The Truth About Energy: Our Fossil-Fuel Addiction and the Transition to Renewables

John K. White (Cambridge University Press)

Newsletter 2026

Windmills, Kinderdijk, South Holland

Now a UNESCO World Heritage Site in the Albasserwaard region southeast of Rotterdam, the Kinderdijk comprises 19 windmills and three 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.

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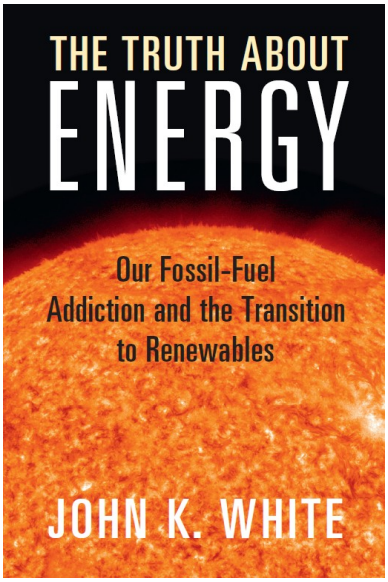
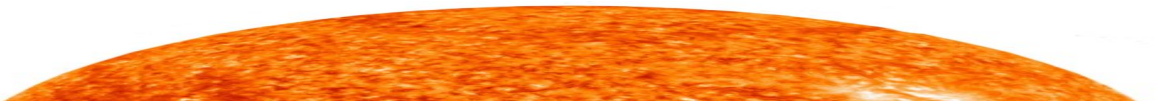


The transition to renewable energy is vital and fast-paced, but how do we choose which technologies to drive this energy transition? Everyday power generation is examined from wood, coal, oil, natural gas, hydro, and nuclear to biomass, solar power, wind, wave, and geothermal, providing the context to critically examine the different technologies competing in a fast-evolving engineering, political, and economic landscape. To what extent does each technology contribute to a clean, green infrastructure? Examples are given, including recent advances in China, the United States, and Europe.

Some questions answered in *The Truth About Energy*

• What type of radiation is heat? • Why was James Watt's steam engine unique? • Is all coal the same? • Where was the first commercial electric-generating station and who built it? • How is petroleum separated into components and what is the difference between petrol/gasoline and diesel? • How rich were John D. Rockefeller, Henry Ford, and J. Paul Getty? • What is the difference between conventional and unconventional oil? • How much oil is in controlled by OPEC and what is "peak" oil? • What is the difference between natural, enriched, weapons-grade, and depleted uranium? • Should we be worried about Chernobyl and Fukushima? • Where does all the nuclear waste go? • Why does the temperature in a tokamak need to be 10 times that of the sun's core? • Who made the first functional solar cell? • What is the difference between a solar cell and a light-emitting diode (LED)? • What is the difference between a PV and a CSP solar installation? • Where is the world's largest solar farm? • Where are the world's largest onshore and offshore wind farms? • When and where was the first geothermal power plant? • Is hydroelectric power green? • Why did Nikola Tesla originally use AC current? • Which company was the first to use computer batteries for cars? • What is VPP and V2G? • Can we power a house from a car? • Why is lithium salt ("white petroleum") in such demand? • Will cutting down on plastic reduce petroleum use? • Can we make a difference to global warming from more conservation in the home? •



E21NS is a chronological collection of energy links from numerous global sources – over 400 précised articles on wind, water, solar, storage, ... with links to each source.

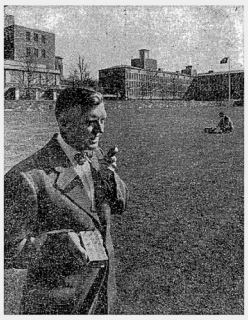
Benjamin Franklin and the Kite Experiment

June, 1752 The Franklin Institute | Philadelphia | energy: electricity

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.

Vast power of the sun is tapped by battery using sand ingredient

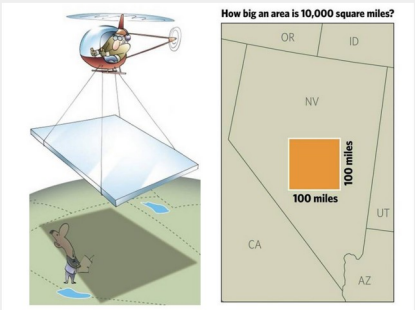
April 26, 1954 New York Times | United States | renewables: solar



A 6%-efficient "solar energy battery" (solar cell) was demonstrated at Bell Labs in Murray Hill, New Jersey. Developed by physicist G.L. Pearson, chemist C.S. Fuller, and electrical engineer D.M. Chapin, a solar cell functions via a "p-n" (positive-negative) junction with impurities introduced at the silicon surface in a similar process to transistor fabrication.

Energy: The power of the desert

April 5, 2009 Las Vegas Sun | United States | renewables: solar



In 1997, NREL's now acting director Roland Hulstrom calculated the area of PV solar farms needed to power U.S. energy use. He included a telling picture of a 100-mile by 100-mile square in the middle of Nevada to simplify the concept: 10,000 square miles. Of course, one can easily spread out the sun instead.

The greenest island in the world?

October 5, 2015 BBC | Spain | renewables: wind

A novel wind-power/water-storage plant provides 50% of the energy needs for 10,000 el Hierro islanders, saving 500 tons of fossil fuel/month (40,000 barrels oil, 19,000 tons CO2 per year). Not dependent on imported diesel, 5 2.2-MW turbines (11.5MW) and 2 fresh-water reservoirs (700 m apart) generate electricity, pumping water up during high wind for reuse.

