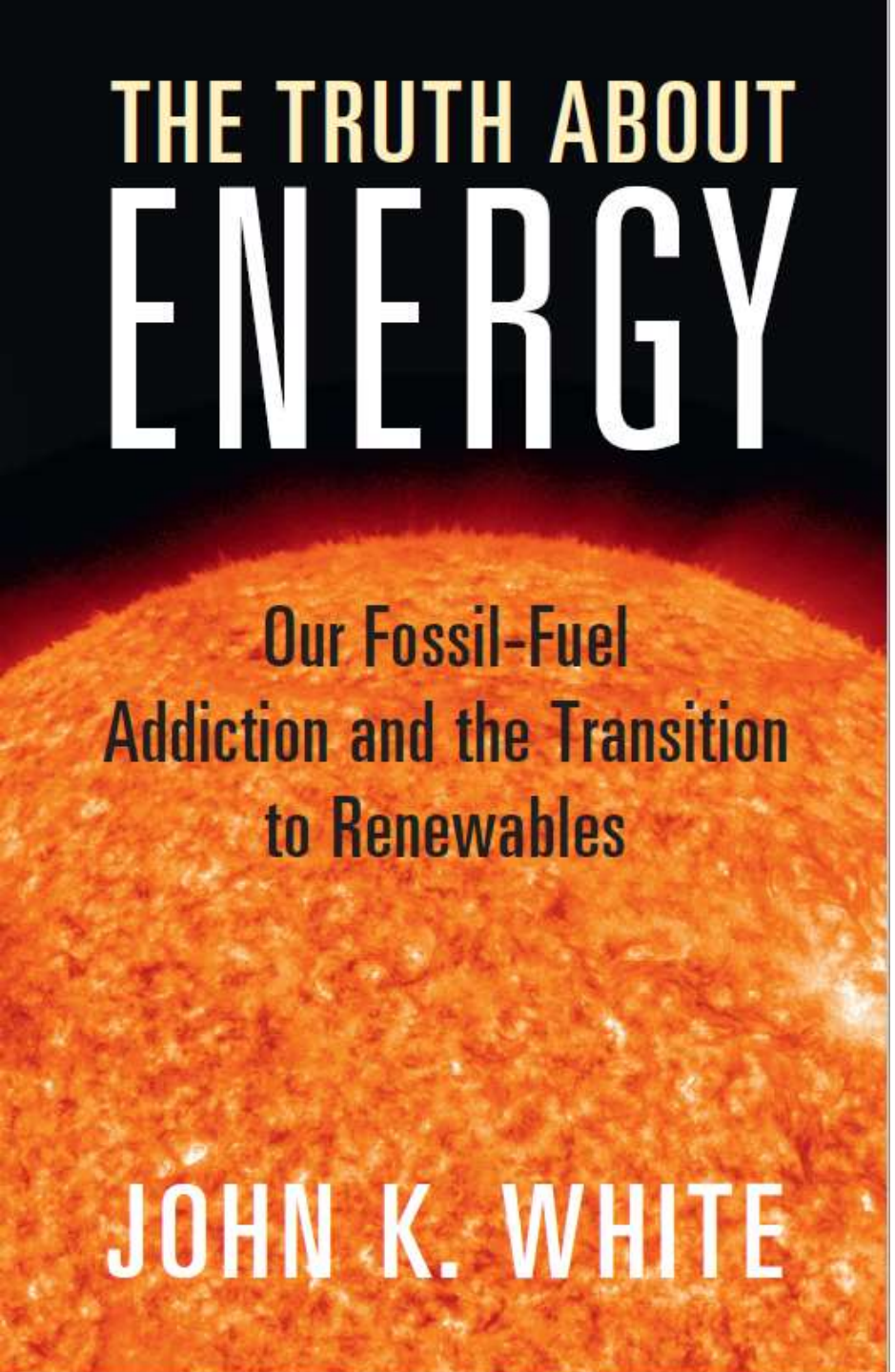

PART I (Out with the Old)

1. Wood to Coal: A Short History of the Industrial Revolution
2. Oil and Gas: Twentieth-Century Prosperity
3. The Nuclear World: Atoms for Peace

PART II (In with the New)

4. Old to New: The Sun and all its Glory
5. The Old becomes New Again: More Sustainable Energy
6. Driving the Revolution Revolution: From Volta to Tesla and Back

PART III (Less is More)

7. Rethink, Rebuild, Rewire

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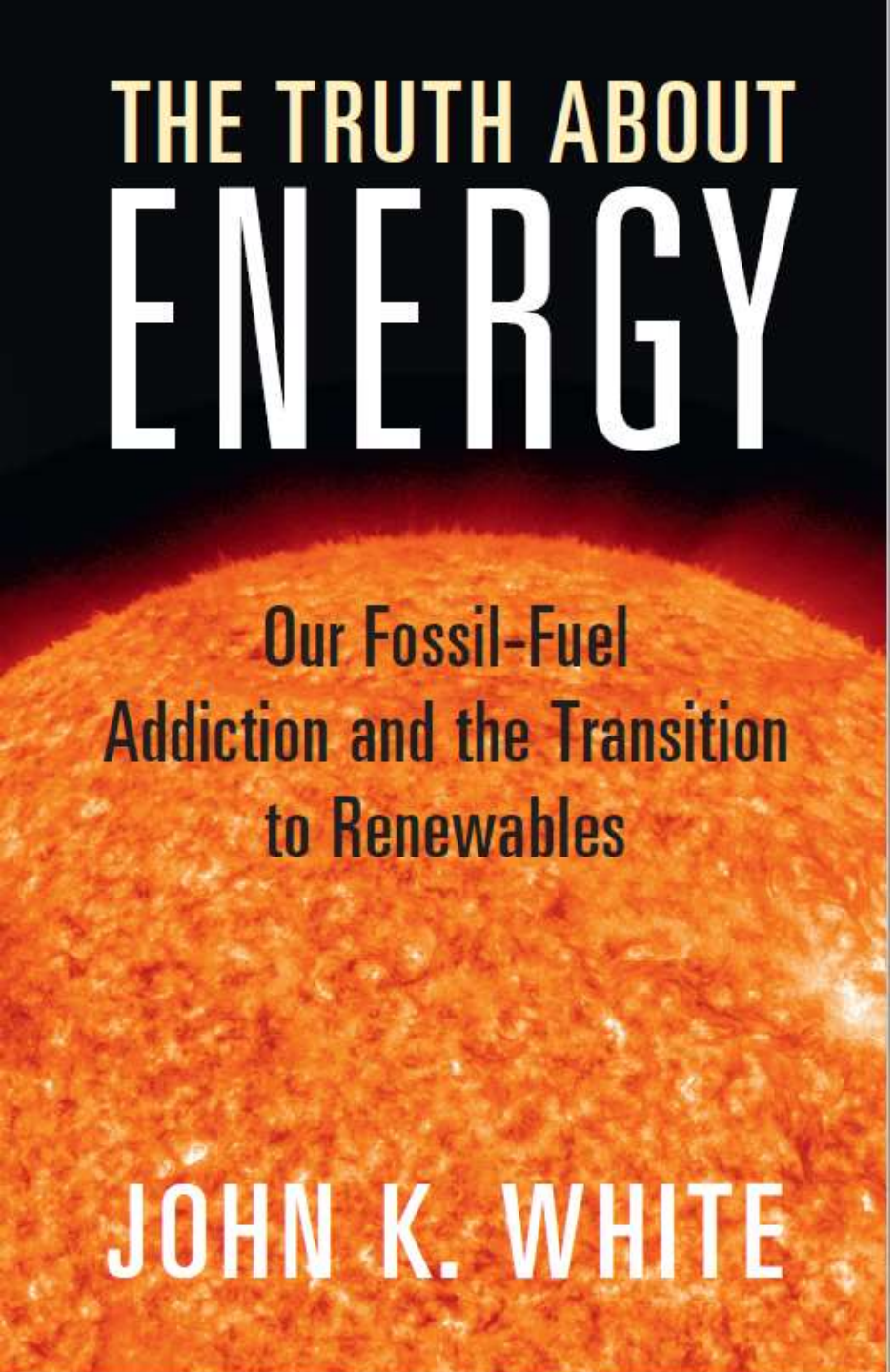
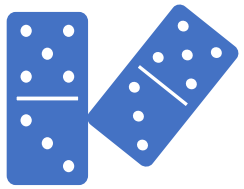
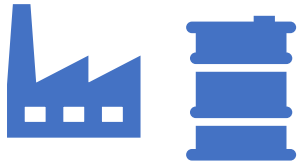
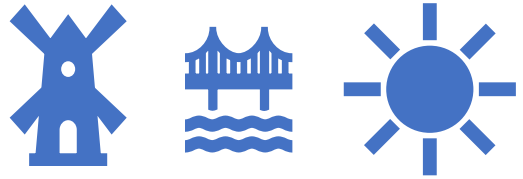




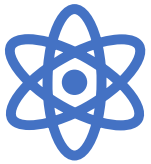
0. The Energy Dominoes



1. Coal (and the Industrial Revolution)



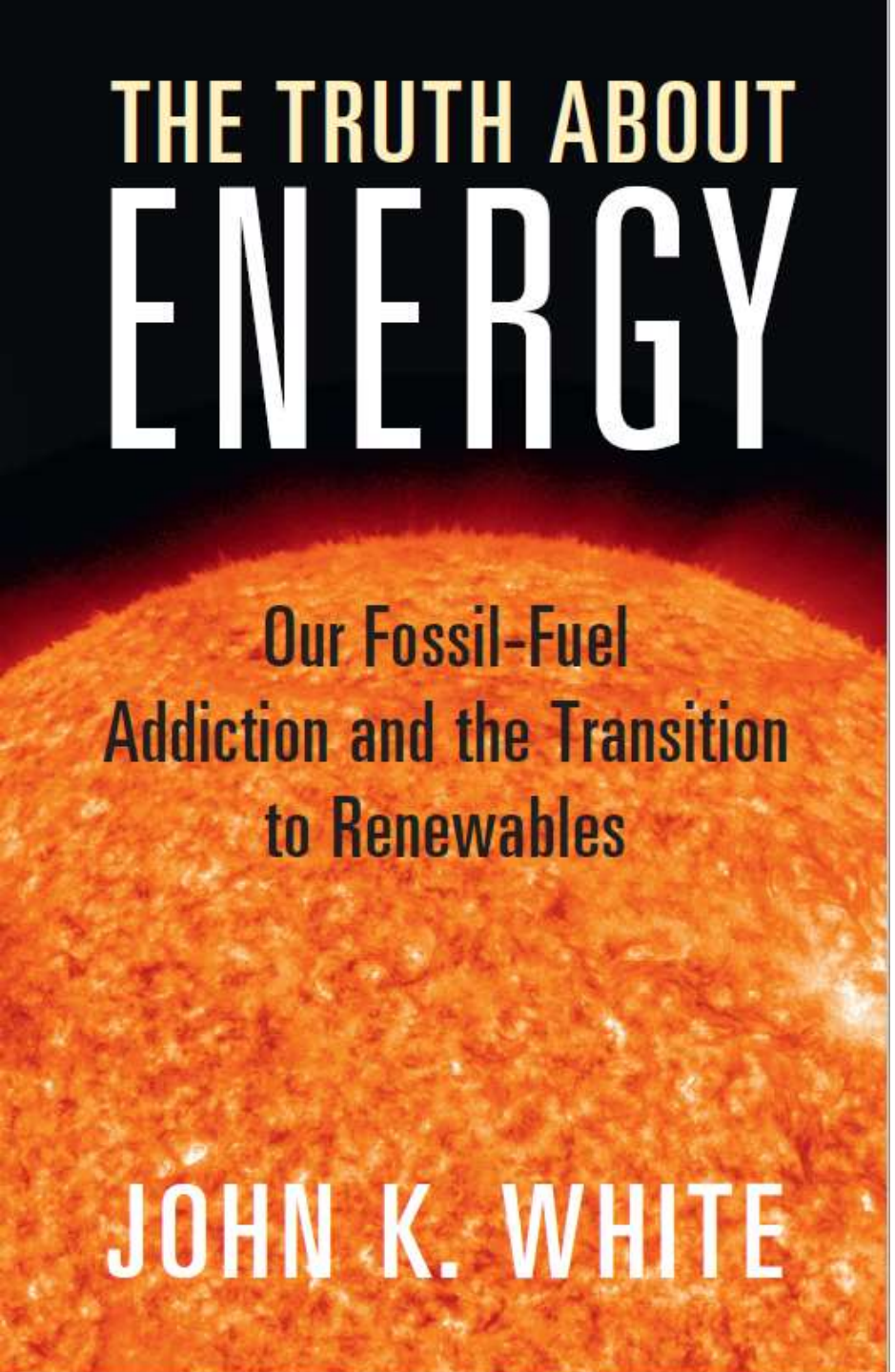
2. Renewables



3. Lithium versus hydrogen

4. Spain/Asturias/ Gijón

5. Reduce, reuse, recycle (RRR…)



- Teaser quiz (5 questions)
- Energy dominoes (quickly)
- Spain and Asturias
- Questions?

(+ some simple fun demos)

Teaser quiz 1/5

Quizzes -- Energy

8 quizzes: Physics | Energy | Geography | Spain | Math | History | Arts | Letters
50 questions of increasing difficulty. Can you get to level 5?

☐ Random questions?

0/0 Level 1	Select a choice: +1 for a correct answer, -1 for a wrong answer. The correct answer appears here.

How far away is the sun?

- **100 km**
- **10,000 km**
- **1.5 million km**
- **150 million km**

Teaser quiz 2/5

johnkwhite: Home | Who | What | Where | Energy | Math | Articles | Caracolas | Quizzes | Contact

Quizzes -- Energy

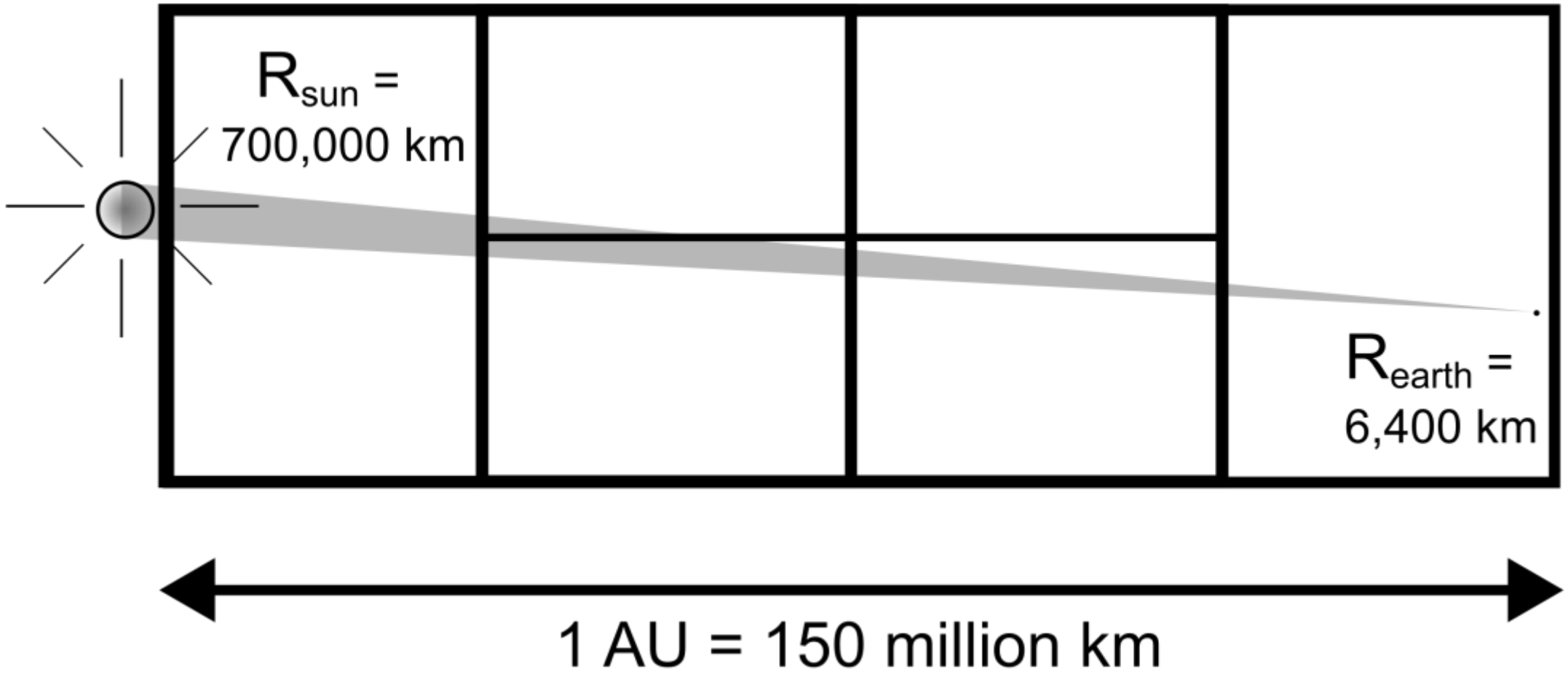
8 quizzes: Physics | Energy | Geography | Spain | Math | History | Arts | Letters
50 questions of increasing difficulty. Can you get to level 5?

☐ Random questions?

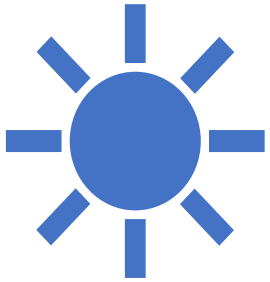
0/0 Level 1	Select a choice: +1 for a correct answer, -1 for a wrong answer. The correct answer appears here.

How much of the sun's radiated power reaches the earth?

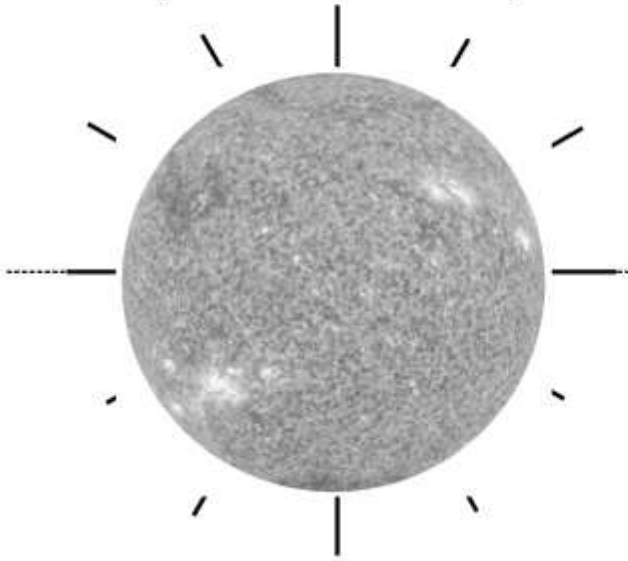
- **1 thousandth**
- **1 millionth**
- **1 billionth**
- **1 2 billionth**



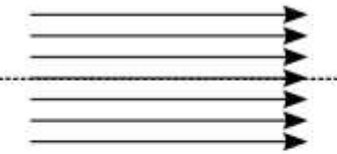
1 / 2 billionth of the sun's energy
makes it to earth



~ 380×10^{24} watts
(in all directions)

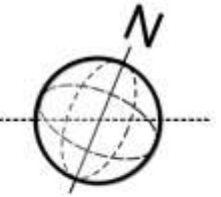


~ 1/2 billionth
of solar energy
(directed toward earth)



~ 170 petawatts

1,370 watts per
square metre



Teaser quiz 3/5

Quizzes -- Energy

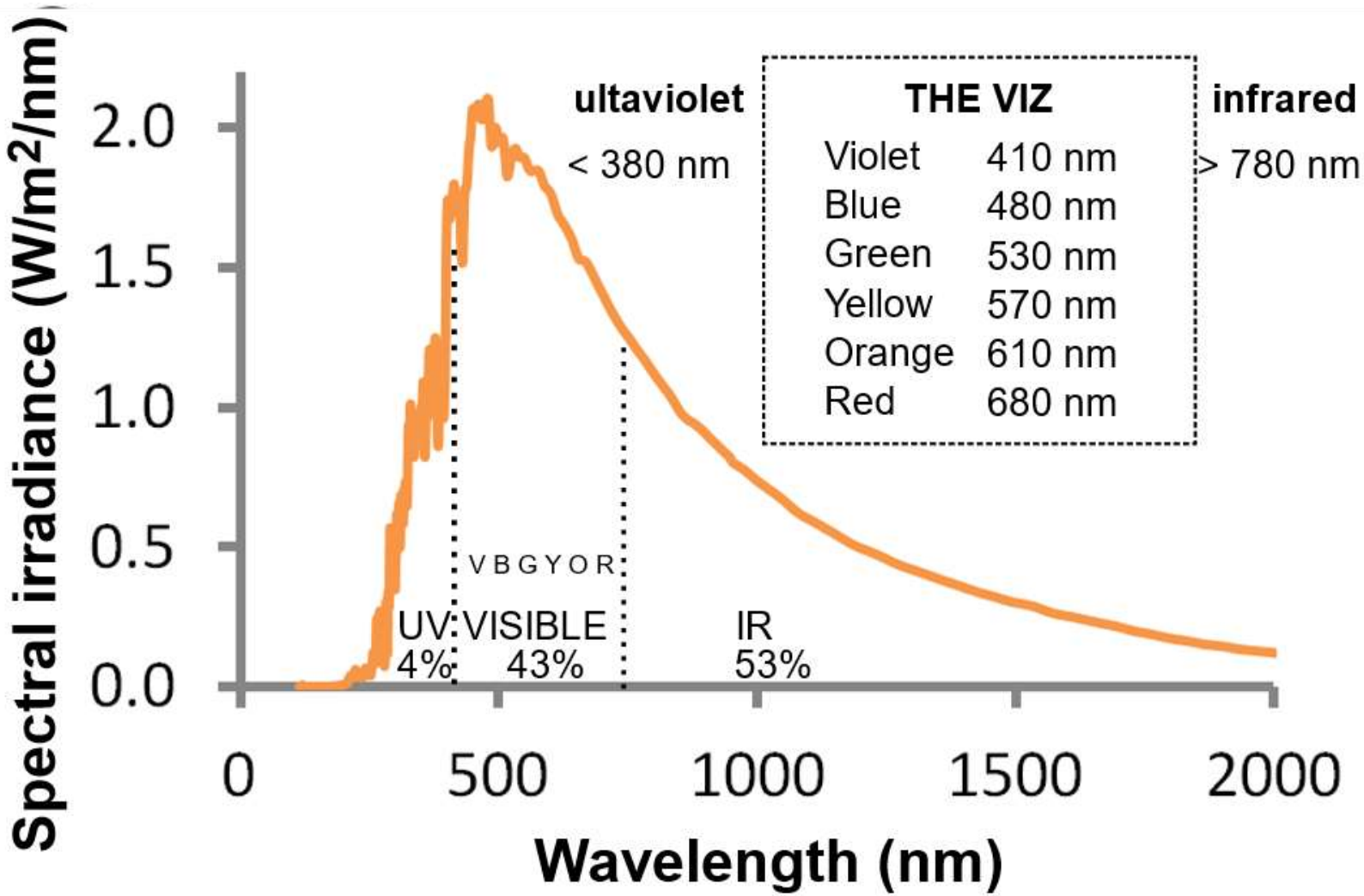
8 quizzes: Physics | Energy | Geography | Spain | Math | History | Arts | Letters
50 questions of increasing difficulty. Can you get to level 5?

☐ Random questions?

0/0 Level 1	Select a choice: +1 for a correct answer, -1 for a wrong answer. The correct answer appears here.

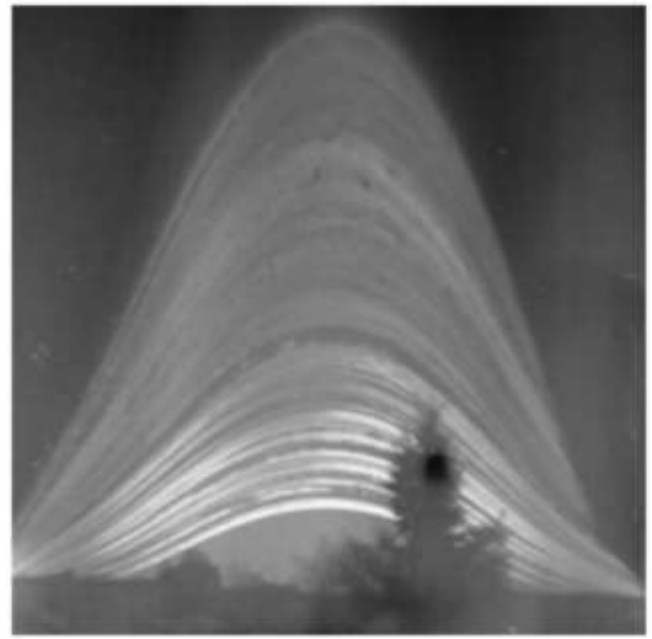
How long does it take for the sun's rays to reach earth?

- **8.3 seconds**
- **8.3 minutes**
- **8.3 hours**
- **8.3 days**


Spectral irradiance (W/m²/nm)
2.0
1.5
1.0
0.5
0.0
0
500
1000
1500
2000
Wavelength (nm)
ultaviolet
< 380 nm
infrared
> 780 nm
THE VIZ
Violet 410 nm
Blue 480 nm
Green 530 nm
Yellow 570 nm
Orange 610 nm
Red 680 nm
VBGYOR
UV 4%
VISIBLE 43%
IR 53%

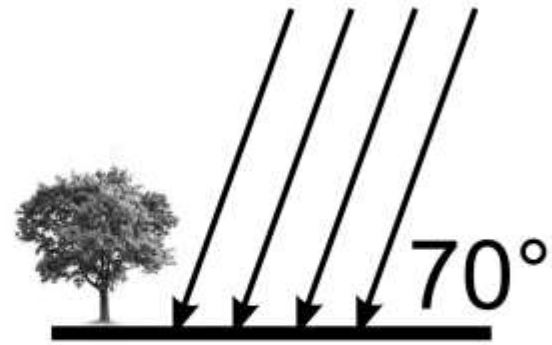
winter
solstice
(~December 21)

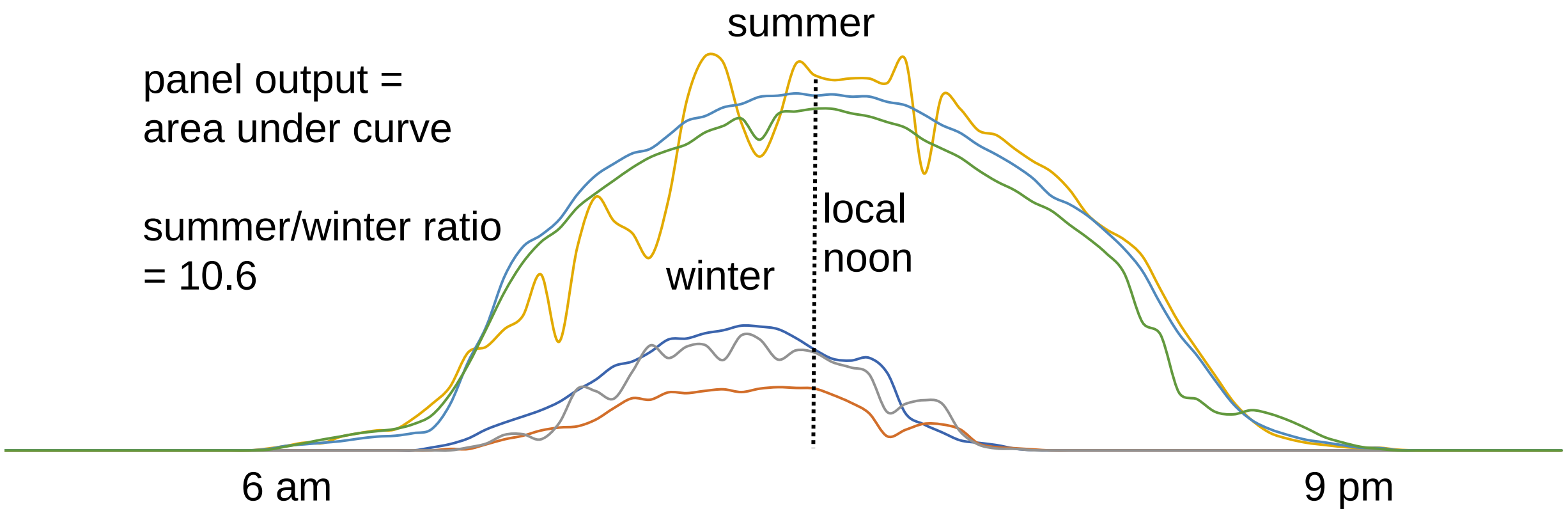
max summer

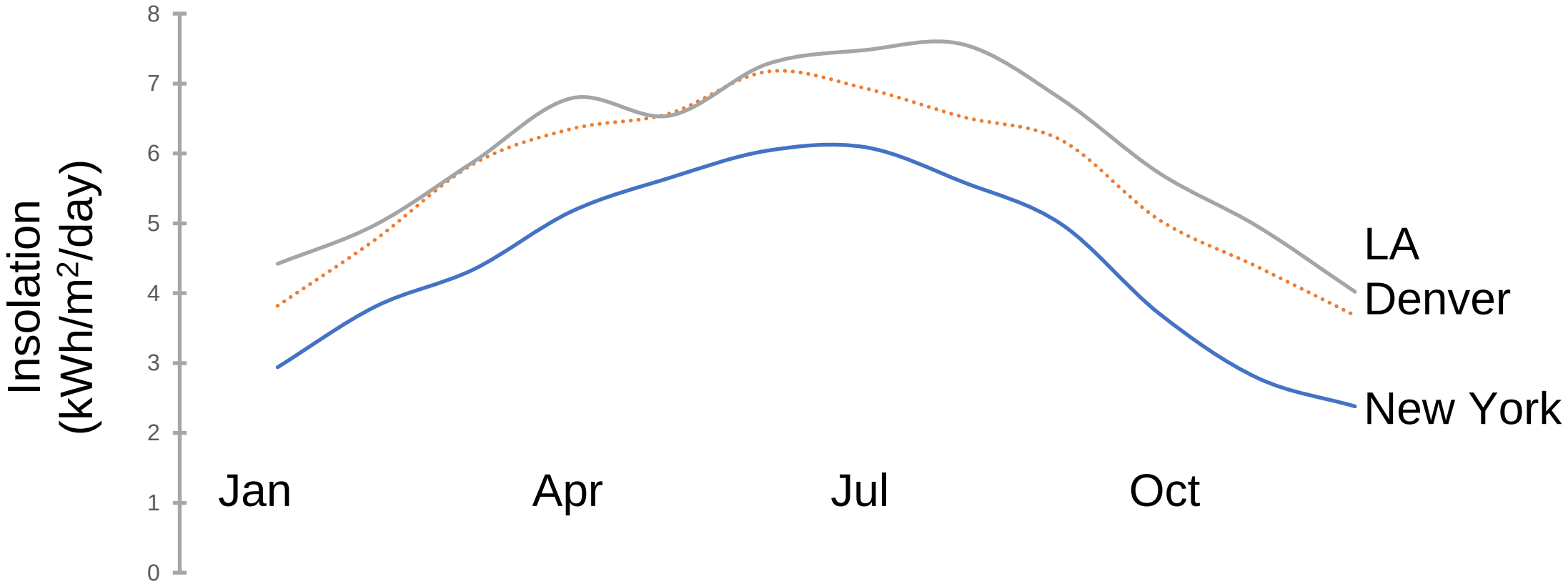


max winter

summer
solstice
(~June 21)




summer
panel output =
area under curve
summer/winter ratio
= 10.6
winter
local
noon
6 am
9 pm


Insolation
(kWh/m²/day)
8
7
6
5
4
3
2
1
0
Jan
Apr
Jul
Oct
LA
Denver
New York

Teaser quiz 4/5

Quizzes -- Energy

8 quizzes: Physics | Energy | Geography | Spain | Math | History | Arts | Letters
50 questions of increasing difficulty. Can you get to level 5?

