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Dedication:

Energy Shocks is dedicated to Elon Musk and Tucker Carlson who have done so much to advance freedom of speech allowing people everywhere to gain awareness and understanding of the truth.

Contents

Introduction

Energy Shocks was written to dispel many of the misunderstandings and misrepresentations related to energy and carbon dioxide, while explaining how energy and carbon dioxide actually work.

Energy Shocks is composed of three sections.

In the first section, *Energy Shocks* provides a comprehensive understanding of energy, covering the history of the human use of energy in addition to assessing each of the forms of modern energy. The first section of *Energy Shocks* critically assesses the Energy Transition, intended to replace fossil fuels with alternatives that do not emit carbon dioxide. *Energy Shocks* develops the power of energy to make our world a better place, acknowledging that at a conceptual level green energy can make a positive contribution to our energy mix; however, *Energy Shocks* elaborates why the scope of the potential contribution from green energy is significantly more limited than often assumed.

In the second section, *Energy Shocks* makes the point that the most important discoveries ever made relating to carbon dioxide were not made by John Tyndall in 1859 when he determined that carbon dioxide is a greenhouse gas: The most important discoveries ever made relating to carbon dioxide were made between 2016 and 2019. For reference, satellites, such as NASA's Terra satellite, which was launched in 1999, have only recently been in orbit long enough to provide us with the shocking realities of how our Earth is actually changing over the decades due to increased concentrations of carbon dioxide in the atmosphere. Specifically, in 2016, a team of thirty-two scientists from globally recognized institutions discovered that increasing the concentrations of carbon dioxide in the atmosphere is the most significant driver of increased plant growth on our Earth.[1] In 2018, a team of seven scientists, including several from NASA itself, published a report, based on satellite data, indicating that "contrary to the prevailing view" forests are growing (net of losses) at a staggering

[1] **Carbon Dioxide Fertilization Greening Earth, Study Finds** – NASA – https://www.nasa.gov – Accessed: March 2021; and
Greening of the Earth and its Drivers – Zaichun Zhu and 31 additional authors – Nature Climate Change – 25 April 2016

rate of 2.0% per decade.[2] In 2019, a team of fifteen scientists from globally recognized institutions determined, based on observations from NASA's Terra satellite, that the green leaf covered area of the Earth is increasing at a staggering rate of 2.3% per decade.[3] The second section concludes that based on a growing body of evidence, mainly based on directly observed satellite data, there are new perspectives to contemplate the changes that are occurring on our Earth.

In the third section, nineteen independent subjects are developed through short essays to give broader context to understand energy and carbon dioxide. The most critical subject developed relates to farming, which is the foundation of human civilization and prosperity. Agriculture has been largely ignored in discussions relating to the Energy Transition – an oversight that is increasing global hunger, poverty and habitat loss for wildlife.

Energy Shocks provides sufficient depth of analysis for experts while attempting to be imminently readable by non-experts.

The book is entitled *Energy Shocks* because the emerging realities of the Energy Transition and carbon dioxide are providing new, and critical, perspectives to consider both subjects. To the extent that *Energy Shocks* critically assesses many widely held assumptions, the hundreds of citations to referenced sources are integral to *Energy Shocks*.

The underlying purpose of *Energy Shocks* is to demystify both energy and carbon dioxide and to provide a straightforward understanding of how they work and to provide context to appreciate how they relate to other issues affecting our world.

[2] **Global land change from 1982 to 2016** – Xiao-Peng Song, Matthew C. Hansen, Stephen V. Stehman, Peter V. Potapov, Alexandra Tyukavina, Eric F. Vermote & John R. Townshend – Nature – 8 August 2018

[3] **China and India Lead the Way in Greening** – Abby Tabor – NASA Earth Observatory – https://earthobservatory.nasa.gov – Accessed: March 2021; and **China and India lead in greening of the world through land-use management** – Chi Chen, Taejin Park, Xuhui Wang, Shilong Piao, Baodong Xu, Rajiv K. Chaturvedi, Richard Fuchs, Victor Brovkin, Philippe Ciais, Rasmus Fensholt, Hans Tømmervik, Govindasamy Bala, Zaichun Zhu, Ramakrishna R. Nemani & Ranga B. Myneni – Nature Sustainability – 11 February 2019

1. Energy

Energy Fundamentals

Energy, fundamentally, has always been and will always be extremely straightforward.

Energy is simply what makes things work and, no, energy is not complicated.

Heat is the Most Useful Form of Energy

For most of humanity's existence energy consisted of heat energy from fire. Heat, inclusive of the heat from nuclear energy, still provides 95.3% of our global needs in energy.[4] The 4.7% of our needs in energy that are not provided by heat are provided by hydro power, solar power, wind power and other sources.[5]

Heat enables humanity to transform raw materials into materials that we find useful. Heat underpins the creation of almost everything that is manmade. Intense heat is the most useful form of energy because it has direct applications and because it can also be easily transformed into other forms of energy that are useful, namely, into mechanical energy to make things move or into electricity.

The Importance of Combustion

Combustion is another word for fire.

Combustion is a chemical process that combines oxygen with fuel.

Combustion creates heat and emits carbon dioxide.

In contrast to widely held perceptions, 90.3% of global energy consumption is derived from combustion.[6]

[4] **Key World Energy Statistics 2021 (Data for 2019)** – International Energy Agency – September 2021
[5] **Key World Energy Statistics 2021 (Data for 2019)** – International Energy Agency – September 2021
[6] **Key World Energy Statistics 2021 (Data for 2019)** – International Energy Agency – September 2021

The heat energy produced from the combustion of fossil fuels, namely, coal, oil and natural gas provide 80.9% of our global needs in energy.

In contrast to widely held perceptions, the heat energy from the combustion of wood, alcohol (bio-gasoline) and vegetable oils (bio-diesel) is overwhelmingly the most important source of energy labelled as renewable.[7] Wood, alcohol and vegetable oils are referred to as bio-fuels.

The effort to reduce our dependence on the heat energy provided from the combustion of fossil fuels has increased our dependence on the heat energy provided from the combustion of bio-fuels, which provide 9.4% of the energy consumed globally.[8]

Humanity is Defined by Its Use of Energy

The heat from combustion – fire – is our oldest source of energy. Therefore, combustion is the best place to start expanding on our understanding of energy.

Combustion propelled humanity out of the Stone Age into the Bronze Age, combustion carried us into the Iron Age and combustion underpinned the Industrial Revolution. Looking back further in time, combustion carried our survival through the ice ages.

Combustion is not just essential to human existence, combustion is indissociable from human existence. We are both the only species to use combustion and the only species that is genetically adapted to and dependent upon the heat energy produced by combustion. Most critically, our big energy-consuming brains are adapted to cooked food; specifically, cooked food is easier to digest and therefore it provides our bodies with more useful energy net of the energy used in digestion.[9] Our tastes, our small teeth, our narrow rib cage and our

[7] **Key World Energy Statistics 2021 (Data for 2019)** – International Energy Agency – September 2021

[8] **Key World Energy Statistics 2021 (Data for 2019)** – International Energy Agency – September 2021

[9] **Catching Fire: How Cooking Made Us Human** – Richard Wrangham – Profile Books – September 2009;
Control of Fire in the Palaeolithic, Evaluating the Cooking Hypothesis – Richard Wrangham – Current Anthropology – 16 August 2017 and

digestive systems too are all genetic adaptations to our use of the heat from combustion to cook food – they are genetic adaptations to our use of an external source of energy, specifically to the heat energy provided by fire.[10]

The degree to which our bodies benefit from cooked food is evidenced by the very strong attraction we have to food that has been grilled at temperatures that are comparable to that of an open fire – or specifically over the charcoal embers of a wood fire. At these temperatures the chemistry of food changes through processes known as Maillard Reactions after the French chemist who in 1912 discovered their chemistry.[11] Maillard Reactions give the grilled cheese on pizza its great taste. Maillard Reactions are what makes caramel taste so good. Likewise, Maillard Reactions are the reason for which beer is so popular. We are genetically adapted to be attracted to the taste of the roasted barley that gives beer its flavor because roasted food – cooked food – gives us more energy (net of digestion) than uncooked food. Our genetic adaptations to our use of an external source of energy – namely, fire – are profound. We are genetically adapted to cooked food. Those adaptions define the make-up of our species. Genetically, we are a product of energy. External energy came first and we are a genetic product of the use of that energy. When we think about energy, we need to understand our visceral attachment, dependence and genetic links to external sources of energy. It is a colossal mistake to think of energy simply as a means of turning the lights on or of allowing travel: Energy is much more than that, it is a deeply rooted and necessary part of our existence as a species.

Food for Thought: Was Cooking a Pivotal Step in Human Evolution? The dietary practice coincided with increases in brain size, evidence suggests – Alexandra Rosati – Scientific America – 26 February 2018

[10] **Catching Fire: How Cooking Made Us Human** – Richard Wrangham – Profile Books – September 2009;
Control of Fire in the Palaeolithic, Evaluating the Cooking Hypothesis – Richard Wrangham – Current Anthropology – 16 August 2017 and
Food for Thought: Was Cooking a Pivotal Step in Human Evolution? The dietary practice coincided with increases in brain size, evidence suggests – Alexandra Rosati – Scientific America – 26 February 2018

[11] **An Introduction to the Maillard Reaction: The Science of Browning, Aroma, and Flavor** – Eric Schulze – seriouseats.com – 13 April 2017 – Accessed: March 2020

The oldest definitive archaeological evidence of the use of fire for cooking is dated to 1.0 million years ago.[12] The human species in its current anatomical form, which is adapted to the use of fire for cooking, emerged about 300,000 years ago – at least that is the date ascribed to the oldest fossilized record of human existence.[13]

For perspective, humans are thought to have acquired language, through a genetic adaptation allowing our brains to think in terms of language, only 80,000 years ago.[14] No other species has the mastery of combustion and no other species has language. Our use of combustion and language are the two reasons that humans are so different from the other animals with whom we cohabitate our planet and the reasons for which we completely dominate our Earth. With those powerful tools, the mastery of combustion and language, our dominance was inevitable.

Humans are defined by our use of heat energy from combustion and language. Critically, our use of energy, specifically the use of heat energy from combustion, predates our genetic adaptation to think and communicate using language. Moreover, our use of heat energy was surely a necessary precursor to the development of language to the extent that language requires our high-powered brains, which are a genetic adaption to cooked food and to our use of heat energy from combustion.

Although we think that humanity invented the use of controlled combustion, that is untrue. The ancestors of the human species invented ways to use and control combustion. The heat energy produced by combustion actually created humans through genetic adaptions to cooked food.

The key point is that energy is not a peripheral advantage for humanity, our use of energy is inextricably what makes us human.

[12] **Microstratigraphic evidence of in situ fire in the Acheulean strata of Wonderwerk Cave, Northern Cape province, South Africa** – Francesco Berna *et al.* – Proceedings of the Natural Academy of Sciences of the United States of America (PNAS) – 15 May 2012

[13] **An Evolutionary Timeline of Homo Sapiens** – Brian Handwerk – The Smithsonian Magazine – 2 February 2021

[14] **Why Only Us Language and Evolution** – Robert C. Berwick and Noam Chomsky – The MIT Press – 2016

Think about it, we have been using the heat energy produced by combustion for much longer than we have been thinking in languages.

The use of an external source of energy, heat energy provided by combustion, was not a choice made by humanity it was a prerequisite, and remains a prerequisite for our existence.

The ancient Greeks revered combustion not because it gave them bricks, glass and steel – it did – but because combustion gave them art, science and culture.[15] Humanity is what it is because of the heat energy provided by combustion. For the entirety of our existence, across all cultures and histories combustion has been recognized as being the source of our material well-being.

In conjunction with our rising standards of living and the growth in our population, today, coal, oil and natural gas, provide humanity with the heat energy that it needs to exist.

The reality is that without combustion we would not have Netflix or the internet or mobile phones or green energy. The reality is that without the heat energy provided by combustion we would all precipitously perish, mostly through almost immediate starvation.

We will see in future sections that coal, oil and natural gas underpin the entirety of humanity's ability to produce enough food for 8 billion people to live on a small planet with limited space for farming.

The oldest and most solid constant of humankind is that we have always been advantaged by combustion, or more specifically by the heat energy produced from combustion. Changes to how we have used combustion have, when they have occurred, underpinned the most important advances in human civilization. The biggest changes relating to our use of energy have related to i) changes in the fuels we have burned and ii) changes in the technologies that have enabled humanity to better exploit combustion.

Combustion, Photosynthesis, Energy and CO_2

[15] **Fire in the mind: changing understandings of fire in Western civilization** – Stephen J Pyne – Philosophical Transactions of the Royal Society of London – 5 June 2016; and
Prometheus' Gift of Fire and Technics: Contemplating the Meaning of Fire, Affect, and Californian Pyrophytes in the Pyrocene – Marjolein Oele – Philosophy – 2020

So, we know it is important, but what is it? What is combustion?

Combustion, another word for fire, is actually a basic chemical process. All forms of combustion combine oxygen with fuel to produce heat. Fuel is defined as anything that can burn.

Combustion burns organic matter. Coal, oil, natural gas, wood and other bio-fuels all have organic origins. The heat energy released by combustion is sourced from our sun and captured by plants and other organisms via photosynthesis.

Carbon is the essential building material for all organic matter. All organic matter contains carbon and the combustion of organic matter, like the decomposition of organic matter, emits carbon dioxide.

Combustion essentially reverses the natural processes of photosynthesis, specifically:

1. Photosynthesis absorbs energy. Combustion releases energy;
2. Photosynthesis releases oxygen into the atmosphere. Combustion absorbs oxygen from the atmosphere;
3. Photosynthesis absorbs carbon dioxide from the atmosphere. Combustion releases carbon dioxide back into the atmosphere.

Yes, to reiterate a critical point, all combustion releases carbon dioxide back into the atmosphere – reversing the capture of carbon dioxide from the atmosphere at the time when photosynthesis originally transformed energy from sunlight into the energy contained within fossil fuels.