Portugal runs for four days straight on renewable energy alone

May 18, 2016 The Guardian | Portugal | energy: future

Portugal ran on renewable energy sources for 107 straight hours from May 7 to 11, 2016, using only solar, wind, and hydro power. In 2015, renewable sources provided 48% of Portuguese electricity, 22% from wind power, while wind provided 42% of electrical demand in world-leading Denmark (20% in Spain, 13% in Germany, 11% in the UK).

Investors predict "start of the end" of coal in Asia

March 20, 2019 TreeHugger | Saudi Arabia | fossil fuels: oil

Following coal-powered plant closures in the West, Asia has begun divesting from coal, the dirtiest fossil fuel. Despite China's recent rapid growth, much of it fueled by coal, and Japan's energy crunch from the post-2011 tsunami nuclear shutdown, coal is now being phased out for renewables, good for reducing global warming and pollution.

L.A. takes climate change fight to the streets by pouring cooler pavement

April 25, 2019 Los Angeles Times | United States | climate change: urban

Los Angeles is already almost 6 °F warmer than surrounding rural areas because of heat-absorbing buildings, paved roads, and minimal shade and vegetation, and will rise 4 °F more by 2050 at the current rate of increasing GHG emissions. The mayor hopes a more reflective surface-paving coating will lower temperatures (so-called cool pavement).

ABB electrifies the Niagara Falls' iconic Maid of the Mist ferries

May 6, 2019 CleanTechnica | Canada | electric vehicles: conversion

The iconic Niagara Falls *Maid of the Mist* tour boat is getting an electric makeover, Swiss-Swedish utility company ABB announced. A 316-kWh battery pack will charge in 7 minutes during passenger changeovers on 2 new boats, good to run a 563-hp motor and reduce diesel emissions at the world's most famous cataract.

Tidal power is a promising source of electricity, but faces significant waves of challenges

July 10, 2019 The Financial Post | Canada | renewables: tidal

After financing fell through on a grid-tied 2-MW OpenHydro sea-floor tidal turbine in the Bay of Fundy's Minas Passage off the Nova Scotia coast, companies are again trying to harness the world's largest tides, including a $117-million project by DP Energy, Uisce Tapa, to deploy 6 1.5-MW turbines by 2022 as stipulated in a power purchase agreement.

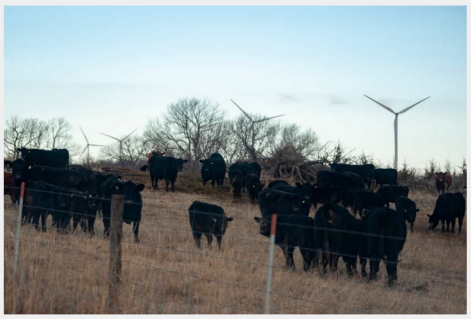
All systems go: 1st all-electric commercial seaplane takes flight in B.C.

December 10, 2019 CBC | Canada | electric vehicles: airplane

An historic first short-haul all-electric test airplane stayed aloft for 3 minutes above the Fraser River east of Vancouver. The joint Harbour Air and MagniX 11 e-plane was powered by NASA-approved lithium-ion batteries and a standard-design though lightweight electric motor. As batteries improve, the sky is literally the limit.

Wind energy gives American farmers a new crop to sell in tough times

February 20, 2020 USA Today | United States | renewables: wind



Long-term wind-turbine leases give farmers an extra income to cover fluctuating produce prices, emergencies, and tariffs. Each turbine can earn $3-7,000 annually, especially important during the US-China trade war as 2019 bankruptcies increased by 20%. U.S. wind power rose to 7% in 2019 up from 2.3% in 2010 and is now cheaper than natural gas.

Producing energy from wind or solar is now CHEAPER than coal ...

March 12, 2020 The Daily Mail | Global | renewables: prices

The Carbon Tracker report How to waste over half a trillion dollars states that renewables are now cheaper than coal, creating stranded coal assets and an investment rethink. In the UK, falling coal demand, green subsidies, and investment initiatives have hastened coal's demise, where coal power has decreased from 70% in 1990 to under 3% today.

Renewables generate more energy than fossil fuels in Europe for the first time ever

August 14, 2020 euronews | Europe | energy: future

Solar panels and wind turbines generated over 20% of Europe's power in the first half of 2020, led by Denmark (64%), Ireland (49%), and Germany (42%). At 40% EU power, all renewables (WWS and bio) exceeded fossil fuels (34%) for the first time. Globally, renewables were 10%, a 14% rise from 2019, although coal still produces a third of world electricity.

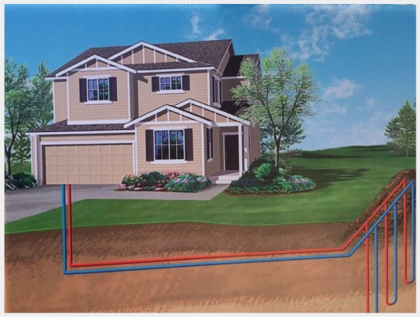
The post-petroleum resource race and what to make of it

May 20, 2021 Common Dreams | Global | storage: mining

As wind turbines, PV panels, and EVs increase, more cobalt, lithium, nickel, and REEs are needed. Wind and solar power is 7% of electric power and EV adoption less than 1%, but lithium demand may rise 50x and cobalt 30x by 2040, leading to possible resource wars in the DRC (80% of cobalt) or Argentina and Chile (80% of lithium). EV share could be 15% by 2030.