☐ Random questions?

0/0 Level 1	Select a choice: +1 for a correct answer, -1 for a wrong answer. The correct answer appears here.

How thick would the earth's atmosphere be if the earth was the size of a basketball?

- **1.9 mm**
- **1.9 cm**
- **1.9 m**
- **1.9 km**

Teaser quiz 5/5

Quizzes -- Energy

8 quizzes: Physics | Energy | Geography | Spain | Math | History | Arts | Letters
50 questions of increasing difficulty. Can you get to level 5?

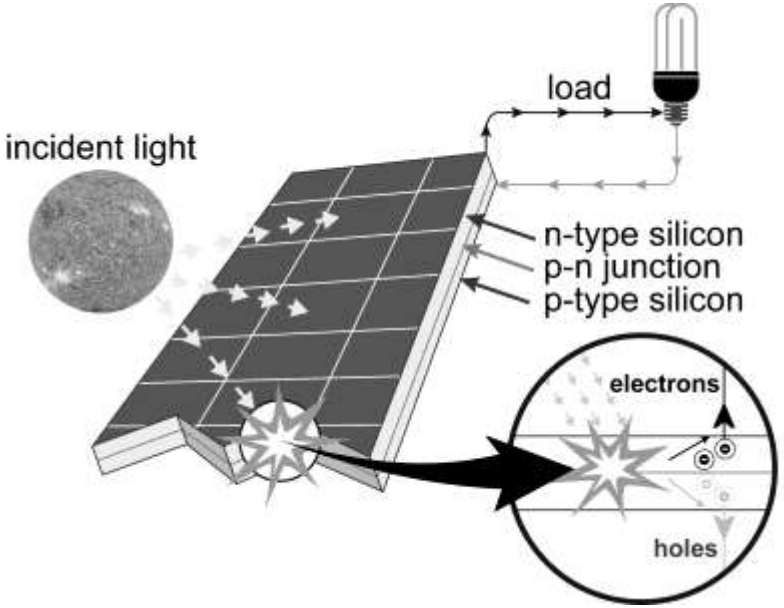
☐ Random questions?

0/0 Level 1	Select a choice: +1 for a correct answer, -1 for a wrong answer. The correct answer appears here.

How thick would the earth's crust be if the earth was the size of a basketball?

- **0.9 mm**
- **9 mm**
- **9 cm**
- **9 m**

The Truth About Energy – A few demos



Photons to electrons

1954 PV solar battery (**Bell Labs**) –thin, silicon-doped wafer converts light into electricity at 6% efficiency ("compares favorably with the efficiency of steam and gasoline engines"). 1962 AT&T's Telstar generated 14 watts from 3,600 modules.

Sanlúcar la Mayor (Sevilla)

The world's first commercial solar thermal power plant, **PS10** uses 624 heliostats over 10 ha and a 114-m-high solar tower to produce 11 MW. **PS20** uses 1255 heliostats on 80 ha and a 165-m-high tower to generate 20 MW. Both PS10 and PS20 are located northwest of Seville and are owned by Atlantica Yield with Abengoa heliostats.

Don Quixote

"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."

The Truth About Energy – A few demos

El Hierro, Islas Canarias

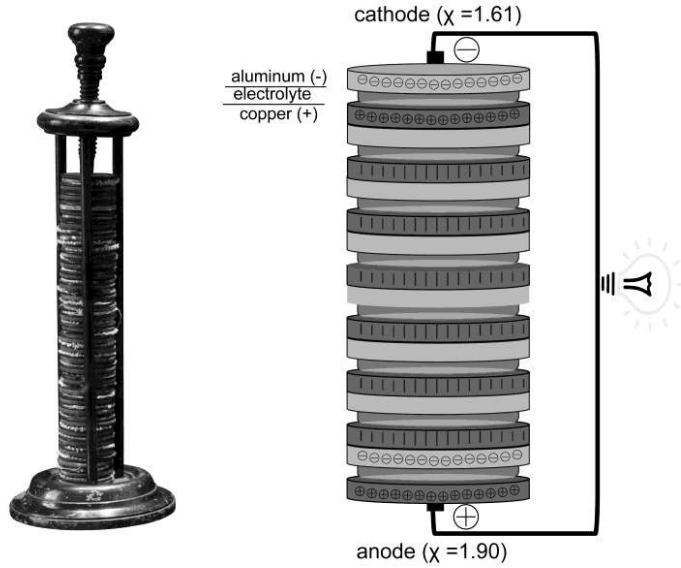
(11.5-MW, 5 turbines)

El Hierro wind-hydro plant generates almost all of the electrical power for an island community of 10,000 people, providing a good rule of thumb:

1 MW costs $1 million for 1,000 people (~ 250–330 homes).

Tesla Roadster

The first electric vehicle to use Li-ion batteries and travel over 200 miles on a single charge. Only 2,450 were made, including Elon Musk's red Roadster, employed as a unique dummy payload in a 2018 SpaceX Falcon Heavy test launch driven by a mannequin called Starman.



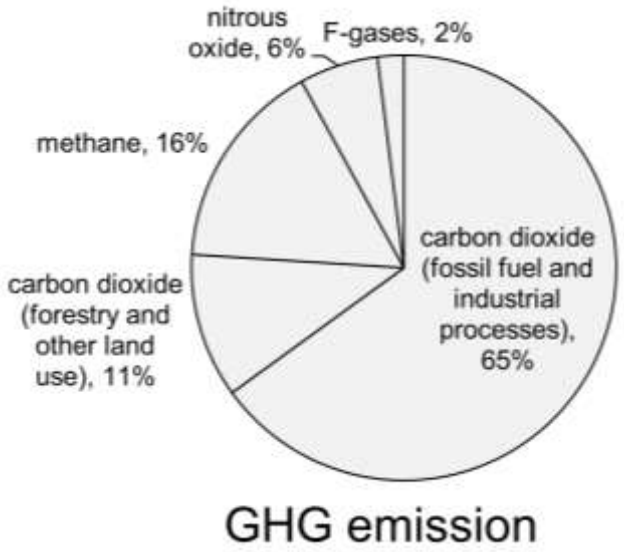
Volta's "wet" battery

Two metals with different electronegativities wrapped around a brine-soaked electrolyte to create a movement of electrons from negative to positive electrode. The terms positive and negative charge were coined by Benjamin Franklin.

Climate change / global warming (metrics

50 gigatons GHG (76% CO_2)

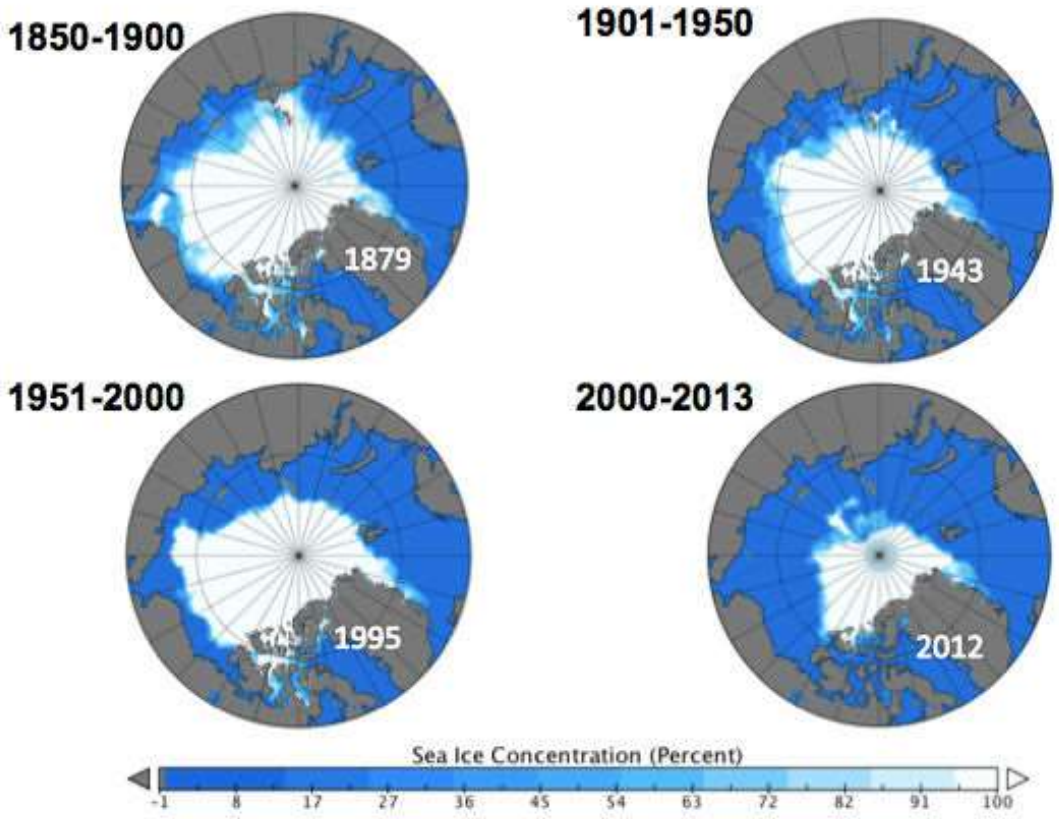
CH_4 (80 times GWP of CO_2)



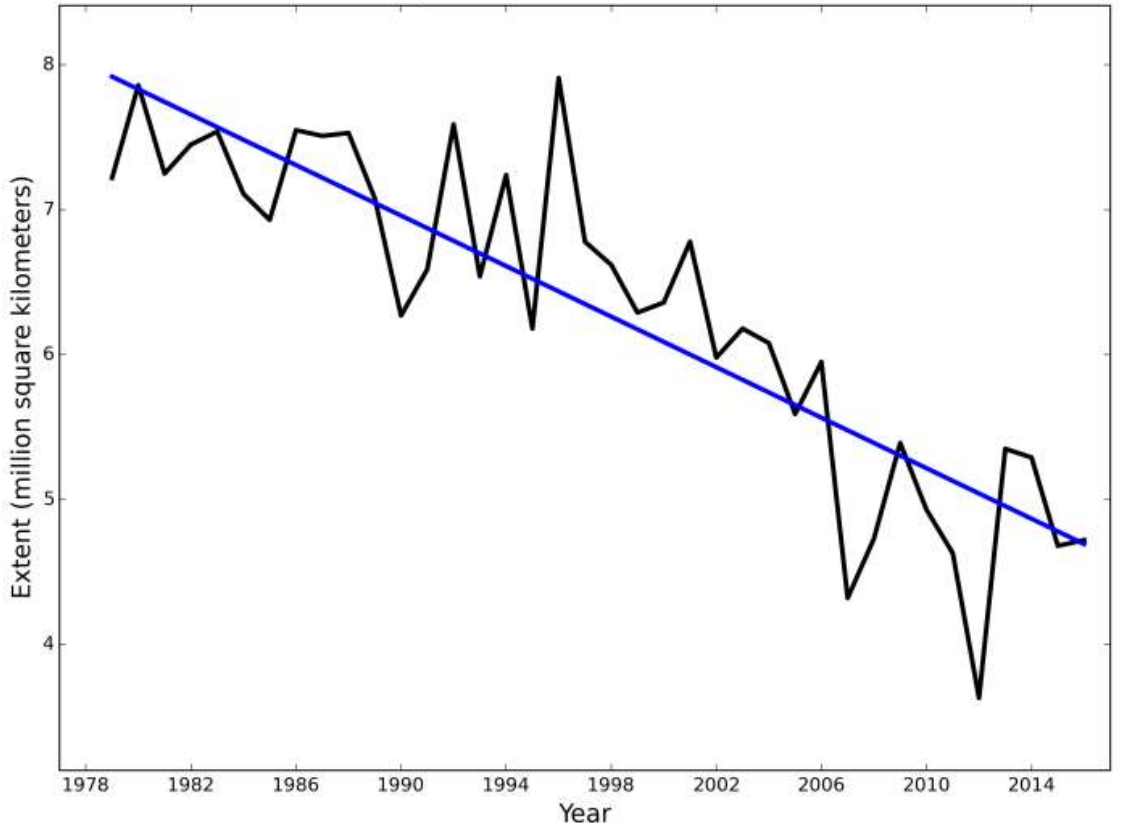
GHG emission

climate change versus habit change

Climate change / global warming (metrics)

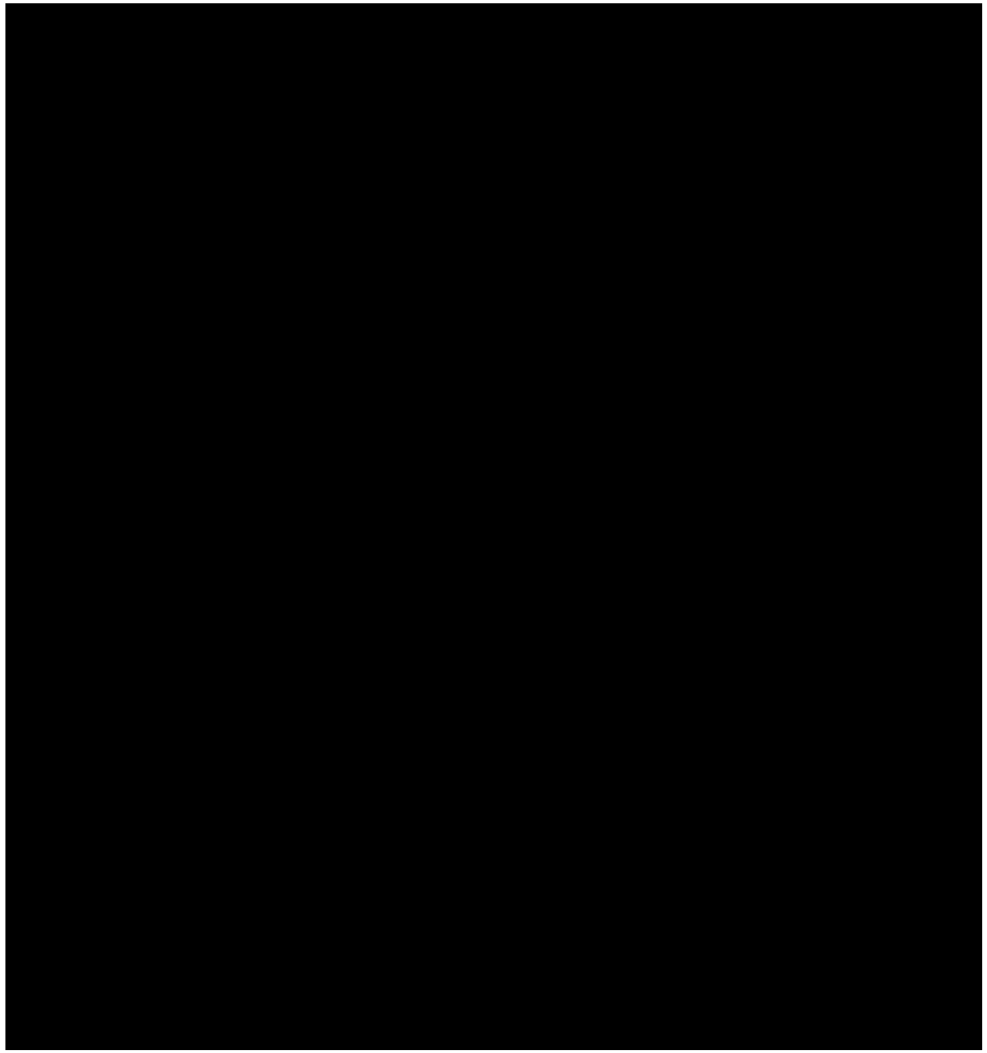


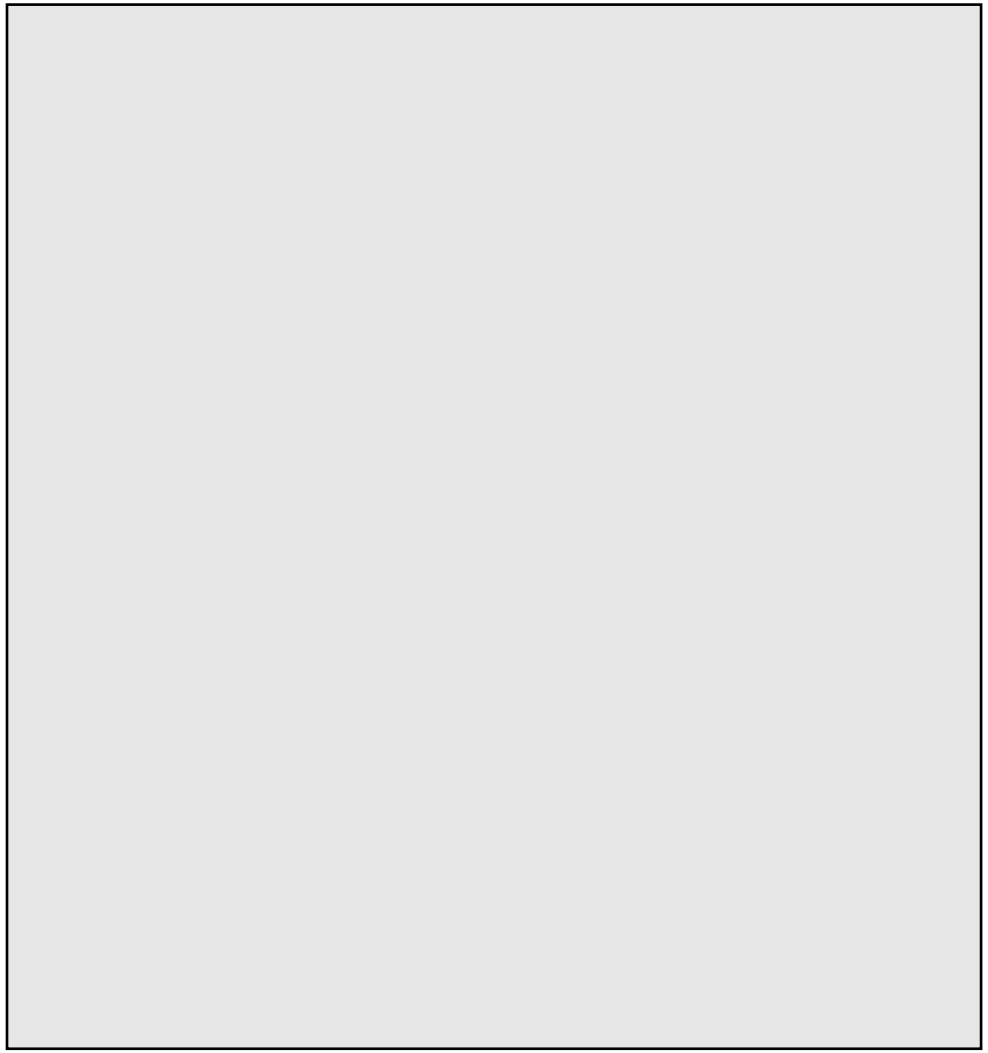
North Pole sea ice shrinking every year



Arctic September sea ice extent 1979 to 2016

Climate change / global warming (metrics)





Other Qs

What % of our energy is fossil fuels?

How many barrels oil do we consume/ day?

Where is the world's largest nuclear power plant? (is it safe?)

How many solar power plants are in Asturias?

Who invented the turret windmill?

How many Teslas were sold last year?

What is the atmospheric concentration of CO_2?

…

Some Spanish connections

a)

b)

a) Mieres district heating plant (23°- 85°C, 6 MW)

b) Mutriku wave energy plant (OWC) (300 kW)

c)

d)

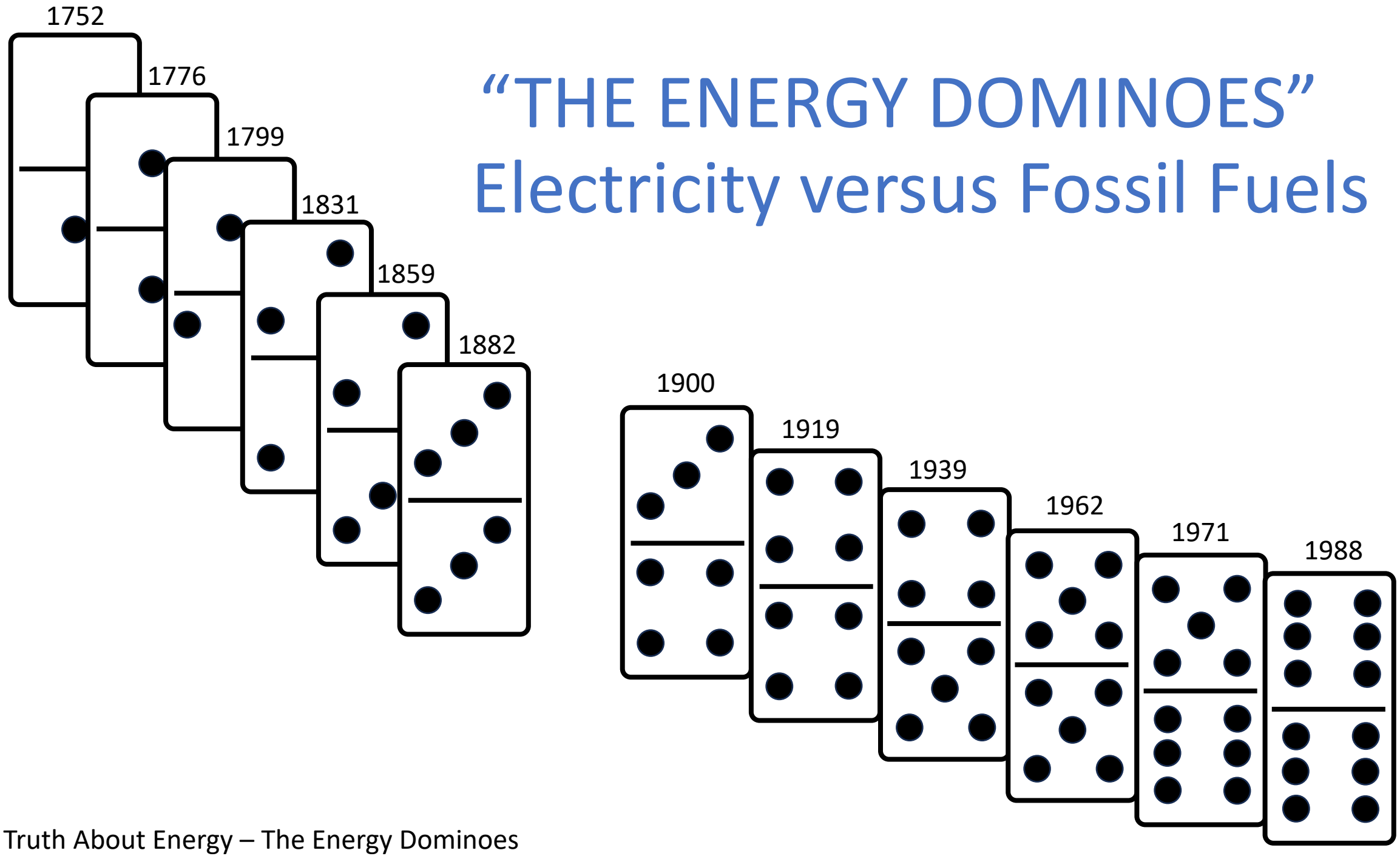
c) Seville pantograph

d) La Mancha windmills

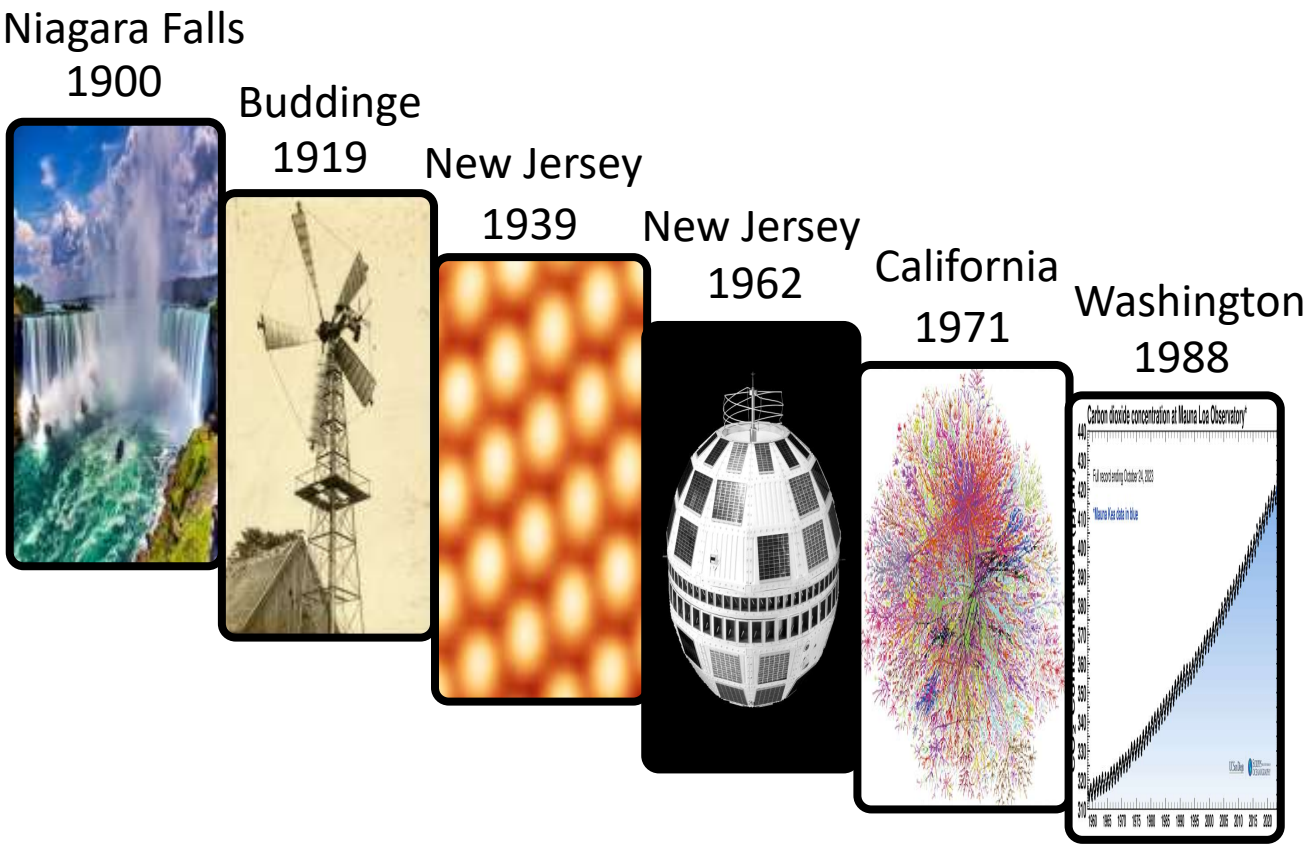
Some Spanish connections

1. Windmills of La Mancha (Consuegra, near Toledo)
2. Galician wind farms
3. El Hierro wind farm
4. Pumped storage hydro (La Muella II, near Valenica)
5. Chrome Dome accident (Palomares)
6. Gas tremors (Castellón)
7. PS10 and PS20 (Sanlúcar la Mayor, near Seville)
8. Olmedilla PV park (60 MW/2008) (Castile-La Mancha)
9. District heating in mines (Mieres)
10. Wave energy plant (Mutriku)