Fossil fuels, namely, coal, oil and natural gas are essentially concentrated forms of organic energy that are fundamentally comparable to wood or any other fuel that burns. Oil, for example, can be considered to be an organic fuel that has been transformed over time from its original state as a solid fuel into a liquid fuel – a liquid that is exceptionally concentrated in energy – that, in effect, is exactly what oil is and how it was formed.

Today, we have a good intuition for the look and feel of combustion from burning wood, coal and natural gas; however, for many, combustion from burning oil can be mystifying. This is in large part because we never see combustion from burning the products derived from oil because they are burned mainly inside engines. This can

occur in any number of ways – again reflecting the extraordinarily versatile utility of intense heat. As one example, let's take a look at how a gasoline engine works: Spark plugs are used to bring gasoline to its ignition temperature, at which it combusts with oxygen. The heat energy created by the combustion of gasoline causes air to expand with an explosive force, that expanding air pushes a piston; heat energy is thereby transformed into mechanical energy. That mechanical energy is what makes vehicles powered by gasoline engines move forwards. The key is to appreciate that if we could look inside many of the things that are all around us, we would see combustion at work.

A point of anecdotal interest that can further demystify combustion is an explanation of flames. Flames are simply the result of heat. Near the point of combustion where chemical reactions are actually occurring, the heat is particularly intense. Extremely intense heat causes molecules to emit light (incandescence). For example, steel glows red when it is very hot. Likewise, the flames of a candle are simply caused by the emission of light from very hot molecules.

Energy, a Gift Bestowed upon Humanity

It is essential to understand that combustion is a gift bestowed upon humanity, our most primordial and fundamental blessing. This means that fuels that burn have been presented to humanity, by mother nature, in a natural state that makes them perfect for human use. Unlike the materials that humans make using combustion, which require us to transform raw materials into useful products, the fuels that we use to create heat energy are useful in their raw form. We do refine and slightly modify fuels, but we do not create them. The costs and burdens associated with modifying fuels that release heat energy through combustion are insignificant relative to their utility.

Economists, generally speaking, think in terms of labor and capital because labor and capital have costs.[16] However, it is energy that really underpins the entirety of our human existence and achievements. Heat energy from combustion does not fit neatly into economists' paradigms because the utility and advantages it brings

[16] **Gaps in Mainstream Economics: Energy, Growth, and Sustainability** – Robert U Ayres – Green Economy Reader. Studies in Ecological Economic. (volume 6) – 23 September 2016

include our existence and everything achieved by humanity. Therefore, the benefits of heat energy from combustion are wildly disproportionately greater than their associated costs. That fact alone has underpinned more than anything else the entirety of the material prosperity of humanity and the entirety of human progress.

The primary fuels that we burn to create heat energy are coal, oil, natural gas, wood and other bio-fuels. Each fuel has its own set of characteristics that give it advantages and disadvantages.

Energy is Grounded in Pragmatic Realities

Oil is the king of fuels because its physical properties make it extremely practical. For example, jet fuel, which is a product derived from oil (through simple fractional distillation), packs a tremendous punch in terms of its energy content relative to its weight and volume. For reference, jet fuel contains more than three times as much energy as wood for any given weight of fuel. Jet fuel contains more than 40 times as much energy as the leading lithium-ion batteries currently available (295Wh/kg) and 24 times as much energy as the most energy-dense condensed-matter electrical battery (500Wh/kg) currently available.[17] It is true that batteries are getting better and better, and we will return to the topic of electrical batteries. Refocusing on oil, jet fuel derived from oil is a liquid, which makes it easy to handle and facilitates its movement from a storage tank to the point at which it will be burned. Importantly, it remains a liquid under normal operating temperatures and pressures: it does not easily evaporate or freeze. Like all fuels it can be stored indefinitely without any loss to its energy content. Fundamentally, jet fuel is no different than wood, they both simply produce energy in the form of heat; however, the pragmatic physical differences between jet fuel and

[17] **(14.4MJ/kg for firewood with a 20% moisture content)** source: **Wood Fuels Handbook** – Dr. Nike Krajnc – Food and Agriculture Organization of the United Nations – 2015;
(**43.9MJ/kg for kerosene/jet fuel)** source: **Approximate conversion factors** – Statistical Review of World Energy – BP – July 2021;
(295Wh/kg = 1.1MJ/kg for market leading li-ion batteries) source: **Tesla's 4680-Type Battery Cell Teardown: Specs Revealed** – Mark Kane – insideevs.com – 17 July 2022 – Accessed January 2023; and
(500Wh/kg = 1.8MJ/kg for market leading condensed matter batteries) source: **CATL launches condensed battery with an energy density of up to 500 Wh/kg, enables electrification of passenger aircrafts** – CATL – 19 April 2023

wood make jet fuel incalculably more valuable than wood as a source of energy.

It is a mistake to think of energy as a single concept as if all forms of energy are the same thing; in fact, the practical differences between each form of energy is the only thing that matters. That is why we don't use wood to fly airplanes – as straightforward as this is, it is often overlooked. For example, energy from wind turbines, in the absence of a means of storing electrical energy, is unreliable – that severely limits the practicality of wind power. The point is that the subject of energy is grounded by practical realities, something that is too often ignored.

The Fundamentals of Electricity

Having looked at our most ancient form of energy – the heat energy released by combustion. Let's turn our attention to our most modern form of energy, namely, electricity.

In 1882, Nicola Tesla invented a motor that could transform rotational (mechanical) energy into a form of electricity (alternating current) that could travel long-distances in copper wires. This allowed electrical energy produced in one location to be used in another location, which immeasurably increased the usefulness of electricity. This invention represents the foundation of modern electricity as we know it. Today, electricity provides 19.7% of our needs in energy – about one fifth of the energy we consume is provided by electricity.[18] Electricity is not a source of energy, it represents a means of carrying energy from a given source to where energy can be used: Before it is carried from one place to another, electrical energy must firstly be created by transforming energy from a given source into electrical energy. Today, heat provides 75.5% of our needs in electricity.[19] As mentioned, intense heat is an extremely versatile form of energy and there are many ways that intense heat can be easily transformed into electrical energy. The largest electricity generators consist of steam driven (heat driven) turbines that turn motors, of Nicola Tesla's invention, to generate electricity.

[18] **Key World Energy Statistics 2021 (Data for 2019)** – International Energy Agency – September 2021

[19] **Key World Energy Statistics 2021 (Data for 2019)** – International Energy Agency – September 2021

Heat from combustion, heat from nuclear power, hydro power, wind power and solar power are all used to generate electricity. It is critical to appreciate that nuclear power, hydro power, wind power and solar power are used exclusively to create electricity (ignoring theoretical and trivial distractions).

Electricity's origins tell us what it is good at: Transporting energy via copper wires from where it was sourced to where it can be conveniently used for lighting, electric motors, electronic devices and to generate low-intensity heat.

Using electrical energy to produce the high volumes of intense, high-temperature heat required to create materials is challenging. For example, steel and cement are just two of the many materials used by humanity, yet they alone account for 5.8% and 2.4%, respectively, of global energy consumption.[20] Processes that are required to make steel occur at temperatures over 2,000°C (3,600°F).[21] Processes to make cement occur around 1,450° Celsius (2,640° Fahrenheit).[22] Electricity is limited in its practical ability to efficiently provide high volumes of intense heat to meet those needs. Considering that heat provides over three-quarters of our needs in electricity and that useful energy is lost in transforming heat into electricity and then again when electricity is transformed back into heat, electricity is not conducive for producing huge volumes of intense heat that are required to create the materials that demand the most energy.

Fuels that produce intense heat through combustion remain the most broadly useful sources of energy because they have the broadest number of direct applications and because intense heat can be transformed easily into other forms of energy, such as electrical

[20] **Energy consumption in the iron and steel sector by scenario** – International Energy Agency – 26 October 2022;
Key World Energy Statistics 2021 (Data for 2019) – International Energy Agency – September 2021;
Global cement production, 2010-2019 – International Energy Agency – www.iea.org – Accessed Jan 2023; and
Cement - David Hogson, Paul Hugues, Tiffany Vass - IEA - September 2022
[21] **How We Make Steel** – British Steel – https://britishsteel.co.uk – Accessed January 2023
[22] **Climate change: The massive CO2 emitter you may not know about** – Lucy Rogers – BBC News – 17 December 2018

energy. Electricity, on the other hand, is limited in its useful applications, which is why it carries no more than 19.7% of the energy we use (electricity is never a source of energy, only a carrier).[23] However, you might observe that electricity has grown in market share from 0%. In fact, that is true: The first electrical power station was built in 1882, it was London's coal fired Edison Electric Light Station.[24] A large component of the future of energy will relate to expanding the utility of electrical energy and the market share of electricity. Electrical batteries are clearly going to play a big role in increasing the practical applications for electrical power and that theme will be a constant driver of change over the decades ahead.

Fuels that generate heat from combustion have the pragmatic benefit of being both a source of energy and a store of energy. That simple nuance completely transforms the pragmatic utility of fuels because it means that the costs of storing fuels is negligible. In turn that means that fuels can be used as and when required with almost no associated storage costs. It is so basic we forget to think about it, but the value of a barrel of oil relates in large part to the fact that it can be stored for when we want to use it.

In contrast to fuels that burn, electricity cannot be stored in an empty vessel, storing electricity requires a costly electrical battery capable of transforming electrical energy into chemical energy for use in the future when it will be transformed back into electrical energy. For that reason, it is costly to store electricity and as a result electricity prices are more volatile than the prices of other forms of energy. The price of electricity in the most sophisticated energy markets will jump wildly from hour to hour – it cannot be bought cheaply and stored for when the price is higher. Today, electricity is indissociable from the electricity grid – there must be a direct physical connection made by electrical transmission lines between the source of the energy and its point of use. If the price of electricity is cheap in Texas, USA, but expensive in Europe, there is no link that makes it possible to buy electricity in Texas and sell it in Europe. You cannot fill up a battery with energy in one market and sell it in another market without losing a lot of money. The point is to appreciate that electricity is a form of

[23] **Key World Energy Statistics 2021 (Data for 2019)** – International Energy Agency – September 2021

[24] **The history of energy in the UK** – National Grid –https://www.nationalgrid.com – Accessed: April 2023

energy that is completely different from fuels that burn. Electricity exists only in the moment that it is created and its uses are limited to those where a grid connection is assured. However, as battery costs are falling, and as batteries are getting better, electricity is growing in importance and utility. Electrical batteries are freeing electricity from the grid and the need for a direct copper wire connection between the source of energy and the energy's point of use.

Electrical batteries today are being used to store electricity in products such as mobile phones and electric vehicles, but electrical batteries, today, are too expensive to store electricity to even out the price of electricity from the morning to the afternoon or to store energy from wind power and solar power to supply our electrical grids when the wind is not blowing or the sun is not shining. Electrical batteries are of course changing quickly and, as ever, the practical realities and costs of what electrical batteries can and cannot do will determine where they are used and where they are not used.

Global Energy Supply by Source

To get our bearings more broadly in respect of energy, let's now look in detail at the sources of energy for the USA, the EU, China and the world as provided in Table 1, with other key comparators.

For reference, Table 1 is by far the most important table in this book because it summarizes energy wholistically, which is what matters.

Energy supply by source				*Table 1*
	USA	**EU**	**China**	**World**
Oil	36.0%	32.8%	18.9%	30.9%
Natural Gas	33.0%	24.6%	7.6%	23.2%
Coal	10.0%	14.3%	60.7%	26.8%
Biofuels	4.8%	9.8%	3.8%	9.4%
Total from combustion	**83.8%**	**81.5%**	**91.0%**	**90.3%**
Nuclear	8.0%	13.4%	2.7%	5.0%
Hydro	2.3%	1.6%	3.2%	2.5%
Wind	3.8%	1.9%	2.0%	1.4%
Solar	1.8%	1.0%	1.1%	0.6%
Other	0.2%	0.6%	0.0%	0.1%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Year of energy publication:	2023	2020	2022	2021
Source of energy data:	*EIA*	*IEA*	*IEA*	*IEA*
Energy from fossil fuels	79.0%	71.7%	87.2%	80.9%
Energy from heat	91.8%	94.9%	93.7%	95.3%
Energy not from heat	8.2%	5.1%	6.3%	4.7%
% global population (2022)	4.2%	5.6%	17.9%	100.0%
% global energy use (IEA data)	15.3%	9.7%	23.4%	100.0%
% global GDP (2022)	25.3%	16.5%	17.9%	100.0%

Sources: Various[25]

We can see in Table 1 that the contribution from green energy, namely, solar power and wind power, is conspicuously meagre if one considers that tax-payer funded subsidies (and an assortment of other

[25] **EU 2020, Energy Policy Review (Data for 2017)** – International Energy Agency – April 2020;
US primary energy consumption by energy source, 2019 – US Energy Information Administration – https://www.eia.gov – Accessed: January 2021;
China, Key Energy Statistics (data for 2020) – International Energy Agency – https://www.iea.org – Accessed: May 2023
Statistical Communique of the People's Republic of China on the 2022 National Economic and Social Development (used to allocate "Other" into Wind Power and Solar Power components) – National Bureau of Statistics of China – 28 February 2023
Key World Energy Statistics 2021 (Data for 2019) – International Energy Agency – September 2021;
Global Energy Review 2019 (for % of Global Energy Use; Data for 2019) – International Energy Agency – April 2020; and
GDP – World Bank – https://data.worldbank.org – Accessed: May 2023

advantages) have encouraged investments measured in trillions of dollars every year into green energy – $1.4 trillion was spent on green energy in 2022.[26]

If you are surprised by the meagre market shares of wind power and solar power, that is perhaps because their market shares are usually presented in terms the electricity market, which multiplies their apparent importance by a factor of approximately five times (only one fifth of our energy consumption is in the form of electricity). Energy data presented as it is in Table 1 is really all that matters and is by far the best way of making sense of what is really going on.

Conceptualizing Energy in Relation to the Broader Economy

It can be perplexing to assess energy relative to the broader economy. There is one key means of relating energy to the broader economy that must be understood to give discussions about energy context.