Geothermal heating co-op shares warmth among Montreal neighbours

January 20, 2022 CBC | Montreal | renewables: geothermal



A neighbourhood Montreal co-op began heating 7 homes retrofitted with geothermal heat pumps (aka ground source heat pumps or geoexchange systems). To reduce costs and comply with laws, 8 150-m-deep geothermal wells were dug in a private backyard rather than a public alleyway, and are shared. The goal is to connect 50 homes. AC is also avaialble.

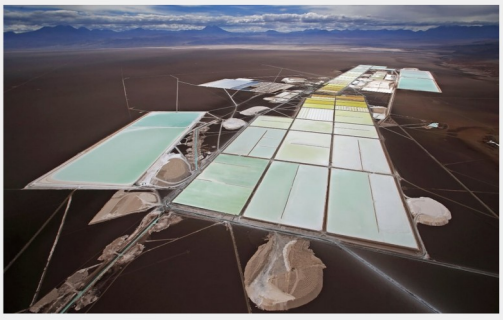
The obligation to install photovoltaic panels on large outdoor car parks adopted in the Senate

November 4, 2022 Public Senat | France | renewables: solar

The French senate passed a bill mandating that all parking lots of at least 80 spaces be covered with PV solar panels by 2028 (over 400 spaces by 2026). The new law is expected to stimulate solar energy production in France, especially in the commercial sector and will amount to a power saving of 11 GW, equivalent to 10 nuclear power plants.

Lithium, coined 'the new oil,' is shifting global markets

May 14, 2023 CBC | Global | storage: mining



Lithium is the lightest metal, but too reactive on its own and separated after hard-rock mining or evaporated brine deposits, although extraction impacts the environment and depletes water supplies. The top producers are Australia (mining) and Chile (brine) at over 10,000 tons annually (>30 million tons available in the "lithium triangle").

An optimist's guide to the EV battery mining challenge

July 26, 2024 Canary Media | Global | electric vehicles: battery

There are sufficient mineral supplies to fuel the EV revolution, especially with better battery chemistry, energy density (up 25% since 2015), and recycling. New mining could end by 2050 in a circular economy, with lithium peaking by 2038 and nickel/cobalt sooner. A one-time mineral extraction is about $1 trillion, equal to current *annual* oil extraction costs.

The UK coal-fired power station that became a giant battery

September 30, 2024 BBC | UK | renewables: storage

Operating since 1967, when the grid was 90% coal-powered, the UK's last coal power station is closing. After 2 years of decommissioning, Ratcliffe-on-Soar may house a battery energy storage system (BESS) to match supply and demand from intermittent sun and wind. A new BESS at the old coal plant Ferrybridge C will store 150 MW and power 250,000 homes.

US battery capacity soars to nuclear scale, creates 'golden opportunity' for grids

November 19, 2024 The Energy Mix | United States | renewables: storage

Since 2010, US battery storage increased from 0 to 20.7 GW and will double by next year, equal to 40% nuclear power. Storage covers intermittency from renewables ("dark lull") and balances mismatched supply and demand (arbitrage), but increases emissions if sourced by fossil fuels. Power lines must be upgraded and expanded to manage more renewables.

Switzerland turns train tracks into solar power plants

April 29, 2025 SwissInfo | Switzerland | renewables: solar

Swiss start-up Sun-Ways installed 48 test solar panels between train rails, producing 16 MWh/year (4-6 homes). More panels can be placed or removed in a few hours for easy maintenance and cleaned by passing trains to generate 2% of grid power from 5,320 km of Swiss rail (1 billion kWh/year, 300,000 homes). Stations and platform roofs can also be used.

New bladeless wind turbine generates clean, quiet, bird-safe power

July 25, 2025 The Brighter Side | Spain | renewables: wind

A Spanish startup designed a new wind turbine using a vibrating upright cylinder to catch the wind, a.k.a. "the Skybrator." No blades, gears, or oil needed; only vortex shedding as the swaying is converted by an alternator into electricity - smaller, quieter, and less invasive.

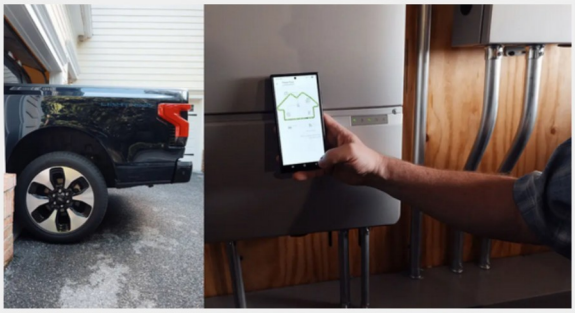
California completes solar canopy over irrigation canal

September 16, 2025 CleanTechnica | California | renewables: solar

A $20 million, 1.6 MW solar array now covers part of the Turlock Irrigation District canal system in California's Central Valley, providing power to farmers, keeping panels cool, and limiting evaporation in drought-prone areas. 8,000 miles of federally owned canals and aqueducts could generate 25 GW and lower evaporation by tens of billions of gallons.