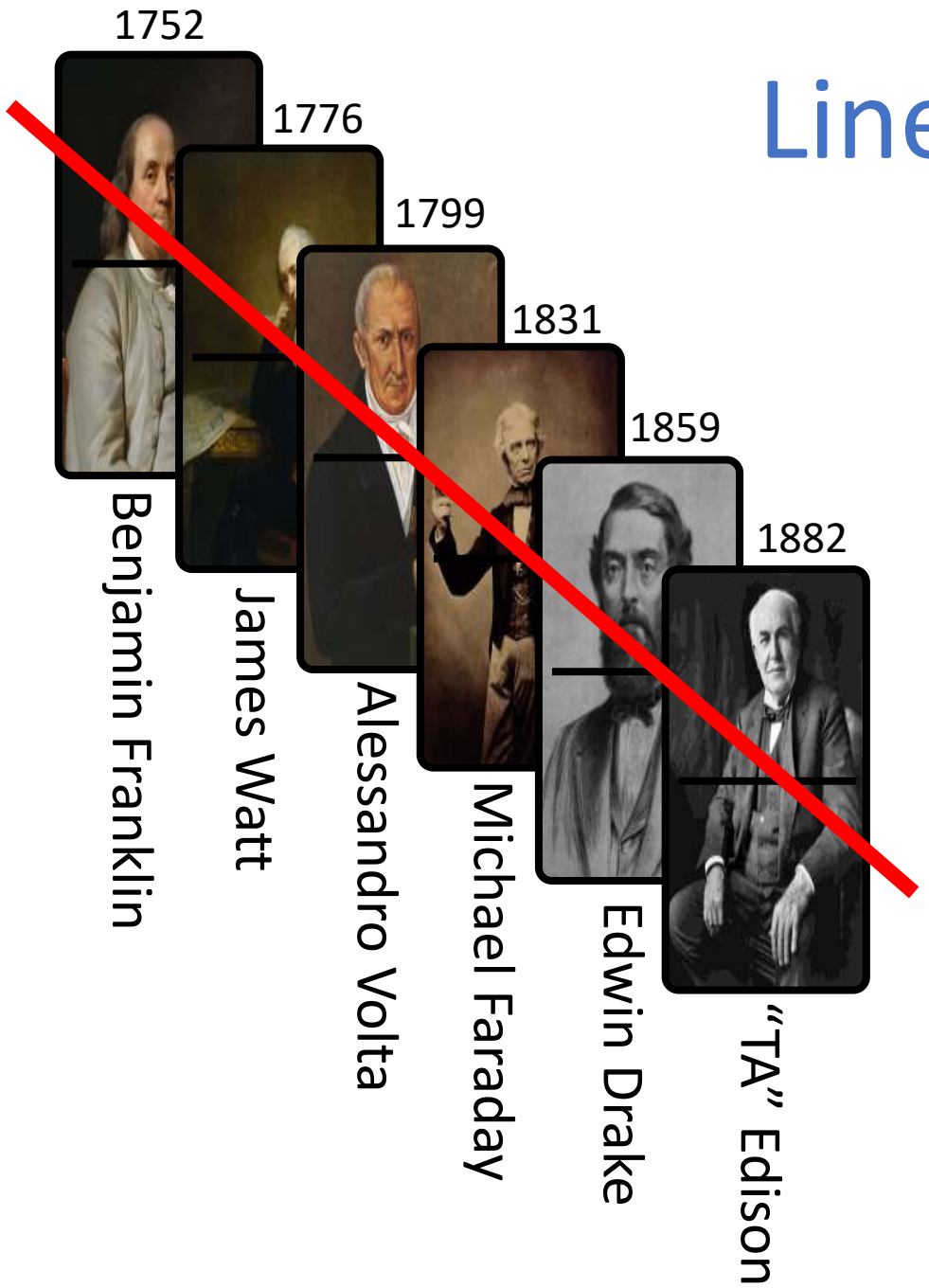
“THE ENERGY DOMINOES”
Electricity versus Fossil Fuels

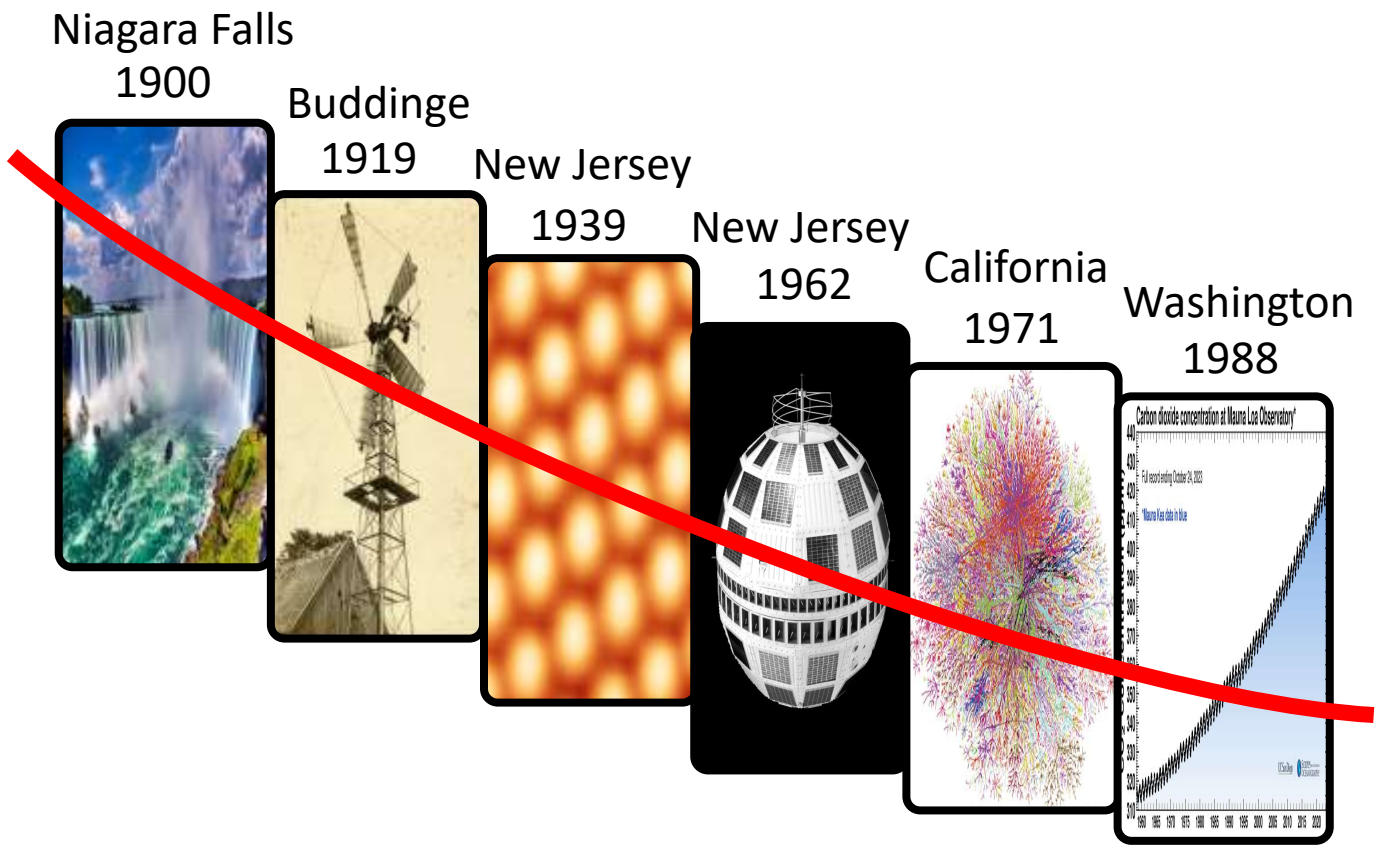


People and Place



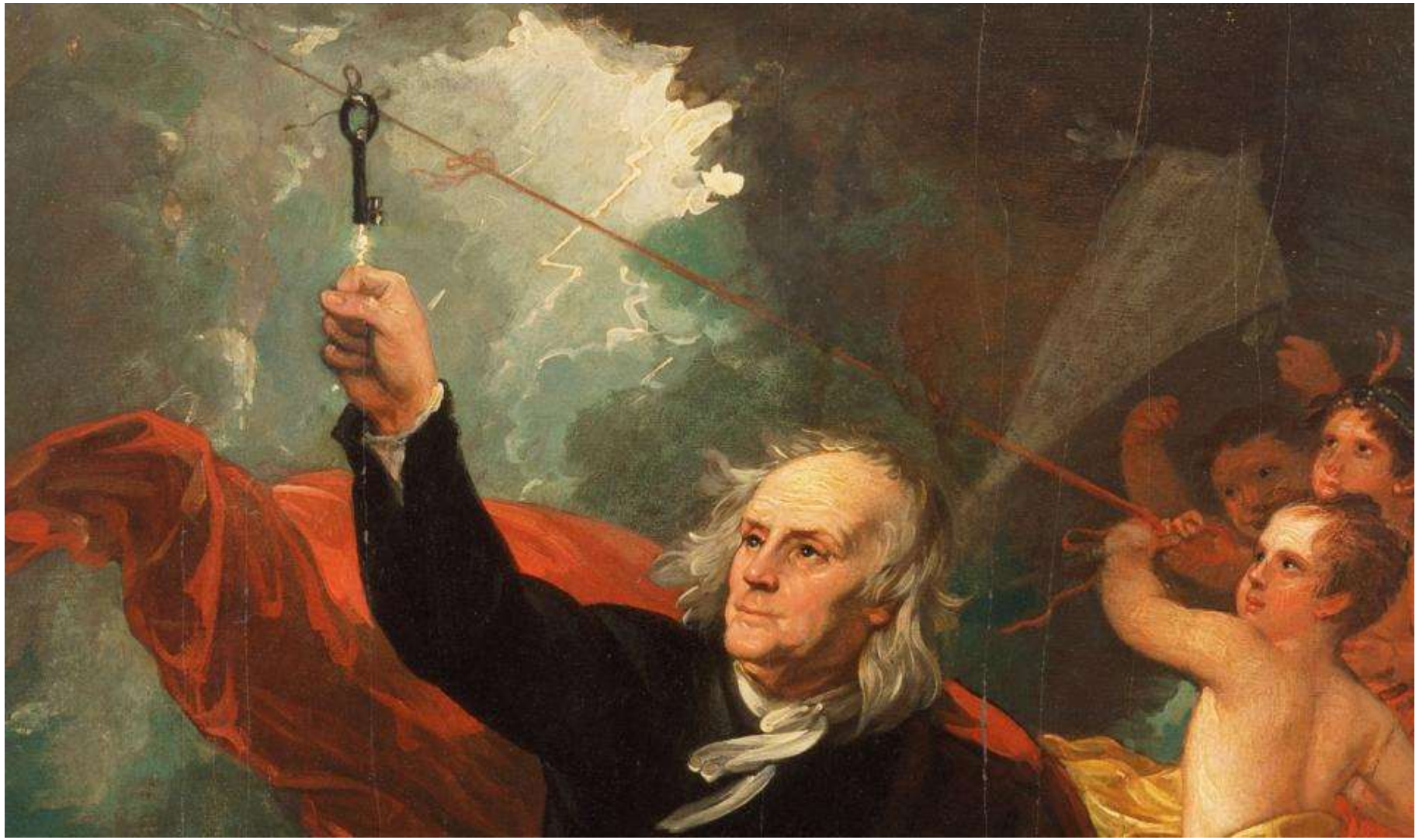
Linear versus Exponential





1752

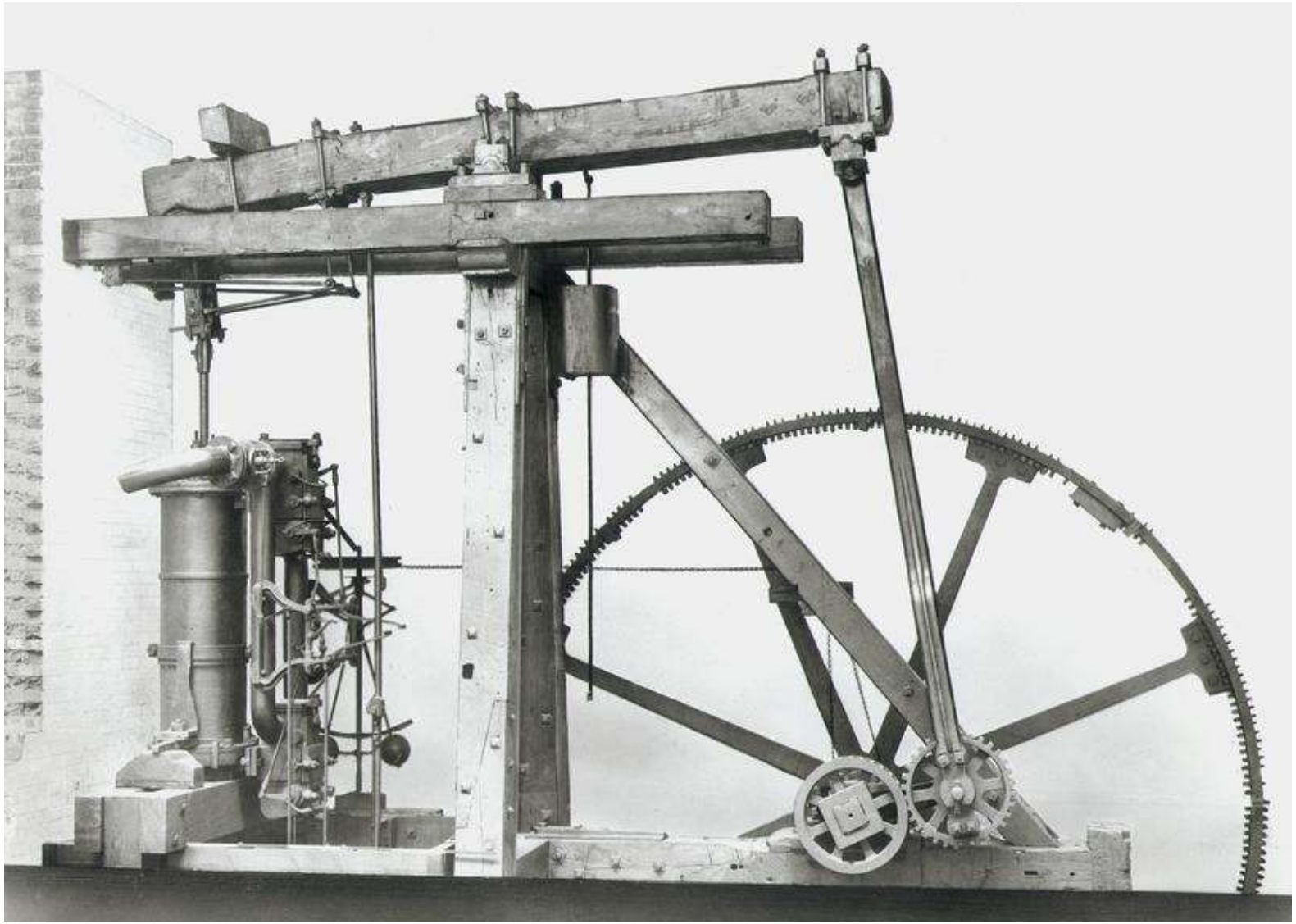
Benjamin Franklin and the kite experiment



Benjamin Franklin waited for ideal stormy conditions to demonstrate the electrical nature of lightning. He used a silk kite, hemp and silk string, metal house key, and a Leyden jar to store electrical charge. The kite was not struck by lightning, but picked up **ambient electrical charge** in the storm. When a storm cloud neared, a spark was produced.

1776

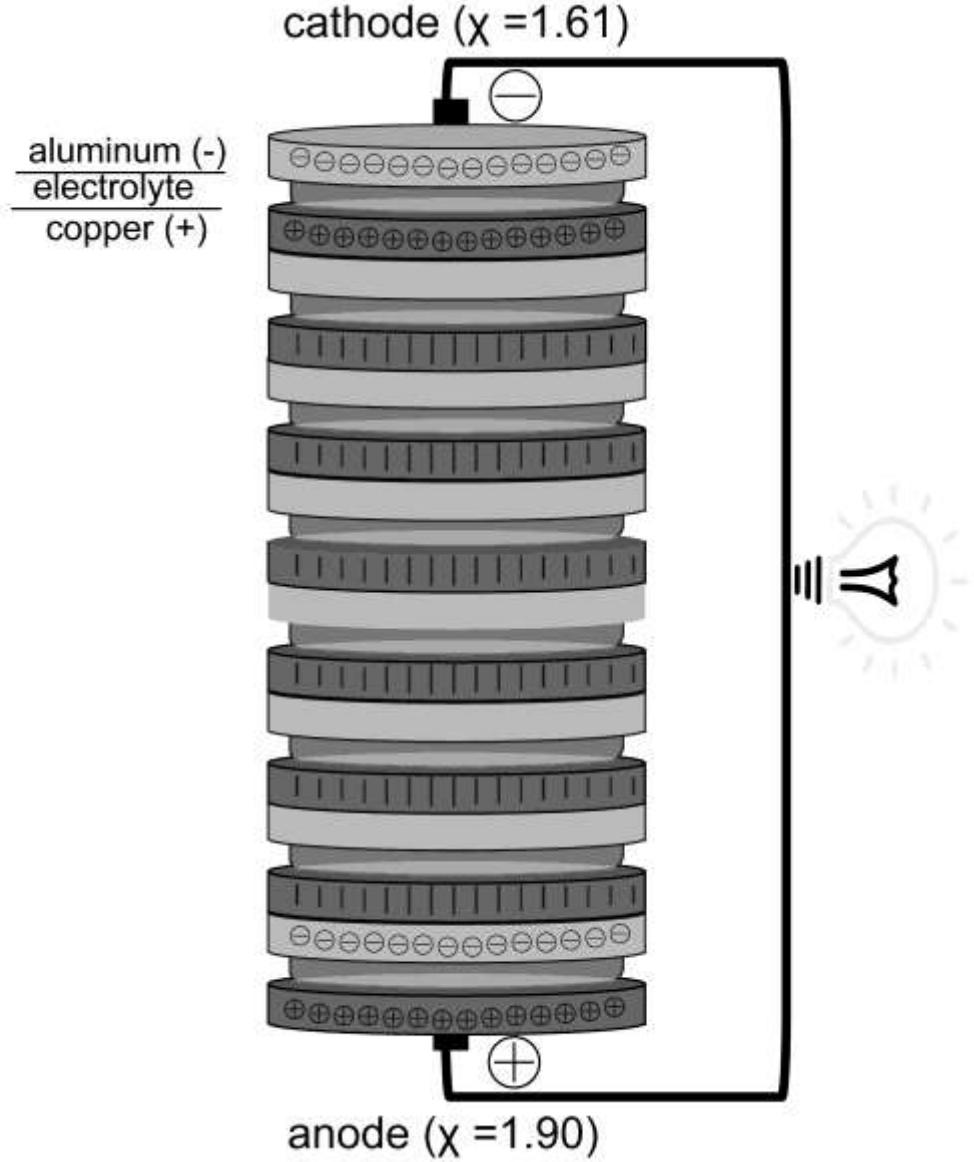
[Rotative steam engine by Boulton and Watt (1788)]



James Watt improved the condensation process by adding a separate condenser to *externally* cool the steam, keeping the piston cylinder as hot as possible. His engine was much smaller and used one-quarter as much coal. The modern unit of electrical power, the watt (W), or ability to "do work" or "use energy" in a prescribed time, was named in his honor.

1799

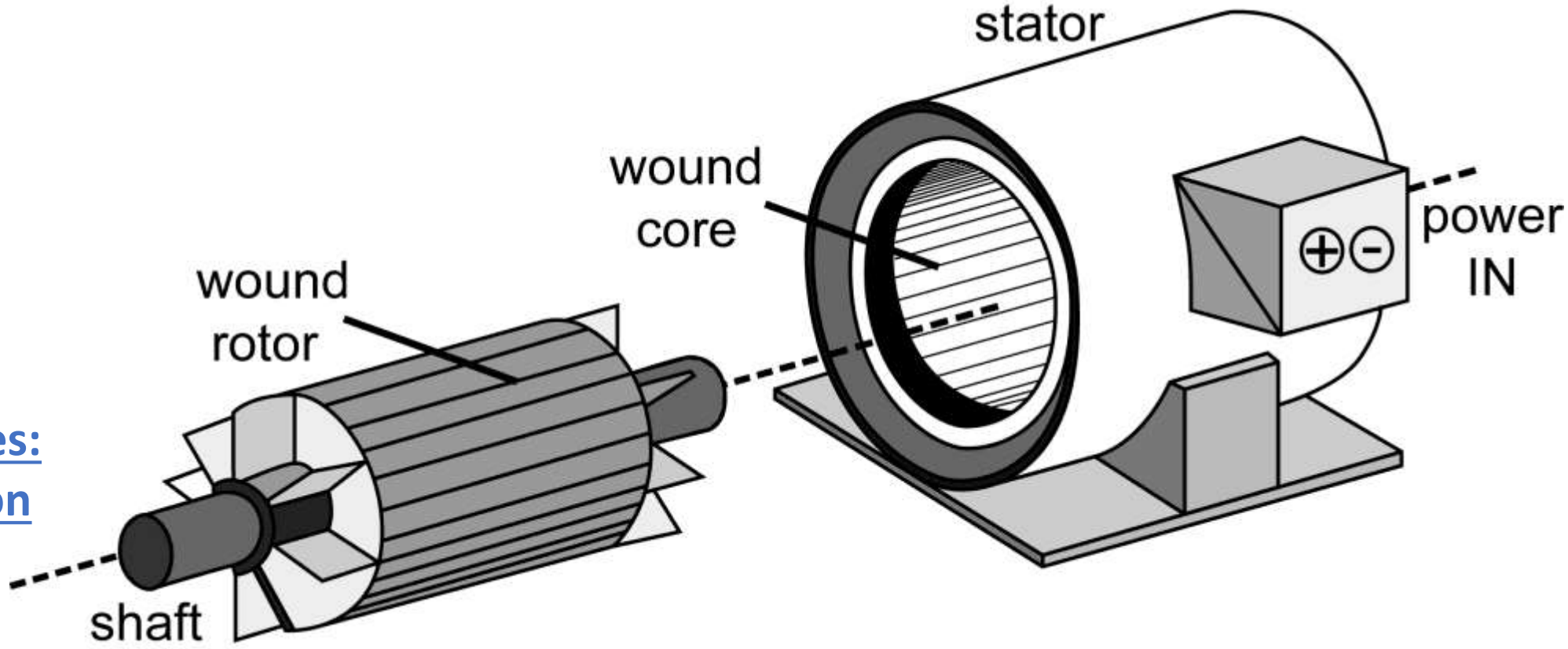
IEEE Milestone: Volta's electrical battery invention



Electricity is *chemically* generated for the first time. **Alessandro Volta**'s "wet" battery consisted of two metals with different electronegativities (χ) around a brine-soaked electrolyte (the ion/electron source) to create moving electrons from negative to positive electrode rather than a jolt of static. He also observed electrolysis: $H_2O \rightarrow 2H_2 + O_2$.

1831

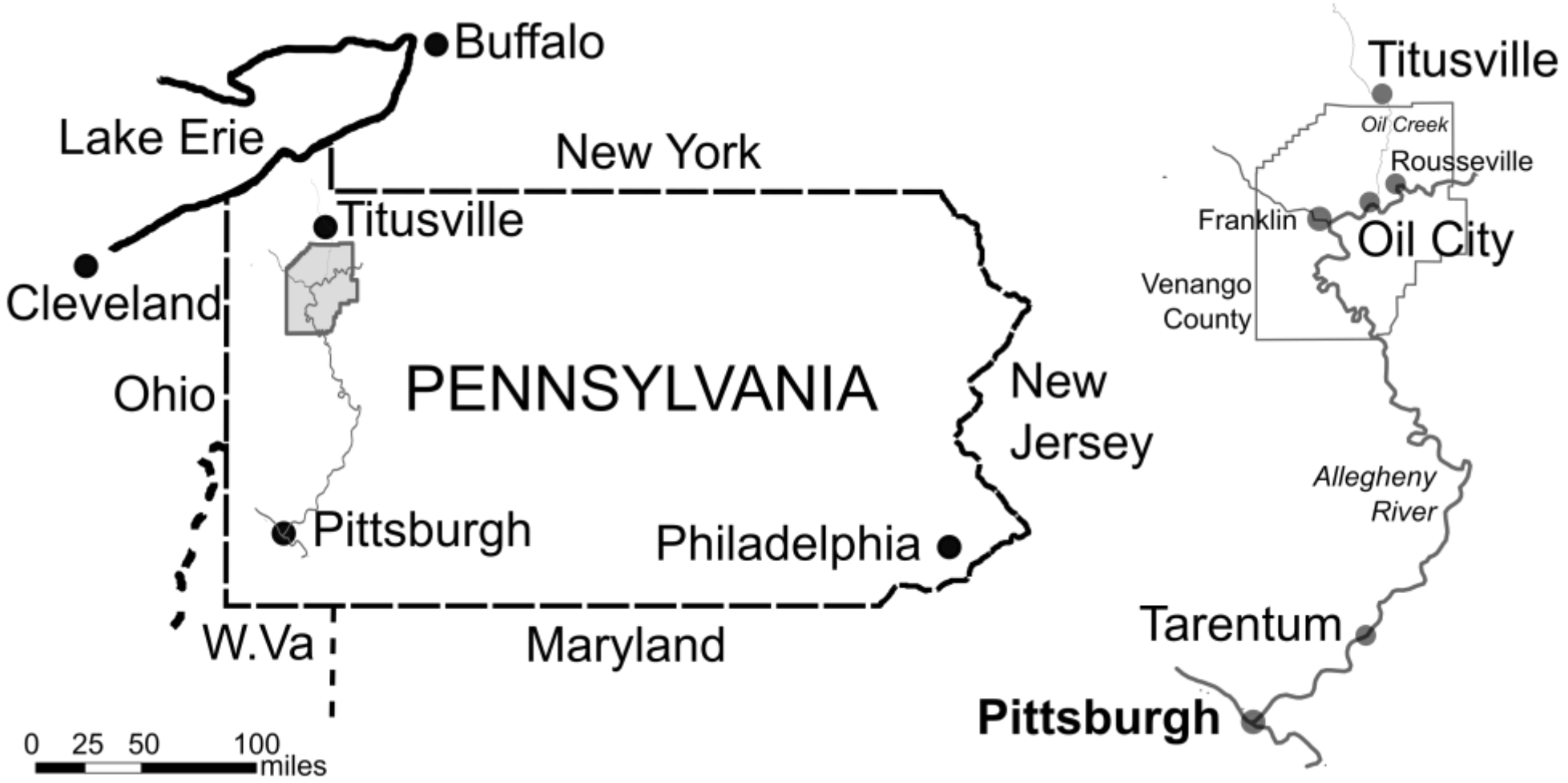
The birth of the electric machines: a commentary on Faraday (1832) 'Experimental researches in electricity'



Inspired by Ørsted's discovery that an electric current in a wire could move a magnetized needle, **Michael Faraday** wondered if a magnet could create an electric current in a wire, so-called "induction." Faraday demonstrated the principle in his lab on October 17, 1831, sharing the results a month later at the Royal Society of London.

1859

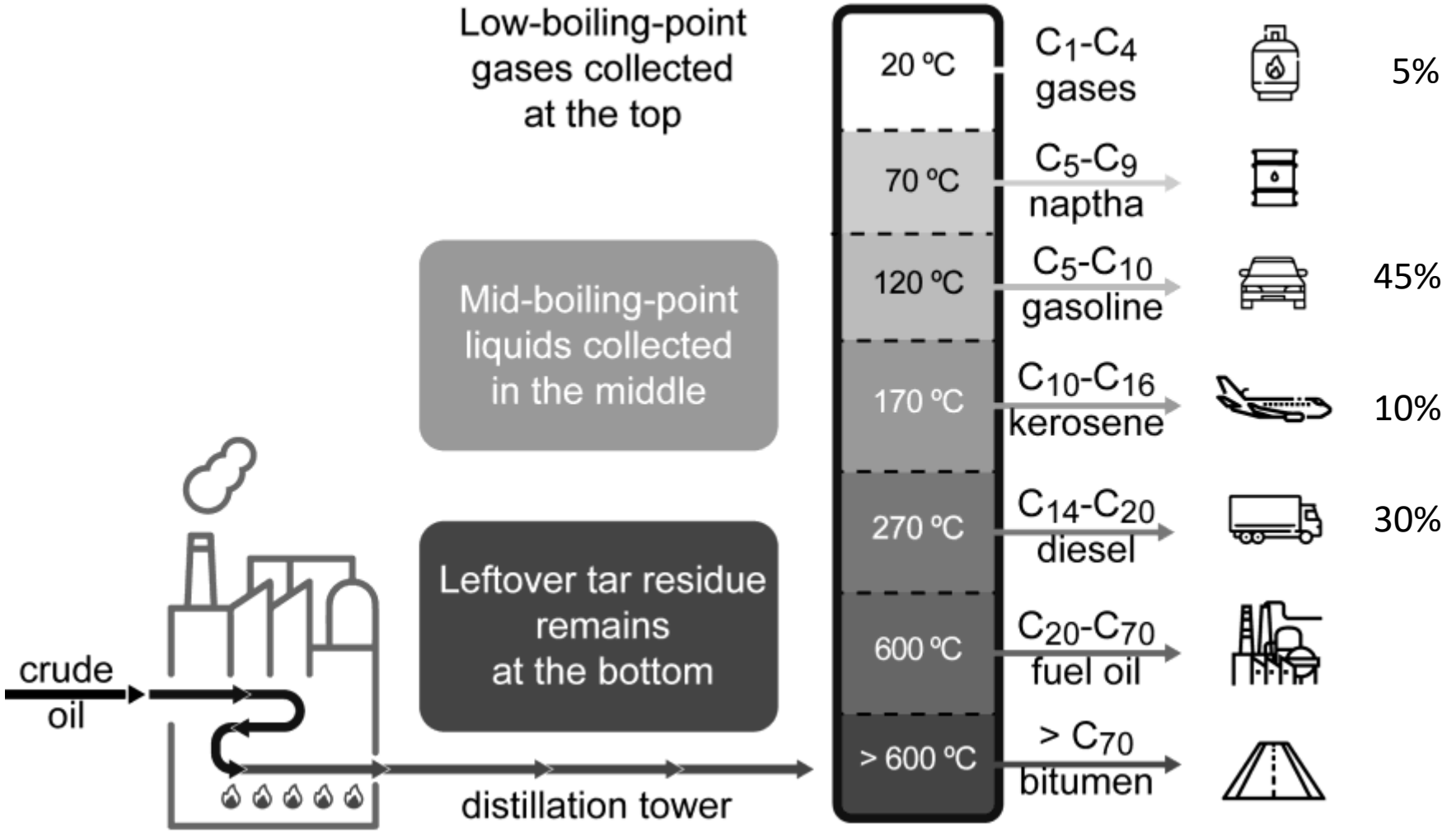
[*Oil History* by Samuel T. Pees: The Drake Chapters]



Armed with a favorable analysis of nearby "seep" oil and the help of a blacksmith cum salt-well driller, "Colonel" **Edwin Drake** drilled for months, almost giving up from lack of funds until oil was eventually found at 69.5 feet (21.2 m), brought to the surface in a hand-fashioned pail, initiating the world's first commercial oil well.