The best way of appreciating how energy relates to the broader economy is by comparing the costs of energy relative to the size of the economy supported by energy. For reference, for most of our human existence, energy has been freely available in the form of wood. Our better forms of energy were worth paying for because they were better than wood, but they have still been essentially gifts of mother nature – very low-cost forms of energy.

According to Rob West, the founder of a leading energy research firm, from the year 1900 to present the global cost of energy (all primary sources of energy) has averaged 4% of the value of the world's economic output.[27] Essentially, the key ingredient, supporting the entirety of our economy has been quite close to being given away. It's not hard to see that low-cost energy is an incredible driving force for economic prosperity.

It also shows that there are limits to the costs of energy that we can afford to pay. As a theoretical exercise, if energy costs as a percentage of global economic output were to go up by a factor of 25 times, we would have no economy, because energy costs would rise from representing 4% of the world's economic output to 100% of the

[26] **World Energy Investment 2022** – International Energy Agency – June 2022
[27] **An Industrial Waste Land?** – Robert West – Thunder Said Energy – https://thundersaidenergy.com/ – Accessed: January 2023

world's economic output – we would have energy, but nothing else – no food, no shelter, no materials, no services, nothing. On the other hand, it is very possible to more incrementally increase the cost of energy in our economy from 4% upward to a moderately higher percentage. Our economic prosperity would feel sluggish, we would have less because we would need to spend more on energy, but with some hardship we could get by. This is critical to appreciate in order to understand and avoid the worst dead-end scenario for the Energy Transition.

The Energy Transition in Economic Context

The Energy Transition refers to the transition from sourcing our energy from fossil fuels, which emit carbon dioxide into the atmosphere, to sources of energy that, at least theoretically, are not associated with emissions of carbon dioxide into the atmosphere.

The worst dead-end scenario for the Energy Transition is that fossil fuels continue to essentially carry the ball in terms of providing humanity with the entirety of its needs in energy while governments, through regulations and subsidies, divert tremendous wealth into wasteful forms of energy that are detrimental to our prosperity. That scenario consists of no fundamental changes to how we procure our energy, but involves a significant percentage of our wealth spent on waste – not an uncommon outcome of centrally planned economies.

Regardless of your views in respect of the best role for governments in relation to the economy and society, a key point is that there are physical limitations relating to how expensive the Energy Transition can become before our economies collapse under the weight of the costs of energy. That is true under a system of free markets and also true under a state controlled communist form of government – there are limits to the costs of energy that an economy can bear.

Based on the research of Rob West, with rising energy prices it is conceivable that the costs of energy relative to the scale of the global economy will rise in the near-term to a level of 13% – a massive increase from the 4% average from the 1900s.[28] If true, that would

[28] **Energy Costs Set to Reach Record 13% of Global GDP This Year** – Todd Gillespie – Bloomberg – 16 March 2022 (citing research from Rob West at Thunder Said Energy Consultancy)

mean that relative to what we are used to, 9% more of the wealth of each human alive would be allocated to the procurement of energy. Going higher than 13% would represent uncharted territory.[29] In the history of human existence there are no records suggesting that humanity has been able to sustain itself economically in a context where energy costs have exceeded 13% of our total economic output. This is an essential consideration as we contemplate the Energy Transition.

For further reference, today, green energy employs more than 50% of the people working in energy,[30] but wind power and solar combined provide only 2.0% of global energy.[31] The heavy social burden of funding all those relatively unproductive employees, in terms of the energy they produce, translates to significantly higher energy costs (or subsidies funded by taxpayers).

The Importance of Large-scale Supplies of Affordable Energy

Two other key points are necessary to understand energy: Firstly, growth in demand for more energy is a global constant and; secondly, the supply of more energy is directly linked to reducing global hunger and advancing human prosperity.

According to the World Bank, the global population is growing at 0.9%[32] per annum and surpassed 8 billion in 2022.[33] Half of the global population lives on less than $7 per day.[34] 828 million humans are currently suffering from hunger.[35] 774 million people do not even

[29] **Energy Costs Set to Reach Record 13% of Global GDP This Year** – Todd Gillespie – Bloomberg – 16 March 2022 (citing research from Rob West at Thunder Said Energy Consultancy)
[30] **World Energy Employment** – International Energy Agency – September 2022
[31] **Key World Energy Statistics 2021 (Data for 2019)** – International Energy Agency – September 2021
[32] **Population Growth** – World Bank – https://data.worldbank.org – Accessed: January 2023
[33] **A World of 8 Billion** – United Nations – Policy Brief – October 2022
[34] **Half of the global population lives on less than US$6.85 per person per day** – Marta Schoch, Samuel Kofi Tetteh Baah, Christoph Lakner and Jed Friedman – World Bank – 8 December 2022
[35] **The State of Food Security and Nutrition in the World 2022** – Food and Agriculture Organization of the United Nations – 2022

have access to the most generic form of energy – electricity.[36] Significantly more energy will be required in the years and decades ahead in order to raise global living standards and to keep pace with a rising global population. That statement is as true today as it was a century ago and it will be true for the foreseeable future: The world needs more energy.

Energy, the West and Developing Countries

To develop that key point further and to get our points of reference, the US and the EU are the leaders of the West, which can be considered to also include the other 38 countries that are members of the Organization for Economic Co-operation and Development. On that basis, the West has a population of 1.4 billion.[37] Outside of the West, the global population amounts to 6.6 billion.

Remarkably, the entirety of the West's focus on energy and the Energy Transition is essentially inward looking, even though the future of energy is clearly going to be defined outside of our borders. To understand the present and the future of energy you need to be thinking of China, India, Brazil and Indonesia, amongst other countries, and of the African continent. In short, the inward-looking perspective of the West in relation to the Energy Transition misses the whole point and completely ignores the demographic and economic realities of our changing world.

It is also critical to appreciate that the West was very concerned with, and effective at, reducing global hunger in the 1970s and the 1980s. Since the 1990s, in the West that interest has been superseded by concerns in relation to global warming. That has permeated the entirety of our media, our social fabric, our governments and the international bodies where the West has a strong influence including the United Nations, the International Energy Agency and the World Bank. It is critical to appreciate that as the West has changed its priorities to focus mainly on global warming, the rest of the world still

[36] **For the first time in decades, the number of people without access to electricity is set to increase in 2022** – Laura Cozzi, Daniel Wetzel, Gianluca Tonolo, Sub-Saharan, Jacob Hyppolite II – International Energy Agency – 3 November 2022

[37] **Population Total, OECD Members** – The World Bank – https://data.worldbank.org – Accessed: April 2023

prioritizes human development inclusive of reducing global hunger and increasing global prosperity. It is simply imperative to understand that our values, outlook and priorities in relation to the Energy Transition are not going to be accepted outside of our borders. Outside the West, where the bulk of the world's hunger and poverty exists, human development still remains the absolute priority. This rift in perspective is colossal and no matter what your personal priorities or values are, this difference in perspective must be recognized to understand the realities of energy today.

Two Important Peripheral Considerations Related to Energy

Having covered almost the entirety of the fundamentals of energy, it is important to look at two key peripheral and modestly complicating considerations that, strictly speaking, do not relate to energy, but that are definitely intrinsically associated with energy and the Energy Transition.

The first modestly complicating consideration is that coal, oil and natural gas are not only useful as forms of energy. They can be used as raw materials or feedstock that is then transformed into materials that we find useful. By far the most important product derived from coal and natural gas is fertilizer. For reference, 6% of the natural gas produced globally and 2% of the coal produced globally is used as feedstock to produce fertilizer[38] (specifically to produce hydrogen [H_2], which is used principally to produce ammonia [NH_3], which is the indispensable feedstock to produce nitrogenous fertilizers). Fertilizers overwhelmingly underpin our capability to grow sufficient food from a limited supply of land to feed humanity. Vaclav Smil, a globally recognized authority on energy and farming, estimates that half of the 8 billion people alive today would simply perish for lack of food without the fertilizer derived from coal and natural gas.[39] Oil and natural gas can also be transformed into plastics, synthetic fibers and a host of other products. Effectively, the molecular structures (composition) of coal, oil and natural gas can be readily altered to produce other materials that humankind finds useful. This does not strictly speaking relate to energy. However, in the modern world,

[38] **The Future of Hydrogen** – The International Energy Agency, Technology Report – June 2019

[39] **How The World Really Works** – Vaclav Smil – Penguin Books – 2022

many of our materials are in fact materials that have been made by transformations of coal, oil and natural gas into something else. For example, if you were to walk through a hospital and strip out the materials supplied by coal, oil and natural gas it would be a hollow shell, devoid of medicine, gloves, syringes, mattresses, and really almost everything that we associate in a material way to hospitals. So coal, oil and natural gas not only underpin the provision of the world's energy but also provide the world with almost the entirety of its synthetic materials. We will see that this not only benefits humanity, but it greatly alleviates the pressures on our natural world by reducing our need to take raw materials from nature. Can you imagine how much more land would be taken from wildlife to farm cotton for our clothes if we did not have synthetic fibers, which are derived from transforming the molecules that compose oil and natural gas? In short, products made from coal, oil and natural gas are everywhere and if those products were taken away from our world, it would be unrecognizable.

The second subject of complexity that relates peripherally, but importantly, to energy is that burning wood (specifically, charcoal) and coal (specifically, coking coal) releases carbon monoxide and other compounds which are essential for the production of steel. To make steel, you need combustion not just because combustion produces heat energy, but because it has the right chemistry.

So we have just done the grand tour of energy and now have a pretty good broad understanding of the subject.

In the next section we will deepen our understanding of energy by looking at the essential history of our use of energy to make materials.

Our First Tech

Capturing Energy from Combustion

Today, we give very little thought to how fires are lit. Spark plugs within internal combustion engines can spark the ignition of thousands of fires every minute without us even being aware of it. When we turn on the lights, we rarely realize that a fire has been lit on the other side of the electricity grid to ensure the reliable electrical energy for that to happen.

In contrast to our current indifference to combustion – another word for fire – it would have been at the forefront of our thoughts for most of our existence as a species. We think of pre-agricultural humans as nomadic hunter-gatherers; however, it might be more accurate to describe them as fire starters.

In many cases, hunting would have been the easy part of providing food, and getting a fire lit would have been the principal challenge. One can imagine the countless number of cold, snowy nights the eyes of small communities would have strained in the hopes of seeing flames erupt from the work of fire starters. In many instances, survival itself would have depended on the outcome.

The Controlled Use of Combustion

We do not have definitive answers as to how we first developed our most important and fundamental technology, the lighting of fire.[40] We do know that techniques to light fires using only natural materials depend principally on the materials that are available locally.

[40] **A Spark in the Dark: Shedding Light on the Origins of Fire-making** – Andrew Sorensen – leidenarchaeologyblog – 10 September 2019 – https://leidenarchaeologyblog.nl – Accessed: July 2020;
The discovery of fire by humans: a long and convoluted process – J. A. J. Gowlett – Philosophical Transactions of the Royal Society – 5 June 2016; and
Who Started the First Fire? – Dennis Sandgathe and Harold L. Dibble – Sapiens – 26 January 2017 – https://www.sapiens.org – Accessed: July 2020

Although there are many techniques to create fire using wood, they all involve the creation of friction to i) heat wood in order to dry it out and thereby lower its ignition temperature, ii) create fine wood dust and iii) create sufficient heat to ignite that wood dust. Hard work – creating friction – was the primary means of fire lighting until the Iron Age when it was discovered that striking flint against high-carbon steel produced sparks that made fire lighting easier, provided the fire starter had collected and dried the right tinder. In reality, fire lighting would have always been extremely challenging and often impossible if the fuel had not been properly dried or if the ambient temperature made it too cold for the fuel to reach its ignition temperature.

The control of fire – the control of combustion – is the foundation upon which humanity has built the entirety of its technological capabilities.

With the mastery of combustion, humans were able to develop materials that would serve as the building blocks of our civilizations. These materials and the story of their acquisition is the subject of this section.

From Energy: Bricks, Glass and Cement

The First Ceramics

The Venus of Dolni Vestonice, shown in Figure 1, is the oldest object of representational art that remains in excellent condition, providing an accurate reflection of the object as it was originally created.[41] The Venus of Dolni Vestonice is the oldest known ceramic. It is due to its properties as a ceramic that it has survived in excellent condition for 29,000 years.[42]

[41] **The Adiposity Paradox in the Middle Danubian Gravettian** – Erik Trinkaus – Anthropologie – 2005
[42] **The Adiposity Paradox in the Middle Danubian Gravettian** – Erik Trinkaus – Anthropologie – 2005

From fire: 29,000-year-old Venus of Dolni Vestonice ***Figure 1***

Photo Credit: Author

Ceramics consist of earthen clay materials that have been fired. During the firing process, through the application of heat energy, provided by fire, clay is partially vitrified – partially turned into glass. Once vitrified, ceramics are both strong and waterproof.

Energy and the Building Blocks of Civilization

We will now focus our attention on bricks, the quintessential ceramics upon which human development was quite literally built.

Erbil, in the Kurdistan region of Iraq, is possibly the oldest continuously occupied human settlement on Earth, with urban life there starting in 6,000 BC.[43] Erbil's urban layout is representative of how the first cities were built. Each city had a central fortress, or citadel, built on raised land.[44] Surrounding the raised land there was a

[43] **Erbil History** – Salahaddin University-Erbil – https://su.edu.krd/about/history/erbil – Accessed: July 2020; **History on a Hill** – Kasha Patel – NASA Earth Observatory – https://Earthobservatory.nasa.gov – Accessed: July 2020; and **Erbil Revealed** – Andrew Lawler – Archaeology Today – September/October 2014

[44] **Erbil Revealed** – Andrew Lawler – Archaeology Today – September/October 2014

wide ring of land in which people would live. Surrounding that a circular fortification wall was built.

Initially mud bricks were used for construction. Fortresses, fortification walls and homes were all built with mud bricks. Mud bricks are just that – bricks made of dried mud that have not been fired.

The Sumer civilization emerged in southern Mesopotamia around 4,500 BC.[45] In that area the Euphrates and the Tigris rivers merge into marshy wetlands before emptying into the Persian Gulf. Today, Basrah, Iraq, is a notable city in the area of ancient Sumer.