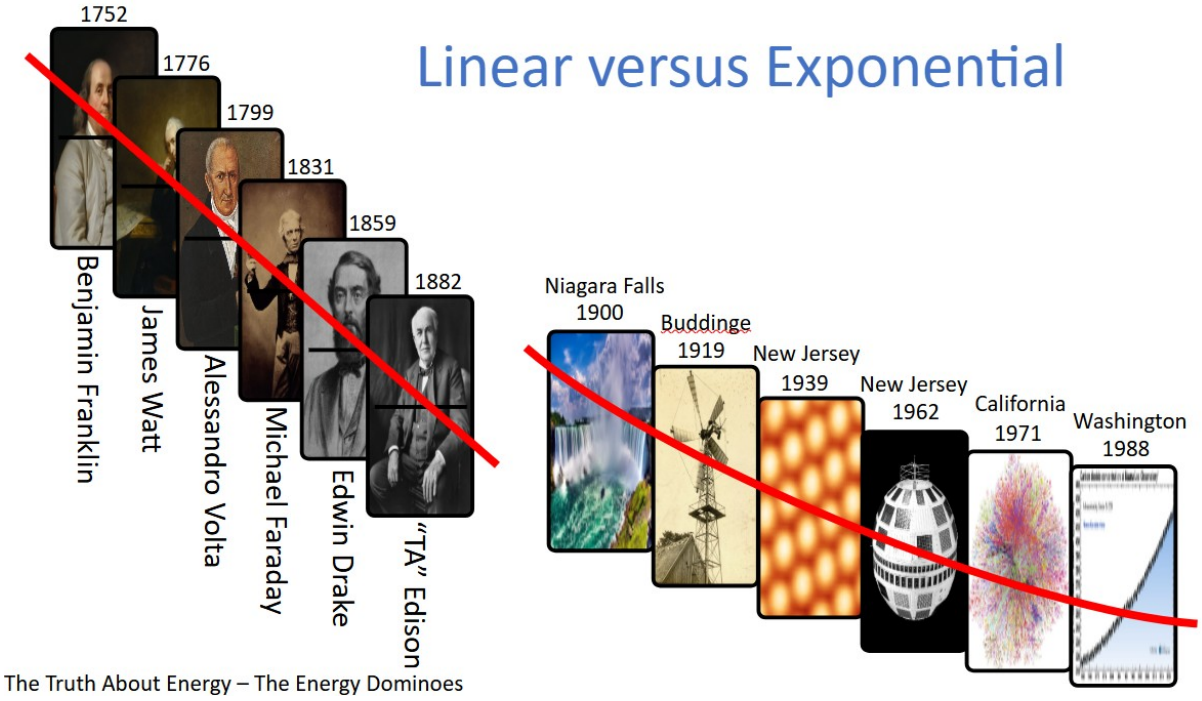
How EVs can fix the grid and lower your electric bill

October 17, 2025 grist | United States | electric vehicles: battery



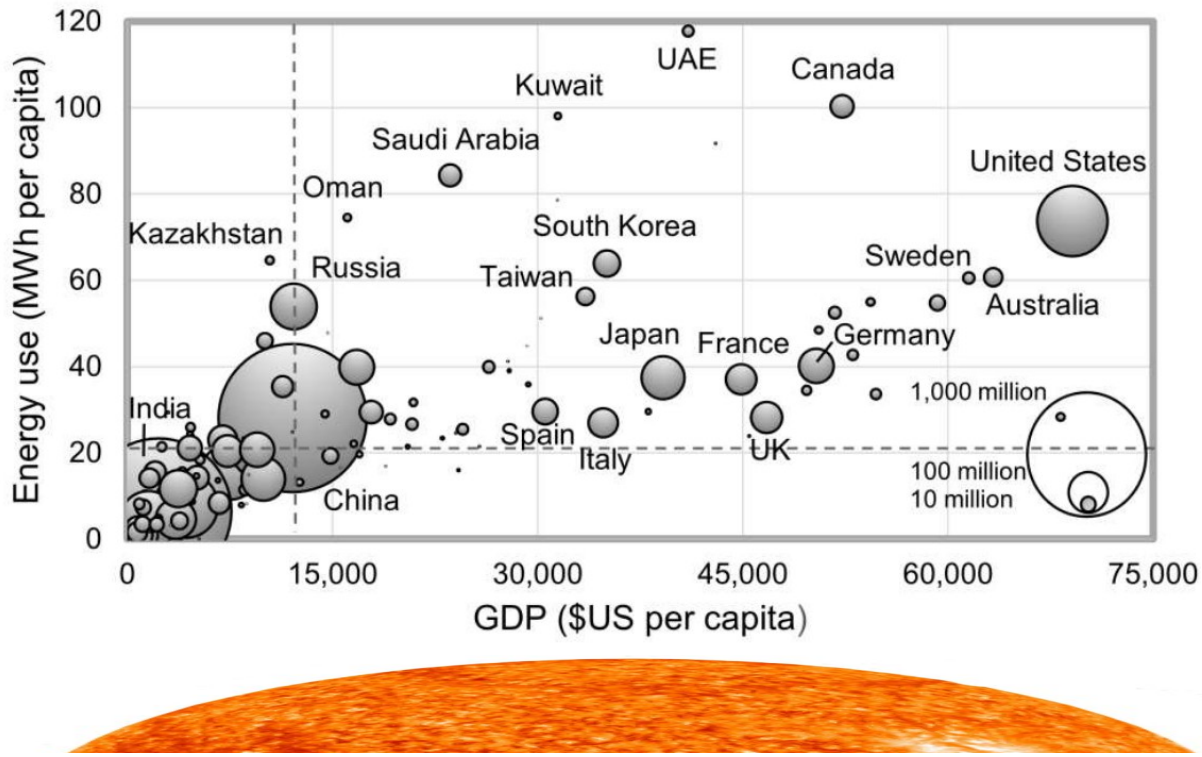
Vehicle-to-grid technology (V2G) or directional charging counters intermittency of wind and solar, requiring one-third of drivers to opt in. Baltimore Gas and Electric Company, Sunrun, and Ford are part of the first US residential V2G project using home solar and Ford's F-150 Lightning EV, whose batteries are 10 x a typical home pack and 90% dormant.