1859

***Oil History* by Samuel T. Pees: The Drake Chapters**



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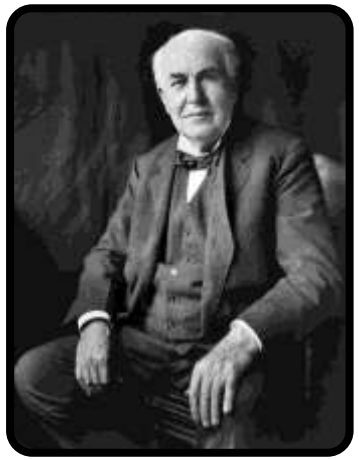
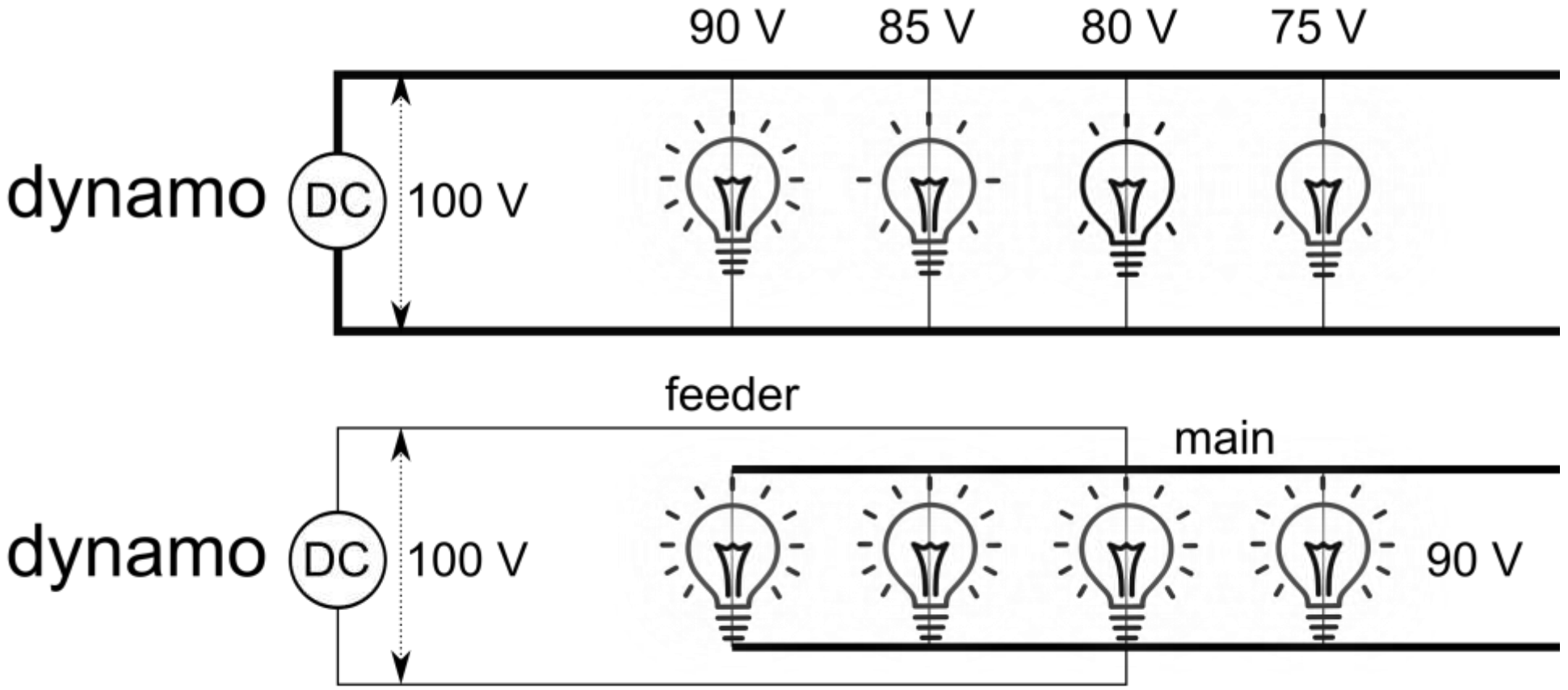
1882

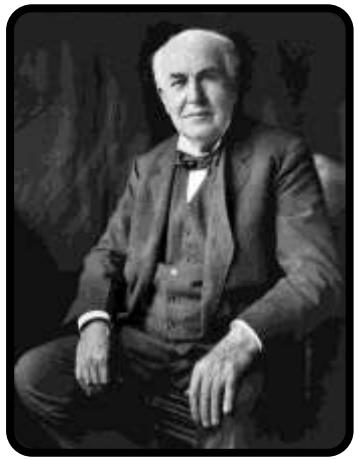


[Historical drama *Edison, the Man,* directed by Clarence Brown (MGM)]



Six, 27-ton, 100-kW “Jumbo” dynamos generated the coal-fueled electric power, **Thomas Edison**’s Pearl Street Station transmitting 100 volts of direct-current electricity underground to 400 lights in a one-square-mile area of Lower Manhattan’s First District (bounded by Wall Street, Nassau Street, Spruce Street, and Ferry Street).

1882



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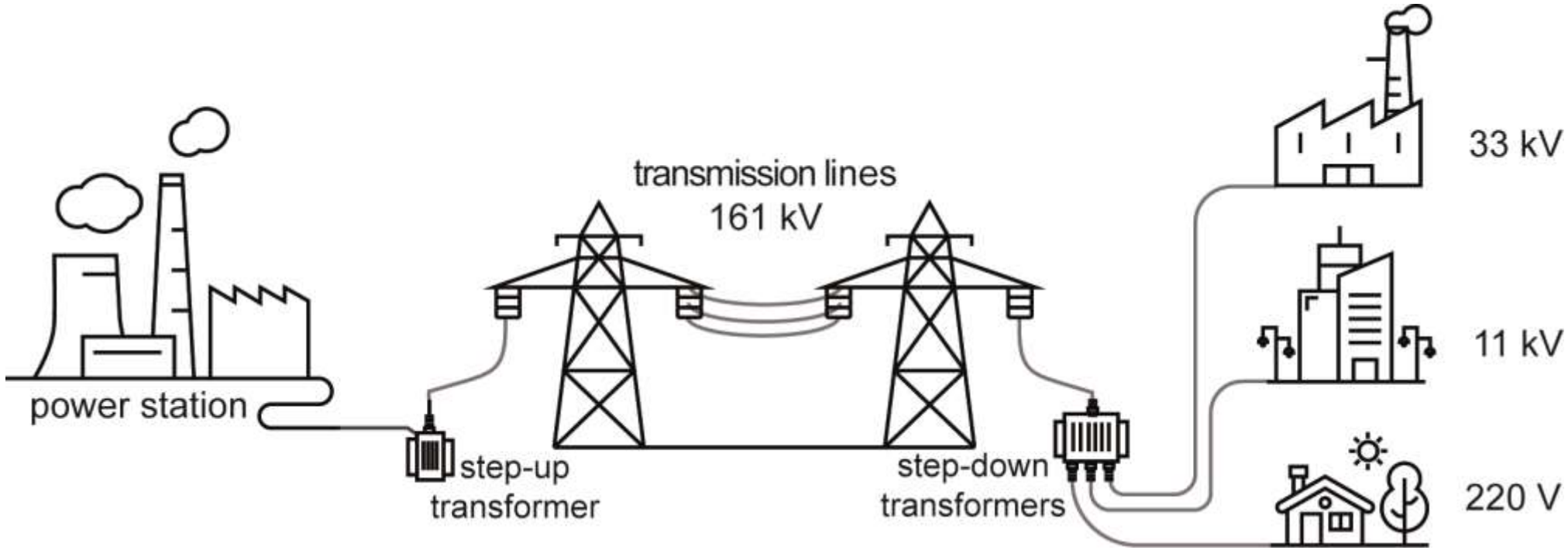

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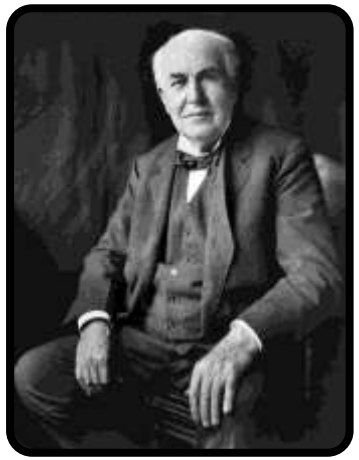
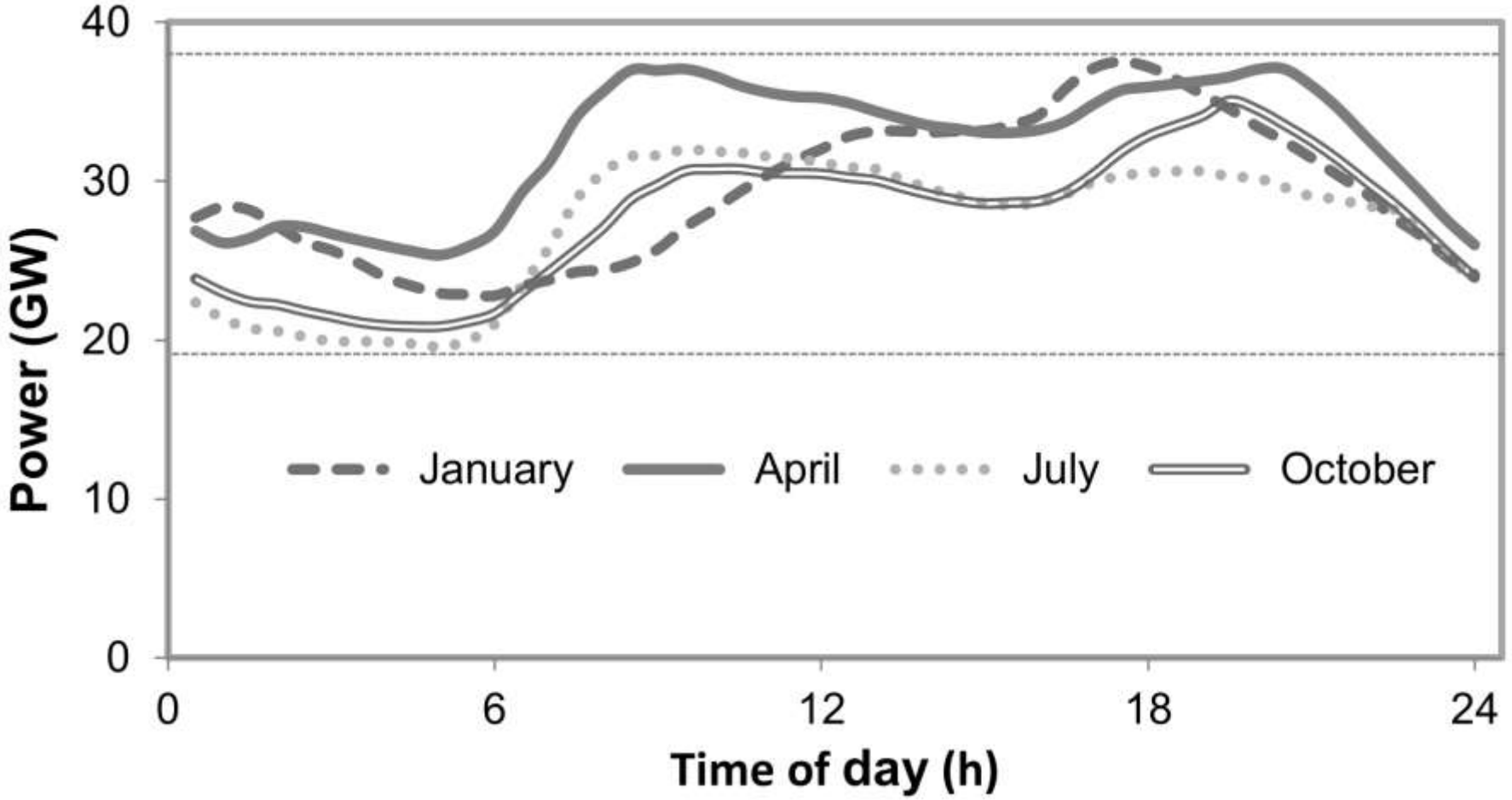
1882



[Historical drama *Edison, the Man,* directed by Clarence Brown (MGM)]



Six, 27-ton, 100-kW “Jumbo” dynamos generated the coal-fueled electric power, **Thomas Edison**’s Pearl Street Station transmitting 100 volts of direct-current electricity underground to 400 lights in a one-square-mile area of Lower Manhattan’s First District (bounded by Wall Street, Nassau Street, Spruce Street, and Ferry Street).

1900: Niagara Falls – Westinghouse, Nikola Tesla, Edison, Alcoa, …

- Canada and the US signed a treaty to keep the beauty of Niagara Falls intact.

- The international pact limits the amount of diverted water for power production, stipulating that at least 100,000 cubic feet of water per second must flow over the Falls from 8 a.m. to 10 p.m. each day during the tourist season.

- Otherwise, the flow can be reduced to half that.

Niagara Falls, Ontario

Sir Adam Beck hydropower station

1900: Niagara Falls – Westinghouse, Nikola Tesla, Edison, Alcoa, …

TVA (1924), Hoover Dam (1935), Grand Coulee Dam (1942)

Aswan (1960), GERD (2022),

James Bay (1971, 1984, …)

Three Gorges Dam (2012)

…

Oscar Wilde (1882)

Niagara Falls, Ontario

Sir Adam Beck hydropower station

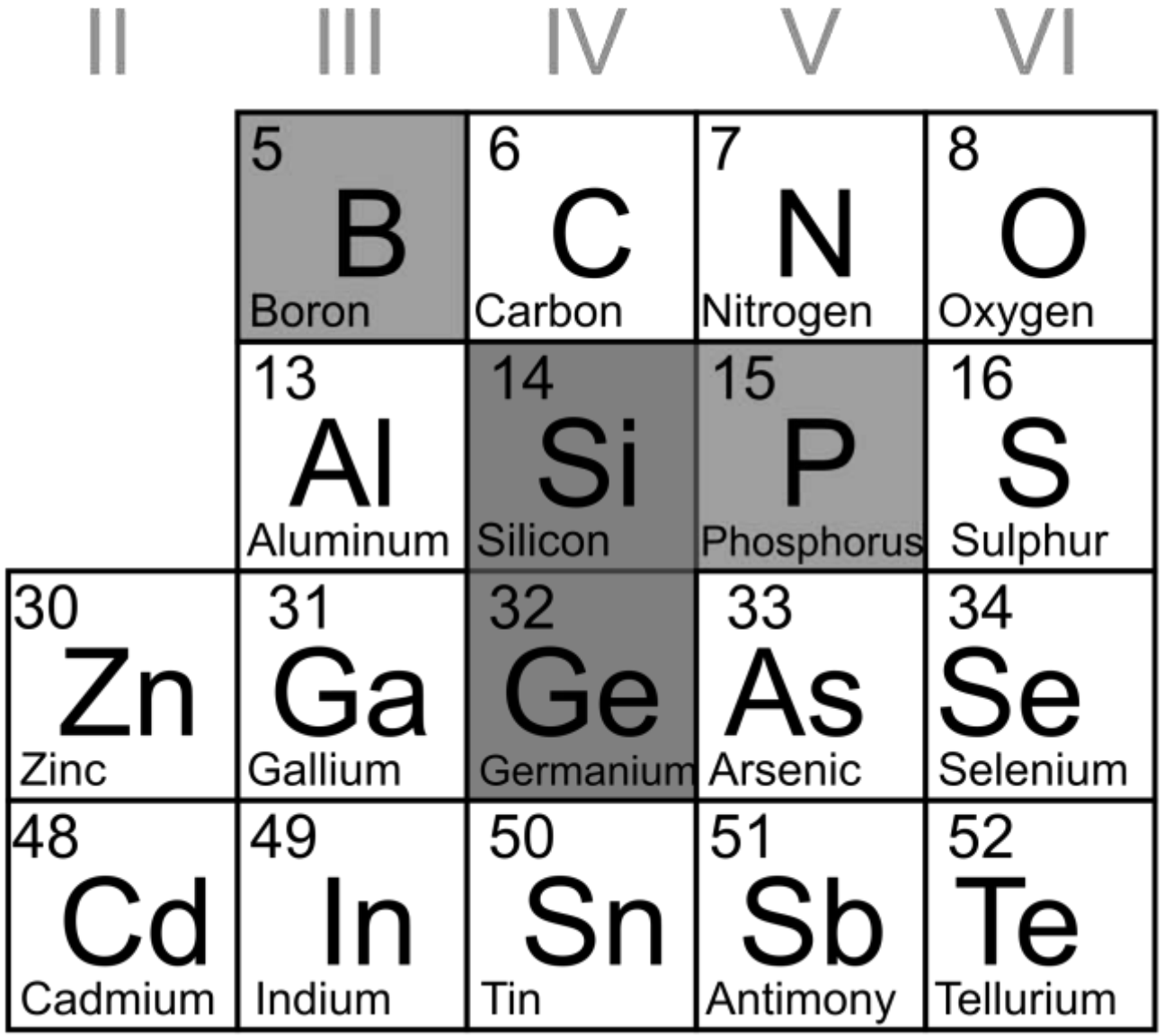
1919: North Sea Wind – Buddinge, Vindeby, Copenhagen, …

- The 40-kW Agricco wind turbine was the first grid-tied (1919) and used true airfoils.
- 4.95-MW Vindeby offshore farm (1991) comprised 11 450-kW turbines with 35-m rotor that the led the way for other offshore projects.
- 40-MW Middelgrunden offshore installation (2000) in the shallow coastal waters of Copenhagen. The world's largest upon construction, comprising 20 2-MW turbines.

Buddinge airfoil wind turbine

1962: New Jersey (Bell Labs) – transistor, PV, satellites, Telstar, …

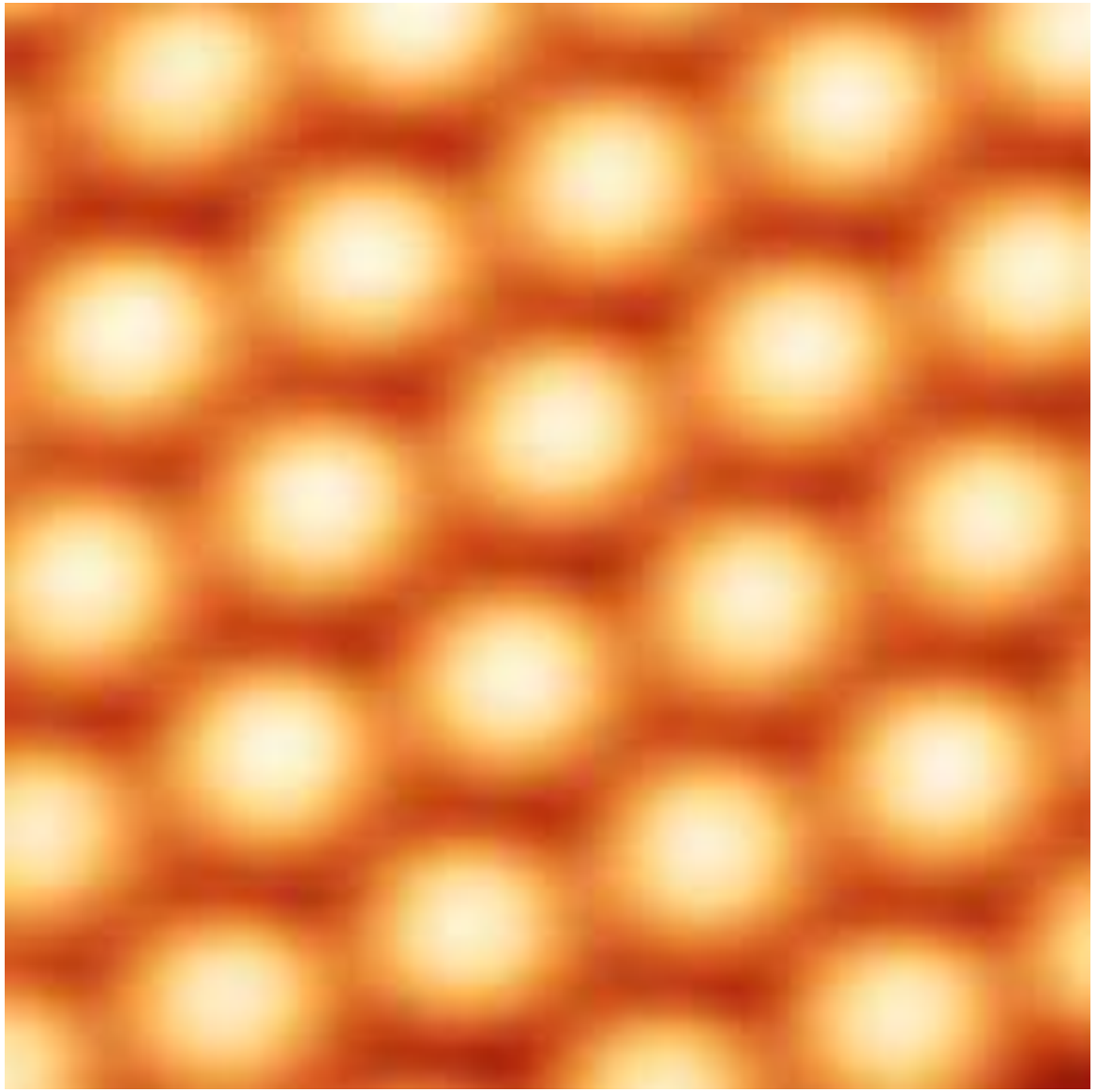
- At Bell Telephone's radio lab in Holmdel, New Jersey, electrochemist Russell Ohl discovered a large voltage in a piece of commercial-grade silicon during his radar research on signal detectors after a current flowed under flashlight illumination.
- The signal was varied, but Walter Brattain, working at Bell's main labs in nearby Murray Hill, noted, "this was the first time that anybody had ever found a photovoltaic effect in elementary material."
- The "doped" p-n junction was born.



Group III, IV, V elements

1962: New Jersey (Bell Labs) – transistor, PV, satellites, Telstar, …

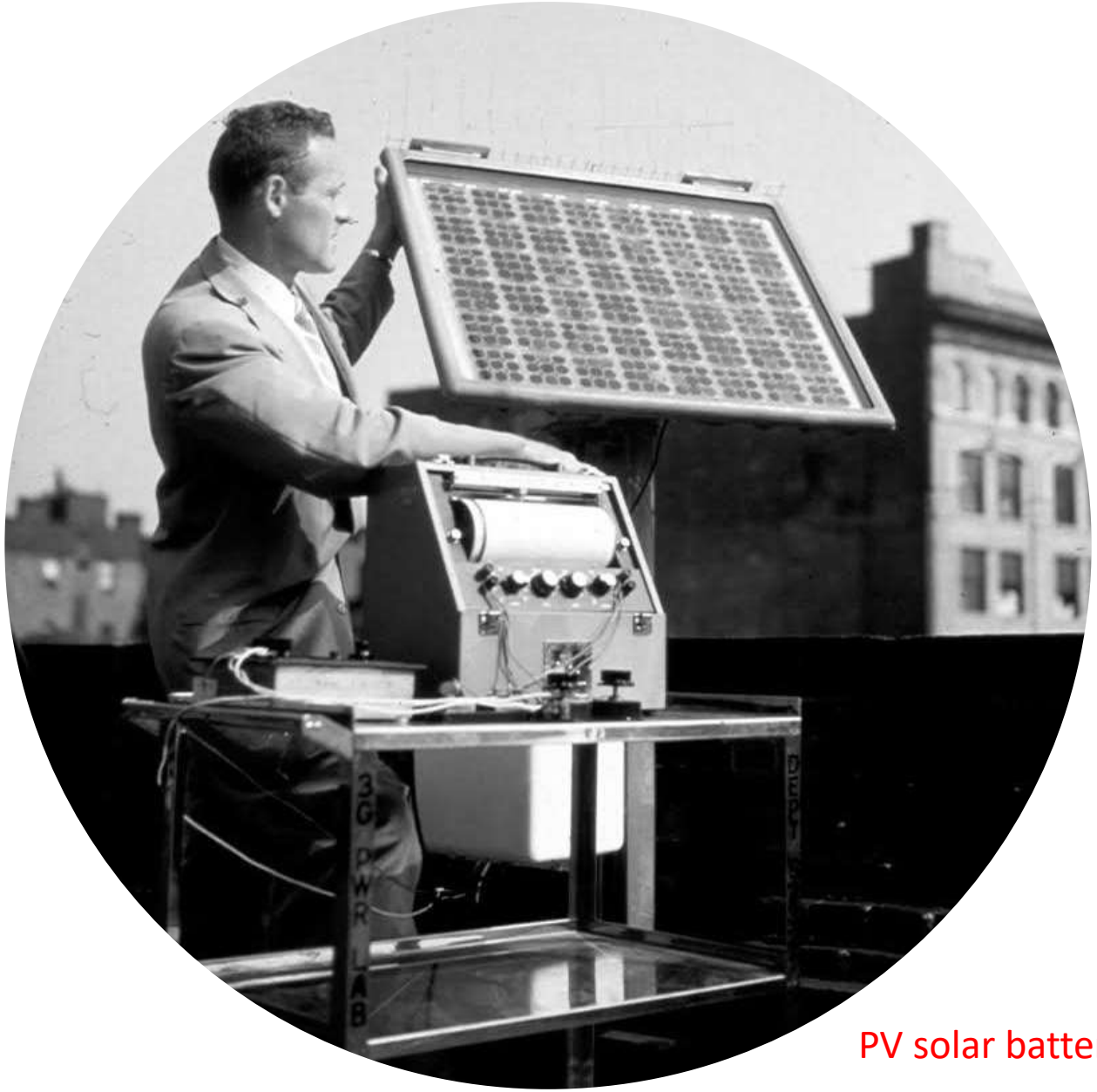
- semiconductor materials (silicon, germanium)
- solid-state diode, transistor
- PV solar cell
- satellites (*Explorer*, *Vanguard*, *Telstar*, …)
- IC (chip), LED, diode laser, CCD
- solar panels



14 Silicon (2 8 4)

1962: New Jersey (Bell Labs) – transistor, PV, satellites, Telstar, …

- 1954: A silicon pnp transistor was difficult to mass produce until the crystal was doped by diffusion (high-concentration dopants added to the molten silicon during crystal growth).
- 1954: PV solar battery: thin, silicon-doped wafer converts light into electricity at 6% efficiency ("compares favorably with the efficiency of steam and gasoline engines").
- 1962: AT&T's 1962 Telstar generated 14 watts from 3,600 modules.