The Sumerians were disadvantaged because the wet and marshy environment in which they lived would quickly deteriorate mud brick constructions. By firing mud bricks to create vitrified ceramic bricks the Sumerians found a solution to their challenge, a solution that would forever transform construction and architecture.

Fired bricks are able to withstand the elements and they are considerably stronger than mud bricks. For these reasons, the use of fired bricks spread throughout Mesopotamia. Fired bricks allowed for the construction of greater fortresses and fortifications, which gave rise to greater city states that ruled over larger territories. The Great Ziggurat of Ur, which was built in brick around 2,100 BC in Southern Sumer, is representative of these developments. That ziggurat as partially reconstructed in the 1980s is shown in Figure 2. It is an impressive example of how materials and technology shape social and political structures.

[45] **The Sumerians** – Samuel Noah Kramer – The University of Chicago Press – 1963

From fired bricks, the Great Ziggurat of Ur ***Figure 2***

Photo Credit: US Air Force, Staff Sergeant Christopher Marasky

The history of human art and culture is inextricably bound to the materials we have used – substantially all of which are produced from energy in the form of heat.

The first written language was developed on fired clay and the first sentences were written on bricks. Those sentences were contracts between merchant Sumerians.[46] They chose to write on bricks for the same two reasons that bricks are used everywhere: They last and they are inexpensive.

To underline that key point, the affordability of bricks is intrinsic to their character.

The Romans industrialized brick production and spread the use of brick making. They were not the only ancient civilization to have made bricks on an industrial scale: The largest man-made structure on Earth, the Great Wall of China, is largely made of fired bricks.

Intense Heat, a Prerequisite for Many Materials

As we have seen, heat is required to induce the chemical reactions required to create bricks. An idealized brick firing process would involve heating bricks for about three and a half days, of which 10 hours would involve heat over 1,000° Celsius (1,832° Fahrenheit).[47]

[46] **The Evolution of Writing** – Denise Schmandt-Besserat – International Encyclopaedia of Social and Behavioural Sciences – Elsevier – 2014
[47] **The UK Clay Brick Making Process** – Brick Development Association – www.brick.org – March 2017

The creation of other building materials such as glass and cement also require tremendous amounts of heat. The heat to produce these materials has historically been provided by fire. Glass production was first developed in Mesopotamia around 2,000 BC by melting sand at temperatures of 1,700° Celsius (3,090° Fahrenheit).[48] Cement was perfected by the Romans, which allowed them to build in the 2nd century AD the dome of the Pantheon – still the world's largest unreinforced cement dome. To produce cement, limestone and clay must be heated to approximately 1,450° Celsius (2,640° Fahrenheit).[49]

Bricks in the Modern World

At present, the cost of heat (from combustion) as a percentage of the total production costs for bricks, cement and glass are respectively estimated to be 30-35%, 30-40% and 15%.[50] The key point is that the cost of energy in the form of heat represents a very large component of the costs of producing these basic materials.

Currently, 1,500 billion fired bricks are produced per year.[51] That equates to 195 bricks per person living on Earth per year. Current country rankings for brick and cement production are provided in Table 2.

[48] **The Origins of Glassmaking** – Corning Museum of Glass – https://www.cmog.org/article/origins-glassmaking – Accessed: August 2020

[49] **Climate change: The massive CO2 emitter you may not know about** – Lucy Rogers – BBC News – 17 December 2018

[50] **Final Report: For a study on the composition and drivers of energy prices and costs in energy intensive industries: The case of the ceramics industry, bricks and roof tiles** – Christian Egenhofer, Lorna Schrefler, Fabio Genoese, Julian Wieczorkiewicz, Lorenzo Colantoni, Wijnand Stoefs, Jacopo Timini – Center for European Policy Studies – 13 January 2014;

Improving thermal and electric energy efficiency at cement plants: intranational best practice – International Finance Corporation, World Bank Group – 2017; and

Glass Industry of the Future, Energy and Environmental Profile of the US Glass Industry – Joan L. Pellegrino, Lou Sousa, Elliott Levine, Michael Greenman, C. Philip Ross, Jim Shell, Marv Gridley, Dan Wishnick and Derek J. McCracken – Office of Industrial Technologies, US Department of Energy – April 2002

[51] **Emissions from South Asian Brick Production & Potential Climate Impact** – Ellen Baum – Climate and Health Research Network, presentation – 11 March 2015 – Accessed at https://cdn.cseindia.org/ (August 2020)

Brick and cement production by country *Table 2*

Brick Production		Cement Production	
Country	**%**	**Country**	**%**
China	67%	China	54%
India	16%	India	7%
Pakistan	3%	Vietnam	2%
Other	14%	Other	37%
Total	**100%**	**Total**	**100%**

Sources[52]

Let us now turn our attention to metallurgy, the development of which brought an end to the Stone Age and ultimately allowed humanity to build into the skies.

From Energy: The Bronze Age

Copper

Bricks, cement and glass are products of energy, specifically they are made from the heat energy produced by combustion. We will now see that bronze and metallurgy are also products of the heat energy from combustion.

Copper is one of the rare metals that occur naturally in a pure metallic form. From about the 9th millennium BC, societies began to work copper by hammering it into desired forms. In this way, jewelry, tools and weapons were created. The oldest known copper ornament is dated to 8,700 BC. It was found in Mesopotamia, in the area of what is now northern Iraq.[53]

It was probably noted by the first workers of copper that heating it made it malleable and easier to work. The first liquefaction of copper represents a significant step in human development. Once liquified by heat, copper could be poured into molds which allowed the fabrication of copper objects in complex shapes. However, copper melts at a

[52] **Emissions from South Asian Brick Production & Potential Climate Impact** – Ellen Baum – Climate and Health Research Network, presentation – 11 March 2015 – Accessed at https://cdn.cseindia.org/ (August 2020); and
Cement Data Sheet, Mineral Commodity Summaries 2020 – US Geological Survey – https://pubs.usgs.gov – Accessed: August 2020

[53] **A Timeline of Copper Technologies** – Copper Development Association Inc – https://www.copper.org/ – Accessed: August 2020

temperature of 1,089° Celsius (1,985° Fahrenheit). How could such a temperature be reached?

Two technologies were required to bring copper to its melting point: charcoal and bellows. Charcoal is the product of wood that has been heated and partially burned in a low oxygen environment. Relative to wood, charcoal has a very low moisture content and produces high and steady quantities of heat energy. Bellows are devices that replicate the effect of blowing on a fire. Although the inventors of bellows would not have known it, bellows simply provide more oxygen for fuel to combust.

The transformation of wood into charcoal is the first example of humanity's transformation of one form of energy into a form that we find more useful. This underlines that energy itself is not of primary value to humanity, it's useful energy that matters.

The Sumerians were the first people to have made wide use of copper, which they introduced to the Egyptians. Copper tools such as axes for churning farmland increased in use and thereby increased agricultural yields. Copper tools also gave rise to carpentry. The rolling of a circular object does not require brilliance; however, the invention of a wheel that can rotate on an axle does. Moreover, actually creating such a working system requires a mastery of the craft of carpentry and good tools. This is because where the rotating wheel makes contact with the stationary axle requires a near-perfect fit. According to David Anthony, a professor of anthropology who is an expert in the invention of the axled-wheel, "It was the carpentry that probably delayed the invention until 3500 B.C. or so, because it was only after about 4000 B.C. that cast copper chisels and gouges became common in the Near East."[54] Heat energy from combustion and the copper derived from that energy had transformational effects on human development during this time. With wheeled carts heavy loads were no longer required to be borne on the backs of humans or domesticated animals.

It is critical to appreciate the links between energy (heat from combustion), better farming (copper axes) and technological

[54] **Why it took so long to invent the wheel** – Natalie Wolchover – Scientific American – 6 March 2012

developments such as the wheel (made with copper tools) – it is energy that underpinned the entirety of these developments.

Bronze

Energy, namely, heat energy from combustion also underpinned the creation of bronze and the Bronze Age.

Copper may have propelled humanity forwards, but it was bronze that completely transformed metallurgy and the course of human development. Relative to bronze, copper was a mere precursor.

Bronze is stronger, harder and more durable than copper.

The earliest evidence of bronze was discovered at Plocnik, Serbia, and is dated to circa 4,500 BC.[55] At its origins bronze use was marginal. However, from 3,000 BC to 1,200 BC in the area of the Eastern Mediterranean, Egypt, Mesopotamia and eastwards as far as present-day Afghanistan the use of bronze was so pronounced that that period of 1,800 years is referred to as that area's Bronze Age.[56]

After heat energy is applied to melt copper and tin, they can be mixed as a liquid to create bronze.

Bronze axes significantly increased agricultural yields. The use of ploughs became widespread for the first time due to their resistance to breaking when reinforced with bronze. Higher agricultural yields resulting from the use of bronze agricultural equipment created a surplus of food, which allowed for more urbanization and created the basis for the development of prosperity.

Bronze tools allowed for fine carpentry: Spoked-wheeled chariots were first produced during the Bronze Age. Professional armies appeared for the first time. They were of course kitted out with mass-produced weapons and armor made in bronze. The wealth created during this era – premised on the high agricultural yields from bronze reinforced ploughs – allowed the Egyptians to construct the great pyramids while fostering the flourishment of writing and art. Energy

[55] **Tainted ores and the rise of tin bronzes in Eurasia, c. 6500 years ago** – Miljana Radivojevic, Thilo Rehren, Julka Kuzmanovic-Cvetkovi, Marija Jovanovic and J. Peter Northover – Antiquity – 87(2013)

[56] **1177 BC, The Year Civilization Collapsed** – Eric H. Cline – Princeton University Press – 2014

from combustion unlocked the bronze (derived from molten copper and tin) that made the Bronze Age possible.

Again, it is critical to appreciate the links between energy (heat from combustion), rising agricultural production (from bronze reinforced ploughs) and civilizational progress – it is energy that underpinned the entirety of these developments.

Wood and Charcoal are Compelling Forms of Energy

To get our bearings relative to modern forms of energy, there is a 0% chance that today electrical energy alone would be able to support the technologies of the Bronze Age or the quality of life enjoyed by humanity during the Bronze Age. This is because large volumes of intense heat are required to make bricks and bronze. Electrical energy is not practical for that purpose. Electricity is indeed becoming more useful as technology advances, but it is miles away from having the practical utility of wood and charcoal.

The reason for which developed economies no longer use the energy technology of the Bronze Age, namely, wood and charcoal, is not that newer forms of energy are necessarily advantageous relative to wood and charcoal, it is because there is simply not enough wood and charcoal to provide us with the energy we need.

Since the Bronze Age the amount of energy consumed per person has grown by multiples. Today, each human on the planet consumes on average an amount of energy equivalent of 5,700 kg (12,600 lbs) of dry firewood per year (equivalent to over 13 barrels of oil per person per year).[57] Moreover, since the time of the bronze age the human population has grown by a factor of 160 times, from 50 million at the end of the Bronze Age to 8 billion today.[58] So each person is using considerably more energy and there are considerably more people on the planet.

[57] **BP Statistical Review of World Energy 2021**;
Approximate conversion factors – Statistical Review of World Energy – BP – July 2021;
Wood Fuels Handbook – Nike Krajnc – Food and Agricultural Organization of the United Nations – 2015

[58] **Historical Estimates of World Population** – United States Census Bureau – https://www.census.gov – Accessed: January 2023

There are simply not enough trees on Earth to fuel the modern world. Attempting to run the world using the energy from wood would result in the rapid and complete deforestation of the entirety of the Earth.

In areas of the world where fossil fuels are unaffordable wood becomes the primary source of energy. Haiti regularly ranks as the poorest country in the America's. In direct relation to its poverty, it is also one of the most deforested countries on Earth, with only 1% of its original primary forest remaining[59] – an ecological catastrophe, causing widespread social and economic damage.

Contrary to many people's perceptions, biofuels, not wind power and solar power, constitute the lion's share of green energy (Table 1). Although the Energy Transition is often perceived to represent technological progress, it is imperative to appreciate that growing the market share of green energy – mainly biofuels – represents a return to the combustion of pre-industrial biofuels, namely, wood, alcohol (labelled as bio-gasoline) and vegetable oil (labelled as bio-diesel).

The miracle of modern energy is twofold: Firstly, we have been able to replace wood (and other biofuels) which is in limited supply with satisfactory alternatives, most importantly, fossil fuels; and secondly, some of the forms of energy that we are using today have practical benefits that make them better than wood – oil is the standout winner in terms of its practical benefits.

Let us now turn our attention to the Iron Age, which like the Bronze Age, was unlocked by energy.

From Energy: The Iron Age

Iron

Heat energy from combustion unlocked the Iron Age. Specifically, better and hotter furnaces, fueled by charcoal, unlocked the potential of iron.

The Iron Age of the most advanced civilizations began around 1,200 BC and ended around 500 BC, which roughly coincides with the

[59] **Haiti's biodiversity threatened by nearly complete loss of primary forest** – S. Blair Hedges, Warren B. Cohen, Joel Timyan and Zhiqiang Yang – PNAS – 29 October 2018

foundation of the Roman Republic and the beginning of recorded history. Roman and Greek civilizations were a product of the Iron Age – they emerged out of and as a direct result of the increased use of iron, derived from heat energy.

Iron must be derived through a process called smelting. Smelting transforms minerals that have a high iron content into something close to pure iron. Smelting involves removing the components of iron ore that are non-metallic through chemical reactions that occur at high temperatures. Combustion, not just heat, is required to smelt iron ore because combustion provides the carbon and carbon monoxide that are required to reduce the iron ore into iron. At its origins smelting also involved the repeated hammering of red-hot ore to remove unwanted impurities and to consolidate the ore. The result of this process is a relatively pure form of iron called wrought iron.

Iron has a melting point of 1,538° Celsius (2,800° Fahrenheit) and furnaces could not reach that extremely high temperature for most of the Iron Age. For most of the Iron Age heat energy was used to make iron soft and malleable for hammering into forms that were useful. The first evidence of the use of casting liquid iron is dated to 645 BC and located in China.[60]

Steel

Wrought iron is not particularly advantageous relative to bronze; it rusts easily and is not appreciably harder. To fully exploit the potential of iron requires it to be carburized, which is the absorption of carbon into iron through heat-related processes. The product of carburation is steel. Steel is not only the product of heat from combustion, but of the carbon that is produced from combustion.

