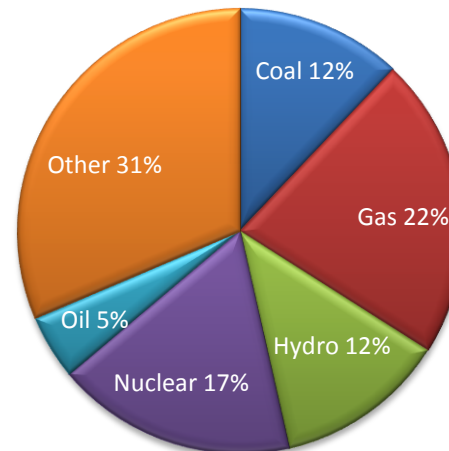
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Electricity (TWh)

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Spain

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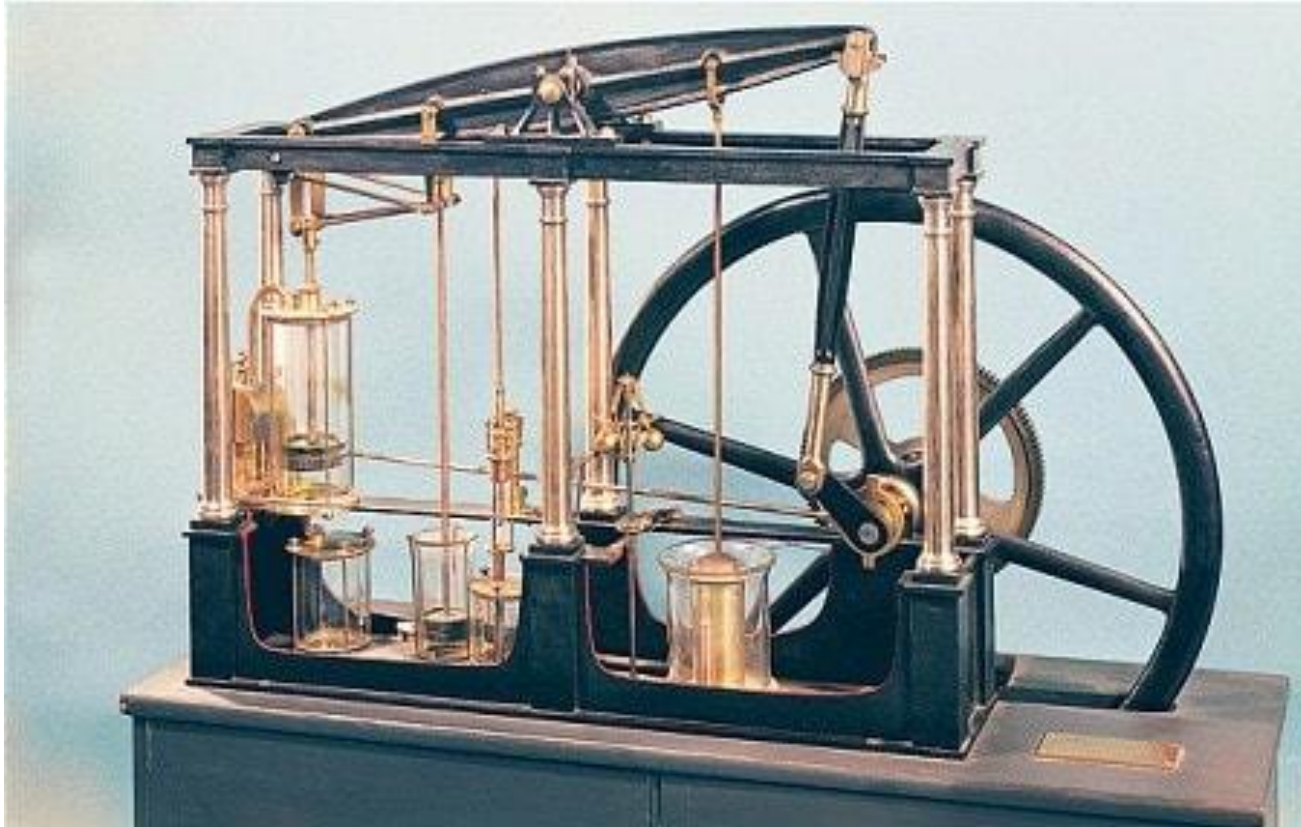
4. Spain and the world

So ...

What *IS* a watt?

- A. An English waffle
- B. An aquatic animal
- C. A Doctor Seuss character
- D. A unit of power

James Watt



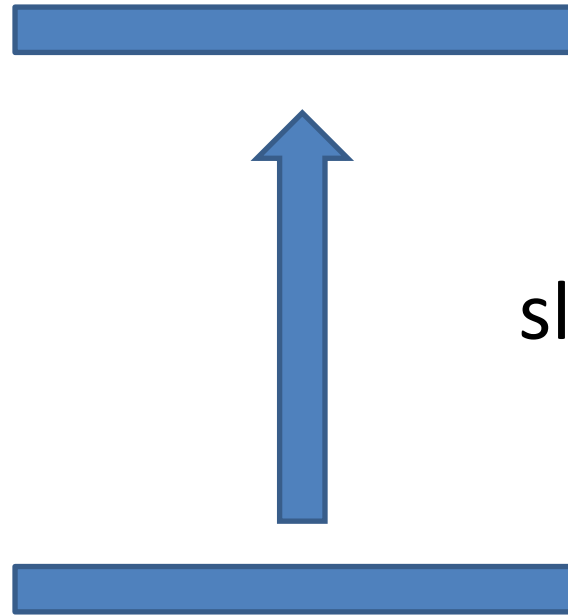
746 watts = 1 hp

James Watt



746 watts = 1 hp

Energy / Power



slow or fast

joule / watt

And ...

How many kilowatt-hours per day do you use?