The Energy Dominoes [pdf]



The Truth About Energy – The Energy Dominoes

Energy Intensity [pdf]



Energy Quiz: 50 questions of increasing difficulty. Can you get to level 5?

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

- 1 thousandth
- 1 millonth
- 1 billionth
- 1 2 billionth

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

Where was the end terminus of the first commerical steam-powered train route?

- Stockton
- Darlington
- Liverpool
- Manchester

In which year did Edwin Drake first find oil in Titusville, Pennsylvania?

- 1819
- 1839
- 1859
- 1879

What is the largest fractional output of crude oil?

- methane
- gasoline
- kerosene
- distillate fuel oil

Which company first patented the solar cell in 1954?

- RCA
- Bell Labs
- Fairchild Semiconductors
- Intel

What does PV stand for?

- potentially viable
- photovoltaic
- permanently variable
- phantastically victorious

Who purportedly built the first turret wind mill in 1500?

- Archimedes
- Cornelis Corneliszoon
- Leonardo da Vinci
- Simon Stevin

CounterPunch Energy Articles

Renewable Energy in the USA: Stupid is as Stupid Does, *CounterPunch*, October 30, 2025

'The days of stupidity' are alive and well in the USA after the Department of the Interior cancelled a Nevada solar farm slated to become the world's largest. The 185-square-mile, 6.2-GW Esmeralda 7 solar and battery storage installation would have powered almost two million homes, but was unceremoniously dumped according to President Donald Trump's wishes as indicated in his typical Truth Social style. Not only is Trump's post full of lies about energy costs, such policy is casting a dark shadow over the economic future of the USA. **[More ...]**

The United States Versus the World: Net-Zero, Militarism, and Donny Rotten, *CounterPunch*, August 15, 2025

While much of the world fumbles over how to live in a better future, the United States is going back to the past. More than a standard flip-flop from one administration to the next, basic truths are being discarded in a daily onslaught of insults, threats, and strained logic, military spending is rising, and new-energy projects are being cancelled, rekindling coal, oil, and gas to keep America brown. Elsewhere, the world recoils from an increasingly deranged Trumpmania that sees everyone as an enemy, where ugliness is normalized, might is right, and fossil fuels are clean. How far back America goes is anyone's guess.**[More ...]**

The United States Versus China: Tesla, BYD and the Trump Follies, *CounterPunch*, April 30, 2025

Once the darling of the left for championing electric vehicles, even with a hefty $44,000-plus sticker price on a range of best-selling "S3XY" models, Tesla CEO Elon Musk was regularly pilloried by the right for his presumed eco-friendly stance and generous government loans. Back then, the Chinese carmaker BYD was barely a twinkle in Warren Buffet's investment eye, but now tops Tesla at over $100 billion in annual sales thanks to lower prices, faster charging times, and Musk's far-right political conversion. As consumers scramble to keep pace in a fast-changing and uncertain world, the fight for motor supremacy ramps up – more than the increased market share of 100 million cars sold each year is at stake. **[More ...]**

The End of Oil and Empire, *CounterPunch*, February 28, 2025

In the wake of Donald Trump's anti-environmental "Drill baby, drill" stance, now may not seem the time to champion a greener future, but we have no choice if we want the earth to remain habitable. Across the globe, the politics of oil continues causing conflict, millions of people die each year from pollution, while rising global temperatures devastate more and more communities. Perhaps we can look to Trump himself for the solution after he noted in his January 20 inaugural speech, "Sunlight is pouring over the entire world." Yes it is – 170 petajoules every second. More than enough to power the future. **[More ...]**

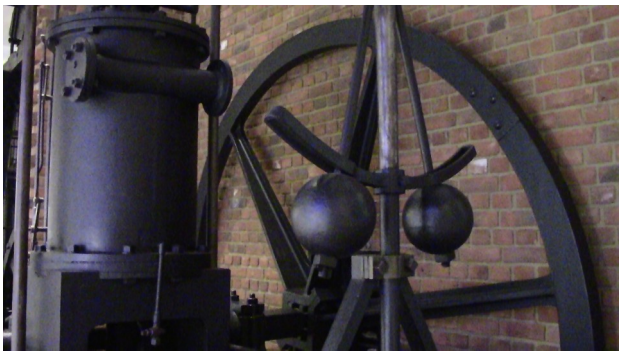
The 20 Best Energy Films: From Gritty Carbon-Spewing Potboilers to Nuclear Reactor Catastrophes, *CounterPunch*, August 9, 2024

Everyone has a favorite Kubrick film, Supremes song, or baseball player – anything whose value can be judged, categorized, or argued about in a presumed pantheon of greats. Alas, ranked lists are hard to compile and open to much debate. My best may be your stinker and vice versa. Despite the difficulty, energy films would seem to be a worthy subject if only to help understand the science, now that a global green transition is growing by the day, albeit unevenly implemented across rich and poor countries. But are there enough to make a Top 20 collection of what may be considered a dry technological subject? **[More ...]**

Energy is everywhere: yellow/green delivery vans, falling water in Niagara Falls, solar- and wind-powered roofs. Learning about energy is essential as we begin the transition from brown to green, from unsustainable to renewable. Here are a few photos taken over the years. Check out johnkwhite.ie for more photos and other energy resources.