Carbon can be introduced into iron during the smelting process or later. Once iron has been carburized into steel, it is receptive to subsequent heating, cooling and hammering processes that will permanently alter its character.[61] Although the elements of steel-craft are basic, the sequencing and degree to which each process is applied

[60] **A History of Cast Iron, ASM Handbook, Cast Iron Science and Technology** – Doru M. Stefanescu – ASM International – 2017

[61] **A History of Cast Iron, ASM Handbook, Cast Iron Science and Technology** – Doru M. Stefanescu – ASM International – 2017

requires a high level of skill to achieve the desired outcome. Steel-craft is unforgiving of errors because its processes are irreversible.

The urban centers of Etruria would become the most prolific producers of iron and steel in the area of the Mediterranean in the centuries that followed the Bronze Age. Etruria was located on the central-west coast of what is now Italy. The peoples of ancient Etruria are called Etruscans. The use of iron ploughs for farming became prevalent in the area.[62] Critically, better ploughs increased agricultural yields. As a result, prosperity, urbanization and trade increased in the region.

Again, it is critical to appreciate the links between energy (heat from combustion), rising agricultural production (stronger iron ploughs) and civilizational progress – it is energy that underpinned the Iron Age.

Steel Made the Roman Empire

In the year 509 BC, the citizens of a town, inspired by Greek political philosophy, overthrew their Etruscan king and declared their town to be "res publica", an entity belonging to the people – a republic. That town was Rome and that development, and the subsequent Roman Empire, would not have been possible without steel, which was made possible by energy – specifically by advances to better exploit the energy of burning wood (charcoal) to increase furnace temperatures.

Steel in the Modern World

Turning our focus of attention to the present, global demand for steel continues to grow. In 2022, global steel demand reached 1,840 million metric tons.[63] For every ton of copper required to support our global economy, we require about 75 tons of steel.[64] For reference, those figures equate to an average annual consumption per person of 230kg (507lbs) of steel and 3kg (6lbs) of copper.

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[62] **The Urbanisation of Rome and Latium Vetus, From the Bronze Age to the Archaic Era** – Francesca Fulminante – Cambridge University Press – 2014

[63] **World Steel in Figures** – World Steel Association – https://www.worldsteel.org/ – 2022

[64] **World Refined Copper Production and Usage Trends** – International Copper Study Group – http://www.icsg.org/ – Accessed: August 2020

As we have seen, smelting is the process that transforms iron ore into iron. Smelting iron ore into iron requires intense heat energy as does the production of steel.[65] Today coal, not woodfuel, is used to smelt iron and to create steel. Today, in practical terms, steel is derived from burning coal. To produce one ton of steel from iron ore requires 0.77 tons of coal on average.[66]

With wind turbines now being built taller than the Eiffel Tower, it is worth highlighting that the monstrous amounts of steel required for each wind-turbine, require an equally monstrous amount of coal – we are talking about train-loads of coal for each wind turbine.

Due to the anti-coal agenda of the EU, Europe has lost its place as a competitive producer of steel. According to the European Commission itself, Europe cannot manufacture steel competitively because up to 40% of the manufacturing costs of steel production are attributable to energy costs and due to its anti-coal agenda the "European industry is faced with higher energy prices than most of its international competitors."[67] Europe does not actually consume less steel as a result of its anti-coal agenda, it simply imports steel made from coal in Chinese and Russian steel plants (see Table 3).

Top importers & exporters of steel 2019 ***Table 3***

Steel Importers		Steel Exporters	
Country	**Mt**	**Country**	**Mt**
EU 28	45	China	69
US	32	Japan	36
Thailand	16	Russia	33

Source: World Steel Association[68]

Coal, Steel and Modern Architecture

Returning to the story of steel, the Empire State Building of New York was completed in 1931. Its height of 381 meters (1,250 feet) made it the tallest building in the world at that time. 10 million bricks form

[65] **Energy use in the steel industry** – World Steel Association – April 2019
[66] **Metallurgical Coal** – BHP – https://www.bhp.com – Accessed: February 2021
[67] **The EU steel industry** – European Commission – https://ec.europa.eu – Accessed: August 2020
[68] **World Steel in Figures** – World Steel Association – https://www.worldsteel.org/ – 2019

the exterior façade of that building.[69] However, its structure is not supported by bricks, which are there merely for aesthetic decoration. The Empire State Building is supported structurally by steel, which has allowed humanity to build higher than bricks and even into the skies.

To underline a key point, although we believe that steel built the New York skyline, we could just as correctly state that the New York skyline was built with coal. The point is to understand that energy shapes everything around us, even the shapes of our greatest cities. Without coal, there would be no New York nor any other great city as we know them on our planet.

Steel is Essential for Efficient Farming

Critically, the importance of steel for farming has only increased since steel reinforced ploughs were introduced during the Iron Age. Farmers in wealthy countries with high agricultural yields can afford steel farm equipment. Farmers in poor countries with low agricultural yields cannot afford steel farm equipment. To increase global prosperity the name of the game is to lower the cost of steel, which will in turn make steel farm equipment more affordable in poor regions. Nothing in the history of the world has proven to be more effective at reducing poverty than increasing agricultural yields.[70] The anti-coal agenda is increasing the cost of steel, which is made from coal, making steel farm equipment less affordable. That is having the direct effect of increasing global poverty and hunger – 100% guaranteed. Positively, the steel provided by coal has emancipated billions from abject poverty, hunger and destitution and it has potential to do more by considerably improving the living standards of half the world's

[69] **Empire State Building Fact Sheet** – Empire State Realty Trust – https://www.esbnyc.com – Accessed: February 2021

[70] **Agriculture and Food** – The World Bank – https://www.worldbank.org – Accessed: March 2021;
Ending Extreme Poverty – Interview of Ana Revenga by Amy Frykholm – 8 June 2016 – The World Bank (as first published by the Christian Century); and
Crop Selection and International Differences in Aggregate Agricultural Productivity – Jorge A. Alvarez and Claudia N. Berg – IMF Working Paper – August 2019

population that, today, lives on less than $7 per day.[71] The scale of that job is enormous and steel produced in massive quantities from coal is up for that job.

Green Steel

For reference, there is substantial media hype focusing on steel plants that do not use coal. Although it is always exciting to explore new possibilities, it is a mistake to infer from micro-scale, laboratory-type government owned, heavily subsidized or heavily loss-making steel plants (that use exceptionally rare, high-grade iron ores) that there are broader applications for coal-free steel that would not, in practical terms, translate to severe steel shortages, exceptionally high steel costs and significant increases to the number of people living on less than $7 per day. Based on the technologies currently available and under development for the foreseeable future, steel is simply indissociable from coal.

Lifting Humanity into the Skies

With materials such as steel, humanity has lifted itself into the skies. Today, the Burj Khalifa in Dubai is the tallest building in the world. Gleaming with glass and steel, it stands 828 meters (2,716 feet) tall. It is in every respect as magnificent as the great constructions of the ancient world. However, even with all the steel and glass in the world, the splendor of the Burj Khalifa would not have been possible without one thing: the elevator. In the next section, we will look at how energy transformed our world, only quite recently, by making things move up and down, rotate and travel.

[71] **Half of the global population lives on less than US$6.85 per person per day** – Marta Schoch, Samuel Kofi Tetteh Baah, Christoph Lakner and Jed Friedman – World Bank – 8 December 2022

Modern Energy

Preamble

Energy, the Enabler of the Industrial Revolution

Many of the epochs of human development, such as the Stone Age and the Bronze Age have been surpassed by subsequent human developments. This is not true of the Iron Age and the Industrial Revolution. We are just as dependent on iron and steel as the Etruscans who first made wide-use of steel; likewise, we are still living in the Industrial Revolution.

Energy was the fundamental enabler of the Industrial Revolution.

Energy unlocked the Industrial Revolution in two ways: Firstly, a process was invented that allowed coal to replace woodfuel for the production of steel, which allowed steel to be produced in far greater volumes; secondly, during the Industrial Revolution, fuels were used for the first time to create movement. We made machines, mainly in steel, and then used heat energy to give motion to those machines. The Industrial Revolution was fundamentally about movement. Steam driven trains, fueled by the heat of burning coal, provide an iconic image of the Industrial Revolution. Likewise, the heat from the most technologically advanced fuels used for today's rocket launches also represent means of using heat energy to make things move – the quintessential invention of the Industrial Revolution.

All of our most recent and advanced technologies stem from the Industrial Revolution. However, smart phones and satellites are actually not the most significant benefits of the Industrial Revolution. By far, the most significant benefit, and the miracle, of the Industrial Revolution is that it has provided means to feed humanity's rapid population growth, which is now standing at 8 billion.

I should know something about this subject because my country, Canada, a grain exporter, was made by the railway. In 1885, the Canadian Pacific Railway brought peoples of different cultures, religions and languages together by connecting Canada from the

Atlantic coast to the Pacific coast.[72] Without that railway, there is no chance Canada would exist in its current form. With it, the whole country made sense. We were able to import and export freely from two great oceans. The food grown in colossal volumes on the Canadian plains continues to roll down the railways to the oceans where it is shipped around the world – energy driven movement. Modern farm equipment involves the displacement of the equipment over fields and a tremendous amount of movement within the equipment itself – energy driven movement. For example, the gigantic modern combines at work in Canada, and elsewhere, i) cut grain stalks, ii) separate the grain from the stalk (threshing), iii) separate the wheat from the chaff, and iv) tie the stalks into bails which are left behind the moving combine – energy driven movement, these are factories on the move.

Railways, trains and ships are made with steel (derived from coal). Agricultural trucks, combines, tractors, seeding and tilling equipment – essentially all farm equipment – is made in steel. Combines now weighing more than 10 metric tons (11 US tons) and the common handheld hoe are made in steel.

Affordable steel (from coal), affordable diesel fuel (from oil) to run farm equipment and affordable fertilizer (from natural gas), make modern farming affordable for more people, which has the direct effect of i) increasing prosperity ii) reducing poverty and iii) reducing hunger.[73] Yes, it is really that easy.

Importantly, the reality is that humanity cannot go back to a pre-industrial existence because our population has grown by a factor of over 10 times from pre-industrial times (1750) and industrial farming is how we produce food for billions.[74]

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[72] **The Last Spike** – Pierre Burton –McClelland and Stewart – 1971

[73] **Agriculture and Food** – The World Bank – https://www.worldbank.org – Accessed: March 2021;
Ending Extreme Poverty – Interview of Ana Revenga by Amy Frykholm – 8 June 2016 – The World Bank (as first published by the Christian Century); and
Crop Selection and International Differences in Aggregate Agricultural Productivity – Jorge A. Alvarez and Claudia N. Berg – IMF Working Paper – August 2019

[74] **Historical Estimates of World Population** – United States Census Bureau – https://www.census.gov – Accessed: January 2023

Industry Has Greatly Advantaged the Environment

It is also noteworthy, as we will see in the next section that the idealized pre-industrial existence of humanity living in harmony with nature is a mirage – it never existed. Pre-industrial Europe was hungry and cold and it had stripped nature to the bone to support its meagre populations. Europe was a treeless wasteland centuries ago compared to its current forested state.[75] Why have Europe's forests regrown?

Due to fuel switching, the heat energy from burning wood has been replaced by the heat energy from burning coal, oil and natural gas. Due to materials switching, wood for construction has been replaced by steel (derived from coal) and by synthetic materials (derived from oil and natural gas). Due to higher agricultural yields resulting from industry (from steel derived from coal, diesel fuel derived from oil and fertilizer derived from coal and natural gas), Europe needs less farmland. These three dynamics have reduced our needs for wood and have reduced our needs for land; as a result, European forests have regrown.

Energy to Make the World Move

The history of modern energy from the time of the Industrial Revolution is best captured by the history of the evolution of our primary sources of energy. In this section we will cover the evolution of the fuels that we have used from the time of the Industrial Revolution – from wood to oil. This section will also cover the history of hydro power, nuclear power, wind power and solar power. We will also assess the history and development of the electrical battery and hydrogen, which both represent means of storing energy.

Wood: Energy for the Billions

Wood is the Source of Energy for 2.4 Billion People

Contrary to widely held perceptions, wood remains one of the most important forms of energy globally. Wood as a source of energy is

[75] **A high-resolution and harmonized model approach for reconstructing and analysing historic land changes in Europe** – Richard Fuchs, Martin Herold, Peter Verburg, J.G.P.W Clevers – Biogeosciences – March 2013

increasing its market share in the most advanced economies of the world.

Citing directly from the 2018 United Nations' State of the World's Forests report, "Woodfuel, defined as including both fuelwood and charcoal, is used by approximately 2.4 billion people worldwide for cooking meals, sterilizing drinking water and heating homes."[76]

According to the World Health Organization the smoke from cooking with open fires causes 3.2 million deaths per annum, including 237,000 deaths per annum of infants less than five years of age.[77]

For reference, propane, a fossil fuel that is derived from oil and natural gas production, represents the single most practical means of replacing woodfuel for domestic uses.[78] Propane is inexpensive, it burns cleanly and it can be compressed and stored easily in tanks – in practical terms it is a natural gas that does not need a pipeline. Shale oil and shale gas produce an inordinate amount of propane. As a result of US shale oil and gas production growth, propane has become the single most exported petroleum product from the US, with circa 1.4 million barrels of propane exported every day.[79] That change represents one the most profound changes in energy markets in recent decades and it is immeasurably improving the living standards of millions by allowing people to switch from burning wood, dung and bio-waste to a reliable, convenient and clean source of energy.

Focusing on the scale of woodfuel being used today, it is critical to appreciate that the real energy challenge for the decades and centuries ahead relates to the provision of better forms of energy to the 2.4 billion people who currently cannot afford energy other than the woodfuel provided by forests.