PV solar battery

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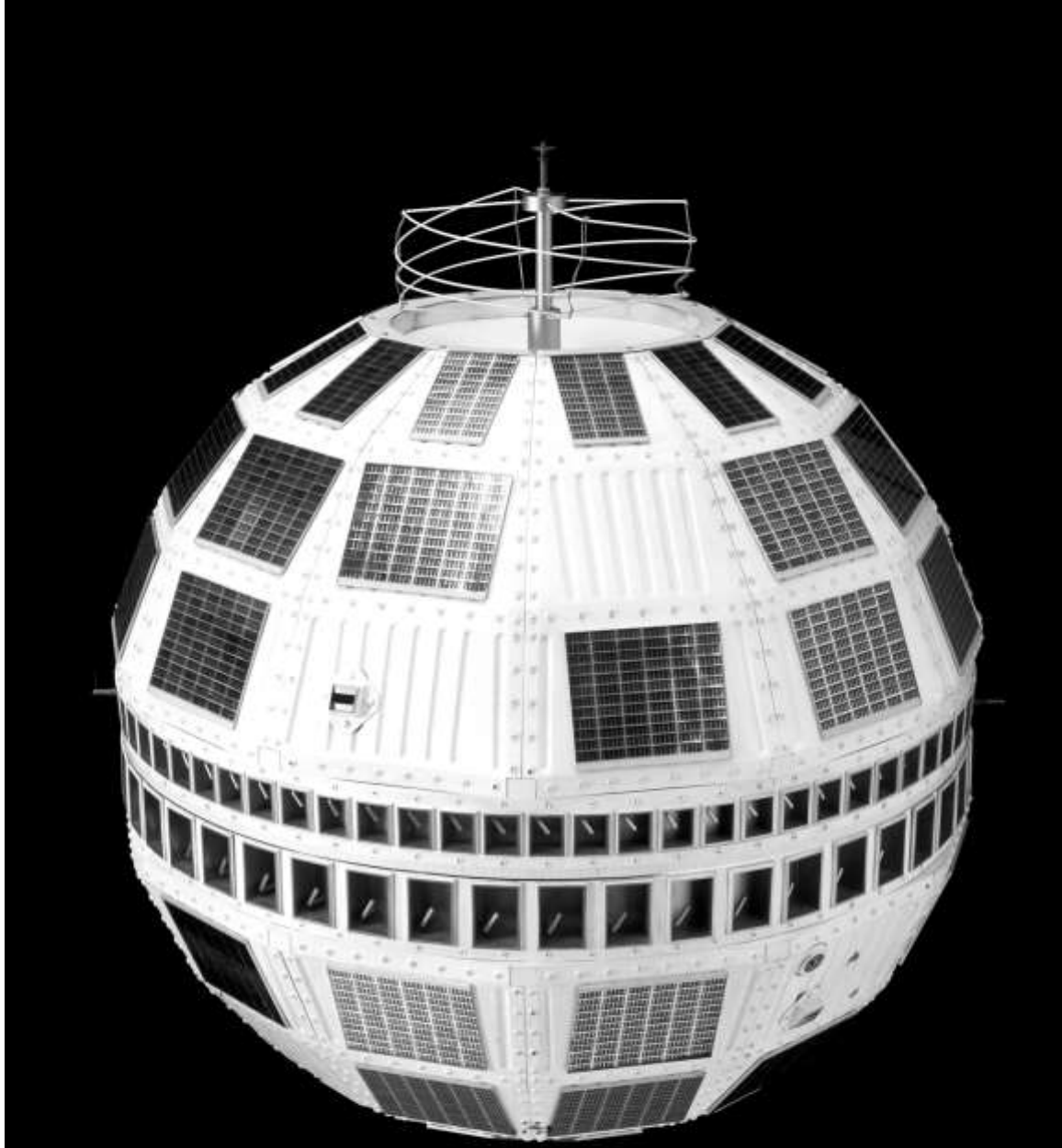

Telstar

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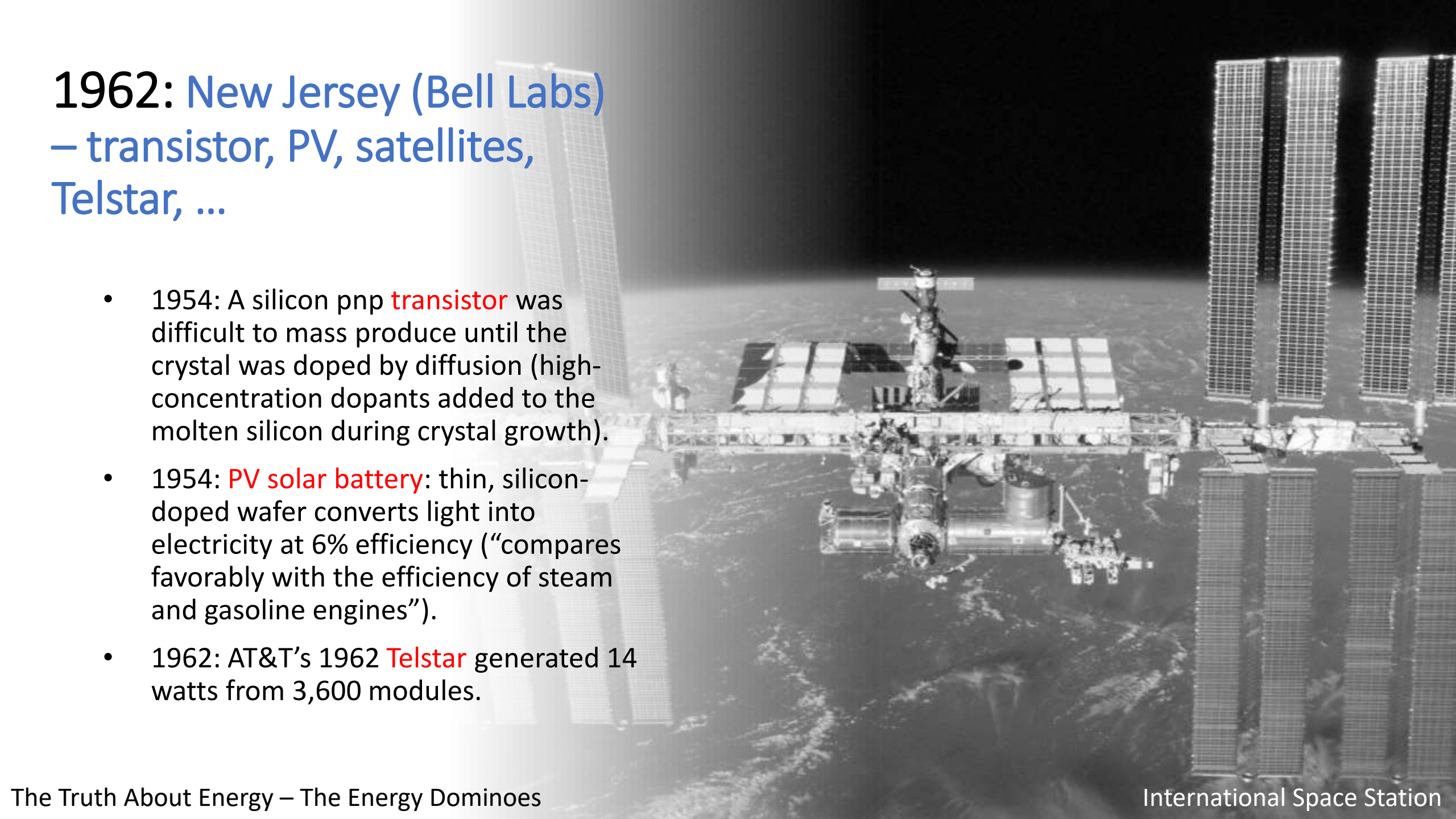

International Space Station

1962: New Jersey (Bell Labs) – transistor, PV, satellites, Telstar, …

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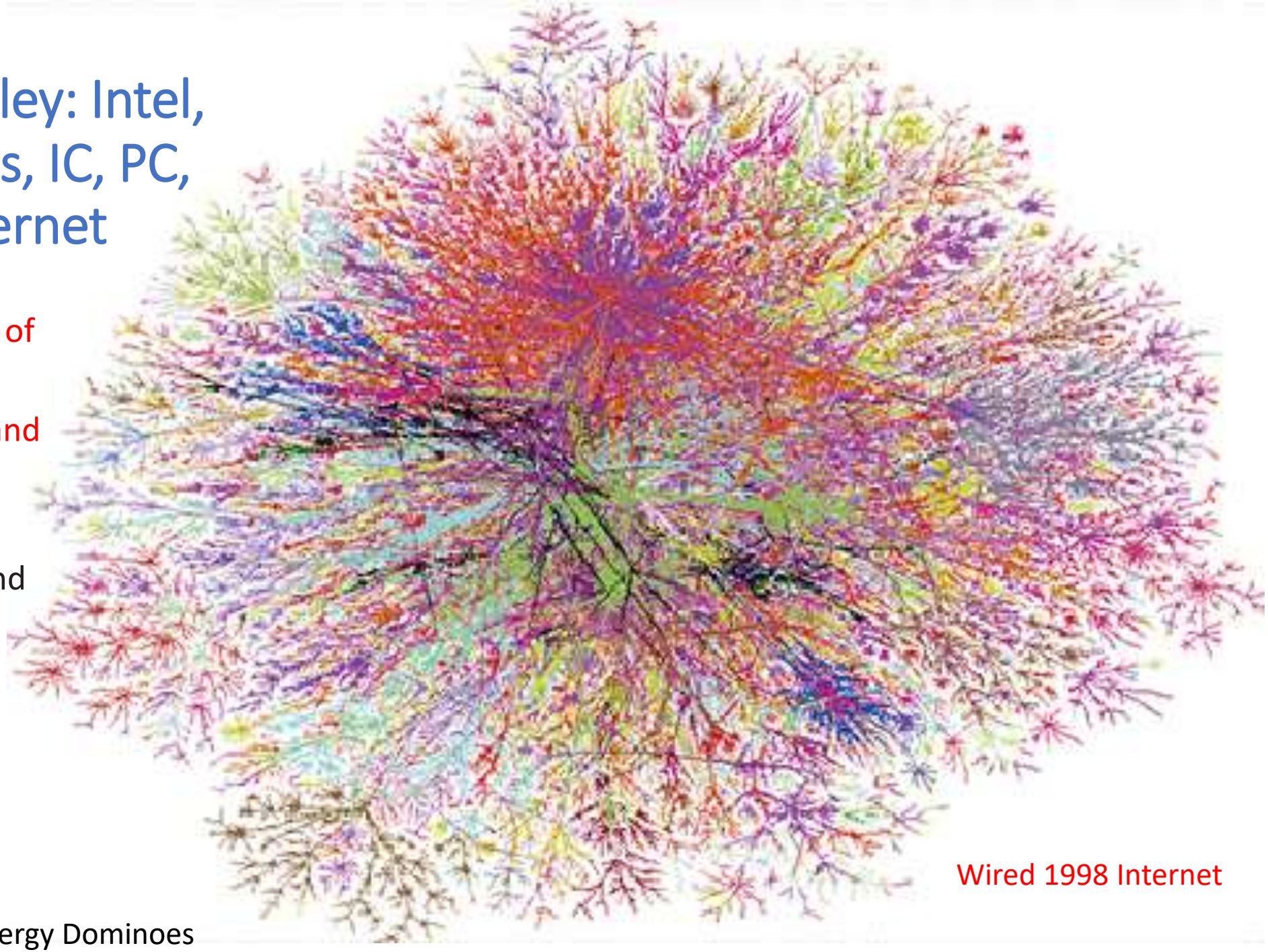
- 1962: AT&T's 1962 Telstar generated 14 watts from 3,600 modules.

200-W rooftop PV solar panels

1971: Silicon Valley: Intel, Texas Instruments, IC, PC, Moore's Law, Internet

Since 1968, the number of transistors on a chip increased from 1 thousand to more than 4 billion over four decades, powering modern life and the technology of the future.

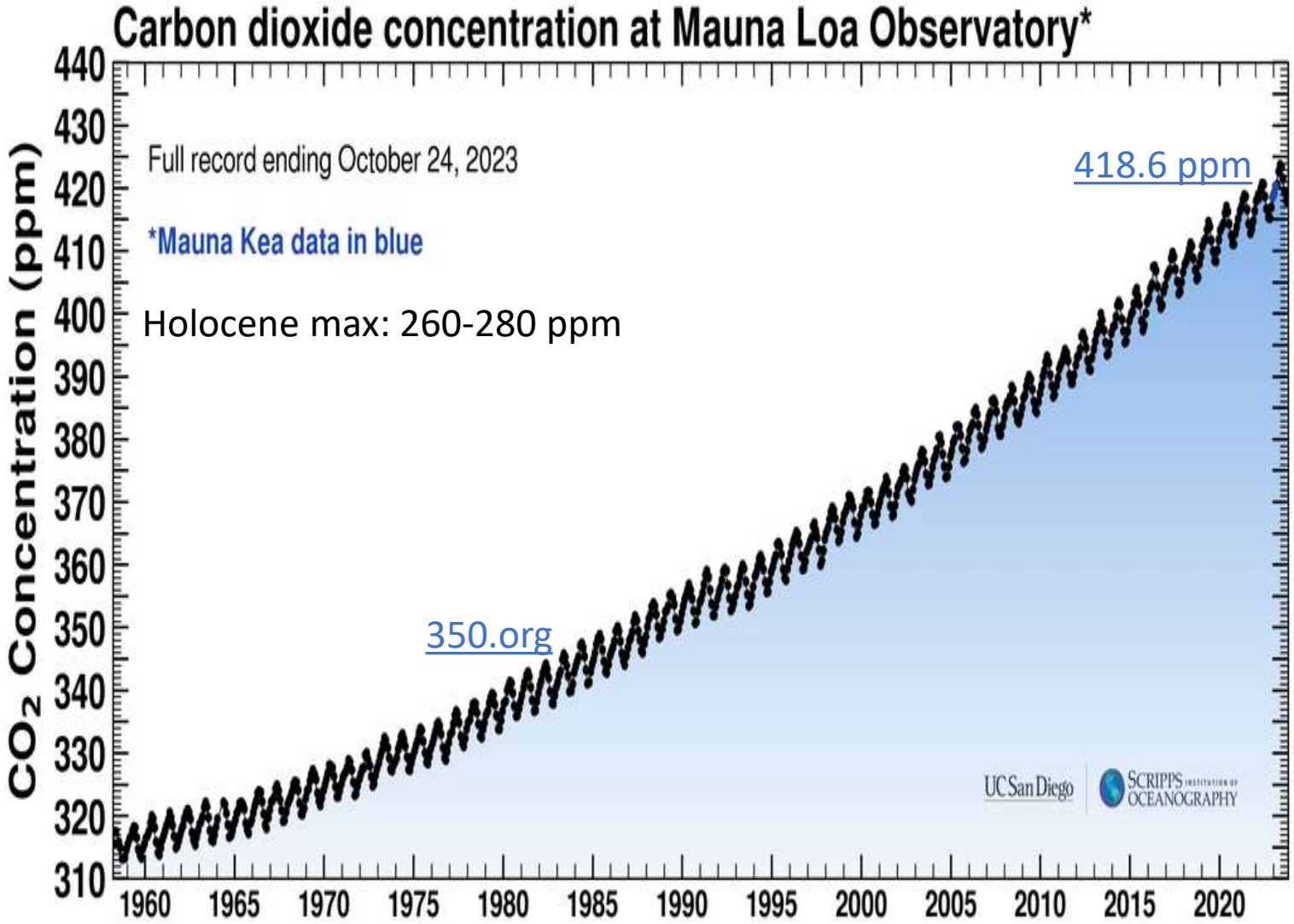


Wired 1998 Internet

1988: Congressional testimony of James Hansen (transcript)

NASA Goddard Space Studies Institute director James Hansen testified to the U.S. Senate on the greenhouse effect.

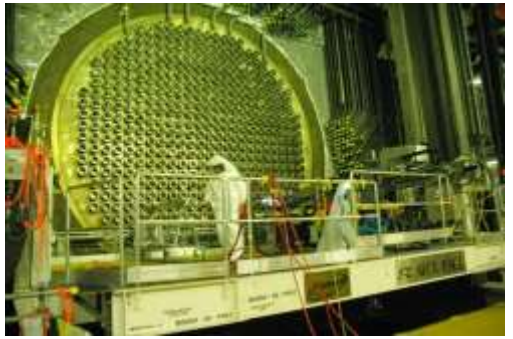
He concluded global temperatures are the highest since instrumental measurements, a causal relationship between GHG and global warming, and the beginning of extreme events.



Scripps Institution of Oceanography UC San Diego

Other Dominoes?

1500 Leonardo da Vinci designs rotating turret windmill
1666 Isaac Newton splits white light into component colours
1830 George Stephenson *Northumberland* train service (Liverpool – Manchester)
1864 Nikolaus Otto designs a 4-stroke ICE run on piped-in coal gas
1865 James Clerk Maxwell 4 EM equations
1887 James Blyth build first electricity-generating wind turbine
1900 Max Planck quantum theory (E = hf)
1905 Albert Einstein *Annus Mirabilis* ($E = mc^2$), photons → electrons
1932 James Chadwick discovers the neutron
1945 Alamogordo/Hiroshima/Nagasaki → uranium trace, arms race
1960 OPEC is created after talks between Venezuela and Saudi Arabia → oil shocks
1960 Rachel Carson *Silent Spring* → EPA
1976 Sharp makes the first solar calculator
1984 Chernobyl reactor meltdown → end of USSR
2008 Tesla Roadster launched with chained Panasonic 18-650 Li-ion batteries
2020 Bhadla Solar Park in Rajasthan, India, generates 2 GW
2022 NIF laser fusion "break-even" with Q of 1.5
2022 US Congress passes the Inflation Reduction Act ($369 billion/10 years)



The Truth About Energy – The Energy Dominoes

Solar

Coal

Oil

Wind

Gas

Hydro

Nuclear

Coal

Oil

Wind

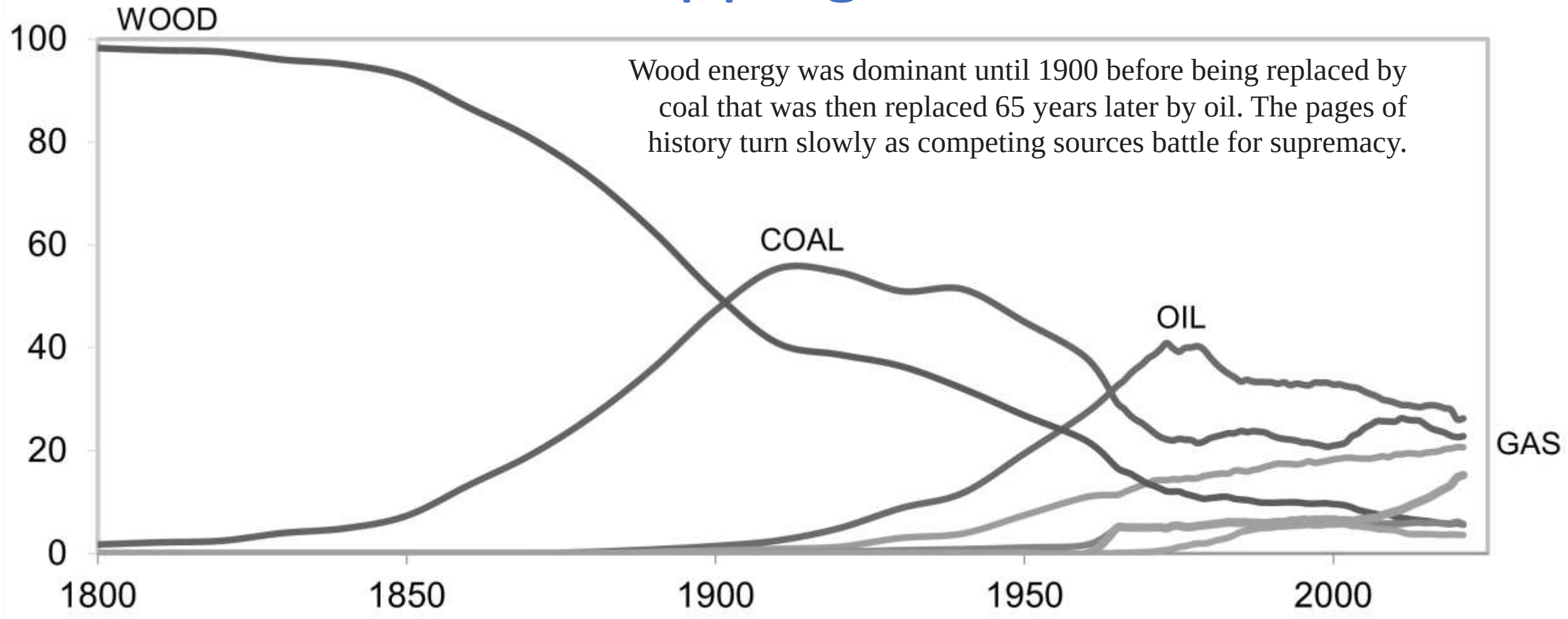
Gas

Hydro

Nuclear

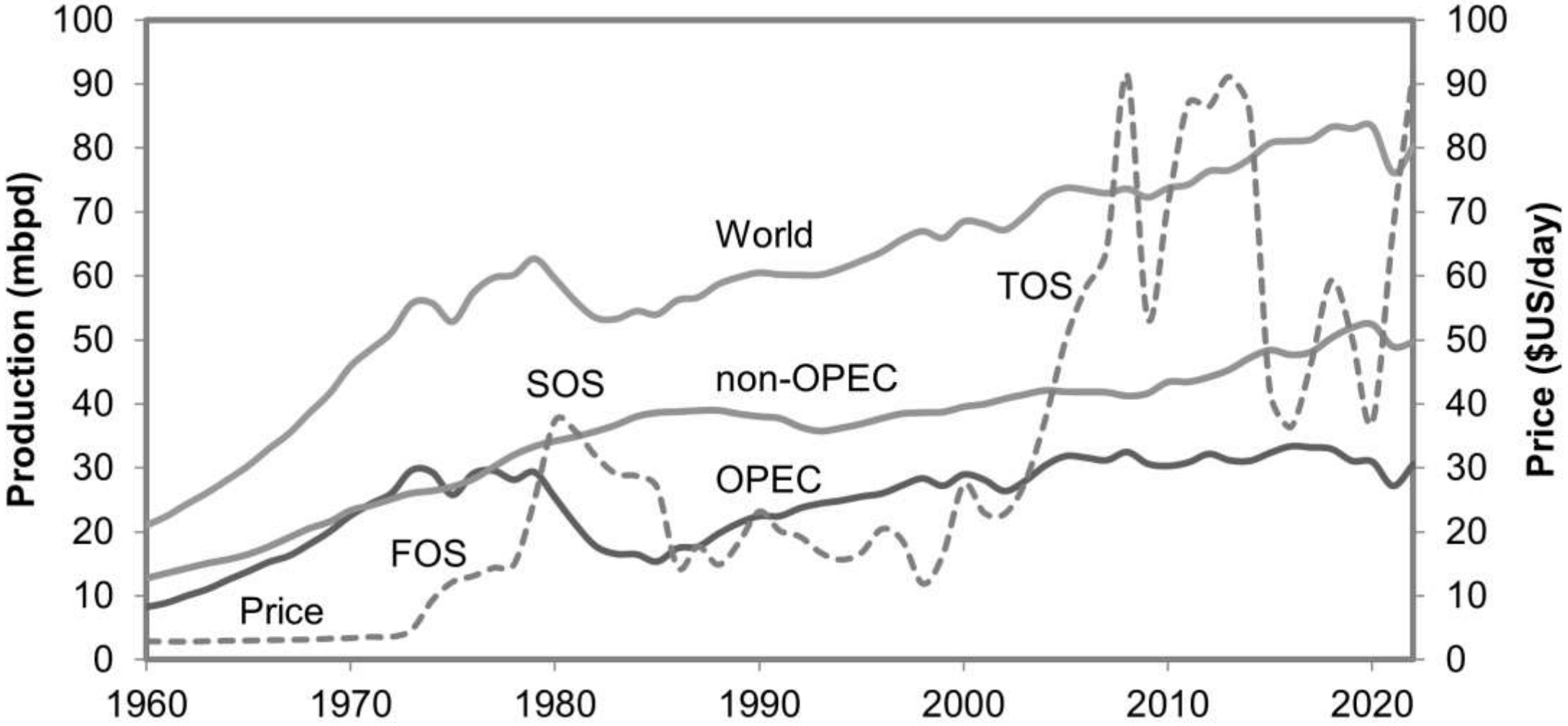
The Truth About Energy – The Energy Dominoes

The Tipping Point?

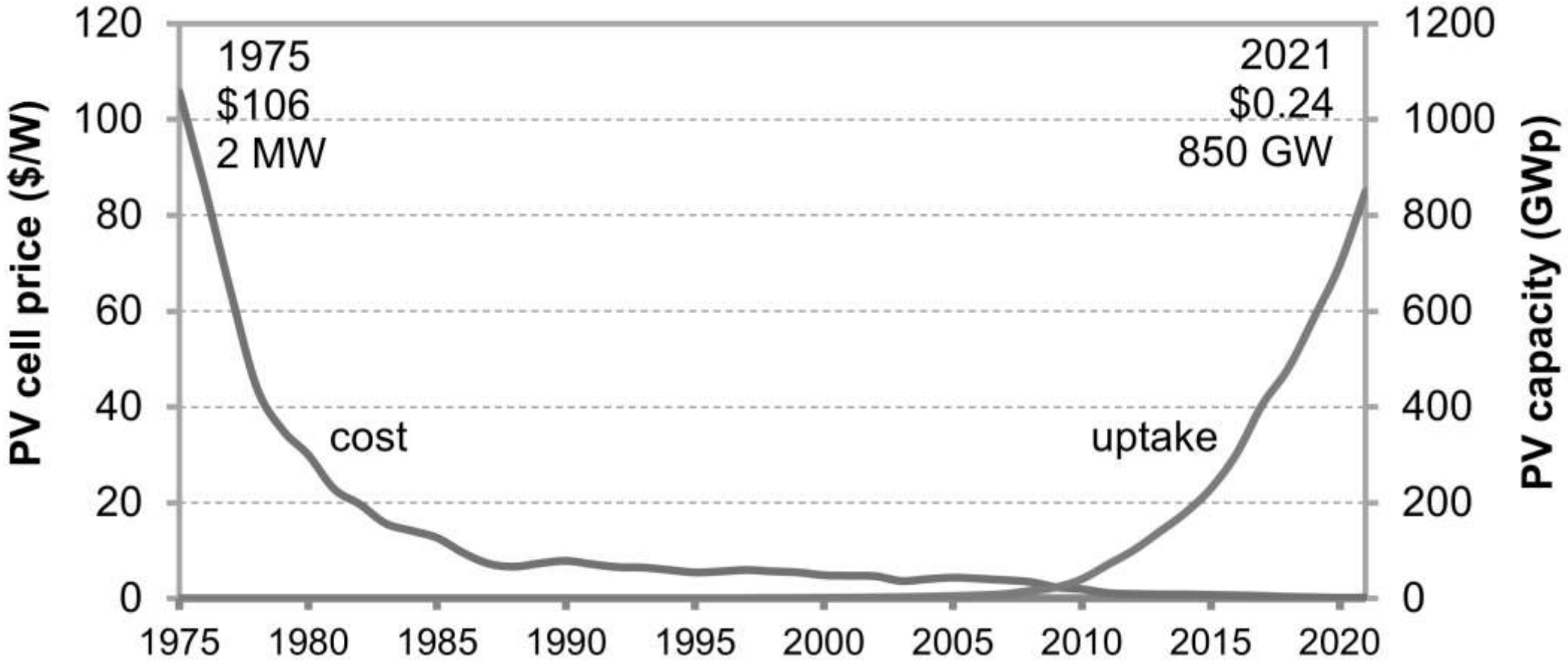


Global energy percentage from 1800 to present of the main energy sources

The story of the 20th century

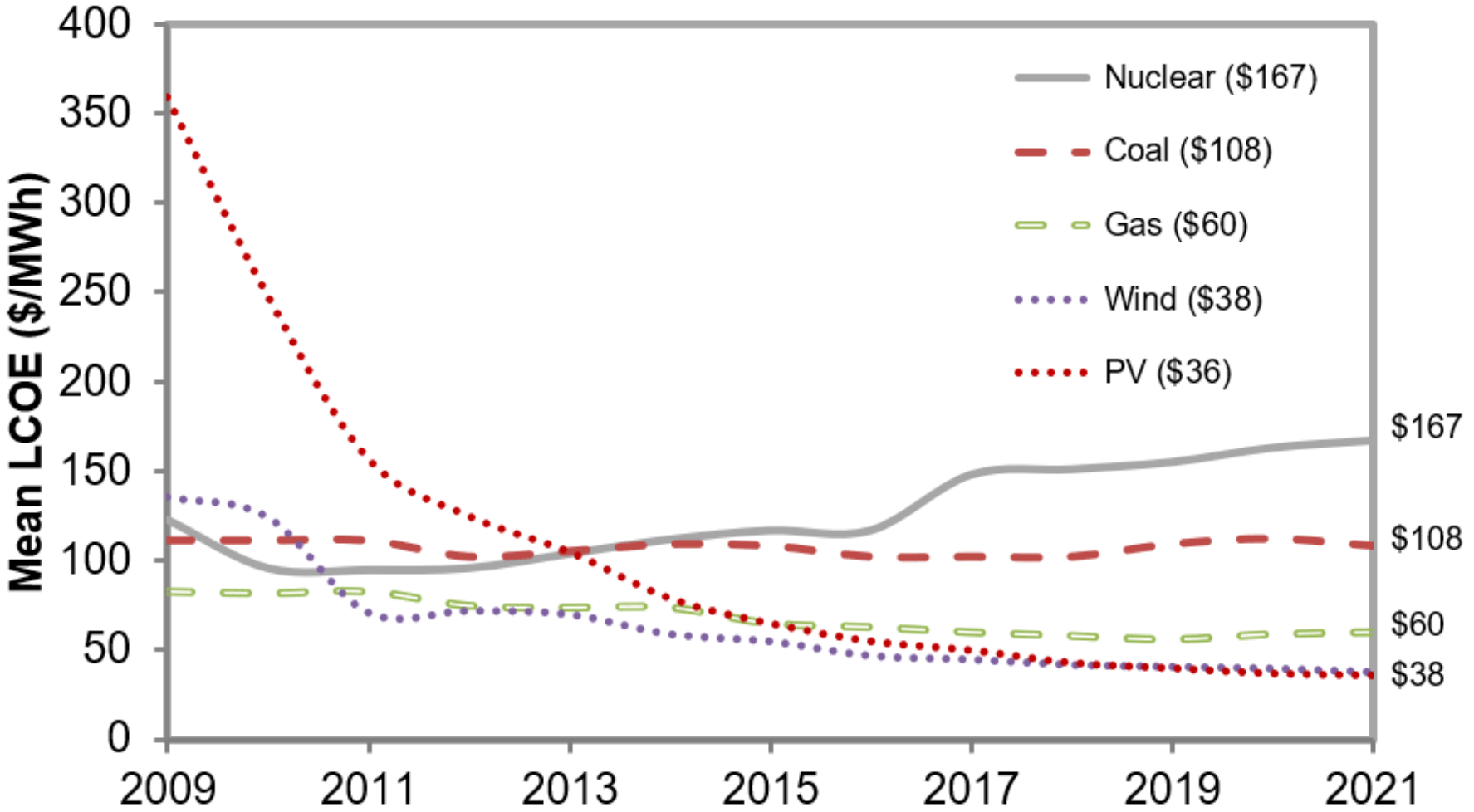


The story of the 21st century



Solar panel price per watt ($/W) versus global installation (GW) (1975–2021)

The story of the 21st century

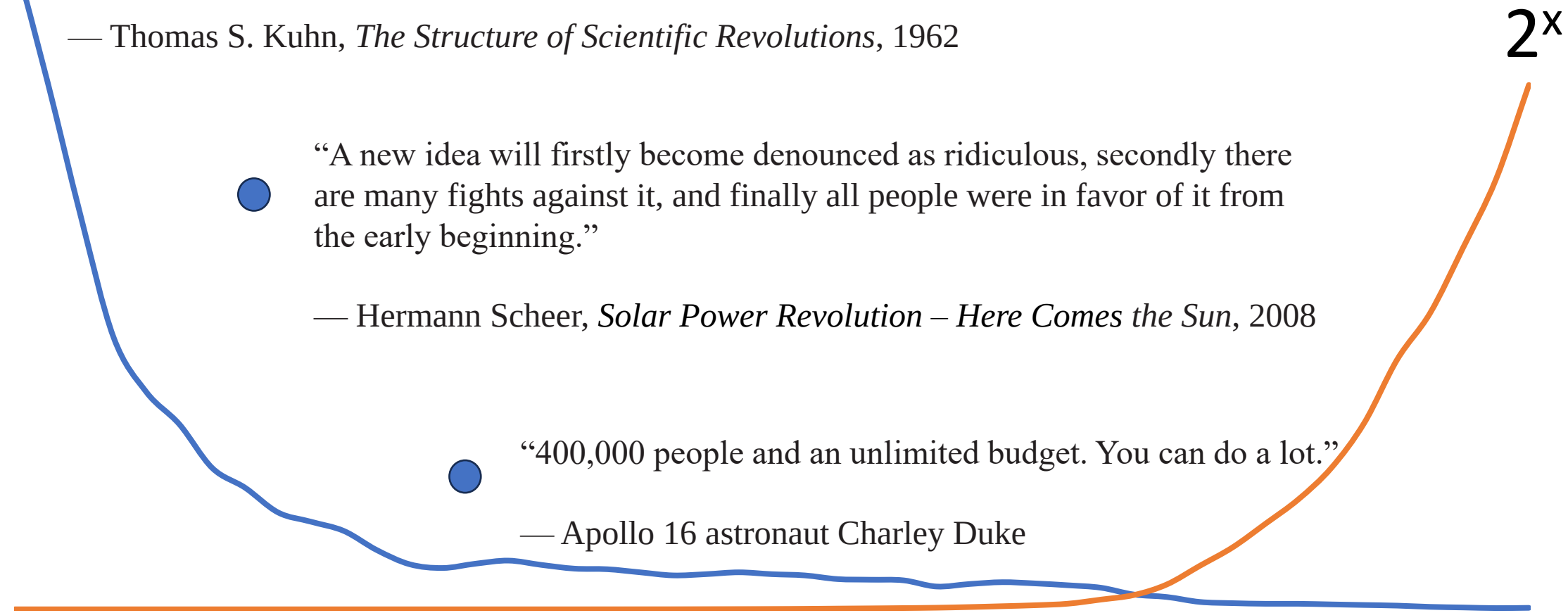


Average levelized cost of energy (LCOE) from 2009 to 2021 (Lazard)

Transition ABCs

"Paradigms gain their status because they are more successful than their competitors in solving a few problems that the group of practitioners has come to recognize as acute."