- A. 3 kWh
- B. 30 kWh
- C. 300 kWh
- D. 3000 kWh

= €3/day @ €0.10/kWh per day

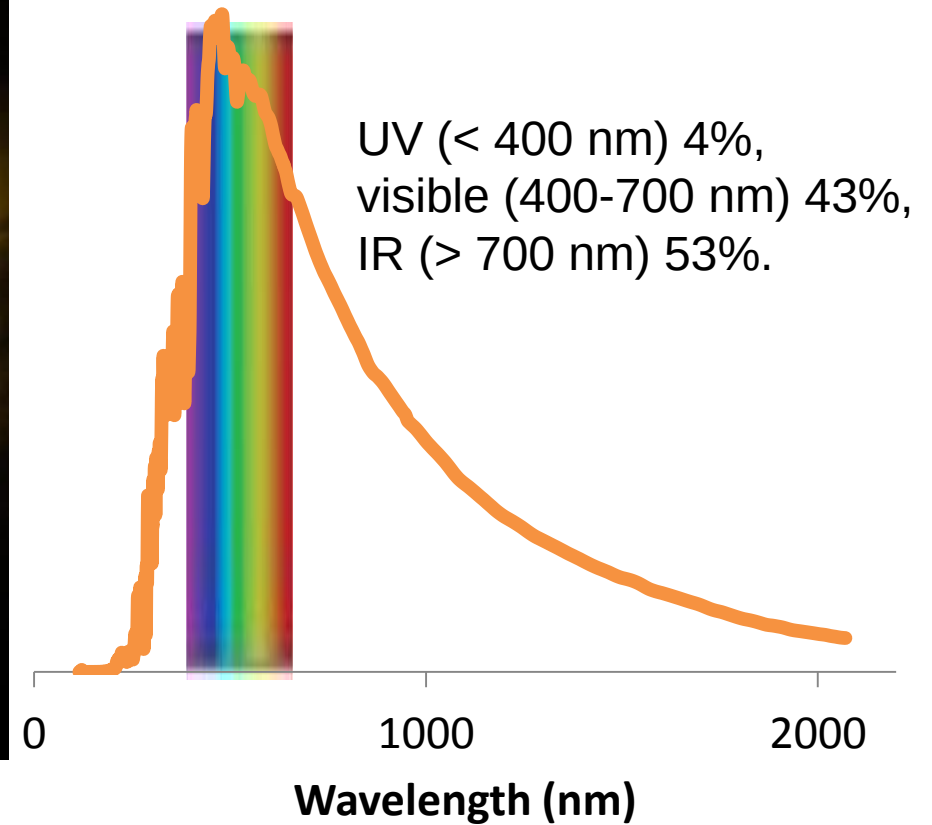
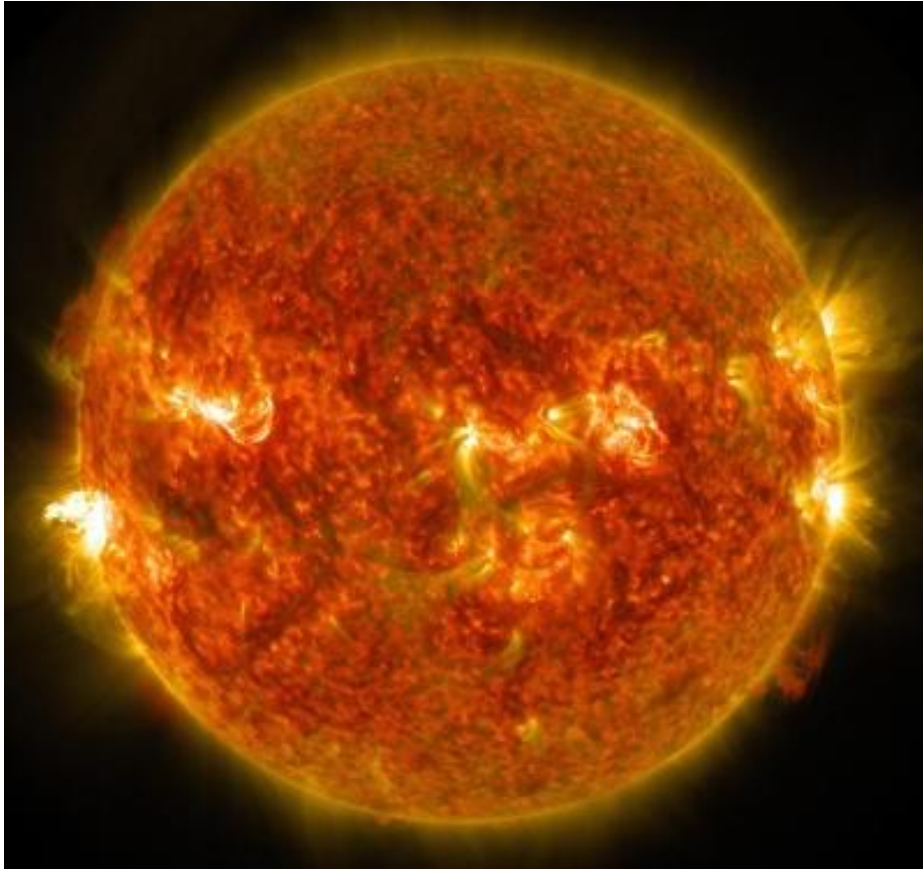
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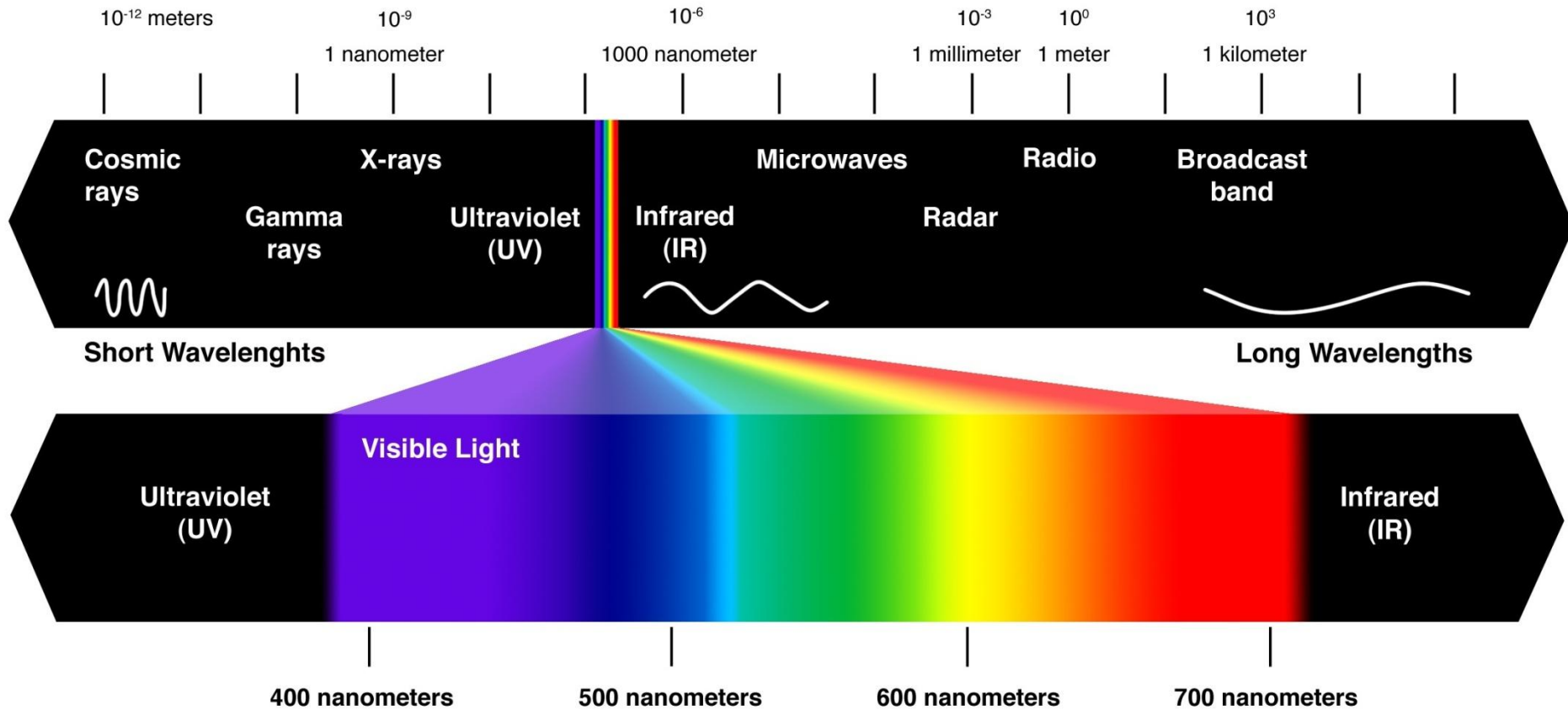
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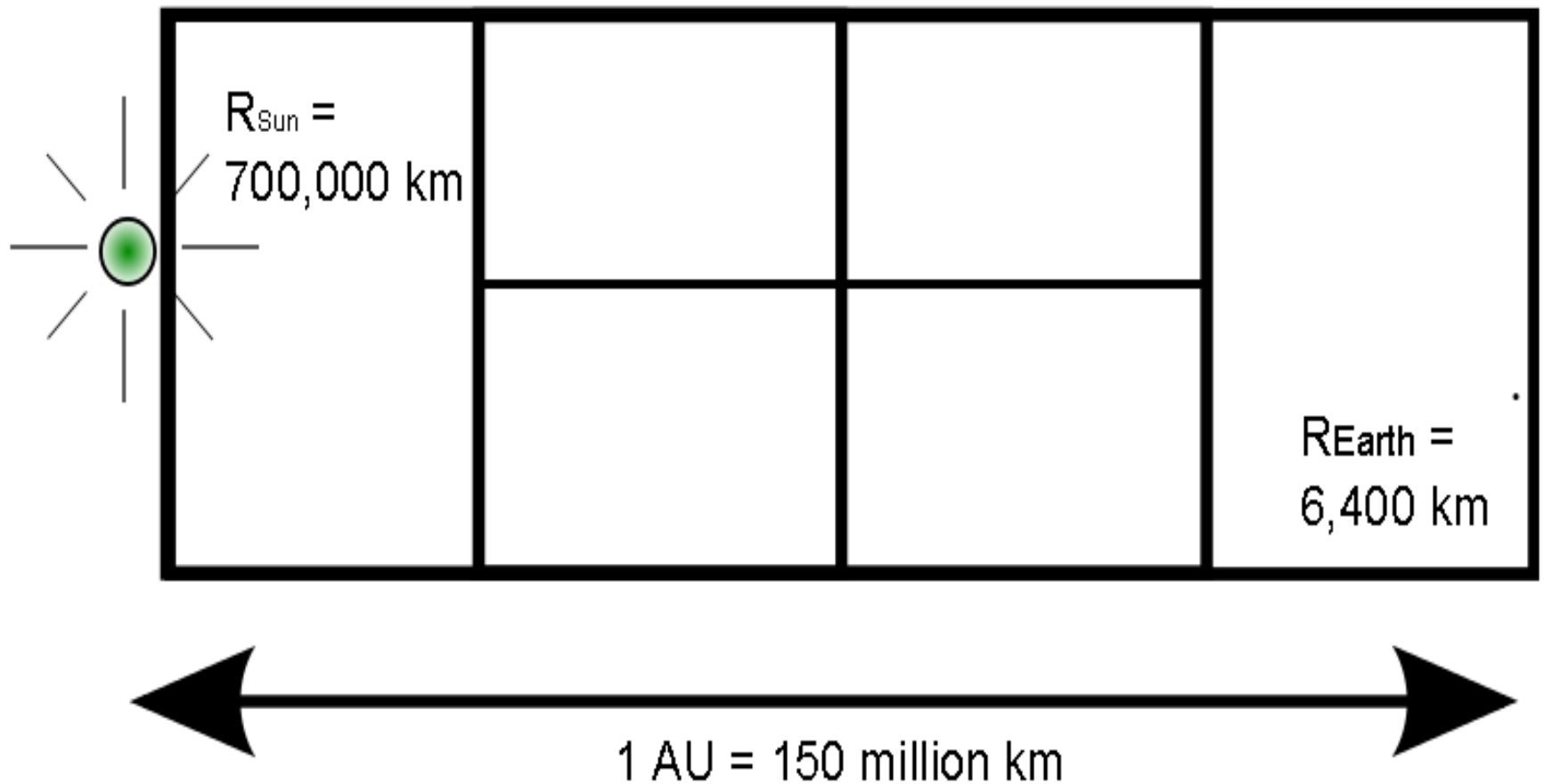
THE SUN