[76] **The State of the World's Forests 2018** – Food and Agricultural Organization of the United Nations – 2018

[77] **Household Air Pollution Key Facts** – World Health Organization – https://www.who.int – accessed: February 2023

[78] **Substituting LPG for Wood: Carbon and Deforestation Impacts** – Atlantic Consulting – July 2018

[79] **The United States exported record amounts of petroleum products in the first half of 2022** – The US Energy Information Administration – 26 September 2022

We will see in the next section that, fuel switching from wood to coal, represents the foundation of the Industrial Revolution.

Contrary to widely held perceptions, both industrialization and the industrialized use of coal have been drivers that have allowed European forests to prosper. This is because the increased use of coal reduced pressures on wood consumption allowing Europe's forests to regrow, even as its population and the size of its economy increased by multiples.

The effects of industrialization on forests are best evidenced by looking at the history of the largest European country by surface area, France. France was a feudal agricultural society until 1830. In that year, France appointed a new king, Louis Philippe the 1st, who sought to replicate the industrial success of the United Kingdom. The Industrial Revolution in France started in the year 1830. From 1830 to 2018, the forested surface area of France increased by 69%.[80] This trend is ongoing: Between 1950 and 2010, the forested area of the EU in addition to the United Kingdom and Switzerland grew by 25.4%.[81]

The reality is that coal and industry allowed Europe's forests to grow back.

Wood is Central to the EU's Energy Strategy

The EU's energy policy is largely driven by the desire to increase the market share of renewable energy. That is a statistical goal, which makes energy statistics the primary focus of EU energy policy.

Europe has relabeled wood as a renewable source of energy and the use of wood therefore advances the statistical goals of the EU.

However, the Executive Director of the International Energy Agency, stated that there are weaknesses in the statistical methodology for

[80] **La Forêt en France Métropolitaine** – Institut National de l'Information Géographique et Forestière – http://education.ign.fr/dossiers/foret-france-metropolitaine – Accessed: August 2020

[81] **A high-resolution and harmonized model approach for reconstructing and analysing historic land changes in Europe** – Richard Fuchs, Martin Herold, Peter Verburg, J.G.P.W Clevers – Biogeosciences – March 2013

wood used by the EU which overstate the statistical contribution from renewables.[82]

Jan Rosenow, a director of European Programs at the Regulatory Assistance Project, a think tank specializing in green energy, explains that only about 30% of the energy released by burning wood residentially is actually used usefully, with about 70% of the heat released out of the chimney. However, she details that that is not reflected in the EU's statistics. She states that the EU's statistical methodology encourages countries to burn more wood and to burn wood as inefficiently as possible because both practices increase the market share of renewables, based on the statistical methodologies employed by the EU.[83] Rosenow stated "It really makes no sense but that's the way the statistics are being done."[84]

For perspective, biofuels account for more of the EU's renewable energy than wind power, solar power and hydro power combined.[85] We are not talking about peripheral details, we are talking about the core of the EU's energy policy and the way it reports on energy.

For reference, the International Energy Agency estimates that biofuels, inclusive of wood and liquid biofuels, provide the EU with 3.4 times as much energy as wind power and solar power combined (see Table 1).[86]

According to the World Wildlife Fund, the EU has knowingly been importing wood cut illegally, mainly from Tropical rainforests.[87] Wood and wood by-products such as wood pellets are almost impossible to trace so it is easily done.

[82] **Exposed: How EU countries use firewood to bloat their renewable energy stats** – Frédéric Simon – Euractiv – 23 January 2023
[83] **Exposed: How EU countries use firewood to bloat their renewable energy stats** – Frédéric Simon – Euractiv – 23 January 2023
[84] **Exposed: How EU countries use firewood to bloat their renewable energy stats** – Frédéric Simon – Euractiv – 23 January 2023
[85] **Biomass** – European Commission – https://energy.ec.europa.eu – Accessed: February 2023
[86] **EU: European Energy Policy Review** – International Energy Agency – June 2020
[87] **Illegal wood for the European market** – Peter Hirschberger – World Wildlife Fund – July 2008

For reference, the EU spent €17 billion ($15 billion) on bio-energy subsidies in 2019.[88]

Wood, Renewable Energy?

Wood comes from forests. Burning wood emits carbon dioxide. However, today, governments in the West label wood as a renewable source of energy.

The basis of labelling wood as renewable is explained by the US Energy Information Administration:

> "According to international convention, CO2 emissions from biofuel combustion are excluded from national greenhouse gas emissions."[89]

To be clear on this point, accounting methodologies to measure the carbon-dioxide emissions from biofuels, namely from, wood, alcohol (bio-gasoline) and vegetable oil (bio-diesel) assume that those forms of energy do not emit any carbon dioxide, because that is the accepted international convention.

The reality is that burning wood, and biofuels in general, is causing large scale deforestation, wildlife habitat loss while having the effect if significantly increasing atmospheric concentrations of carbon dioxide.

It is estimated that on average six mature trees can absorb and store one metric ton of carbon dioxide per year.[90] Deforestation to source wood pellets and to increase farmland to grow biofuels means that carbon dioxide that would naturally be absorbed by trees is no longer absorbed and that the carbon dioxide that had been stored in trees prior to being cut down for biofuel is entirely released into the atmosphere through both decomposition and combustion; however, by convention, none of the carbon dioxide emissions of biofuels are

[88] **EU limits subsidies for burning trees under renewable energy directive** – Jennifer Rankin – The Guardian – 14 September 2022
[89] **Biofuels explained** – US Energy Information Administration – https://www.eia.gov – Accessed February 2023
[90] **How much CO2 does a tree absorb?** – Paul Collins – Climate Consulting – https://climate.selectra.com – Accessed: June 2023

accounted for in the statistics that measure the carbon emissions from green energy.

It also important to appreciate that although green energy has significantly grown its market share due to the growth of the use of biofuels (Table 1), there are limits to the amount of land available for deforestation and farming to source biofuels.

Coal: Fossilized Peat, the Foundation of Industry

Coal's Massive Contribution to Energy Supply

Coal provided the propulsive thrust that initiated the Industrial Revolution and, today, it provides 26.8% of global energy.[91]

The Geological Origins of Coal

Coal is fossilized peat. Over long periods of geological time buried peat turns into coal. Peat is essentially the accumulation of dead organic material that does not decay. Peaty soil is acidic and has a low oxygen content, which prevents decomposition. In total, 3.3% of the Earth's land area consists of peatlands, of which 91% is located in the northern latitudes. These northern peatlands started forming about 15,000 years ago as the Earth slowly began to exit the last ice age. On average since the end of the last ice age, dead organic matter containing 18.1 grams of carbon has settled on each square meter of peatland every year (0.58 ounces per square yard). That may not sound like a lot, but consider that the Earth has 4.4 million square kilometers (1.7 million square miles) of peatland. Peatlands have grown to hold 612 billion metric tons of carbon.[92] The peat that formed over the last 15,000 years has not been buried deeply enough or for long enough to have become fossilized into coal, it simply remains peat.

[91] **Key World Energy Statistics 2021 (Data for 2019)** – International Energy Agency – September 2021

[92] **Global peatland dynamics since the Last Glacial Maximum** – Zicheng Yu, Julie Loisel, Daniel P. Brosseau, David W. Beilman, Stephanie J. Hunt – Geophysical Research Letters – 9 July 2010

Currently, the carbon being captured per year by peatlands equates to the equivalent of 370 million metric tons of carbon dioxide.[93] That figure equates to an offset of about 1.1% of the carbon dioxide emitted by global human energy use.[94] Peatlands are the largest terrestrial store of carbon.

Peatlands are completely at odds with our conception of nature being balanced and cyclical. The rich organic matter consumed by peat is simply lost in the Earth – gone.

Coal, CO_2, CO_2 Fertilization and the Climate

To understand the coal that enabled the Industrial Revolution, we must go back in time to when it was formed. The bulk of the coal driving the Industrial Revolution is derived from peat that was deposited during the Carboniferous Period (359–299 million years ago).[95]

During the beginning of the Carboniferous Period, the climate globally was generally hotter, more humid and more tropical than our current climate.[96] Also at the beginning of the Carboniferous Period, carbon dioxide made up more than 0.1% of the atmosphere, which is more than twice the current concentration of carbon dioxide in our atmosphere.[97]

The formation of coal reduced the amount of carbon dioxide in the atmosphere over the course of the Carboniferous Period.[98] This is because during the Carboniferous Period large amounts of peat accumulated on Earth, which had the effect of capturing carbon and burying it – much like the formation of peat today. The peat that

[93] **Peatlands and climate change** – International Union for the Conservation of Nature – November 2017
[94] **Global CO2 emissions in 2019** – International Energy Agency – 11 February 2020
[95] **Formation of most of our coal brought Earth close to global glaciation** – Georg Feulner – Proceedings of the National Academy of Sciences of the United States of America – September 2017
[96] **The Carboniferous Period** – University of California Museum of Palaeontology, Berkley – https://ucmp.berkeley.edu/ – Accessed: August 2020
[97] **CO2 as a primary driver of Phanerozoic climate** – Dana L. Royer, Robert A. Berner, Isabel P. Montañez, Neil J. Tabor, David J. Beerling – GSA Today – March 2004
[98] **CO2 as a primary driver of Phanerozoic climate** – Dana L. Royer, Robert A. Berner, Isabel P. Montañez, Neil J. Tabor, David J. Beerling – GSA Today – March 2004

accumulated during the Carboniferous Period was transformed into coal through natural geological processes.[99]

By the end of the Carboniferous Period, the amount of carbon dioxide in the atmosphere had declined by ten times and made up as little as 0.01% of the atmosphere.[100] Carbon dioxide, like sunshine and water, is essential for plant growth. Due to carbon dioxide starvation at the end of the Carboniferous Period, the Earth became barren of plants and all forms of life that depend on plants – all terrestrial life – at the end of the Carboniferous Period. To be clear on this essential point, the end of the Carboniferous Period represents the low-point of life on Earth over the last 300 million years.[101] Without dark green plants and forests to absorb thermal radiation from the sun and without the enormous quantities of water vapor emitted by plants, not surprisingly, the climate too was affected by the Earth becoming barren of vegetation.[102]

Before the Industrial Revolution, carbon dioxide made up 0.028% of the atmosphere.[103] Burning coal has contributed materially to rising levels of carbon dioxide. As a result, currently, carbon dioxide makes up 0.0419% of the atmosphere.[104]

Burning coal is reversing the effects of the formation of coal during the Carboniferous Period by releasing carbon dioxide back into the atmosphere. As a result, life on our Earth in becoming more abundant

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[99] **Coal –** National Geographic – https://www.nationalgeographic.org – Accessed: February 2021

[100] **Formation of most of our coal brought Earth close to global glaciation** – Georg Feulner – Proceedings of the National Academy of Sciences of the United States of America – September 2017

[101] **Climate, pCO2 and terrestrial carbon cycle linkages during late Palaeozoic glacial–interglacial cycles** – Isabel P. Montañez, Jennifer C. McElwain, Christopher J. Poulsen, Joseph D. White, William A. DiMichele, Jonathan P. Wilson, Galen Griggs and Michael T. Hren – Nature Geoscience – 24 October 2016
Formation of most of our coal brought Earth close to global glaciation – Georg Feulner – Proceedings of the National Academy of Sciences of the United States of America – September 2017

[102] **Formation of most of our coal brought Earth close to global glaciation** – Georg Feulner – Proceedings of the National Academy of Sciences of the United States of America – September 2017

[103] **The Atmosphere: Getting a Handle on Carbon Dioxide** – Alan Buis – NASA – https://climate.nasa.gov – Accessed: February 2023

[104] **Monthly Average Mauna Loa CO_2** – US National Oceanographic and Atmospheric Administration – https://www.esrl.noaa.gov – Accessed: March 2021

due to the fertilization effect of carbon dioxide. Our Earth is becoming significantly greener and more vegetated due to the increase in carbon dioxide emissions according to the best satellite data available, which is provided by NASA's Terra satellite.[105]

By reversing the effects of the geological formation of coal, burning coal and increasing the amount of carbon dioxide in the atmosphere is making our world less like the dead Earth, which had been starved of carbon dioxide, that existed at the end of the Carboniferous Period and more like the Earth abounding with life that existed at the beginning of the Carboniferous Period, when carbon dioxide was abundant in the atmosphere.

Coal, the Driving Force of the Industrial Revolution

Refocusing our attention on the history of coal, before 1698, energy was not used to make things move, but rather for cooking, warmth, light and to make materials. However, in that year, Thomas Savery of England invented a steam-driven water pump that was heated by the combustion of burning coal. That system was used initially to pump out water from coal mines. This is perhaps the best historical example of how the subsequent developments of a technological breakthrough are impossible to predict. Every machine that is moved by energy has its technological origins firmly rooted in Thomas Savery's coal fueled steam-driven water pump.

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[105] **Carbon Dioxide Fertilization Greening Earth, Study Finds** – NASA – https://www.nasa.gov – Accessed: March 2021;
Greening of the Earth and its Drivers – Zaichun Zhu and 31 additional authors – Nature Climate Change – 25 April 2016;
China and India Lead the Way in Greening – Abby Tabor – NASA Earth Observatory – https://earthobservatory.nasa.gov – Accessed: March 2021;
China and India lead in greening of the world through land-use management – Chi Chen, Taejin Park, Xuhui Wang, Shilong Piao, Baodong Xu, Rajiv K. Chaturvedi, Richard Fuchs, Victor Brovkin, Philippe Ciais, Rasmus Fensholt, Hans Tømmervik, Govindasamy Bala, Zaichun Zhu, Ramakrishna R. Nemani & Ranga B. Myneni – Nature Sustainability – 11 February 2019; and
Global land change from 1982 to 2016 – Xiao-Peng Song, Matthew C. Hansen, Stephen V. Stehman, Peter V. Potapov, Alexandra Tyukavina, Eric F. Vermote & John R. Townshend – Nature – 8 August 2018

In 1765, James Watt, a Scottish inventor, significantly improved the steam engine design. Importantly, he developed a system of gears that was able to transform reciprocating (up-down) motion into rotational motion – the Industrial Revolution, fueled by the combustion of burning coal, was gathering steam.