— Thomas S. Kuhn, *The Structure of Scientific Revolutions*, 1962

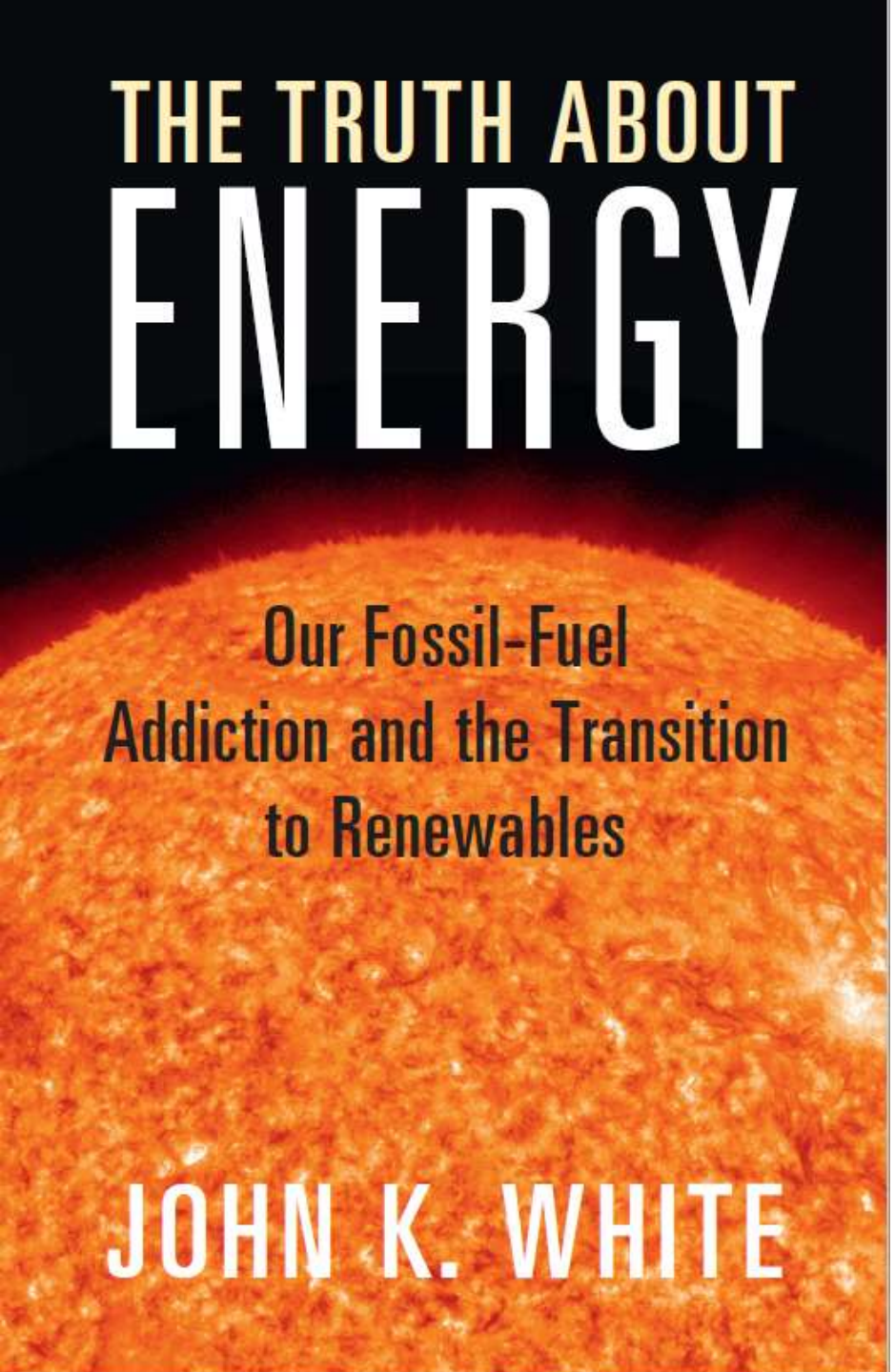


"A new idea will firstly become denounced as ridiculous, secondly there are many fights against it, and finally all people were in favor of it from the early beginning."

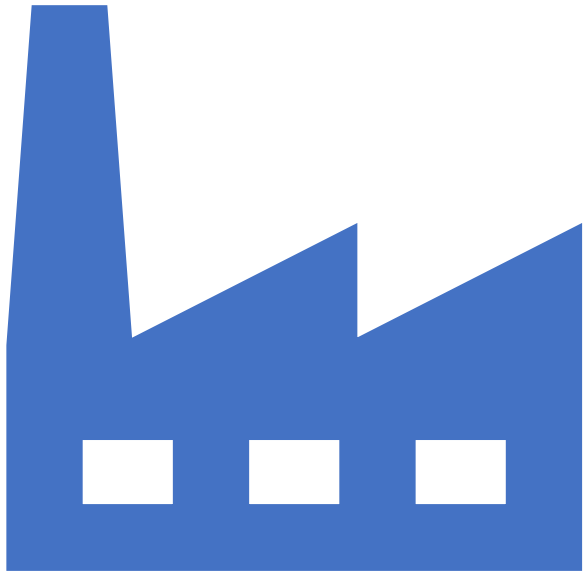
— Hermann Scheer, *Solar Power Revolution – Here Comes the Sun*, 2008

"400,000 people and an unlimited budget. You can do a lot."

— Apollo 16 astronaut Charley Duke



1. Coal (and the Industrial Revolution)



MINERO POR UN DÍA

Minas de Asturias

mumi

El Entrego

El Cadaviu

San Martín

ECOMUSEO MINERO VALLE DE SAMUÑO

Feria de Muestras en Gijón 2023

grupohunosa

1: Coal and the Industrial Revolution

Aboño Thermal Power Plant (EDP)

(340 MW, 540 MW)

Burns various liquid, solid, and gas fuels: fuel oil, diesel, domestic and imported coal, and surplus blast furnace and coke battery gas from the nearby ArcelorMittal steel factory.

coal to gas plan (2025)

1: Coal and the Ind. Rev.

ArcelorMittal Asturias

steel factories (Avilés and Gijón)

Only plant in Spain to produce steel from iron ore. Annual production capacity is ~5 million tons of steel such as in Gijón flat products (thick sheet) and long (rail and alambron).

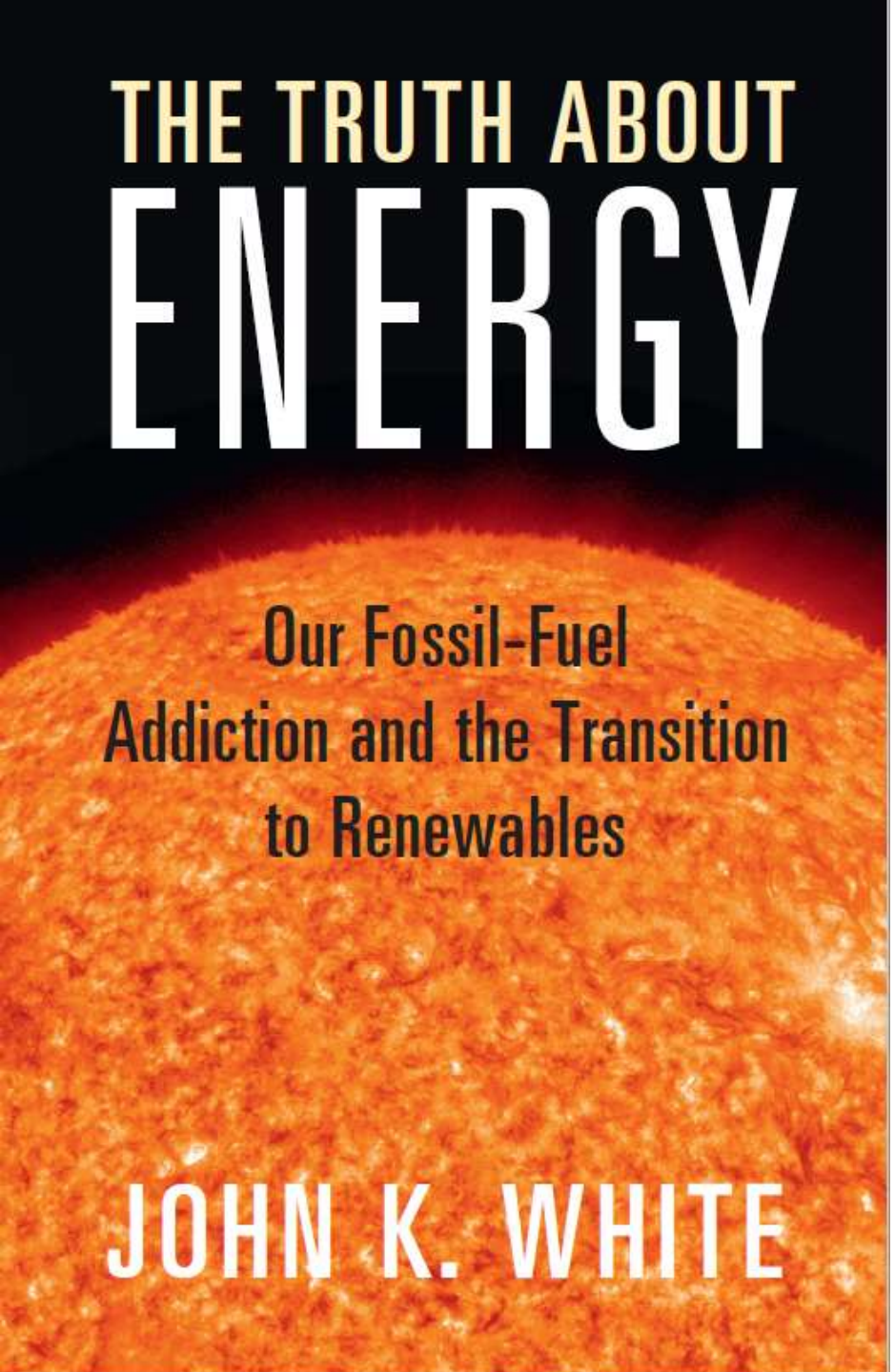
green hydrogen DRI/EAF

China generates more than half and India and the United States about 10% each, burning roughly three-quarters of an 8.5-billion-ton annual production. Coal is available in vast quantities with deposits in over 75 countries with enough reserves to last 100 years at current rates, generating electricity from over 6,000 units worldwide.

#	Country	Number*	Power (GW)	%	CO_2 (Gtons/year)	%
1	China	1,118	1,074	52.0	4.7	49.7
2	India	285	233	11.3	1.0	11.1
3	United States	225	218	10.5	1.1	11.3
4	Japan	92	51	2.4	0.2	2.5
5	South Africa	19	44	2.1	0.2	2.2
6	Indonesia	87	41	2.0	0.2	2.0
7	Russia	71	40	1.9	0.2	2.3
8	South Korea	23	38	1.8	0.2	1.7
9	Germany	63	38	1.8	0.2	1.9
10	Poland	44	30	1.5	0.2	1.7
	Rest of world	261	261	12.6	1.3	13.6
	Total	2,439	2,067	100	9.4	100

Table 1.2 Global coal-fired power plants by country: number, power, CO_2 emissions, 2022

Spain: 2.9 GW operating (< .1%), 10.9 GW retired 2000-2023



2. Renewables

(WWS)

Kinderdijk, South Holland

The UNESCO World Heritage Site in the Albasserwaard region southeast of Rotterdam comprises 19 windmills and 3 pumping stations to drain water from a lower polder to a reservoir to a higher polder via scoop wheels and then on to the River Lek at low tide.

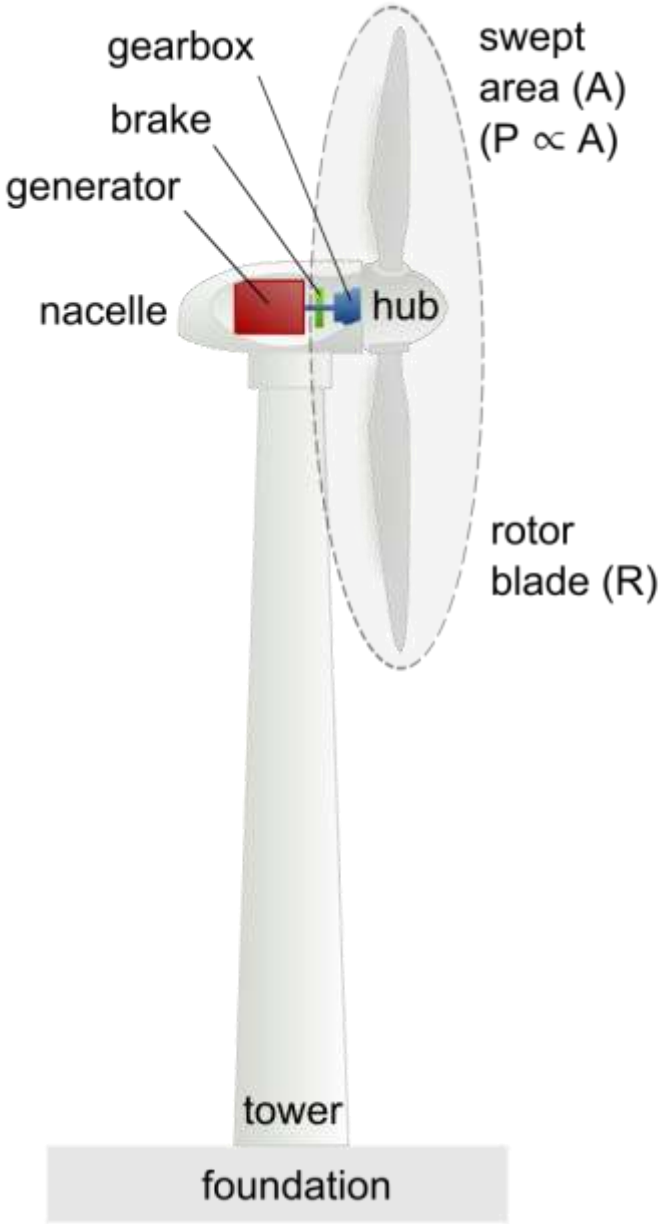
Middelgrunden Copenhagen

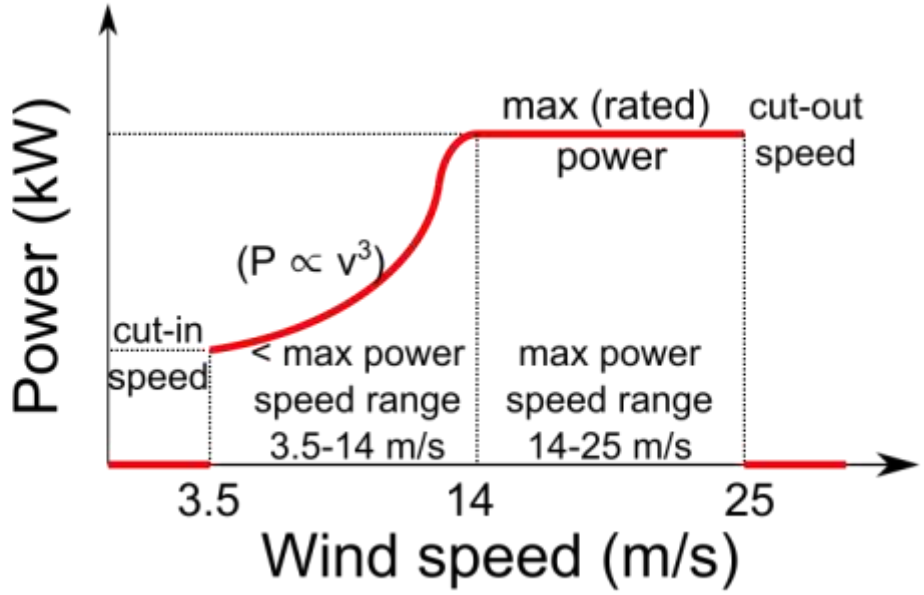
(40-MW, 20 turbines)

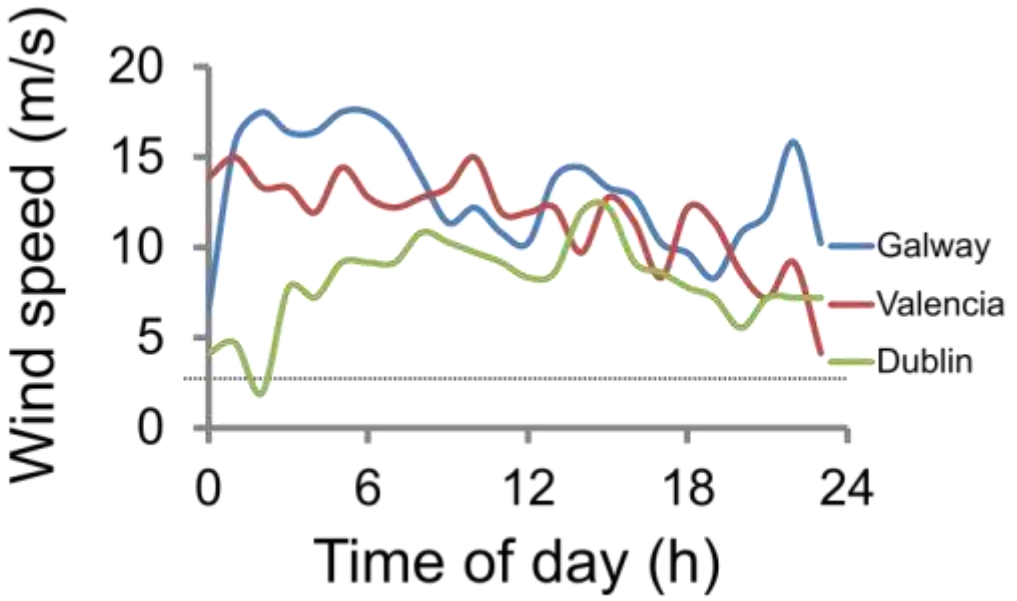
The cooperatively owned offshore wind farm in the shallow coastal waters of Copenhagen was the world's largest upon construction in 2000. With 10 onshore turbines nearby, the 30 WTs provide about 6% of Copenhagen's electric power.

Wind power basics

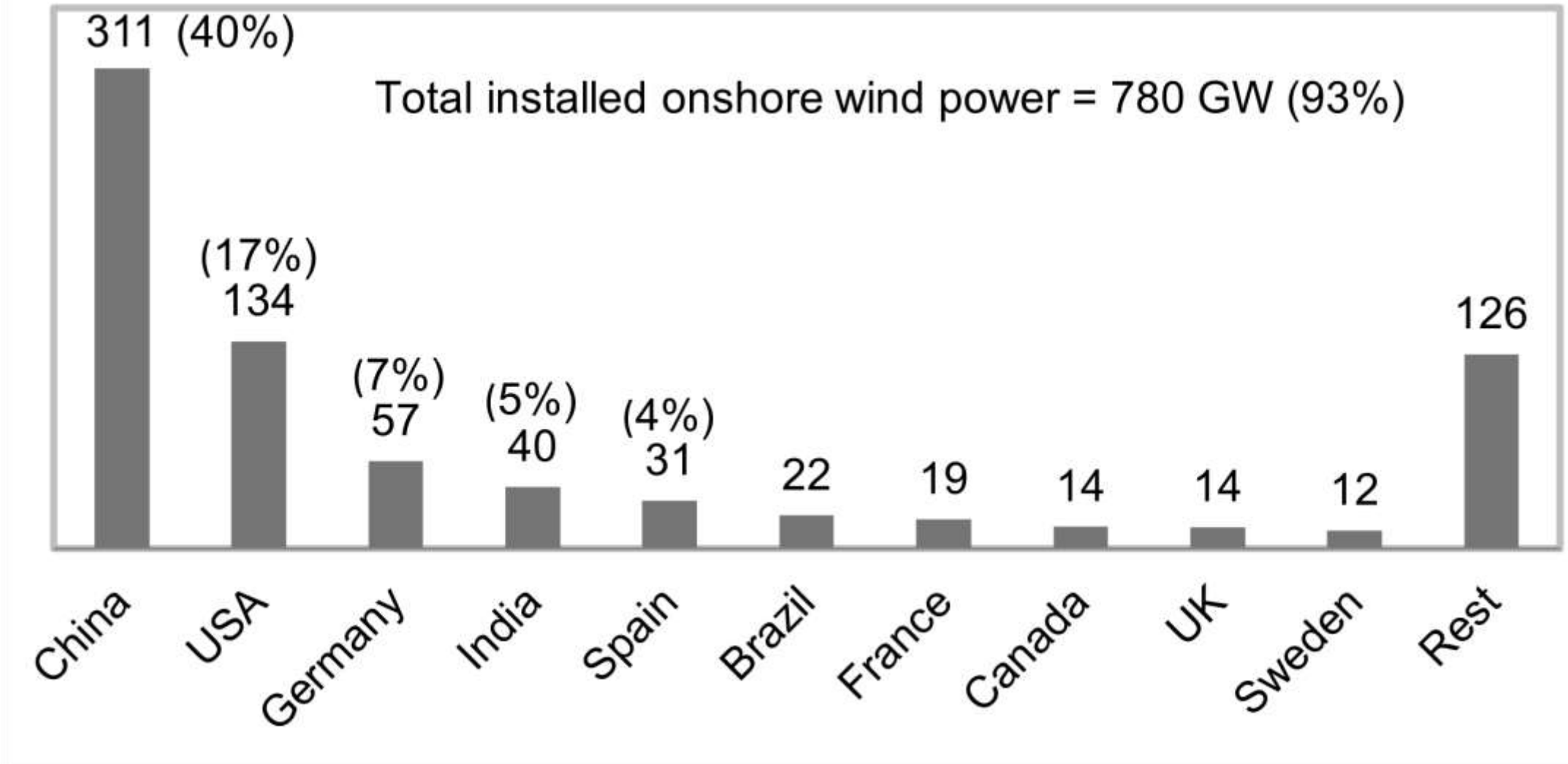
(power, intermittent, load spreading)







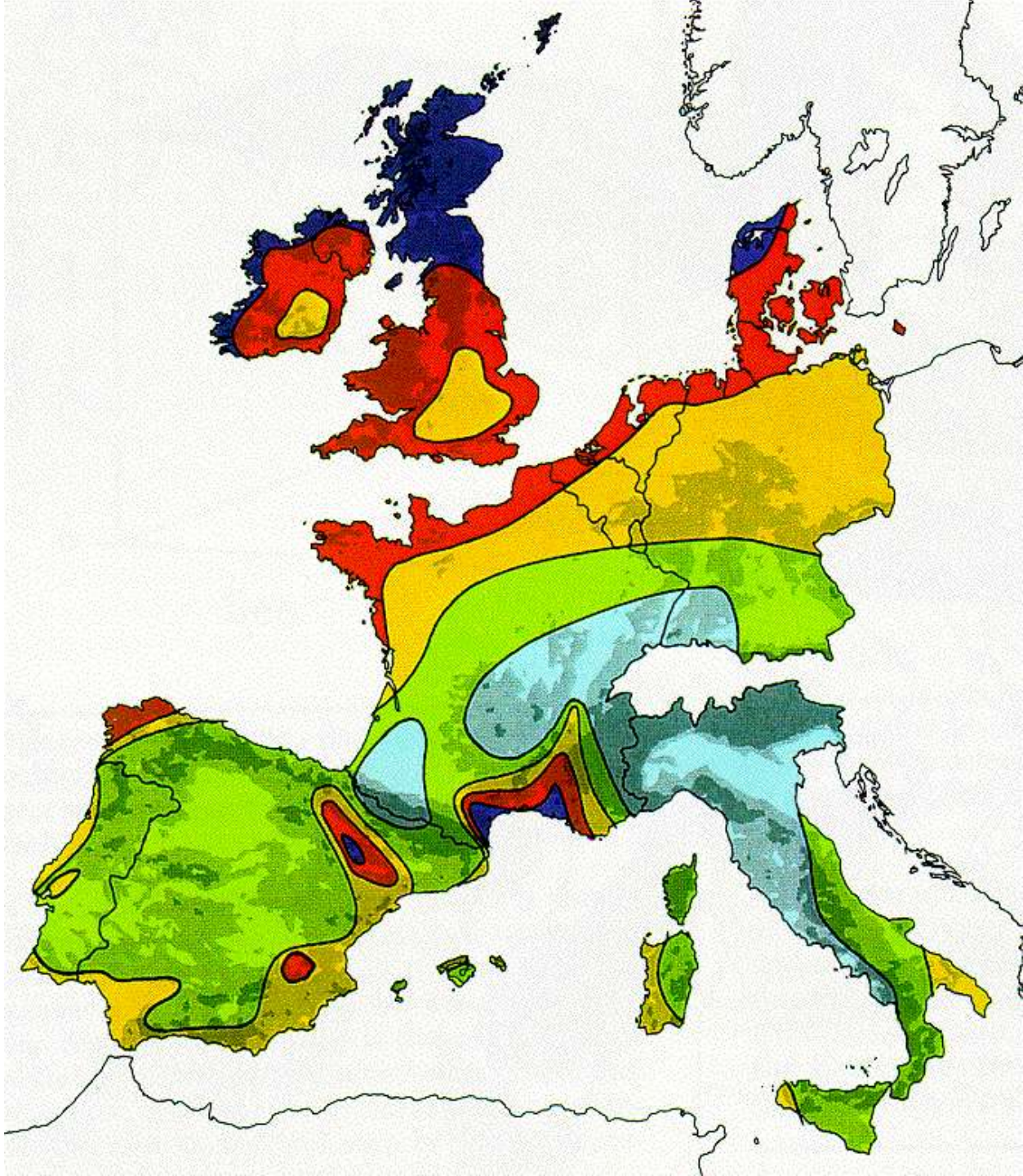
Wind power by country (roughly 1 TW in 2023)



Spain breezes into record books as wind power becomes main source of energy - 2014!

Sector covered 20.9 percent of total demand last year followed by country's nuclear plants, which met 20.8 percent

El País, January 15, 2014



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.”