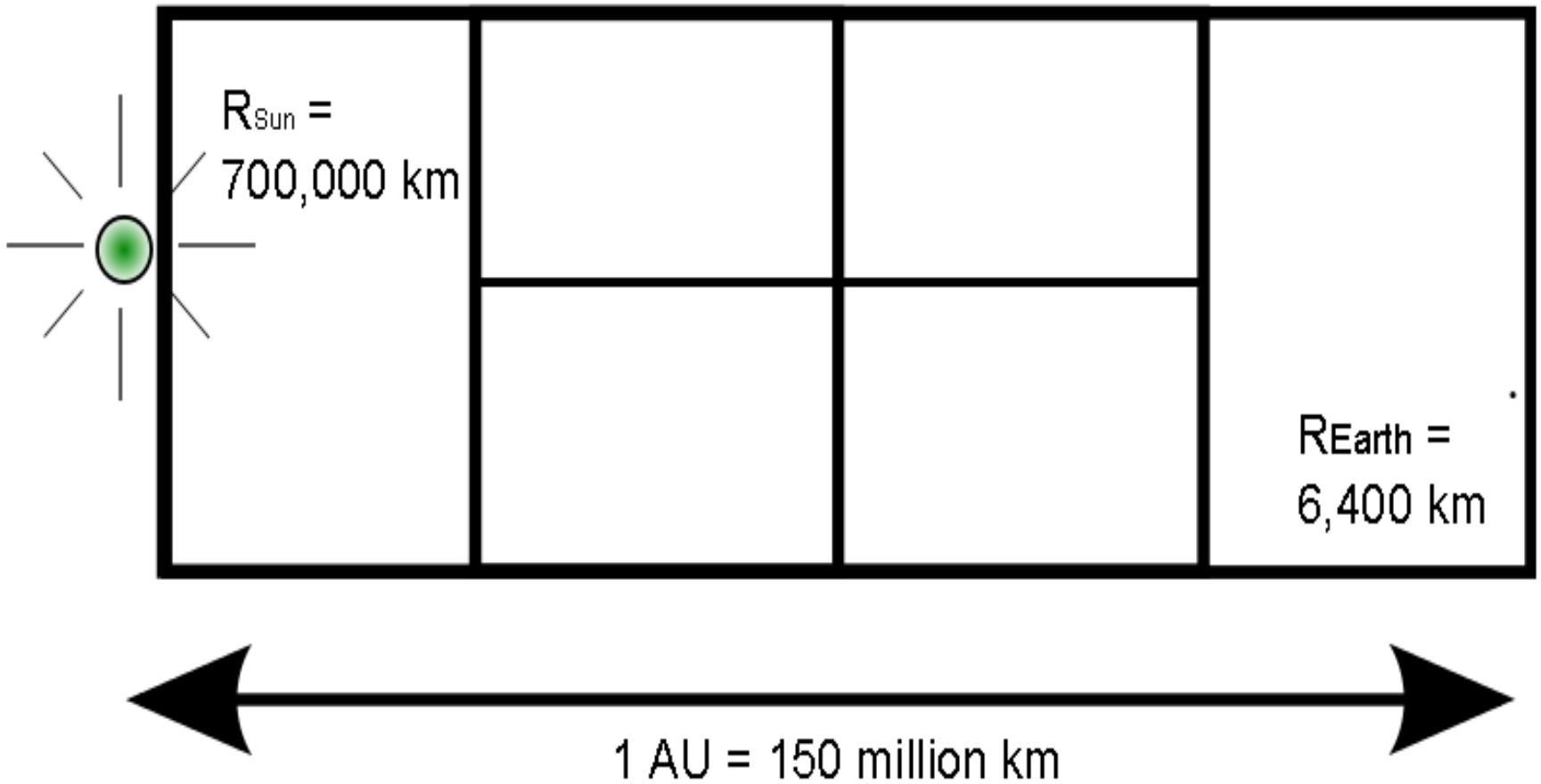
indigo 445 nm blue 475 nm green 510 nm
yellow 570 nm orange 590 nm red 650 nm

THE SUN

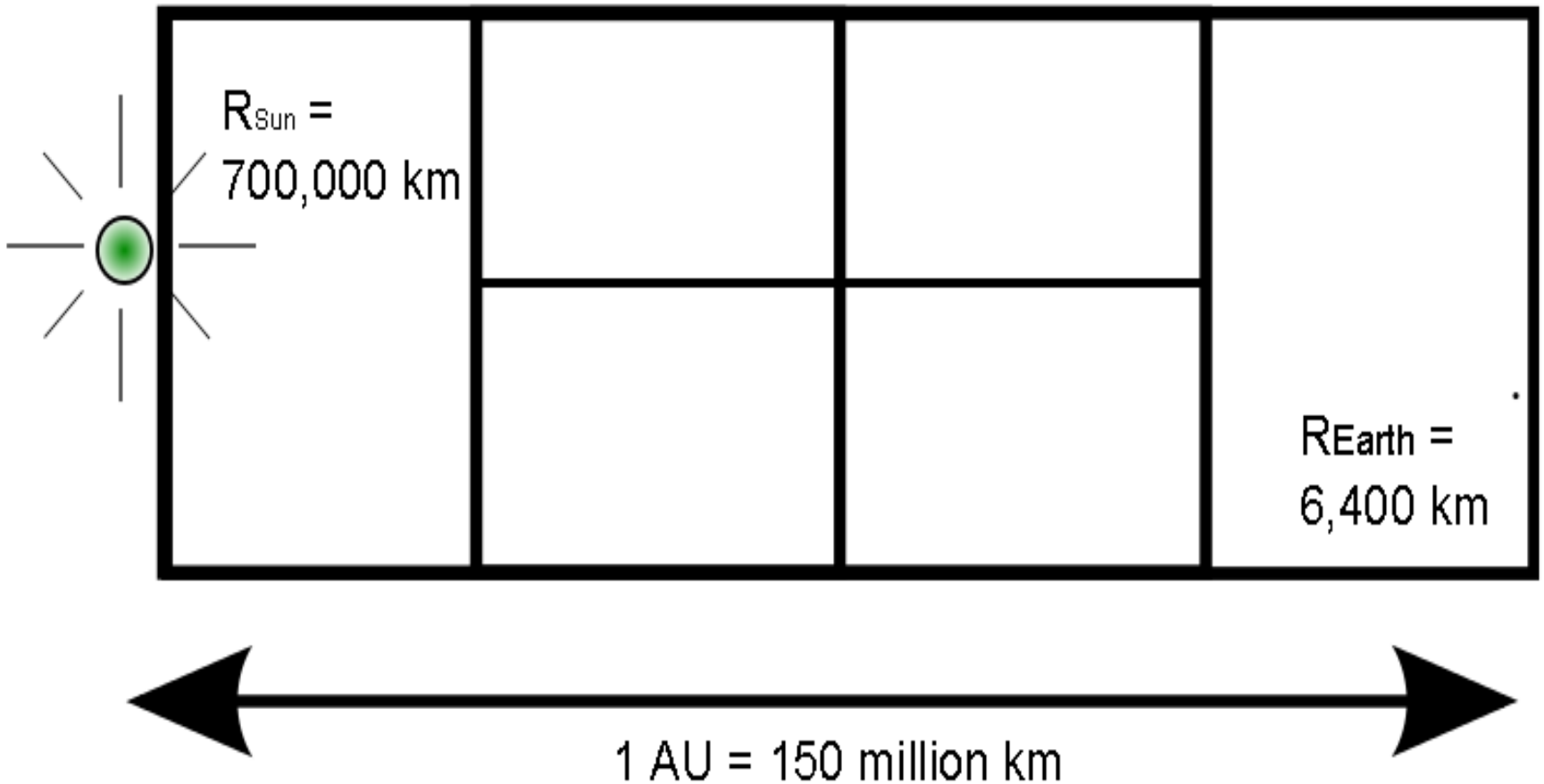




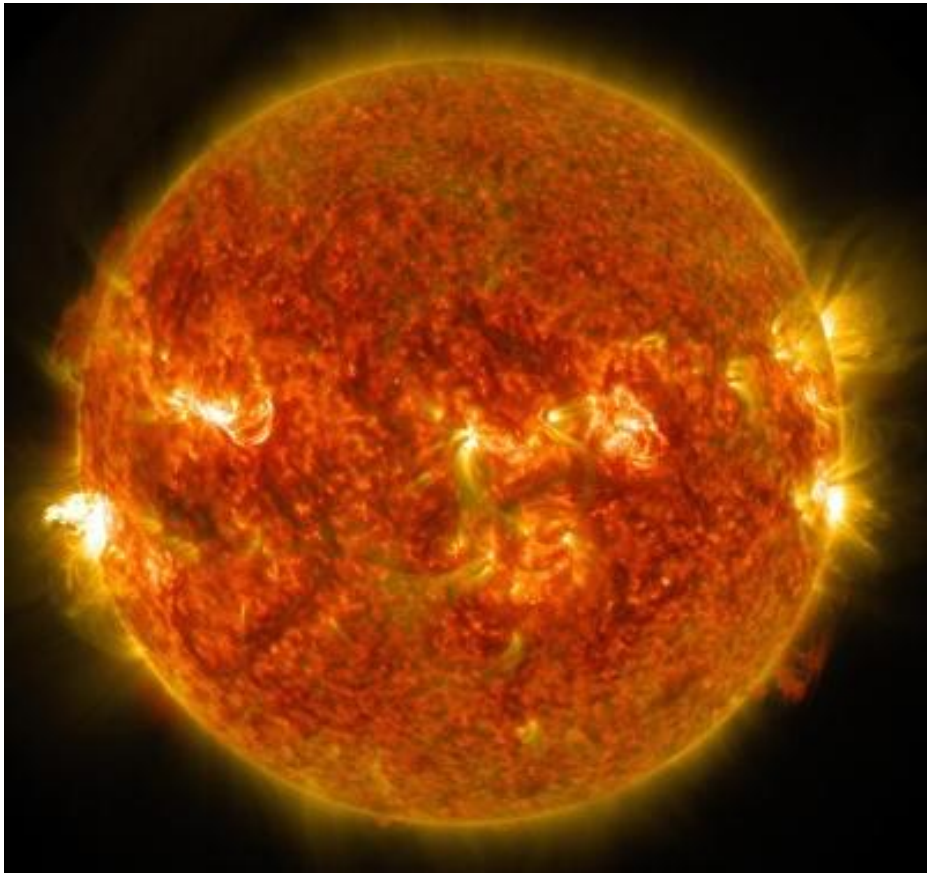
1 / 2 billionth of the sun's energy
makes it to earth



HOW MUCH TIME?