Industrial expansion was, however, limited by the availability of steel until two key developments occurred. Firstly, steel production was limited by the availability of wood (charcoal) until methods were developed to turn coal into coke. The heat and carbon monoxide produced by burning coke makes it a substitute for charcoal for the production of iron and steel. The process of turning coal into coke is comparable to the process of turning wood into charcoal; specifically, heating and burning specific types of coal in an oxygen deprived environment produces coke. Coal, unlike wood, is in practical terms an unlimited resource. Secondly, in 1856, Henry Bessemer invented the modern blast furnace to make steel. His process both increased the potential volumes of high-quality steel production and significantly reduced the cost of steel. The heat for blast furnaces was provided by coal and coke – the Industrial Revolution was now full steam ahead.

It is important to recognize that the current phase of human development in which we are living is the Industrial Revolution and that that revolution was spawned by mass-produced steel produced with coal and by energy released from burning coal that made machinery move.

Coal in Context

Coal was king. It provided the propulsive force to initiate the Industrial Revolution; however, eventually, coal lost it place to oil as the world's premium fuel. Nevertheless, as a reliable, practical, affordable fuel it has held onto very significant market share. It remains the essential enabler of iron and steel production.

According to Daniel Yergin, a renowned expert on the history of energy, the symbolic moment that dethroned coal as a premium fuel occurred when Winston Churchill, appointed First Lord of the Admiralty prior to the First World War, decided that the strength of the United Kingdom's Royal Navy would increase if its ships were fueled by oil rather than coal. Although switching from coal to oil meant that that navy would be dependent entirely on distant, foreign

oil, the change was considered to be worth it because the practical advantages of oil were simply that much greater.[106]

Focusing on the present, selected coal consumption data is provided in Table 4.

Coal Consumption (Mt) ***Table 4***

	1990		2006		2022	
China	709	23%	2,565	40%	4,250	53%
India	132	4%	493	8%	1,103	14%
USA	666	21%	1,017	16%	465	6%
EU	625	20%	750	12%	478	6%
Other	986	32%	1,555	24%	1,729	22%
Global	**3,118**	**100%**	**6,380**	**100%**	**8,025**	**100%**

Source: International Energy Agency[107]

Despite the overwhelmingly positive contribution coal makes to human prosperity, coal is often characterized negatively and as a form of energy that is in decline.

In contradiction to that narrative, global coal demand has been incredibly resilient, reaching a new record high in 2022.[108]

Coal provides 36.4% of global electrical energy (natural gas provides 23.3%; wind and solar combined provide 7.9%).[109] Coal, like natural, gas is an inherently reliable form of energy, unlike wind power and solar power, which operate only when the weather conditions are right.

Historically, natural gas has represented the most serious threat to coal's market share. Natural gas is a threat to coal for the purposes of

[106] **The Prize** – Daniel Yergin – Simon & Schuster – 1991

[107] **Coal Information: Overview (1990 data)** – International Energy Agency – Statistics Report July 2020;
Global coal consumption by region (2006 data) – International Energy Agency – https://www.iea.org – accessed: February 2023;
Coal 2022 (2022 data) – International Energy Agency – December 2022

[108] **The world's coal consumption is set to reach a new high in 2022 as the energy crisis shakes markets** – International Energy Agency – 16 December 2022

[109] **Key World Energy Statistics 2021 (Data for 2019)** – International Energy Agency – September 2021

generating electricity and for the generation of heat for industrial purposes.

Coal is Driving the EV Revolution in China

China is at the epicenter of the electric vehicle revolution.

For reference, coal provided 66.5% of China's electrical energy in 2022.[110] For the avoidance of doubt, the energy that charges electric vehicles in China, and elsewhere, is sourced from coal. Remember, electricity is not a source of energy, only a means of transmitting energy.

The Anti-Coal Agenda of the IEA, UN and World Bank

Fatih Birol, the Executive Director of the International Energy Agency was reappointed by Jennifer Granholm, the Secretary of the US Department of Energy, with the support of Europe's largest countries, according the voting structure for that organization's Governing Board.[111] According to the official press release associated with that appointment Jennifer Granholm stated: "Our decision today for an additional term for Dr Birol as IEA Executive Director again confirms our confidence in his skills and expertise. We look forward to working with the IEA under his continued leadership as we ramp up efforts to accelerate the clean *energy transition* on the road to a *net zero* future."[112]

Although founded to serve as an institution to promote energy security and global prosperity, Jennifer Granholm, explicitly mandated the International Energy Agency to promote the Energy Transition and the Net Zero movement in accordance with the explicitly anti-fossil fuel agenda of US President Joe Biden. For reference, President Biden, stated that his underlying goal was to "end fossil fuels"[113] and

[110] **Statistical Communique of the People's Republic of China on the 2022 National Economic and Social Development** – National Bureau of Statistics of China – 28 February 2023
[111] **IEA decision-making and governing body** – https://www.iea.org – Accessed: February 2023
[112] **IEA reappoints Fatih Birol for new term as Executive Director** – International Energy Agency – 25 March 2022
[113] **In intimate moment, Biden vows to 'end fossil fuel'** – Steve Peoples – AP News – 6 September 2019

that that he intended to shut-down all coal plants in favor of solar power and wind power.[114] To be clear on the importance of this agenda, Biden stated: "Climate change is the existential threat to humanity" and adding that in terms of priorities "it's the number one issue facing humanity and it's the number one issue for me."[115]

It is critical to appreciate the importance of the International Energy Agency's analysis as content for global media and public relations networks.

As a singular example, The Financial Times ran a headline "Solar power expected to surpass coal in 5 years, IEA says", subtitled with "Renewable energy forecast to become largest source of electricity generation as soon as 2025."[116] There is a 0% chance of that occurring, but the public is incited to believe that it will because the headline is sourced to the International Energy Agency.

The International Energy Agency is one of several international agencies that works in concert to promote green energy.

The International Renewable Energy Agency is a trade organization that was established in 2009 with the explicit mission to "promote the widespread and increased adoption and use of renewable energy."[117] It regularly undertakes studies that suggest: "Renewables are by far the cheapest form of power today."[118] The International Energy Agency corroborates that analysis with regular statements that get widely disseminated in the media such as "solar is the new king" replacing king coal, because solar produces the "lowest cost electricity in history."[119] Not only does the conventional media pick up on this,

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[114] **Coal miners slam Biden as White House walks back 'shut down' pledge: 'Trying to destroy the country'** – Thomas Catenacci – Fox Business – 10 November 2022

[115] **Joe Biden calls climate change the 'number one issue facing humanity'** – Emma Newburger – CNBC – 24 October 2020

[116] **Solar power expected to surpass coal in 5 years, IEA says** – Camilla Hodgson and Steven Bernard – Financial Times – 10 December 2022

[117] **Statute of the International Renewable Energy Agency** – International Renewable Energy Agency – https://www.irena.org – Accessed February 2023

[118] **Renewable Power Remains Cost-Competitive amid Fossil Fuel Crisis** – citing Francesco La Camera, Director-General of IRENA – International Renewable Energy Agency – 13 July 2022

[119] **Solar is now 'cheapest electricity in history', confirms IEA** – Carbon Brief – Simon Evans – 13 October 2020

The World Energy Outlook 2020 – International Energy Agency – October 2020

it is also systematically relayed and endorsed by the United Nations, with headlines such as: "Renewables: Cheapest form of power" referencing the work of the organization established to promote renewable energy, namely, the International Renewable Energy Agency.[120] That endorsement will in turn provide the World Bank, the sister organization of the United Nations, with a justification to make lending money to impoverished developing countries conditional on those countries investing in wind power and solar power and renouncing investments in fossil fuels.

Making access to credit conditional on shutting in fossil fuels and investing in green energy projects would seem sensible in a context where powerful governments and international bodies have broadly mediatized the superiority of green energy relative to fossil fuels; however, it also creates risks if their analysis is not well founded.

Let us look at a specific example to see how this works in practice.

The World Bank approved loans amounting to $497 million to South Africa, with the availability of the funds made conditional on the decommissioning of a coal mine (the Komati mine) and repurposing of that mine for renewables.[121] South Africa, is a country with essentially unlimited coal reserves, yet it was forced to dismantle much of its coal energy infrastructure rather than being encouraged to maintain and develop its coal energy infrastructure. As a result, without coal to provide reliable electricity, South Africans are suffering large-scale and systematic power outages. The headlines speak for themselves: "South Africa declares national state of disaster over blackouts."[122] The President of South Africa stated that the power outages are "an existential threat to our economy and our social fabric."[123]

[120] **Renewables: Cheapest form of power** – United Nations – https://www.un.org – Accessed: February 2023

[121] **World Bank Approves $497 Million in Financing to Lower South Africa's Greenhouse Gas Emissions and Support a Just Transition** – The World Bank – 4 November 2022

[122] **South Africa declares 'national state of disaster' over blackout** – Josepth Cotterill – Financial Times – 9 February 2023

[123] **South Africa declares 'national state of disaster' over blackout** – Josepth Cotterill – Financial Times – 9 February 2023

Let us take a closer look at a small microcosm of South Africa, its health care sector, to appreciate the human impact of the anti-fossil fuel agenda emanating from the West.

Dr. Nicholas Brink is a community service doctor who over a difficult conversation on the effects of blackouts spoke of many examples such as the experience of trying to treat a woman who had suffered a miscarriage: "We had to just keep her there and watch her bleed. Without a light source, power for a small suction machine and basic sterilized equipment, we were running out of options." Sadly for the patient "for her, just waiting for the power to come back wasn't an option."[124]

Again, ignoring most of the uses of electricity and focusing only on the health effects of electricity blackouts in South Africa, the main impacts have been:[125]

- Pumps cannot pump water so there is no water;
- There is no light;
- Irregular electrical surges are breaking health care equipment;
- Power cuts affect the refrigeration of food;
- No access to clean water increases the affliction of infectious gastroenteritis on vulnerable populations, with diarrhea being a leading cause of death in children under five;
- Oxygen machines and continuous positive airway pressure machines stop working;
- Insulin, a drug required to manage diabetes, losses its efficacy when unrefrigerated;
- Access to cellphone signals is lost;
- People cannot call ambulances;
- Doctors and medical practitioners cannot access the internet for critical information;
- Neonatal care is hit particularly hard because vulnerable babies need machines to be kept warm and often require continuous

[124] **Rolling blackout and the daily horror story faced by healthcare workers** – Mark Heywood – Daily Maverick – 22 January 2023

[125] **Rolling blackout and the daily horror story faced by healthcare workers** – Mark Heywood – Daily Maverick – 22 January 2023;
Blackouts in South Africa put pressure on healthcare – 3 February 2023 – Africanews – https://www.africanews.com – Accessed February 2023;
In-depth: What South Africa's power cuts mean for health facilities – Tiyese Jeranji – News24 – https://www.news24.com – Accessed February 2023

positive airway pressure machines. Within neonatal care, according to Dr. Brink "we can certainly attribute some deaths" to power outages.[126]

- Pharmacies lose medication that requires refrigeration; and
- Products on dispensary shelves are subjected to deterioration from extreme heat in the absence of air conditioning.

Bloomberg published an article entitled "How 60 Million South Africans Are Being Failed by the West's Green Ambitions" that revealed what is going on behind the scenes. It explained that when Robert Habeck, Germany's Vice Chancellor and Minister for Financial Affairs and Climate Action, visited South Africa, he was told by Gwede Mantashe, a coal-supporting Minister of Mineral Resources and Energy, that South Africans didn't want to be the West's guinea pig for the global Energy Transition. In response, according to people familiar with the conversation, Habeck threatened to withdraw the West's funding of the country.[127]

In contradiction to the anti-coal agenda imposed on South Africa, when Europe suffered its own energy crisis, that continent turned to coal.[128] Moreover, the rest of the world has also broadly turned to coal to achieve its economic and social goals, inclusive of improving healthcare: As we have seen, global coal demand reached a record high in 2022.[129]

Back to Bricks

A philanthropic organization pledged $500 million to promote the shutting in of "every last" coal plant in the US and has since expanded its "war on coal" to developing countries.[130] However well-meaning

[126] **Rolling blackout and the daily horror story faced by healthcare workers** – Mark Heywood – Daily Maverick – 22 January 2023
[127] **How 60 Million South Africans Are Being Failed by the West's Green Ambitions** – Antony Sguazzin and Paul Burkhardt – Bloomberg – 25 April 2023
[128] **U.K. Government Approves First Coal Mine In 30 Years In Cumbria** – Heather Farmbrough – Forbes – 9 December 2022
Germany turns to coal for a third of its electricity – Valentina Romei and Martin Arnold – Financial Times – 7 September 2022
[129] **The world's coal consumption is set to reach a new high in 2022 as the energy crisis shakes markets** – International Energy Agency – 16 December 2022
[130] **Michael Bloomberg pumps $500 million into bid to close all US coal plants** – Valerie Volcovici – Reuters – 20 September 2023;

that philanthropic campaign might be, the danger created by denying coal to developing countries is evidenced by assessing the case of Morocco, where coal has not been widely available.