Fly wheel governor, Kensington, London

Some cite 1776 as the start of the Industrial Revolution with James Watt's invention of the general-purpose steam engine in Glasgow. His game-changing innovation was an external condenser to recycle water more efficiently, allowing his "fire engine" to use a fraction of the coal as in the earlier water pumps of Newcomen, Papin, and Boyle. With partner Matthew Bolton, they built the first great "manufactory" outside Birmingham and changed the world.



Incinerator/district heating, Copenhagen

Located across the harbour from Hans Christian Andersen's famed Little Mermaid, Amhager Hill is a waste-to-energy plant and incinerator that burns solid waste for local district heating. The plant doubles as an astroturf ski hill (*a.k.a.* CopenHill). Most people visit the nearby hippy village of Freetown Christiana, but CopenHill is worth a visit for the views, even if you don't ski. "Depending on your perspective, CopenHill is a novel district heating idea or a gimmick to hide an incinerator."

Marie Curie's lab office, Paris

A founder of nuclear physics with Ernest Rutherford, Marie Curie painstakingly separated radioactive polonium and radium from pitchblende (uranium ore). Madame Curie received 2 Nobel prizes (1903 Physics and 1911 Chemistry) for explaining the "faint, fairy light" of "radioactivity" and the chemical process of elemental separation. Her office has been preserved along with a roomful of artefacts and information about the early years of radium and nuclear science. Located beside the Pantheon, where she and her husband Pierre are buried, the museum is free.

Solar farm, near Burgos

Photovoltaic (PV) solar farms are becoming more prevalent and can be seen on the roadside in numerous sun-kissed locales. This one was along the highway near Burgos in Castille-La Mancha. Concentrated solar power (CSP) plants aren't as easily seen from the road, but I saw one from a plane window just west of Seville. If you want to see the majesty up close, check out Sanlúcar la Mayor in Google Maps Satellite mode. "The symmetric majesty is a wonder to behold."

Windmills, Kinderdijk, South Holland

Now a UNESCO World Heritage Site in the Albasserwaard region southeast of Rotterdam, the Kinderdijk comprises 19 windmills and three 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. If you visit, I suggest taking a boat from Rotterdam.

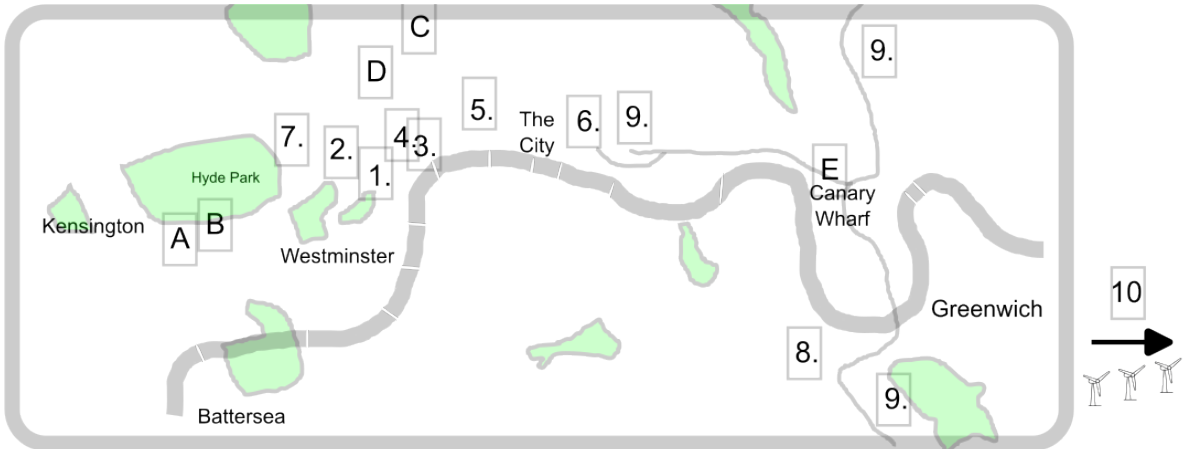
Electric van, Gijón, Asturias

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.

"Waste isn't waste until we waste it," Utrecht

It wasn't always easy to recycle. A 1955 *LIFE* article 'Throwaway Living' sang the praises of our ultra-modern, disposable lifestyle, although a few people questioned the massive amounts of waste generated, such that recycling is now standard across much of the globe. Each item not discarded in a dump/landfill saves on the environment and processing costs to handle the used material, packaging, and garbage we discard to the tune of about 500 kg per person per year, roughly our own weight every 2 months.