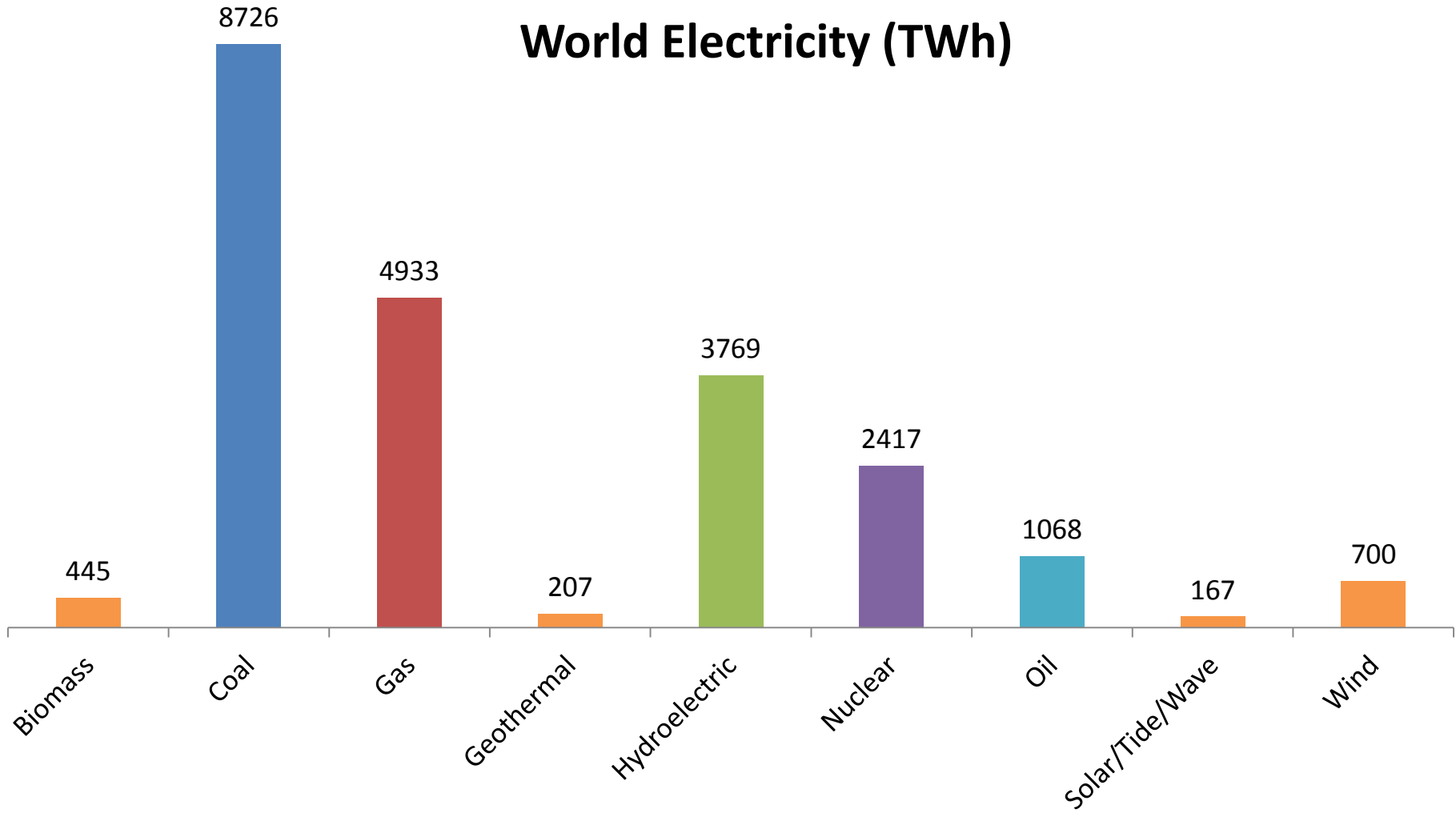
$$\begin{aligned}\text{time} &= \text{distance} / \text{speed} \\ &= 150 \times 10^9 \text{ m} / 3 \times 10^8 \text{ m/s} \\ &= 500 \text{ seconds or } \sim \mathbf{8.3 \text{ minutes}}\end{aligned}$$



1 HOUR

=

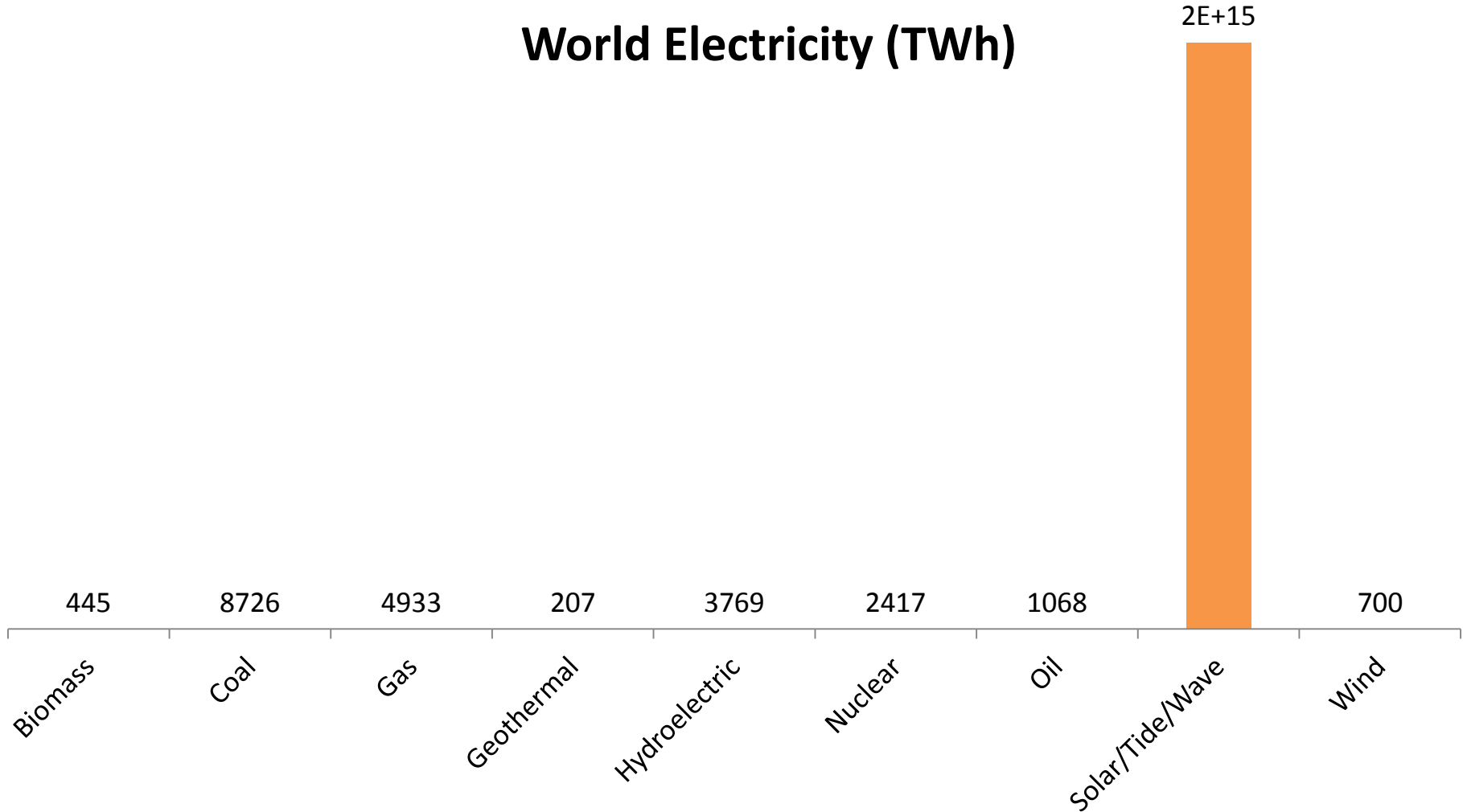
1 YEAR



“Solar energy’s potential is off the chart.”

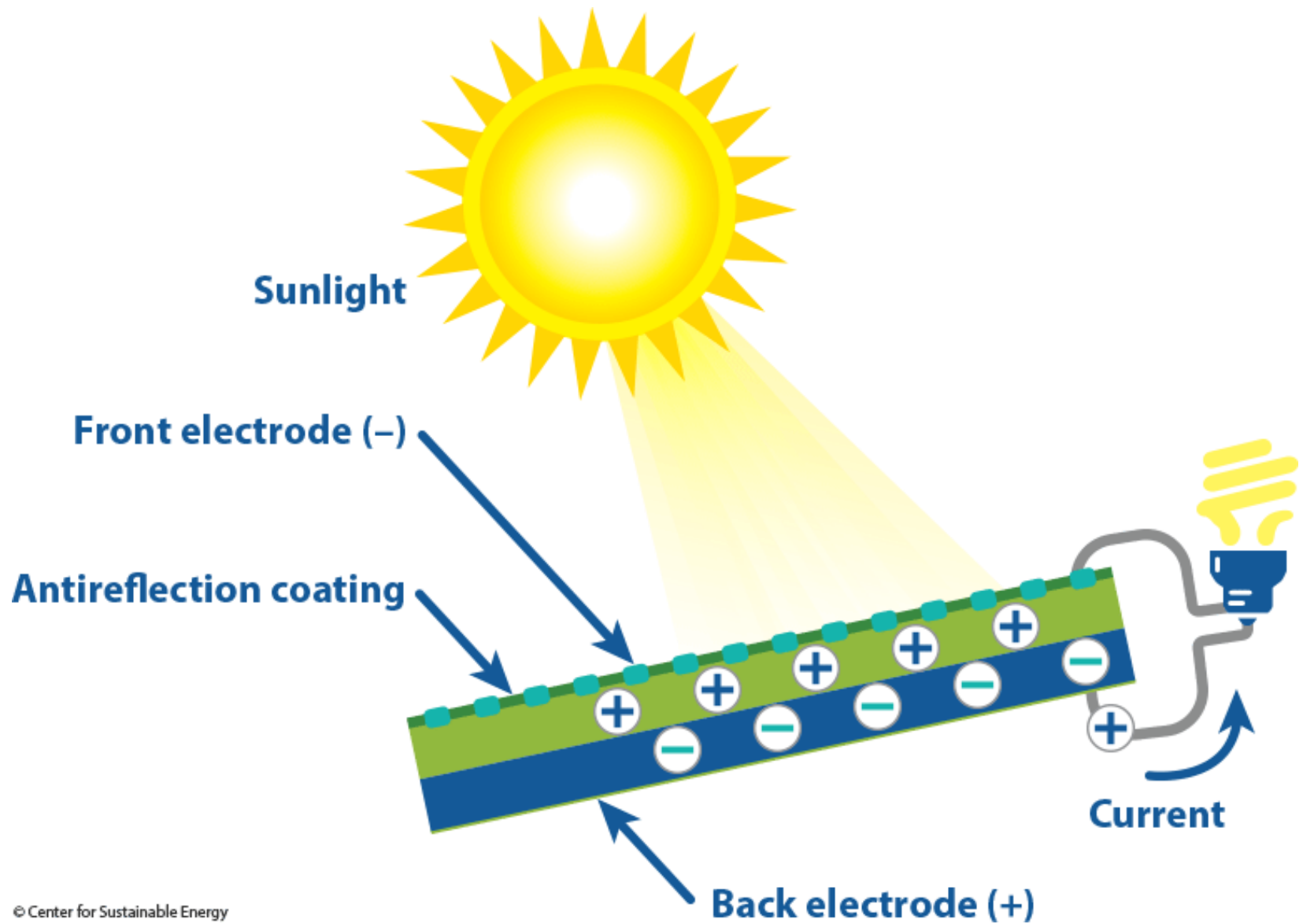
Scientific American, January, 2008

World Electricity (TWh)