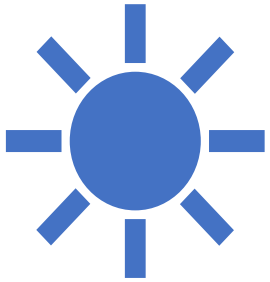
— Miguel de Cervantes Saavedra

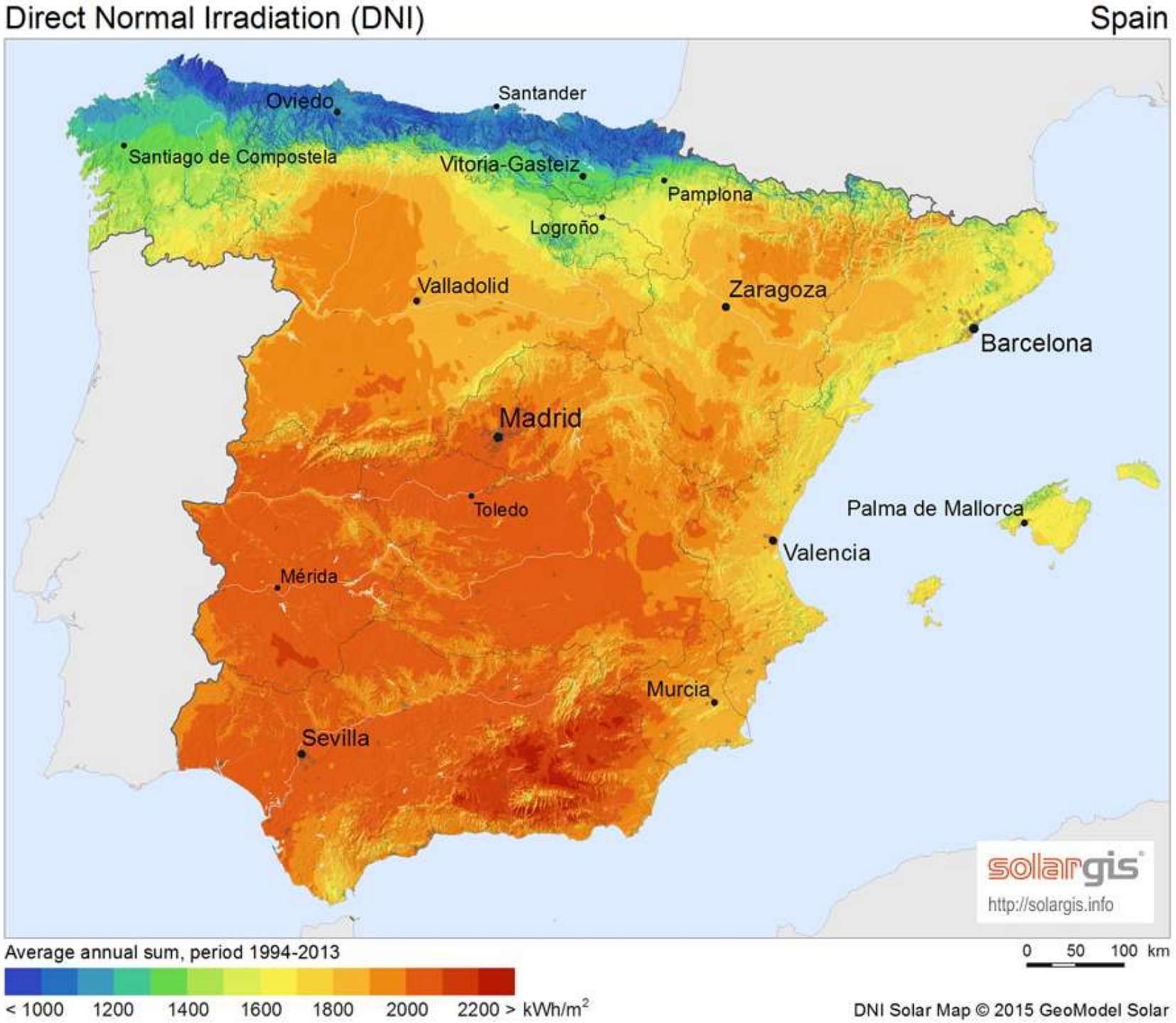
PV installation: rooftop, ground, parking lot, warehouse

2: Renewables: sun

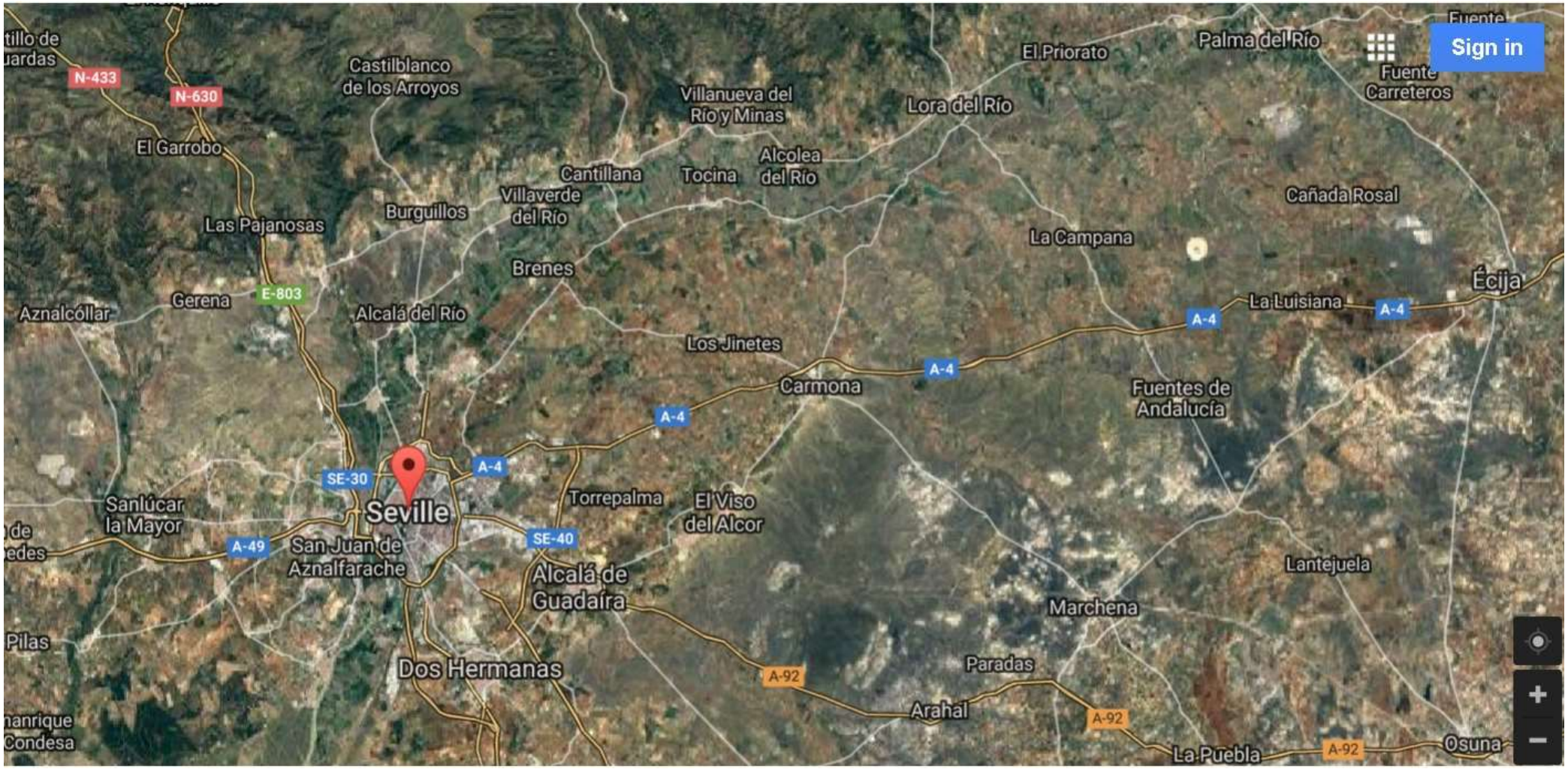
1-GW Yanchi PV solar plant in Qinghai, China

2: Renewables: sun



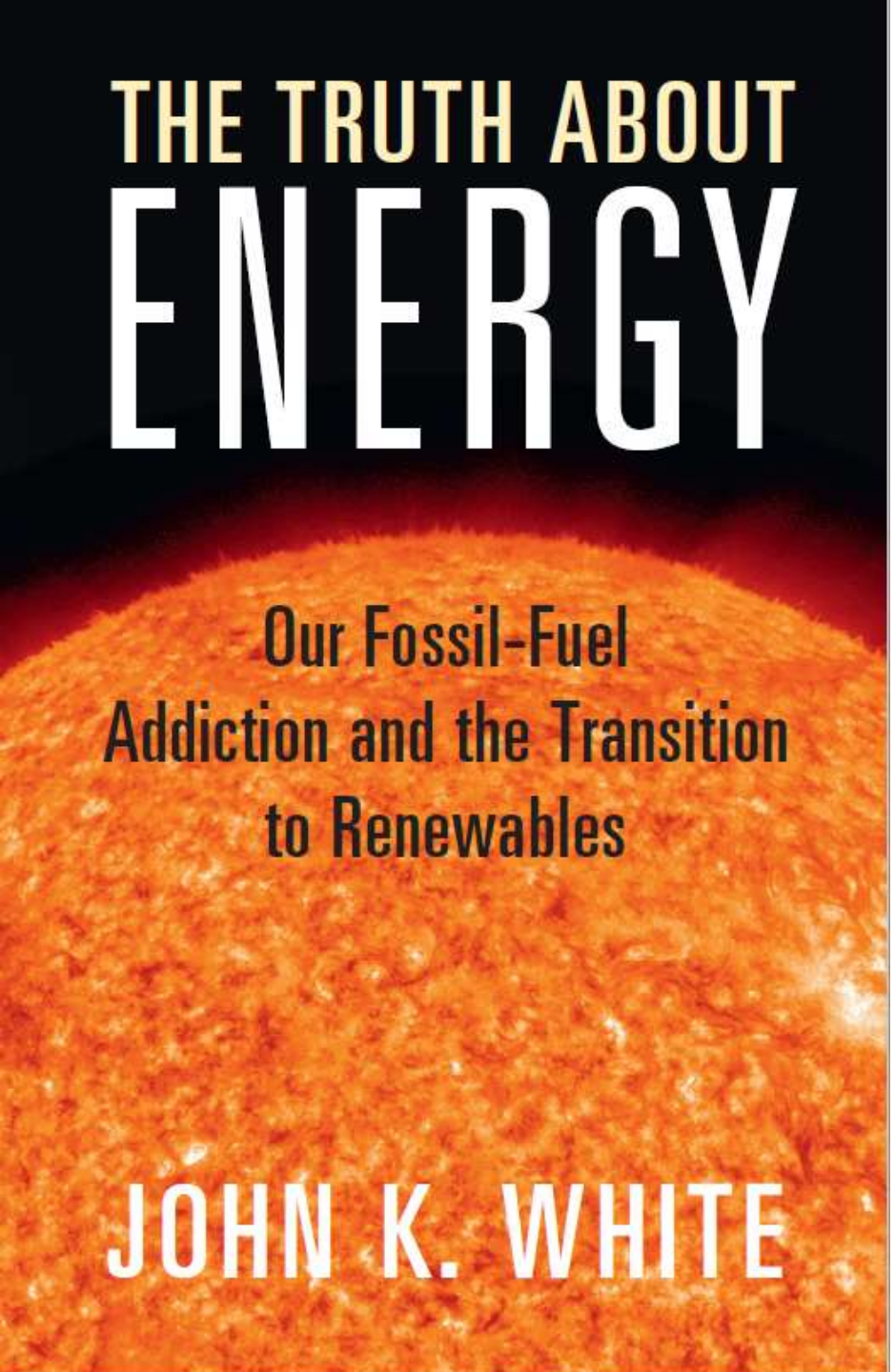


2: Renewables: sun

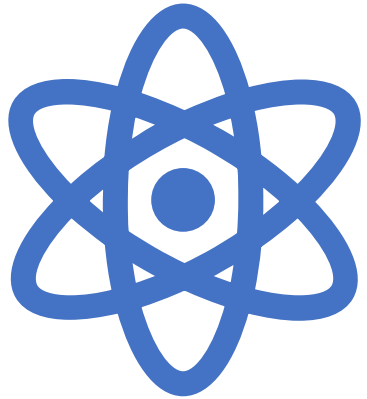


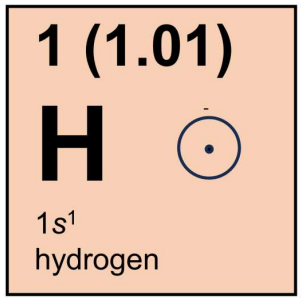
Google Maps (satellite): Andalusia, Spain

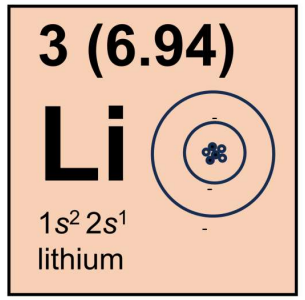
2: Renewables: sun

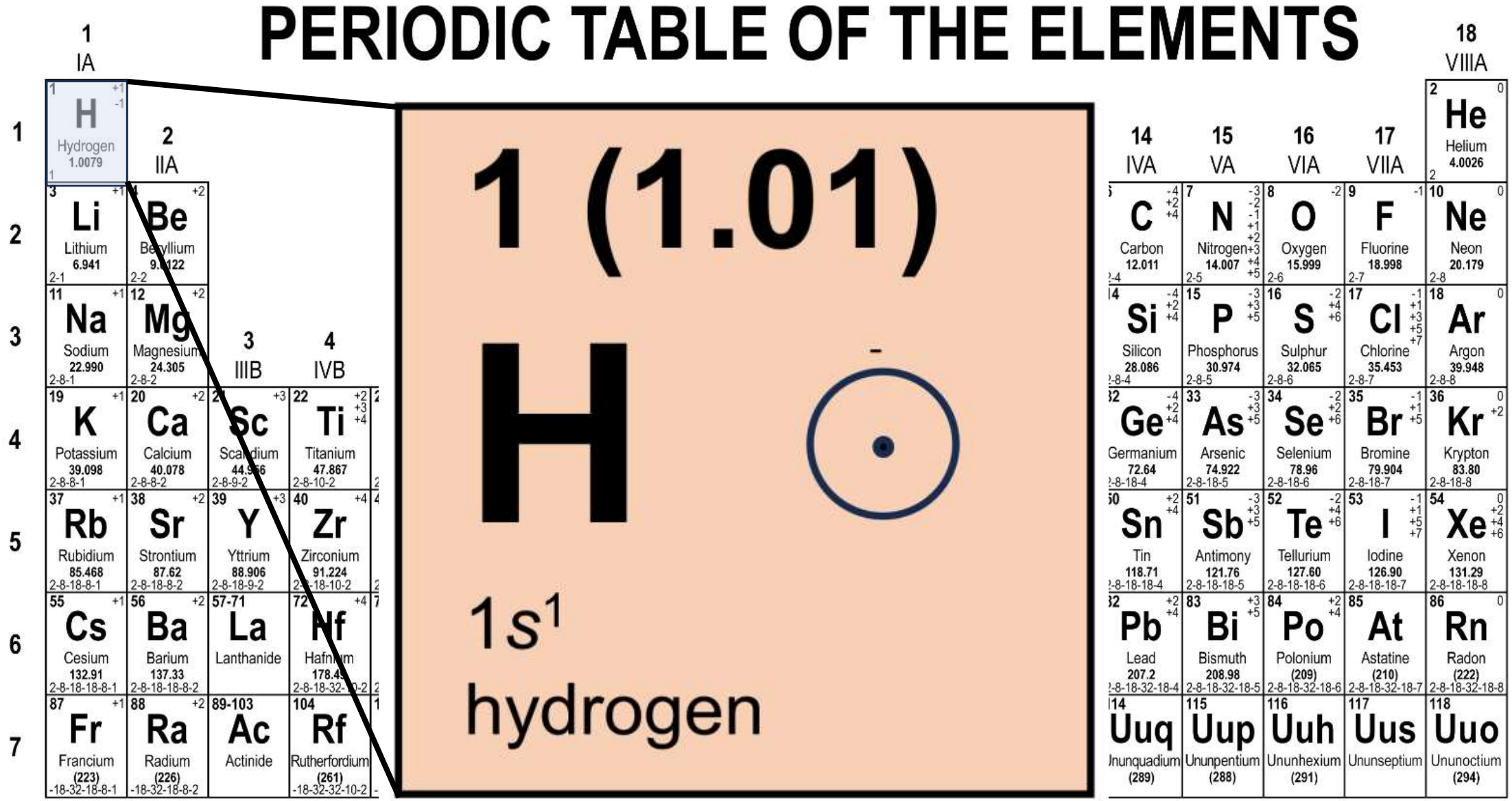


3. Lithium versus hydrogen









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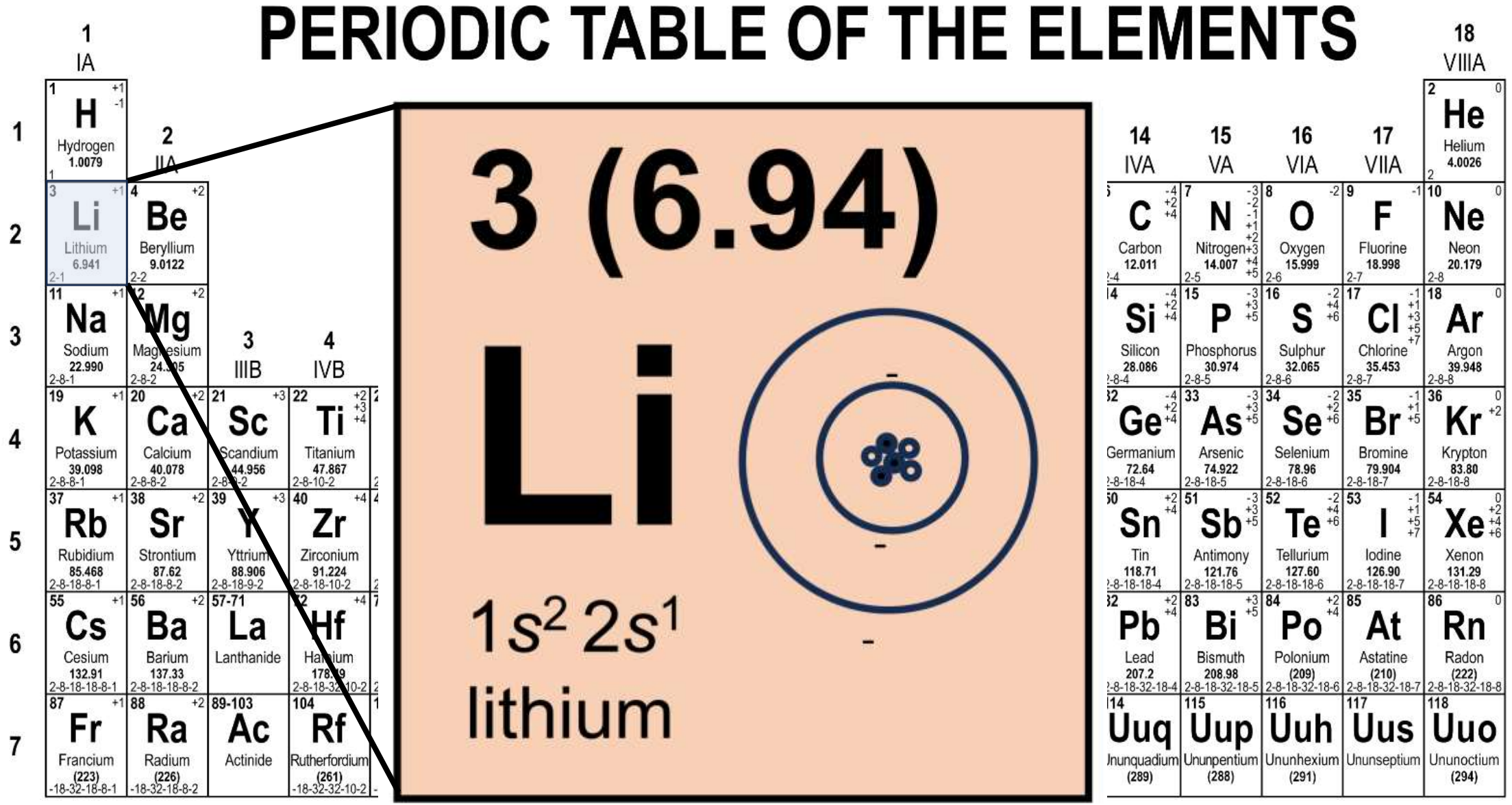


3: Lithium versus hydrogen

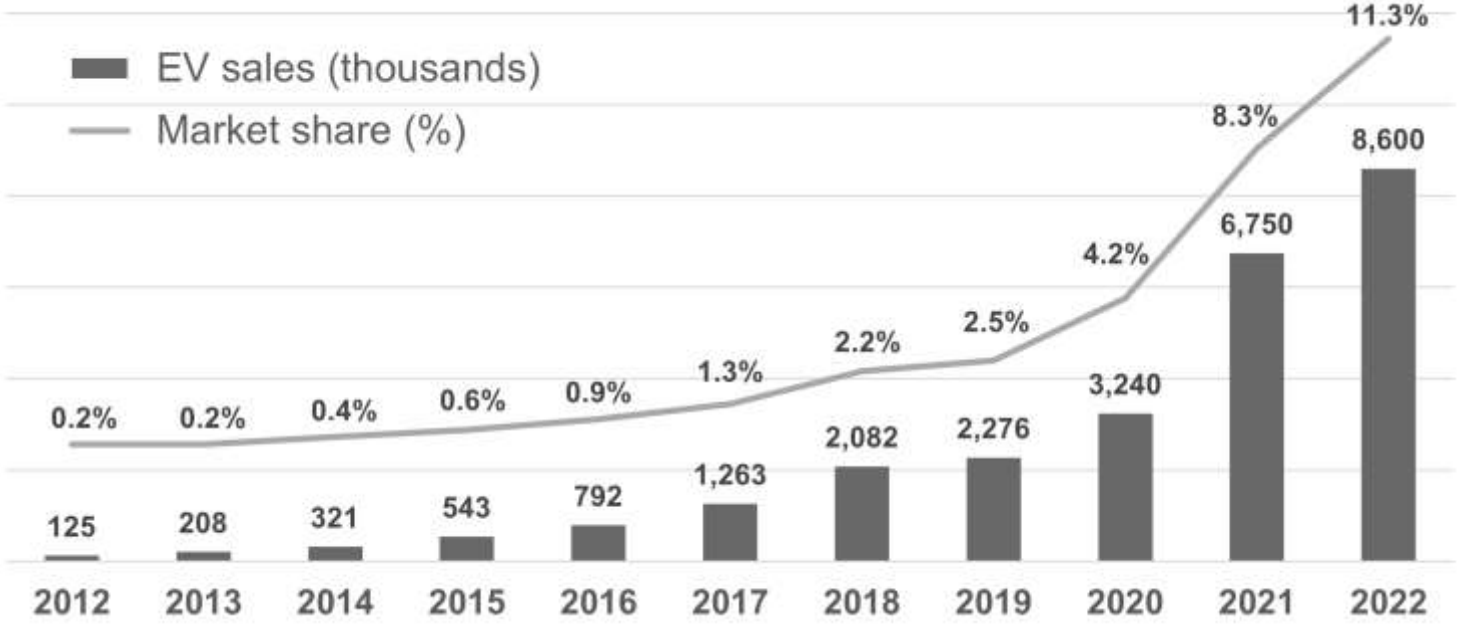
3 (6.94)

Li

$1s^2\,2s^1$

lithium

The Battle of the Batteries - lithium



3: Lithium versus hydrogen

BEV versus FCEV/H2 combustion

1970s

Li-ion battery
Oxford

2003

DaimlerChrysler
ECTOS buses

FINISH

A new hydrogen grid?