LONDON: “When a man is tired of London, he is tired of life” – Samuel Johnson



1. **Royal Society of London** (6-9 Carlton House Terrace). Founded in 1662, the Royal Society was the world’s first scientific society, which evolved from an amateur congregation of neo-alchemist apothecaries and natural philosophers to an order of professional scientists studying and codifying natural laws through the able stewardship from 1703 to 1727 of its twelfth president, Sir Isaac Newton. Outdoor street lighting began along the nearby Pall Mall, the world’s first gas-lit street in 1807. Sir Humphry Davy was president from 1820 to 1827.

2. **The Royal Institution of Great Britain** (21 Albermarle Street). Founded in 1799, the RI is a scientific organization famous for research, public demonstrations, and science education. As laboratory director (1881), chemist and quintessential scientific showman Humphry Davy helped to popularize the wonders of emerging new science, in particular, his brilliant display of artificial “arc” lighting, powered by his own battery, as did his successor Michael Faraday (1825). After setting up his own “artificial sky in a tube” in the basement, John Tyndall (1867) noted that varying amounts of water vapor, carbon dioxide, and methane could be responsible for past ice ages.

3. **Michael Faraday Statue** (2 Savoy Place). Inspired by Hans Christian 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.

4. **The Savoy Theatre** (Savoy Court). Powered by an in-house generator for a December 28, 1881, performance of Gilbert and Sullivan’s comic opera *Patience*, the Savoy Theatre was the first commercial building lit entirely by electric light. The first series of buildings lit by an external central power station began the following year along the nearby Holborn Viaduct by the Edison Electric Company.

5. **Holborn Street dynamo** (Holborn Viaduct) In 1884, Charles Parson designed a rotating steam-powered turbine first used with the Holborn Street dynamo, which generated more energy from the same amount of steam by passing it through a modified set of fans instead of jerkily moving a piston up and down. Parson’s insight was to make the fan blades as small as possible in a compound turbine assembly.

6. **The London Metal Exchange** (10 Finsbury Square). The demand for metal components in electric-vehicle and charge-storage batteries will continue to rise with increased electrification, such that more minerals will be mined in the next three decades than throughout the whole of human history, requiring hundreds of mines and doubling supplies by 2050. In 2019, the London Metal Exchange banned the trading of irresponsibly mined cobalt from 2022.

7. **Millennium Hotel** (44 Grosvenor Square). Alpha particles don’t easily penetrate the skin, but are especially dangerous when inhaled or ingested, for example, the poisoning of the Russian émigré Alexander Litvinenko in the Millennium Hotel, who was given tea laced with polonium-210, a high-intensity alpha emitter.

8. **Deptford Power Station** (Basevi Way, near Greenwich). Following developments in high-voltage transformers and polyphase induction motors, alternating current (AC) became the leading electrical power system for generators, transmission, and industrial applications, including Sebastian de Ferranti’s 1889 Deptford Power Station on the Thames River near Greenwich that lit the City of London less than 2 miles away. The station was demolished in 1993.

9. **Docklands Light Railway line** (DLR map). Artificial intelligence (AI) and automated vehicles (AV) are no longer science fiction. The Docklands Light Railway line in London has operated without drivers since it opened in 1987. The system now comprises 45 stations over almost 40 km of track. A driverless, narrow-gauge, electric Mail Rail system also scurried under the streets of London between Paddington and White Chapel for three-quarters of a century before being discontinued, conveniently bypassing above-ground congestion.

10. **The London Array** (outer Thames Estuary). In 2015, global offshore wind capacity was only 12 GW, including the London Array in the outer Thames Estuary, which accounted for 630 MW from 175, 3.6-MW turbines. The then world’s largest offshore wind farm could power one-quarter of all London homes at peak output.

A Natural History Museum (South Kensington), B Science Museum (South Kensington), C Institute of Physics (37 Caledonian Rd), D The Wellcome Collection (215 Euston Road), Museum of London Docklands (West India Quay)

Living Science: *London, New York, Spain, The Netherlands*

The Truth About Energy: Our Fossil-Fuel Addiction and the Transition to Renewables

Chapter 1: Called "the rock that burns" by Aristotle, coal was the first major industrial fuel, created about 300 million years ago as heat and pressure compressed pools of decaying plant matter. Burned to generate heat to boil water and make steam to move a piston in a Watt "fire engine" or a giant turbine in a modern power station, the industrialization of manufacturing, transportation, and electric power is examined from beginnings in the United Kingdom to today's increased use of coal combustion in developing countries despite the limited thermal efficiency and harmful combustion by-products. A transition simplifies or improves the efficiency of old ways, turning intellect into industry with increased capital — when both transpire, change becomes unstoppable.

Chapter 2: The great discoveries of the past two and a half centuries — the steam engine, electromagnetic induction, the electric power grid, the internal combustion engine, the transistor, personal computers, the internet — change not just the way we live, but an entire global economy. Nothing, however, created more change or made more millionaires than one discovery. By the early 1900s, the iron carriage had made its appearance on the streets of our booming cities, but a new kind of engine and a new kind of fuel would be needed to make a "gasmobile" run. Oil.