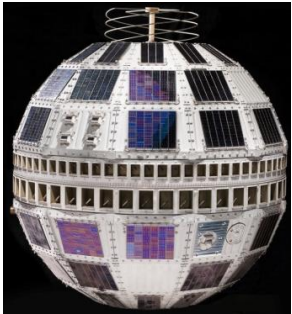
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Scientific American, January, 2008



© Center for Sustainable Energy

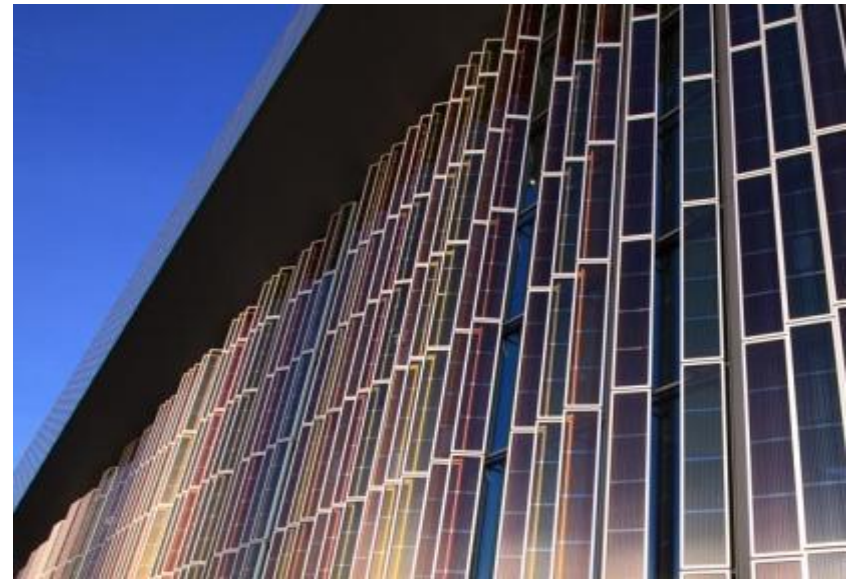
Photons to electrons



From Telstar (14 W) to the ISS (120 kW)



PV installation: rooftop, ground, parking lot, warehouse



Building-integrated PV (BIPV)

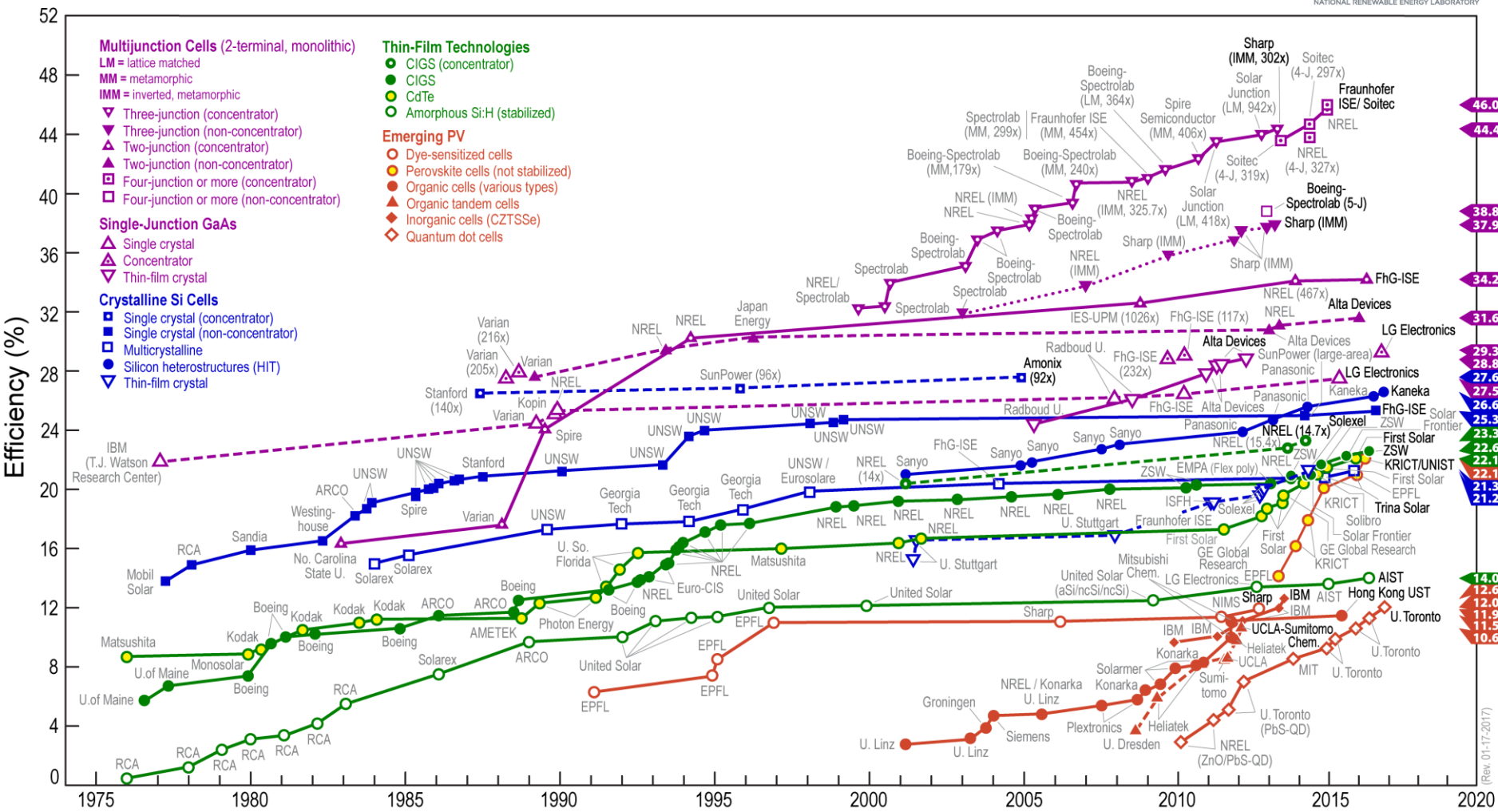


5.6-MW Carrizo Plains PV solar plant in San Luis Obispo County



1-GW Yanchi PV solar plant in Qinghai, China

Best Research-Cell Efficiencies



(Rev. 01-17-2017)



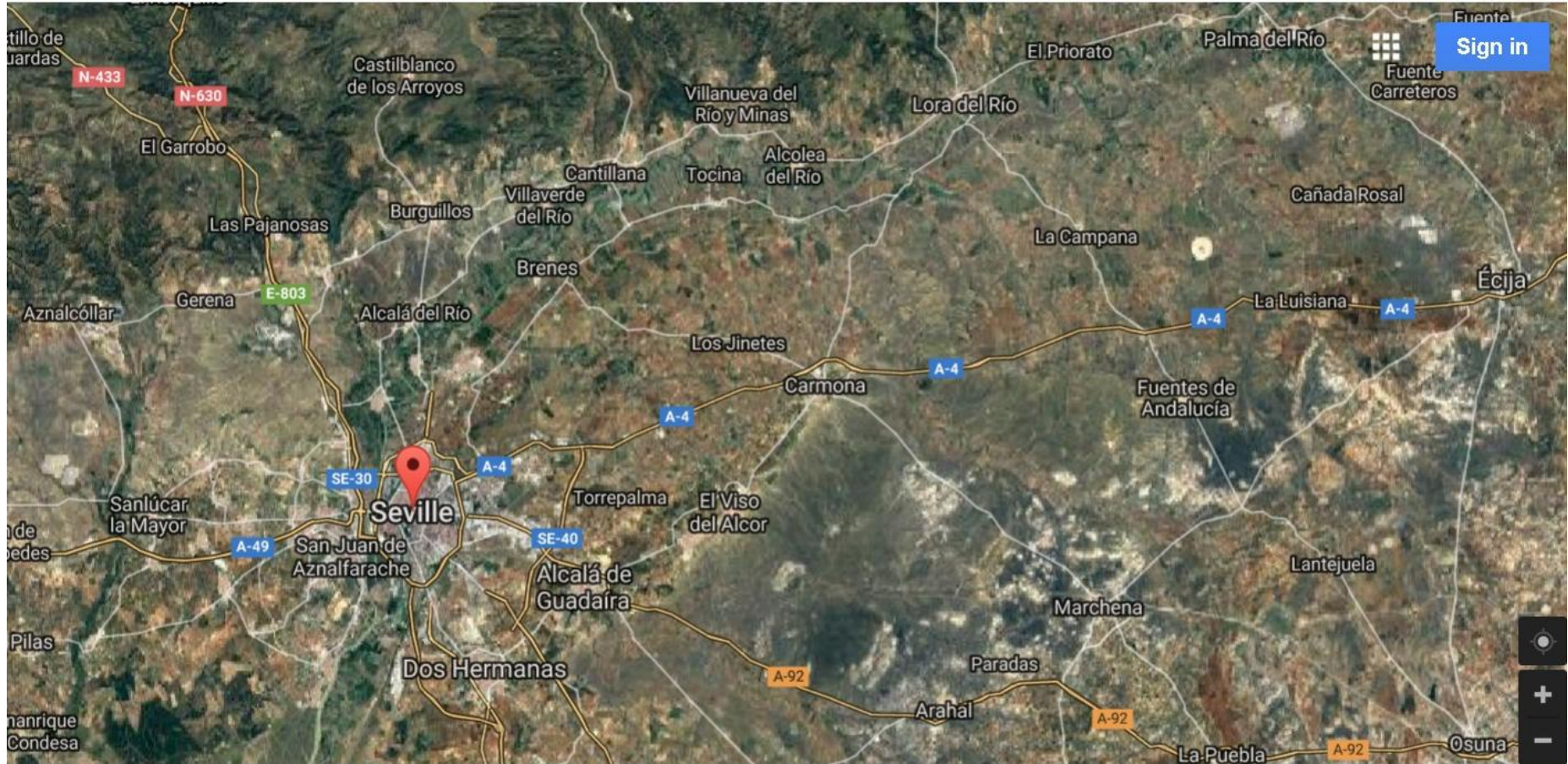
Hybrid: solar concentrator and PV



Noor1 Morocco – parabolic trough



PS10 Sevilla – power tower



Google Maps (Satellite): Andalusia, Spain



El ingenioso hidalgo don Quijote de la Mancha

“Destiny guides our fortunes more favourably than we could have expected. Look there, Sancho Panza, my friend, and see those thirty or so wild giants, with whom I intend to do battle and kill each and all of them, so with their stolen booty we can begin to enrich ourselves. This is noble, righteous warfare, for it is wonderfully useful to God to have such an evil race wiped from the face of the earth.”