H2med

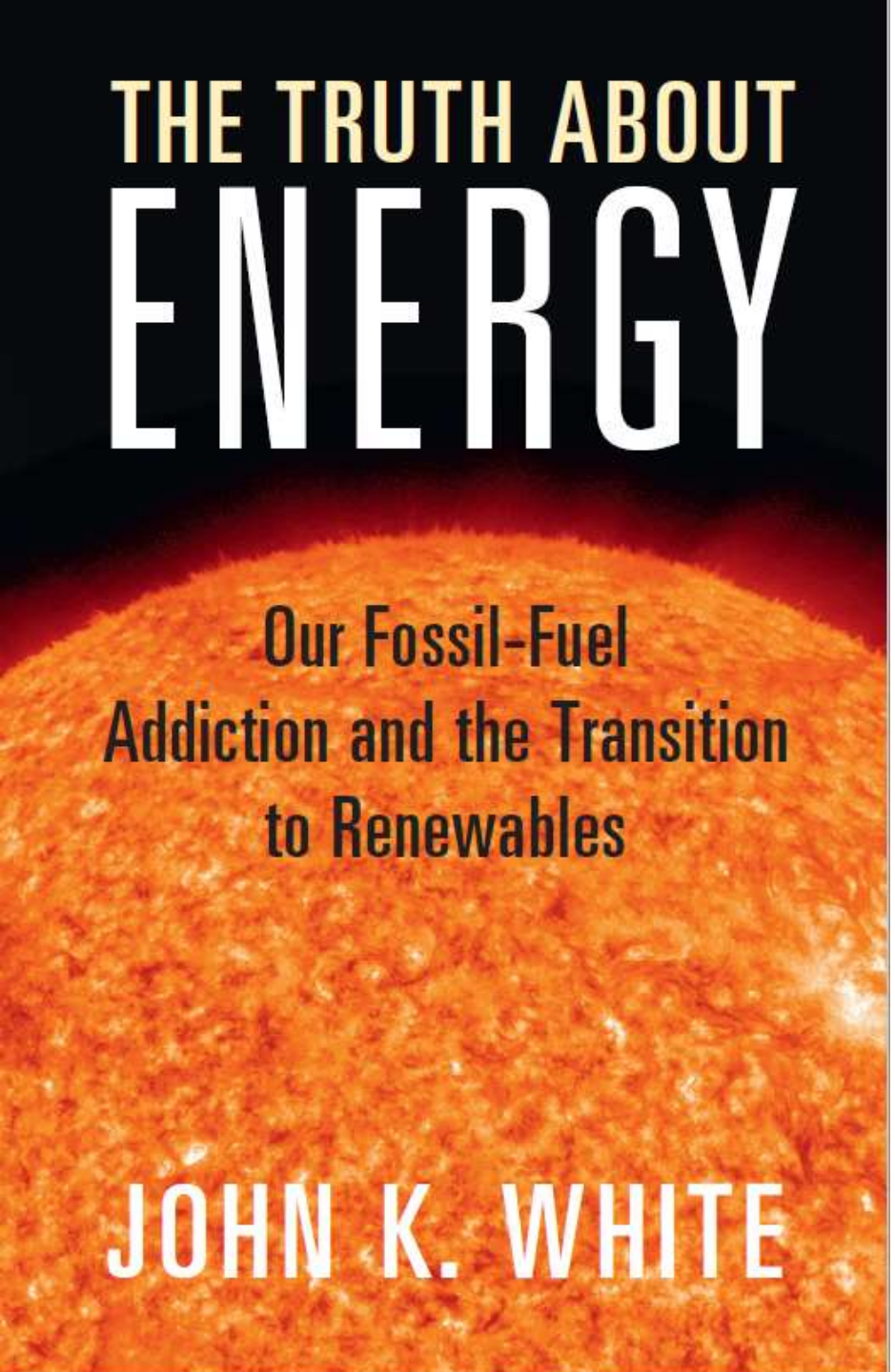
REPÚBLICA PORTUGUESA
XXIII GOVERNO CONSTITUCIONAL

GOBIERNO DE ESPAÑA

Liberté • Égalité • Fraternité
RÉPUBLIQUE FRANÇAISE

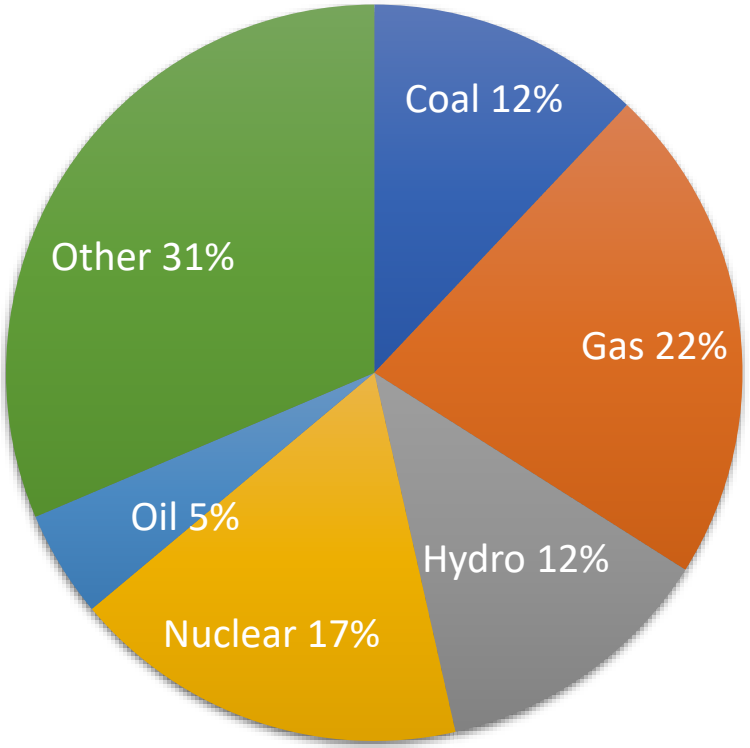
EUROPE'S FIRST MAJOR GREEN HYDROGEN CORRIDOR

3: Lithium versus hydrogen



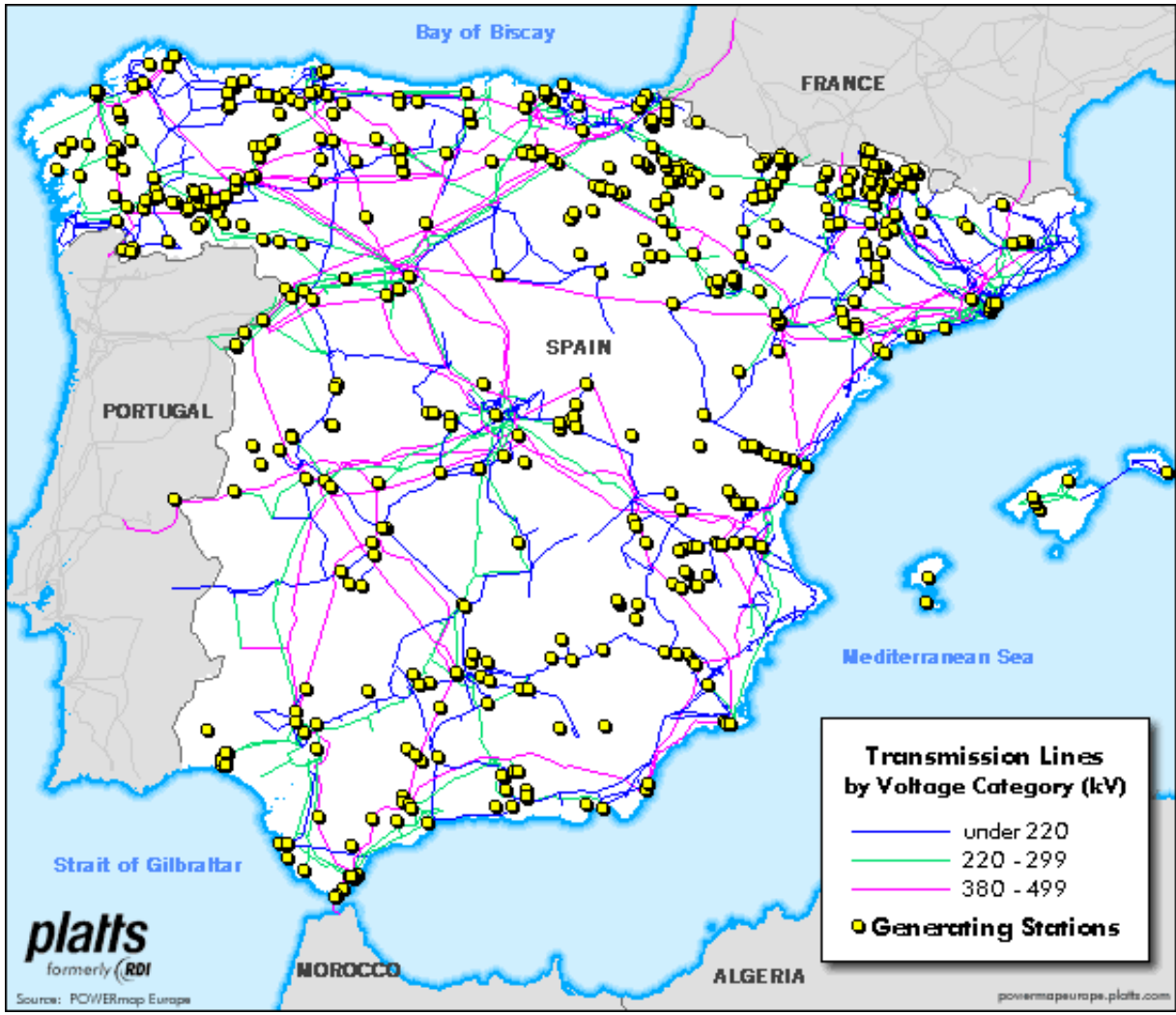
4. Spain/Asturias/
Gijón

Spain: Consumption and Grid

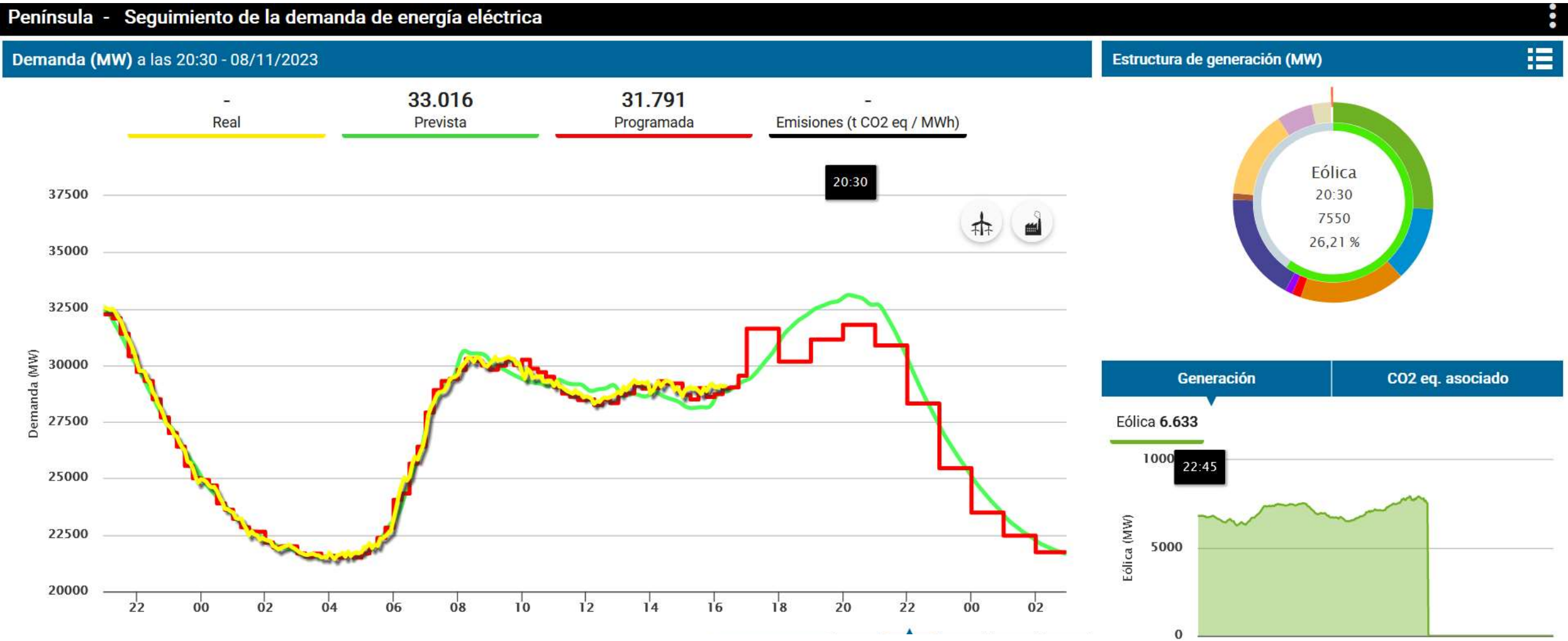


Spain Electricity (TWh)

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



4: Spain/Asturias/Gijón

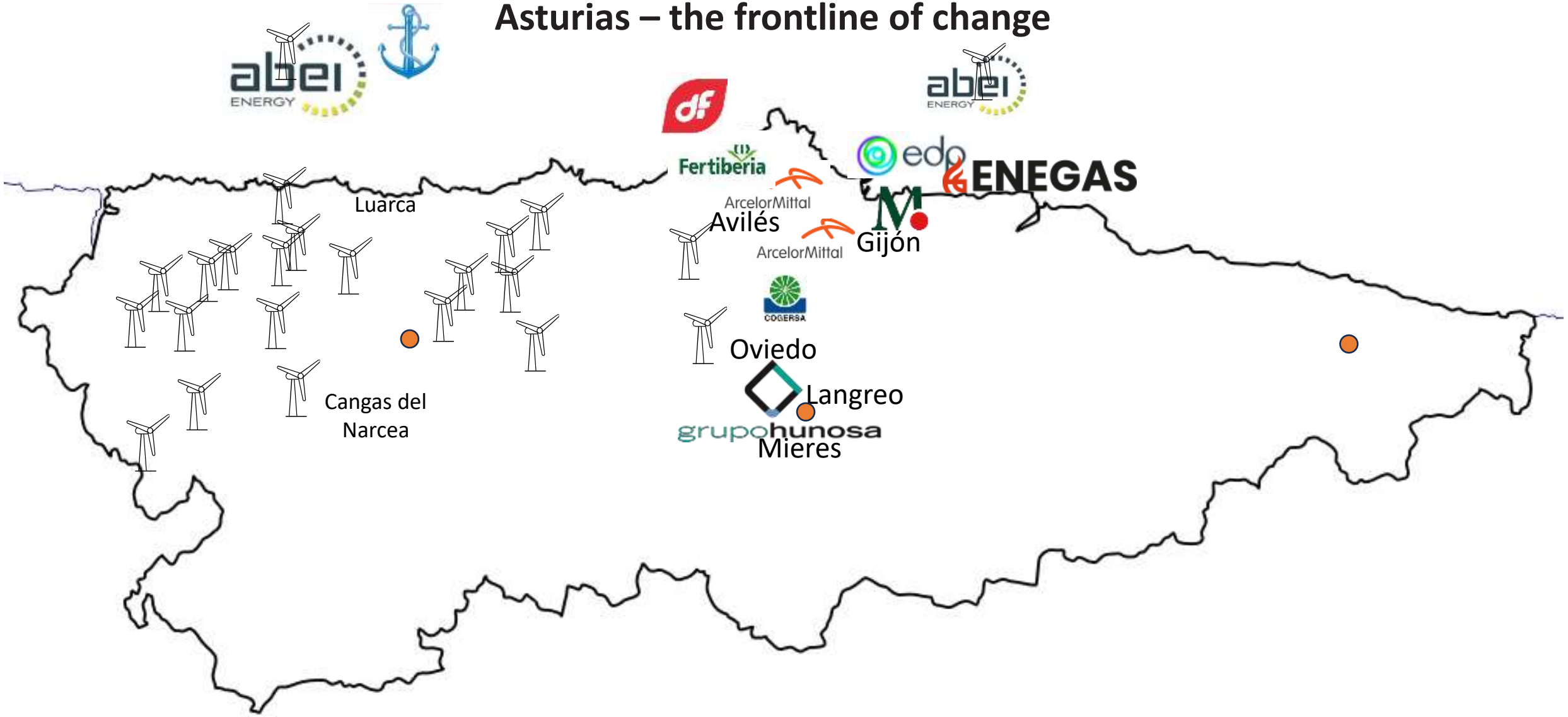


Yellow: actual instantaneous demand (updated every 15 minutes)
Green: demand forecast from historical consumption data
Stepped red: operating schedule from day-ahead and intraday markets, managed by Red Eléctrica

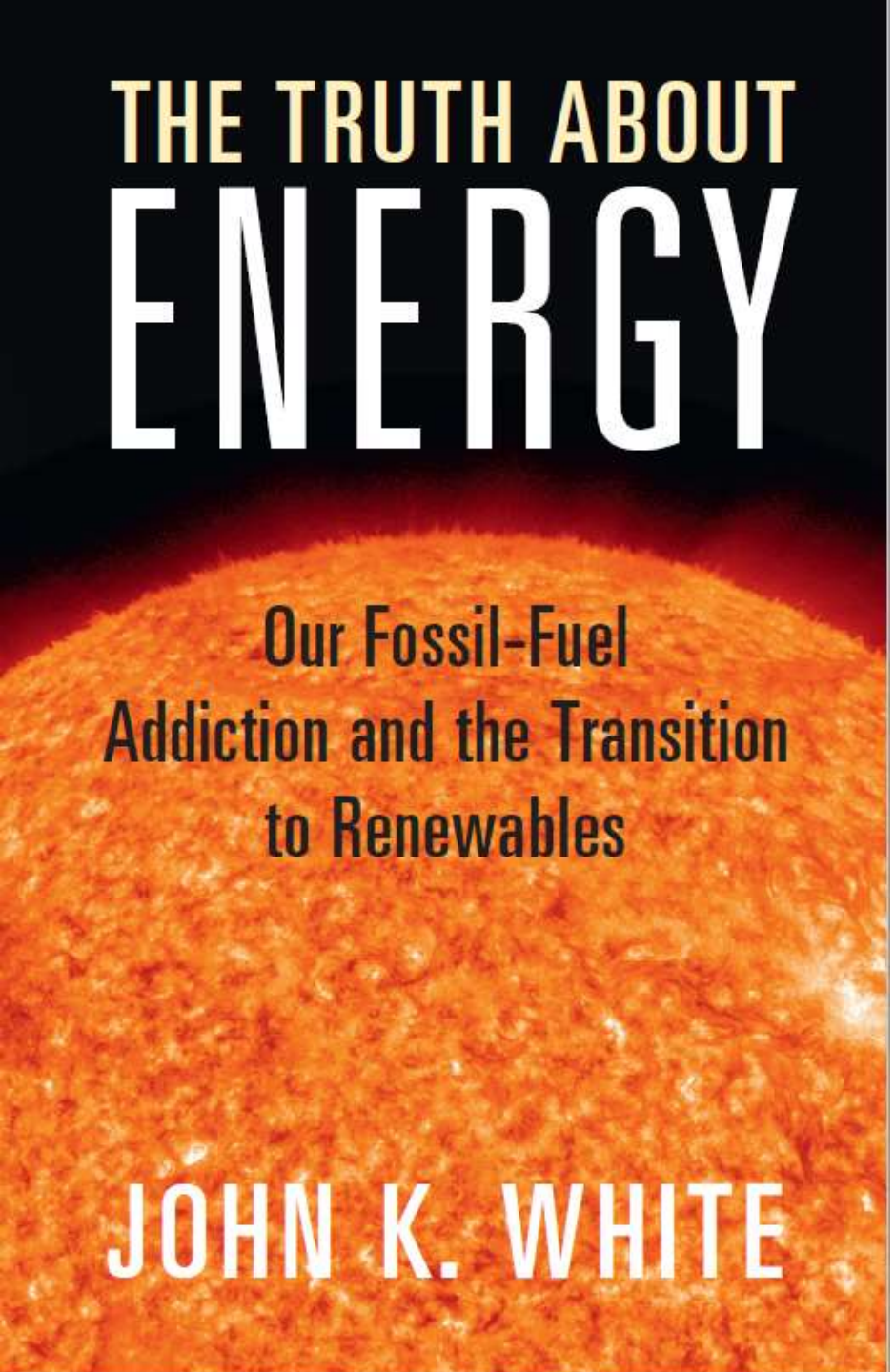
Red Electrica: Demanda y producción en tiempo real

4: Spain/Asturias/Gijón

Asturias – the frontline of change



4: Spain/Asturias/Gijón



5. Reduce, reuse, recycle (RRR…)

Waste, the final frontier

100 million oil barrels/day

500 billion kg of food,
5 trillion plastic bags, and
500 billion bottles/year

How many *earths* do you take up, based on home, travel, food, and shopping habits?

500 kg of waste and 10 tons of CO_2 a year.

5: Reduce/Reuse/Recycle/…

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5: Reduce/Reuse/Recycle/…

Less is more / Use less or become useless / It’s what you do every day

reduce, reuse, recycle, refuse (just say “no”), remove (picking up garbage), refill (so simple), rot (organic decomposition), replenish, repair, regenerate, recover, refurbish, repurpose, redistribute, resell, recharge, rewild, rebel, rethink, rebuild, rewire, ….

“refuse” may be the most important — if you don’t let something you don’t need into your life in the first place you don’t need to get rid of it later! Just say “no.”

Less is more / Use less or become useless / It’s what you do every day

5: Reduce/Reuse/Recycle/…

Less is more / Use less or become useless / It’s what you do every day

Atención: Hay llegado el chatarrero.

Compramos todo clases de chatarra. Compramos cobre, hierro, metales, aluminio, baterías, …

Less is more / Use less or become useless / It’s what you do every day

5: Reduce/Reuse/Recycle/…

Less is more / Use less or become useless / It’s what you do every day

5: Reduce/Reuse/Recycle/…

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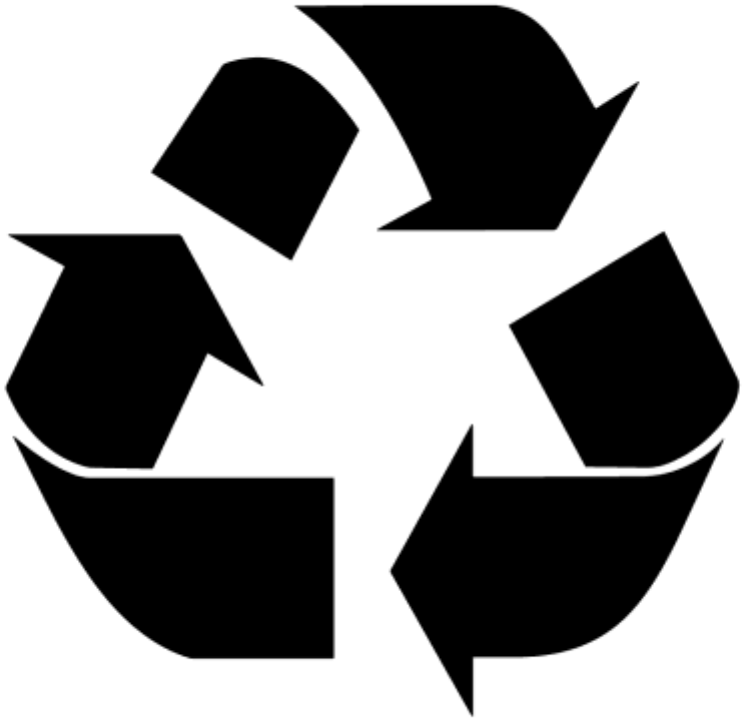

5: Reduce/Reuse/Recycle/…

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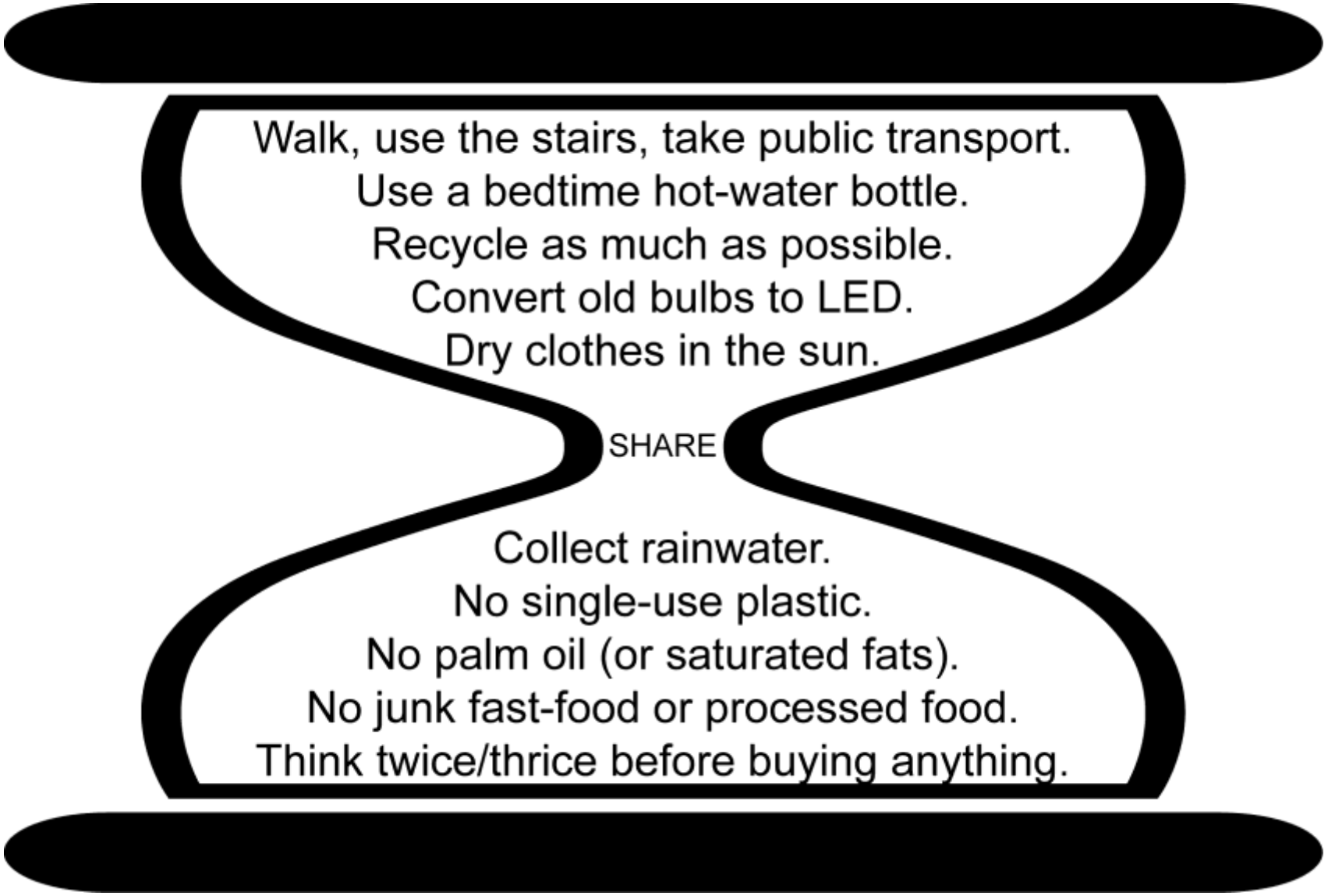


5: Reduce/Reuse/Recycle/…

The Great Bubble Barrier

(Amsterdam)

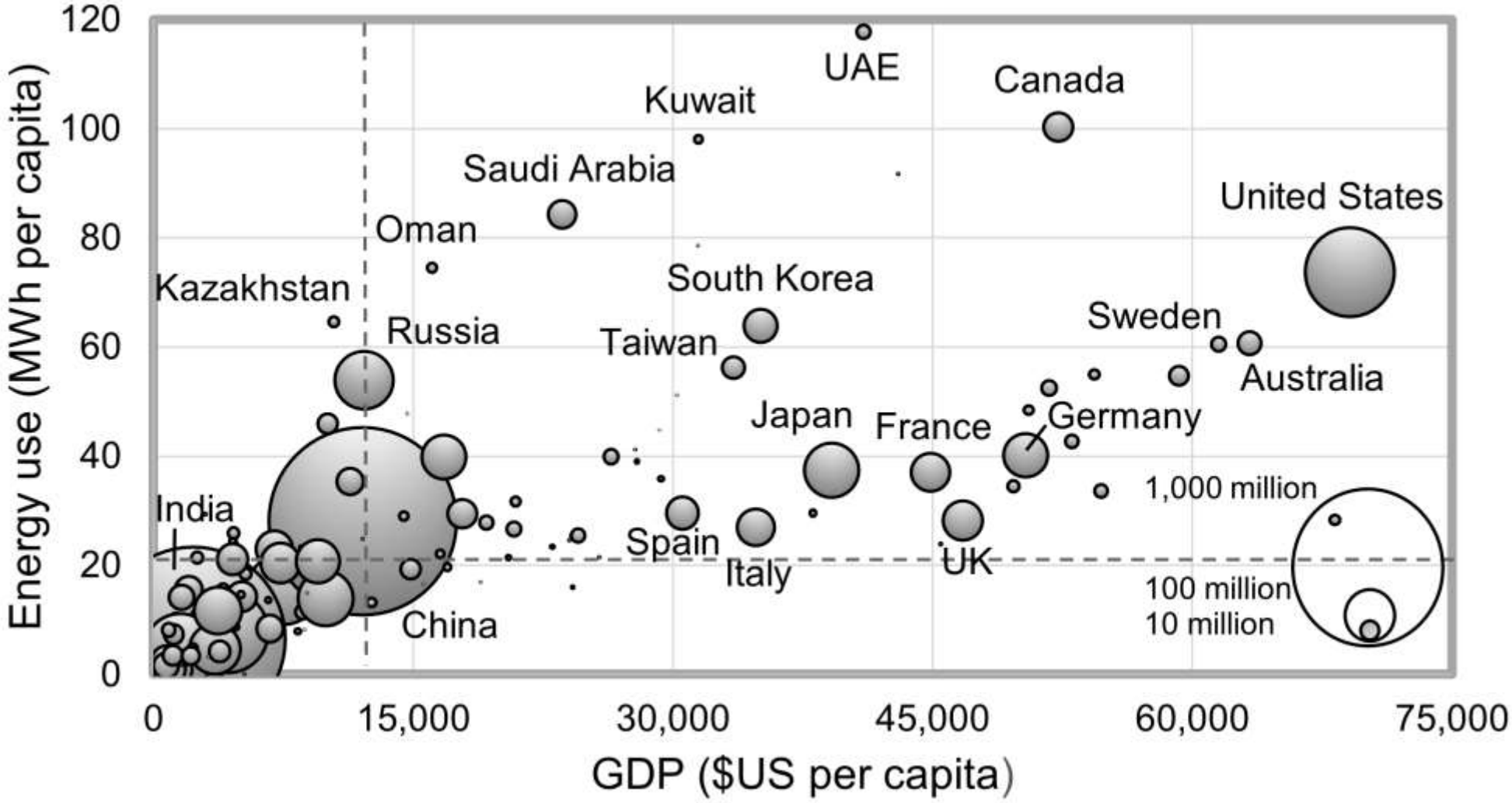
The Great Bubble Barrier in Westerdok blocks plastic from escaping to the sea 24/7 via a curtain of rising bubbles emitted from a seabed perforated tube.

The elegant and simple system was a finalist in the 2023 Earthshot Prize.

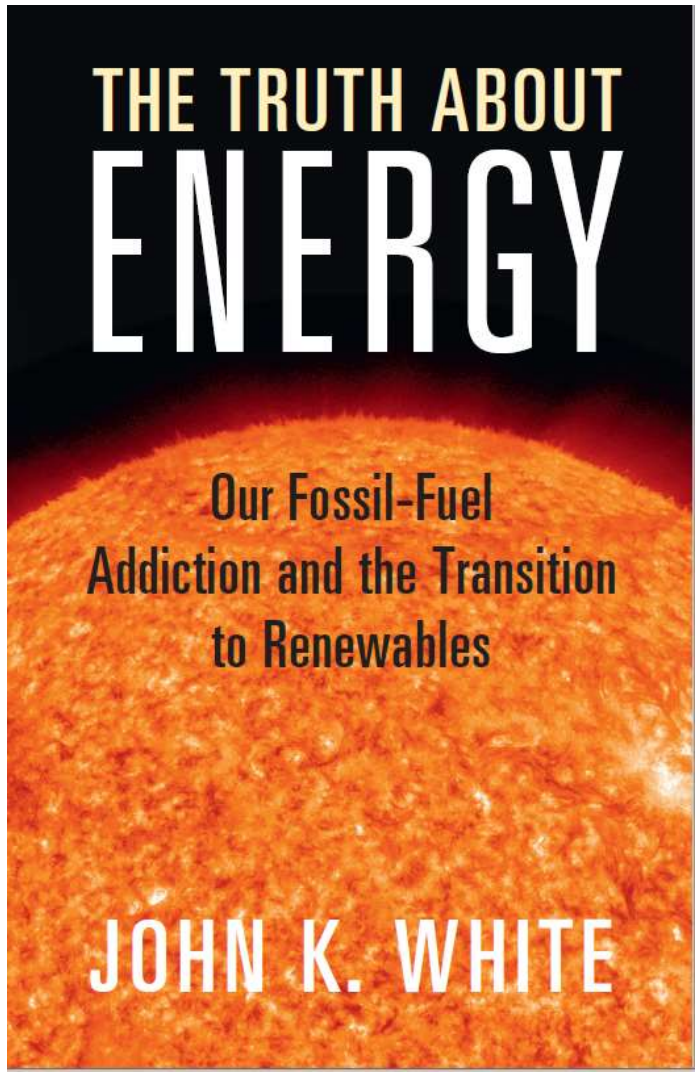
5: Reduce/Reuse/Recycle/…

Energy intensity

If the energy intensity of the countries on the bottom left — essentially Asia, Africa, and South America — rise to the top right without transitioning to clean energy, the atmosphere and the climate are doomed.



5: Reduce/Reuse/Recycle/…



CONCLUSIONS

electricity versus fossil fuels

clean versus dirty

individual or company/group

$$$ and the politics of transition

Pace? / Just? / Who?

The Truth About Energy

is …

… that we use too much, are insufficiently concerned about deleterious effects (pollution, GHG emissions, global supply chains), and aren't in any hurry to implement cleaner, safer alternatives. After more than two centuries of unchecked growth on the back of cheap fossil fuels, there is no urgency to mend our ways or coral those who would willfully destroy or damage Mother Earth.

The Truth About Energy (a few other sources)

Car Wars: Hydrocarbons, lithium, and the greening grid, *CounterPunch*, March 26, 2024

The Truth About Energy is the truth about change, *Fifteen Eighty Four*, March 8, 2024

The times they aren't a-changing: More carbon, more heat, more hot air expected in 2024, *CounterPunch*, January 3, 2024

Petroleum Wars in the Age of Climate Disaster: a Bridge Fuel Too Far, *CounterPunch*, June 3, 2022

Let the Sun Shine: Making Solar Power Work, *CounterPunch*, November 12, 2021

Future Energy Today, Escuela Oficial de Idiomas de Gijón, March 2017

Made in Spain: ArcelorMittal Steel, *Caracolas*, February 11, 2015

The transition from brown to green in pictures

Gijón, Asturias, 2024

Esta furgoneta es verde (This van is green). The Spanish post office colours are yellow and blue. One always needs a sense of humour when dealing with slow mail and slow transitions, but it is good to see they are doing their bit to reduce toxic exhaust pollution in our cities via electric vehicles and help jumpstart the revolution revolution. (Chapter 6)

The transition from brown to green in pictures

Bike sharing, Gijón, 2018

Here I am trying out a city bike in Gijón, free for half an hour with a citizen's card (*tarjeta ciudadana*). Or at least they were free before they changed the pedal bikes to electric. Why can't they leave well enough alone? (Chapter 7)

Muchas Gracias