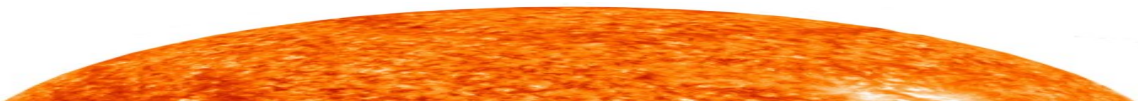
Chapter 3: The history of nuclear power is examined through the work of a number of pioneering physicists, chemists, and engineers, including Marie Curie in Paris (radiation), Ernest Rutherford, James Chadwick, and John Cockcroft in Cambridge (model of the nucleus), and Enrico Fermi in Rome, New York, and Chicago (the first nuclear reactor CP-1). Albert Einstein and Leo Szilard's cautionary letter to Franklin Roosevelt, the Manhattan Project at Los Alamos that oversaw the making of the first nuclear bomb, US Admiral Hyman Rickover's nuclear fleet, and the transition to electricity-generating fission power by the US, UK, and Soviet Union is explored. The '70s growth of "too cheap to meter" nuclear power is shown to be expensive, dangerous, and incapable of treating its own waste.

Chapter 4: Photovoltaic solar power is examined from the atomic level up, starting with solid-state electronics, elemental crystals, and semiconductors. The preferential doping of silicon and germanium to make p-n junctions, transistors, and solar batteries is explained along with the growth of the PV industry that has seen solar panel prices drop and uptake increase exponentially over the past 4 decades according to Swanson's Law (a solar equivalent of Moore's Law). The manufacturing of the modern solar cell, behind-the-meter installations (residential and commercial solar), and utility-scale solar are all discussed.

Chapter 5: The history of wind power is discussed, from pumping water that reclaimed land in the Netherlands in the 1600s to today's megawatt-scale, grid-tied, electricity-generating behemoths. Installations in Denmark (Vindeby, Copenhagen), the US (West Texas, Wyoming, offshore Atlantic), Spain (100% wind in El Hierro), the UK (London Array, North Sea), and China (China's Wind Base program is expected to reach 1 terrawatt of grid power by 2050) are examined as are novel horizontal-axis, vertical-axis, and vibrating turbine technologies. The number of onshore and offshore sites continues to increase the amount of grid-tied renewable energy year on year (now 10%). The problems of long-distance transmission, stranded power, and recycling are discussed.

Chapter 6: The role of the car is examined from the advent of the internal combustion engine (ICE) in the early 1900s (Benz and Daimler in Stuttgart, Olds and Ford in Detroit) to electric vehicles (EVs) in the past 2 decades (GM's EV1, Toyota's hybrid Prius, and Tesla's Roadster). With over 1 billion cars on the road and annual sales of almost 100 million, 90% run on hydrocarbon combustion, EV propulsion is changing the rules of the road. By 2035, the sale of gasoline and diesel cars will end across Europe and other regions. Examples of electric propulsion are given, including cars, trucks, buses (especially China), marine transport, and airplanes, as are the challenges to electrify each sector (cost, range, weight, charging infrastructure). Vehicle-to-grid (V2G) technology, energy storage, and microgrids are all examined.

Chapter 7: Conservation, the circular economy, and the concept of "negawatts" are explained using everyday examples in the house, on the road, and in modern industry. Ways to save energy and money through increased efficiency and changed consumer habits are discussed as is the sharing economy that sees fewer cars for personal use. If we want more control of our daily lives, smaller-sized, scalable renewable energy allows us to become self-sufficient, letting us make our own decisions about our own needs. With an off-grid power setup, no one can tell me what to do.



"I have not failed. I've just found 10,000 ways that won't work."
— **Thomas Edison**

"The meek shall inherit the Earth, but not its mineral rights."
— **J. Paul Getty**

"Nothing in life is to be feared, it is only to be understood."
— **Marie Curie**

"Any sufficiently advanced technology is indistinguishable from magic."
— **Arthur C. Clarke**

"If the facts don't fit the theory, change the facts."
— **Albert Einstein**

"Science is organized knowledge. Wisdom is organized life."
— **Immanuel Kant**

"We came all this way to explore the moon, and the most important thing is that we discovered the Earth." — **William Anders**, Apollo 8 Astronaut

"This universe is bigger than all of us. That earthrise photo gave us the sense that we live on a fragile planet, that we have limited resources, and that we better learn to take care of it."
— Apollo 8 commander **Frank Borman**, seeing the earth for the first time from the moon, a moment captured by crewmate Bill Anders in his famous *earthrise* picture

"We are stardust / We are golden / And we've got to get ourselves / Back to the garden"
— **Joni Mitchell**, Woodstock

"If you see a threat it's your responsibility to sound the alarm."
— **Greta Thunberg**

"President Lula called COP30 'the COP of truth.' The hard truth is that we have failed to ensure we remain below 1.5 degrees. This is moral failure – and deadly negligence."
— **António Guterres**

John K. White is a physicist, writer, and educator, who has worked in the engineering, science, and education fields in Canada, the Netherlands, Ireland, and Spain. He is the editor of the website E21NS (Energy in the 21st Century News Service), the author of *The Truth About Energy: Our Fossil-Fuel Addiction and the Transition to Renewables* (2024, Cambridge University Press), and a former lecturer in the School of Physics, University College Dublin, and the Department of Education, University of Oviedo, where he taught courses in atomic physics, applied optics, and science education.

The Truth About Energy *is available from the Cambridge website, on Amazon, or at local bookshops. Educational materials (talk [pdf], photos, energy quiz, energy films), a local podcast Green Energy: A solution or a challenge? – An interview with John White, and CounterPunch articles can be viewed and downloaded at johnkwhite.ie.* ***Do the Math!*** (Sage, 2012) and ***The House of Words*** (Tuttle House, 2012) are also available online.