"What giants?" Asked Sancho Panza.

"The ones you can see over there," answered his master, "with the huge arms, some of which are very nearly two leagues long.”

"Now look, your grace," said Sancho, "what you see over there aren't giants, but windmills, and what seems to be arms are just their sails, that go around in the wind and turn the millstone.”

"Obviously," replied Don Quijote, "you don't know much about adventures.”

— Miguel de Cervantes Saavedra



GE WIND TURBINE

BLADES

Lift and rotate when hit by wind, causing the rotor to spin.

ROTOR

Combination of the blades and hub.

PITCH SYSTEM

Turns blades out of the wind to control rotor speed. Also, stops the rotor from spinning in conditions where wind is blowing too slow or too fast.

GENERATOR

Produces 60-cycle AC electricity within the turbine.

CONTROLLER

Starts and stops the turbine from working, depending on conditions.

YAW DRIVE

Controls upwind turbines to orient them should wind direction change.

TOWER

The base of the turbine, built to support the rest of the structure.



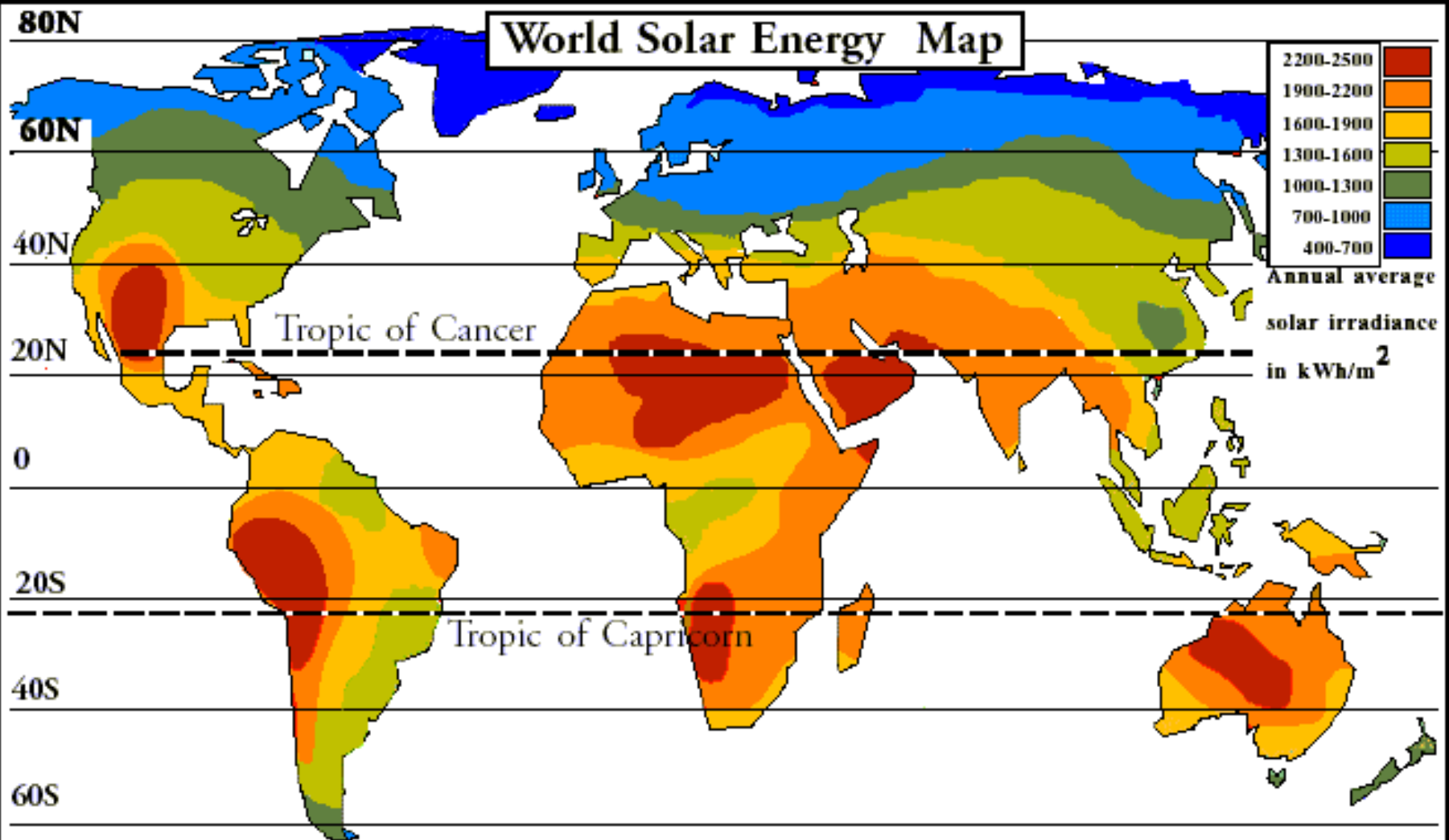
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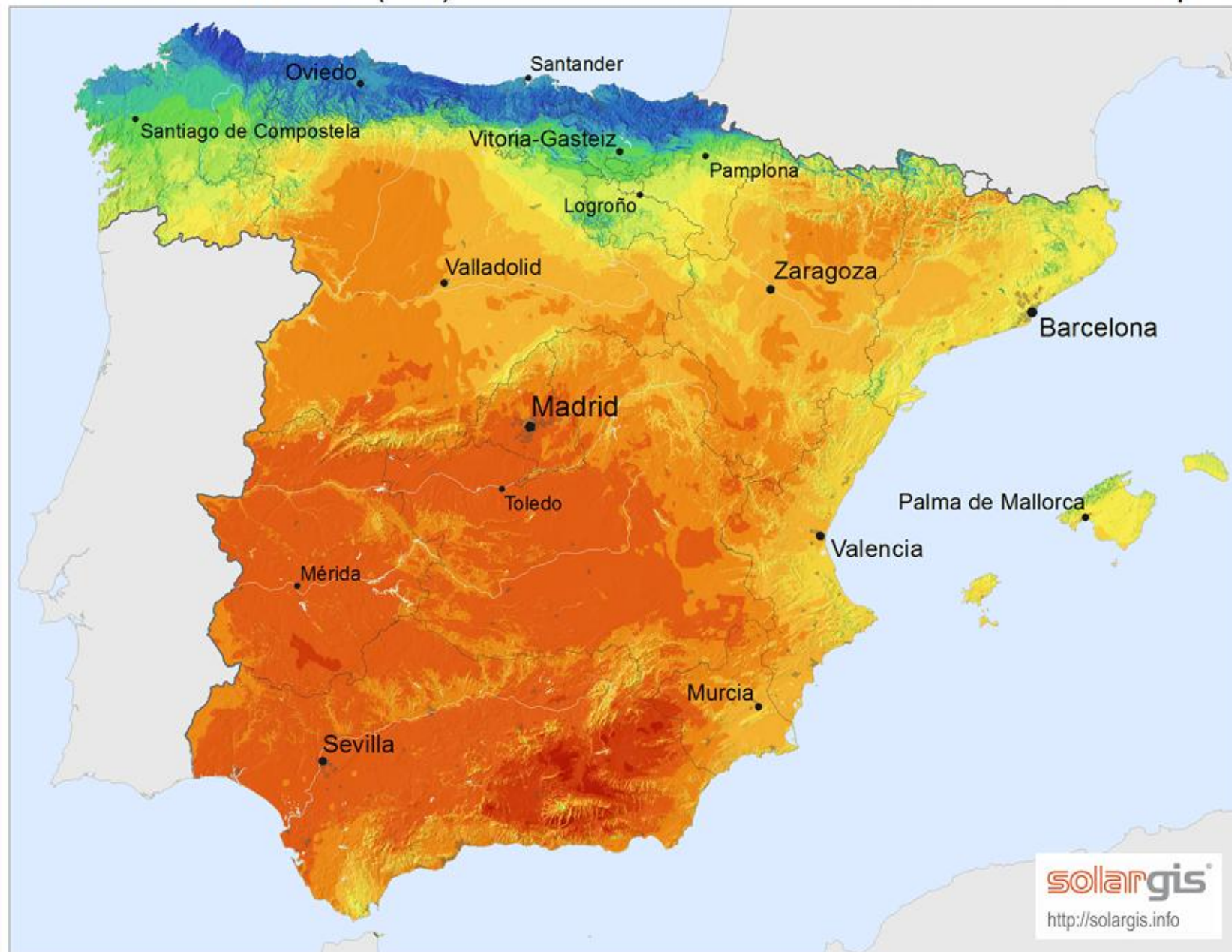
4. Spain and the world

World Solar Energy Map

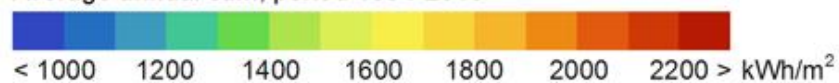




World power in a square

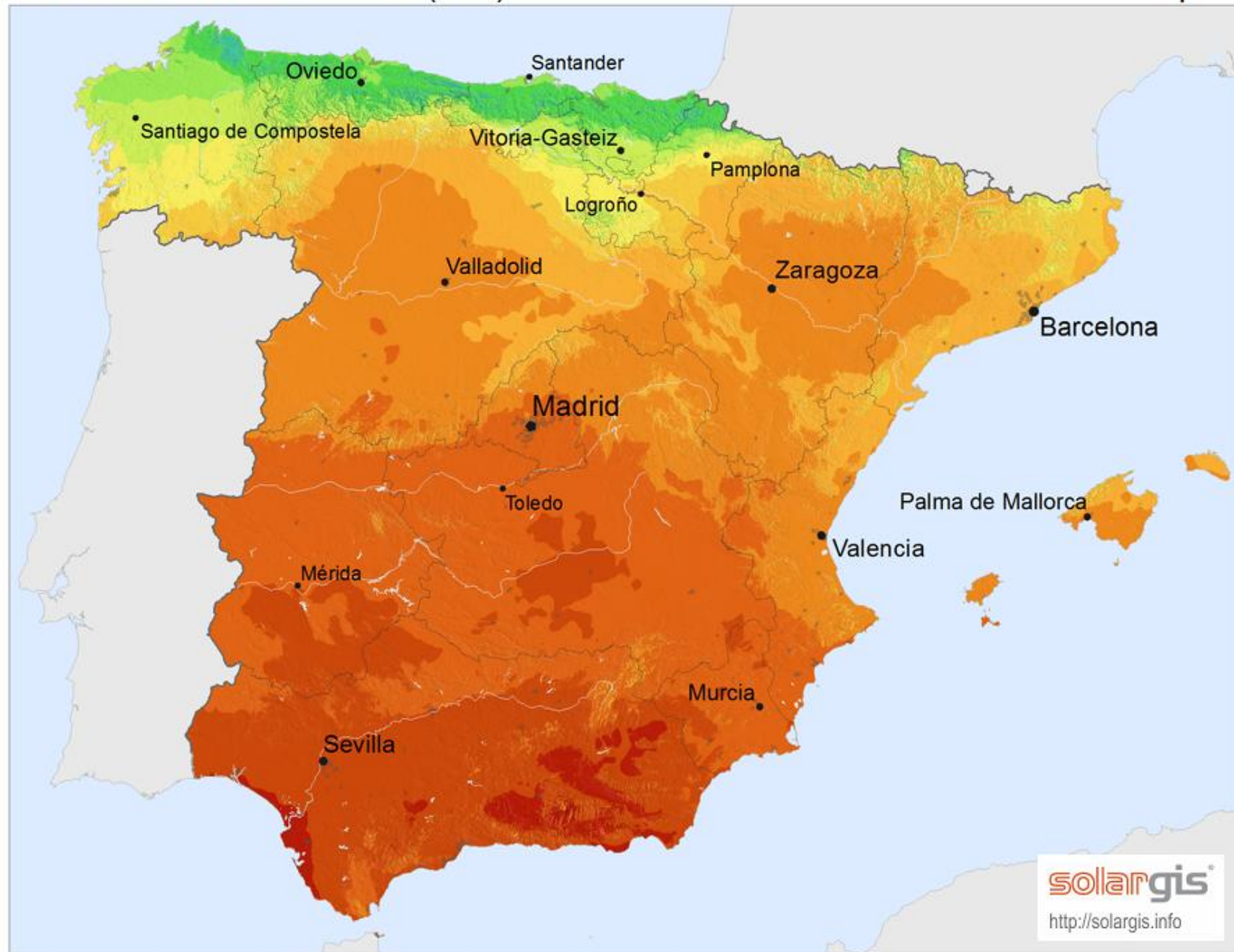


Average annual sum, period 1994-2013



Global Horizontal Irradiation (GHI)

Spain



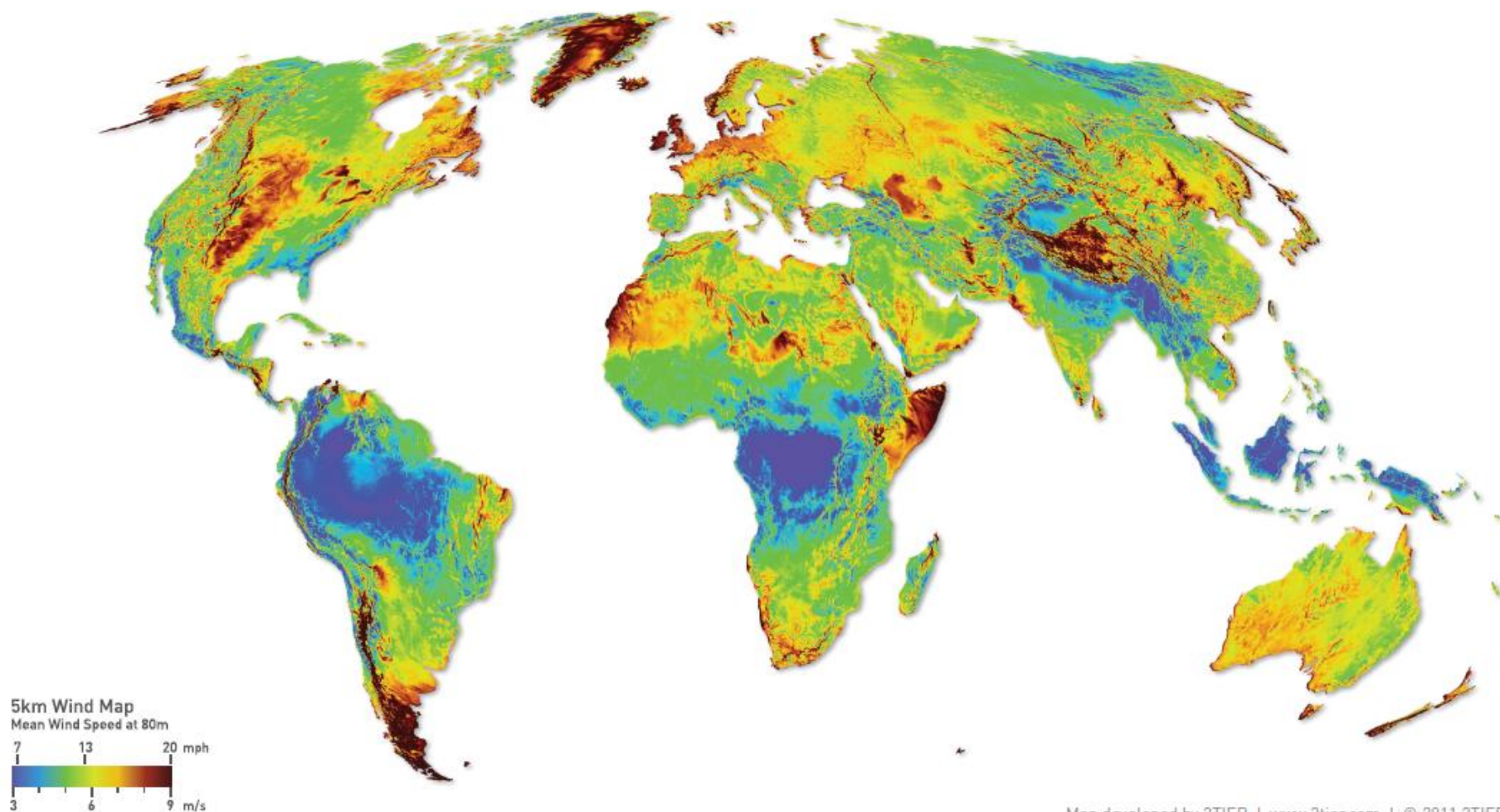
Average annual sum, period 1994-2013



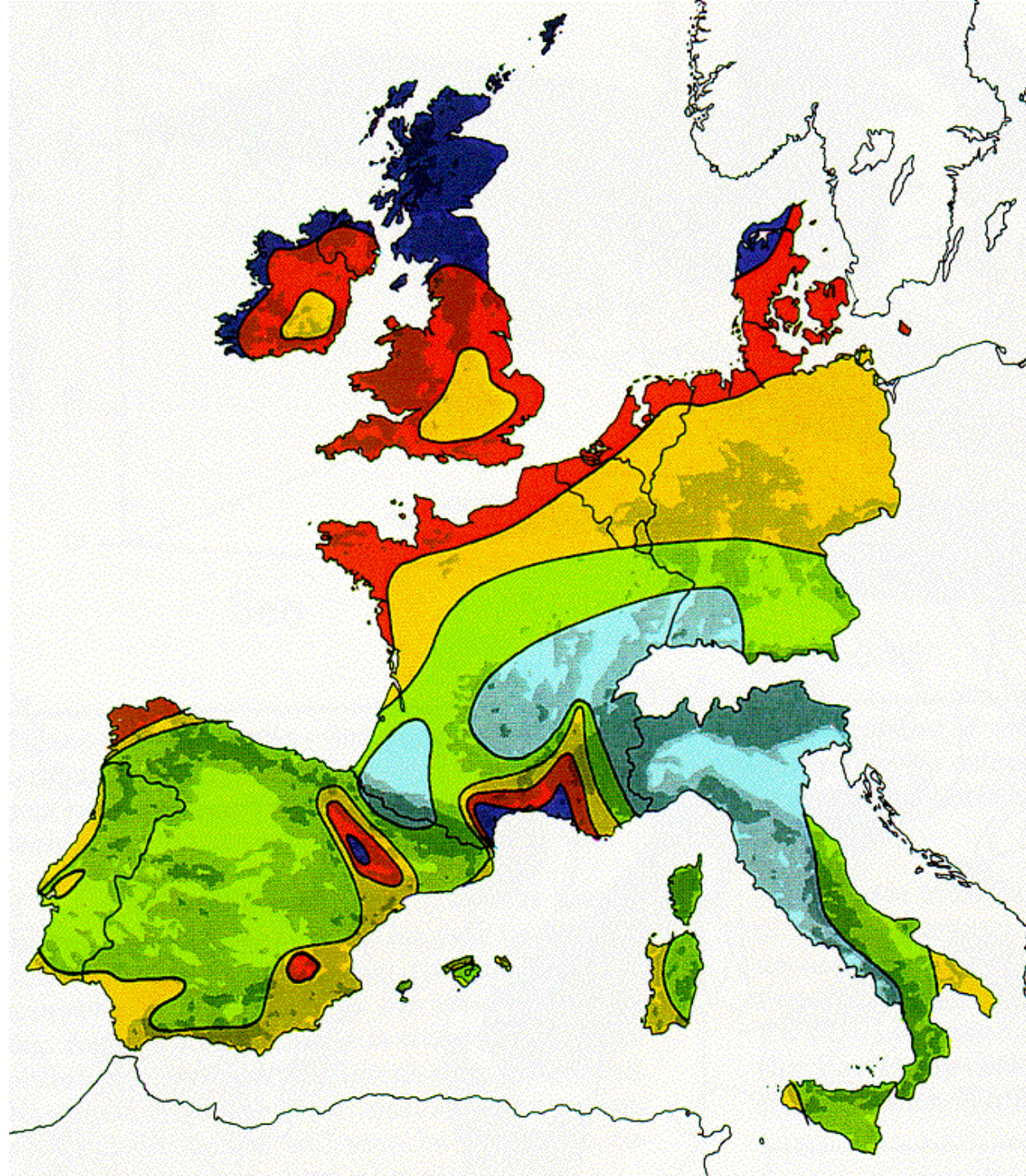
0 50 100 km

solarGIS
<http://solargis.info>

Global Mean Wind Speed at 80m



Map developed by 3TIER | www.3tier.com | © 2011 3TIER Inc.





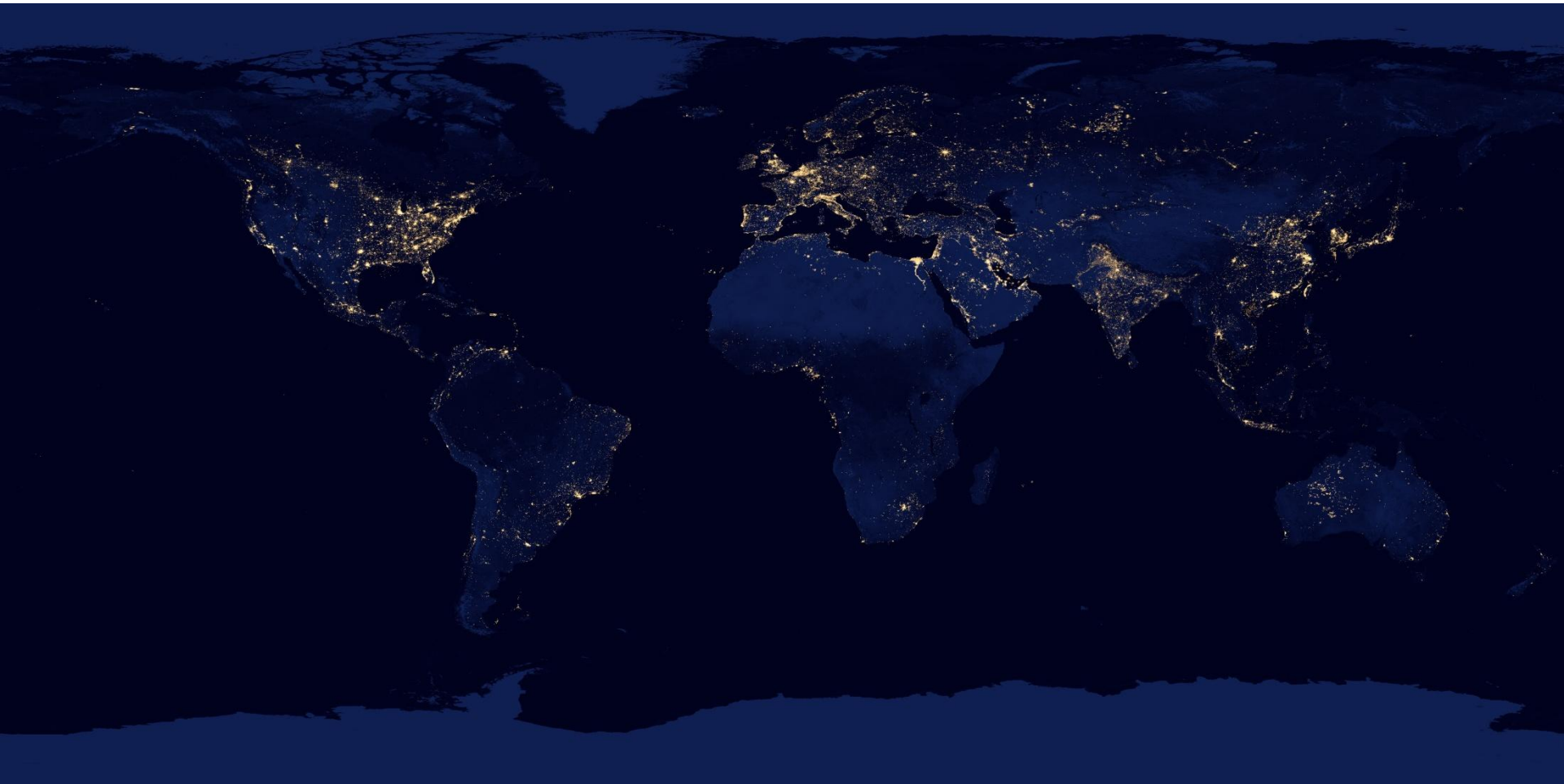
El Hierro: Wind and hydro



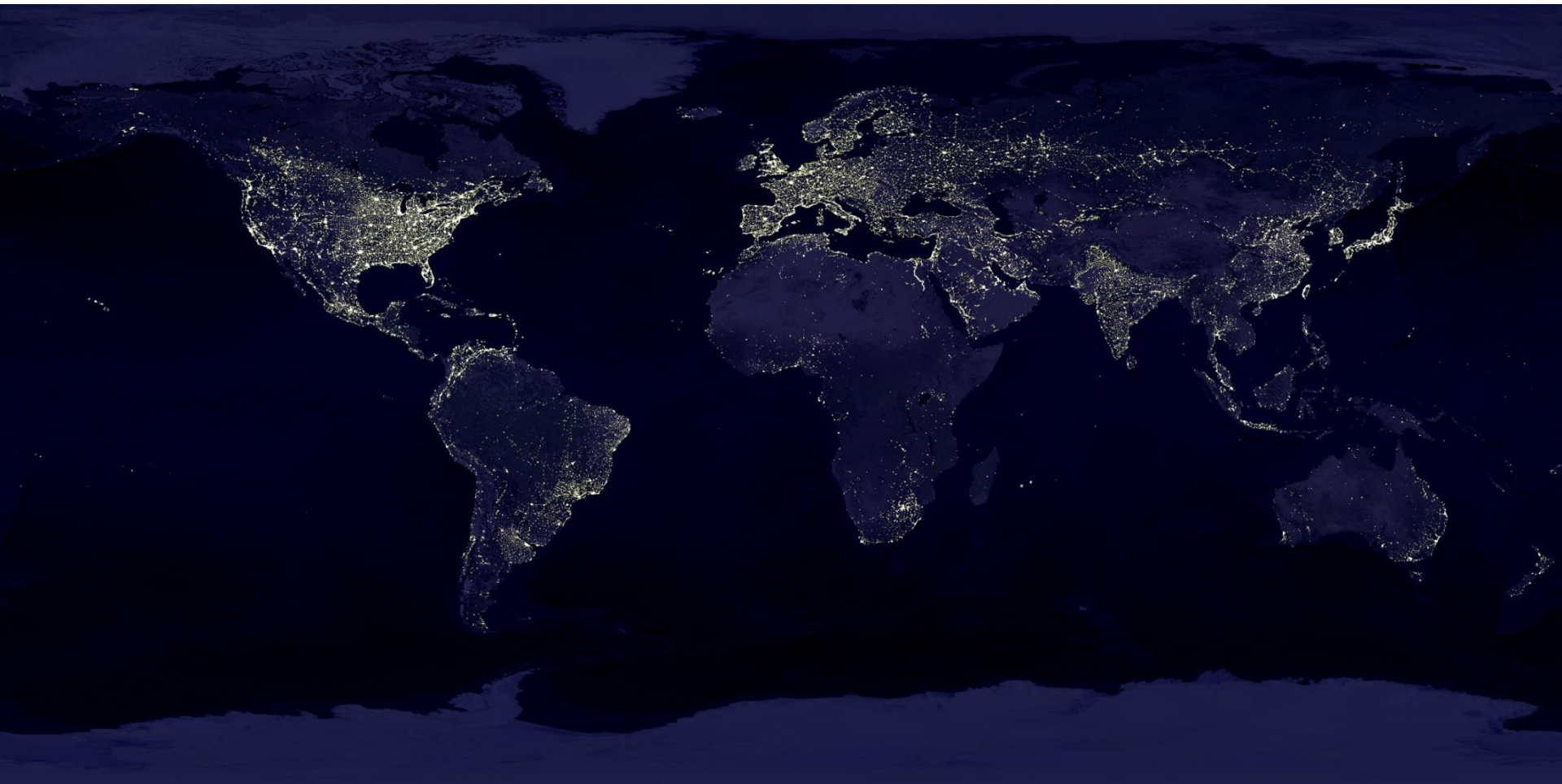
El Hierro: Wind and hydro



American Samoa: Photovoltaic



LIGHTS ON



MORE LIGHTS ON EVERY YEAR

“A new idea will firstly become denounced as ridiculous, secondly there are many fights against it, and finally all people were in favour of it from the early beginning.”

Hermann Scheer (quoting philosopher Gustav Fechner)

“While all living things enjoy the blessings of the sun, we have to rely on electricity from power stations. With magnificent heat and light streaming down on us, we must think of ways of using those blessings. This is where solar cells come in.”

Tokuji Hayakawa

The OLD 3 Rs

REDUCE

REUSE

RECYCLE

The NEW 3 Rs

***Rethink,
Rebuild,
Rewire.***