Morocco is presented as one the great success stories of the Energy Transition because it has borrowed significantly from the World Bank to reduce its coal consumption and increase its solar power.[131]

As we have learned, heat is a prerequisite to fire bricks – heat is capable of transforming mud bricks into strong ceramic bricks. Intermittent solar power is not suitable to the generation of the high-intensity heat required to fire bricks. Without access to affordable coal, Moroccans have been unable to fire their bricks. In a Reuters article entitled "Buried Under Bricks" there is an in-depth analysis of how the use of mud bricks contributed significantly to the human devastation resulting from the 2023 earthquake that hit Morrocco – an earthquake that leveled urban areas into the dust of mud bricks.[132] That earthquake combined with the use of mud bricks killed at least 2,946 Moroccans.[133]

Each of the skylines of the greatest cities of our modern era is attributable to coal, which provided the materials to construct those skylines. As shown by the case of Morocco, denying developing

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Michael Bloomberg's 'war on coal' goes global with $50m fund – Damian Carrington – The Guardian – 9 November 2017; and
Bloomberg Philanthropies Intensifies Global Effort to Turbocharge Clean Energy Transition in 10 Developing Countries – Bloomberg Philanthropies – 17 May 2022

[131] **World Bank Approves Additional Financing for Morocco to Develop a Second Solar Power Complex** – The World Bank – 11 June 2018;
New bond issue set to help Africa go 'green', A way of bankrolling a clean energy revolution – Jocelyne Sambira – Africa Renewal Magazine; the United Nations – August 2015;
International Energy Agency publishes new review of Morocco's energy policies – International Energy Agency – 7 May 2019;
Breaking Down Barriers to Clean Energy Transition – The World Bank – 16 May 2023; and
Lessons from Power Sector Reform, The Case of Morocco – Zainab Usman and Tayeb Amegroud – The World Bank – August 2019

[132] **Buried under the bricks, How mud-brick housing made the Morocco earthquake so deadly** – Mariano Zafra, Aditi Bhandari, Dea Bankova, Adolfo Arranz and Prasanta Kumar Dutta – Reuters – 15 September 2023

[133] **Buried under the bricks, How mud-brick housing made the Morocco earthquake so deadly** – Mariano Zafra, Aditi Bhandari, Dea Bankova, Adolfo Arranz and Prasanta Kumar Dutta – Reuters – 15 September 2023

countries the coal they need to manufacture the materials required to manufacture solid constructions is unhelpful for the development of those countries.

Coal in Summary

Coal provides a staggering 26.8% of global energy in the form of reliable, affordable intense heat.[134] Coal does not just provide energy, it provides the means of creating bricks, steel, cement and of growing affordable food. For that reason, global demand for coal reached a record high in 2022.[135]

Although it has become fashionable to denigrate coal, we often overlook coal's unique advantages, its affordability, the scale with which it can be provided and the overwhelmingly positive contribution it makes to our way of life.

Oil: Valued for What It Is Able to Accomplish

Oil, Fueling the Modern World

Oil provides 30.9% of our global needs in energy.[136] Oil has displaced coal as the king of energy.

Oil is used principally for premium purposes and not, in general, for the generation of generic, low-value electricity – it is too valuable for that. This is because oil's qualities, including its high energy density, make it possible for oil to do things that no other fuel or form of energy can do.

The Geological Origins of Oil

Oil is formed similarly to coal, with some important differences. A considerable amount of the oil we use was deposited as organic plant matter within mud at the bottom of ancient seas and oceans. This mud

[134] **Key World Energy Statistics 2021** - International Energy Agency - September 2021
[135] **Global coal demand set to remain at record levels in 2023 – International Energy Agency** – 27 July 2023
[136] **Key World Energy Statistics 2021 (Data for 2019)** – International Energy Agency – September 2021

turns into rock, specifically shale, when it is buried to a sufficient depth by the accumulation of overlying sediments. If organic-rich shale is buried to within certain depths for a long enough period of time, the organic plant matter within shale transforms into oil. The genesis of oil is an expansive process. It creates pressure as the volume of oil in the shale is increased. Ultimately, oil gets expulsed from shale as a liquid, perhaps several kilometers (miles) under the surface of the Earth. In this respect oil is nothing like coal, which does not move and remains a solid rock. Once expulsed from shale, oil tends to rise upwards. This is because within sedimentary rock, where oil originates, water typically fills the spaces between rock grains. Oil is lighter than water and its buoyancy pushes it to the surface of the Earth. Occasionally, oil's upward rise is blocked by a layer of impermeable rock. A highly porous sedimentary layer of sandstone shaped like a dome over which impermeable rock is draped would be perfect for catching oil trying to rise to the surface of the Earth. Such a geological setting would be representative of many of the world's largest oil discoveries.[137]

Oil wells, which consist mainly of steel tubes, produce oil that has been trapped in the subsurface. Oil wells are drilled from the surface and they penetrate into the porous rocks where oil is trapped. Oil flows from porous rocks into the steel tubing of oil wells and from there up to the surface.

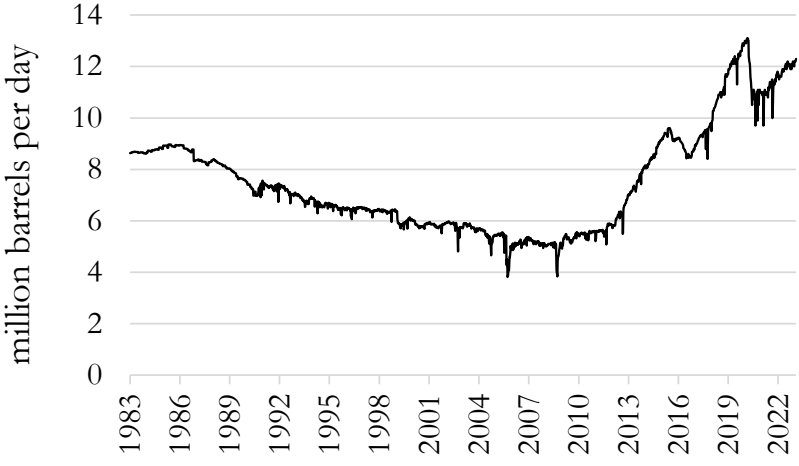
Powering the US Out of the Financial Crisis

Traditionally, oil has been produced from permeable reservoirs consisting of sedimentary rock that has sufficiently large pore spaces between the rock grains to allow the oil to flow through it. Recent technological developments in the US have made it possible to produce oil and gas from relatively impermeable oil and gas reservoirs; specifically, in recent decades technological breakthroughs have made it possible to i) drill the bottom of wells horizontally, which allows the wells to penetrate more of the oil and gas bearing reservoirs, and ii) fracture, or frack, the reservoirs through the injection of fluid into the reservoir at high pressures and flow rates, which creates spaces through which oil and gas can flow to the well.

[137] **Elements of Petroleum Geology** – Richard C. Selley and Stephen A. Sonnenberg – Elsevier – 2014

This technology was first applied to natural gas, which greatly increased its supply, lowered its price and supported the enormous gains in market share of that form of energy. The US oil & gas industry turned its attention to fracking for oil around 2008. In doing so, US oil production reversed its declines and grew at an extraordinary pace from that period forwards (Figure 3).

US Crude Oil Production ***Figure 3***



Source: US Energy Information Administration[138]

As a result, the US received the equivalent of a massive daily cash injection from not having to expend hundreds of millions of dollars every day on oil imports. Those daily cash injections provided the US economy with the firepower to recover after it had been knocked out cold by the financial crisis of 2008. Although the period from 2008 to present has been widely perceived to be a tech-boom period, the US oil & gas industry, and fracking in particular, contributed significantly to the provision of cash to make that tech-boom possible.

Conceptually, Oil is Liquified Wood

Oil is also called petroleum, which is derived from the Latin words "petra" for rock and "oleum" for oil. Gasoline, jet fuel and diesel are oil-derived fuels. Those fuels are burned in internal combustion

[138] **Weekly U.S. Field Production of Crude Oil** – US Energy Information Administration – https://www.eia.gov – Accessed: February 2023

engines. Heat from burning oil is the driving force of internal combustion engines.

Oil is a gift of mother nature, which has found a way of transforming the energy in sunlight into a liquid fuel. Oil conceptually is liquid wood with a very high energy content relative to its volume and weight. Our use of oil simply represents the most modern incarnation of our prehistoric use of fire – combustion. As a reminder combustion is a chemical process that releases heat, to which we can attribute our creation, our survival and the entirety of our material progress as a species.

Switching the fuels that we have used for combustion, firstly from wood to coal and then from coal to oil necessarily had the effect of catapulting humanity into our modern age of prosperity and personal freedom.

In the 1840s, the UK was the wealthiest and most powerful country in the world and the average life expectancy of the British at that time was 41 years.[139] Today, the average global life expectancy, including developing countries, is 73 years – an astounding difference.[140] Oil, building on the gains made by coal, has underpinned that rise in life expectancy. By every metric, whether one looks at education, health, prosperity or travel, humanity has been catapulted out of a relatively hard, brutish existence into its modern age by oil, building on the gains made by coal. Oil, and coal, have provided the energy to unleash the full potential of humanity.

In 2023, to sustain our standard of living, inclusive of the provision of our food, required the consumption of 5 barrels of oil, on average, for each person alive.[141] Apart from its greater practical utility, oil is differentiated from wood by its potential to provide energy on a significantly greater scale.

The Constituents of Oil

We need oil. So what is it?

[139] **Do we really live longer than our ancestors?** – Amanda Ruggeri – BBC – 3 October 2018
[140] **Life Expectancy (data for 2019)** – World Health Organisation – https://www.who.int – Accessed February 2023
[141] **OPEC Monthly Oil Market Report** – November 2023

Oil, or petroleum, in its natural state is actually a blend of countless different types of molecules, just like wood is made up of an abundance of different molecules. Petroleum has the great advantage of being a liquid and it is sorted into its various usable products according to their ranges of evaporation temperatures. This is achieved through a process called fractional distillation. For example, jet fuel evaporates between 177-232°C (350-450°F). Diesel evaporates at a higher range of 232-343°C (450-650°F) and gasoline evaporates at a lower range 29-85°C (85-185°F).[142] There are many other products produced by oil and the ranges may change depending on the market in which the products are sold.

Oil Provides Synthetic Materials and Reduces Demands on Nature

In addition to producing energy, oil provides the feedstock chemicals required to produce many synthetic materials, inclusive of synthetic fibers. Professional athletes are typically seen head-to-toe in clothes that are made in materials derived from oil. Athletes choose synthetic materials because they are more comfortable, lighter, more breathable, quicker to dry and generally higher performing materials than cotton, the most abundant of farm-produced fibers. Using synthetic oil-derived fibers instead of farmed fibers such as cotton reduces pressure on land use, essentially allowing more land for wildlife habitat. We are not talking about small-scale theoretical land use: Globally, a surface area of 324 thousand square kilometers (125 thousand square miles) is used to grow cotton.[143] That equates to 47% of the surface area of the state of Texas, USA. That is a tremendous land area taken from wilderness to farm cotton. Synthetic oil-derived fibers currently have a market share of 62% of the fiber market.[144] Other things being equal, as synthetic fibers gain market share, more land is made available for wilderness.

Oil-derived products are ubiquitous, from surfboards and the components of mobile phones to products that are less obviously linked to oil, such as paints and water pipes. Plastics derived from oil

[142] **Crude oil distillation and the definition of refinery capacity** – US Energy Information Administration –https://www.eia.gov – Accessed: February 2023

[143] **Measuring Sustainability in Cotton Farming Systems** – Food and Agricultural Organization of the UnitedIn Nations – 2015

[144] **Preferred Fiber & Materials Market Report 2019** – Sophia Opperskalski, SuetYin Siew, Evonne Tan, Liesl Truscott – Textile Exchange – https://textileexchange.org/ – Accessed: August 2020

are inexpensive, light and durable. It would simply be impossible to imagine our lives without them, there is no obvious replacement for the synthetic materials produced by oil.

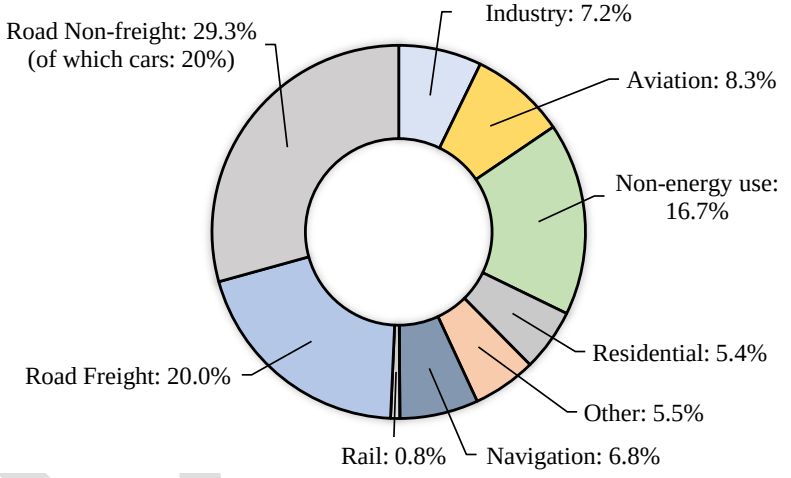
Oil reduces the need to destroy wildlife habitat by providing synthetic materials that reduce the amount of land taken from wilderness to supply materials.

As seen in Figure 4, approximately one-sixth of each barrel of oil produced is not used for energy, but rather for feedstock to produce synthetic materials.

The Uses of Oil – Mobility to the People

Although oil is used to make materials, its primary use is to make things move. Cars, trains, planes, farm equipment and boats are all powered by products derived by oil (Figure 4).

Uses of Crude Oil ***Figure 4***



Sources: International Energy Agency and BP[145]

In 1885, Carl Benz, a German engineer and entrepreneur, was the first person to develop and market a working automobile powered by the

[145] **IEA World Energy Balances 2020** – International Energy Agency – July 2020;
IEA study unveils key role for trucks in global oil-demand growth – International Energy Agency – 3 July 2017; and
Back to the future: electric vehicles and oil demand – Spencer Dale and Thomas D. Smith – BP – 2016

internal combustion engine – driven by the heat of burning oil. As a reminder, combustion is simply another word for fire.

Although the automobile was invented in Germany, the automobile age was invented in the US: It was the Model T automobile developed by Henry Ford that created the modern age of mobility. The Model T "put the world on wheels" by making cars affordable to the general public. It was first produced in 1908. The Model T is the quintessential symbol of energy's ability to promote personal freedom.

The affordability of automobiles and the oil used to fuel them is their essential characteristic. Automobiles are for the benefit of everyone. Automobiles provide normal people with extraordinary personal freedoms. In 2019, more than a century after the introduction of the Model T, Ford produced the top selling vehicles in both the United States and the United Kingdom, which were, respectively, the F-150 truck and the Ford Fiesta.[146] The point is to appreciate that the ethos of Henry Ford, that automobiles are for the benefit of everyone, not just the elite, has survived to this day.

The Implications of EVs on Western Car Manufacturers

Focusing on the present, electric vehicles are a threat to oil's market share for road travel.

President Biden is openly committed to the policy goal of forcing the market share of electric vehicles in the US to 50% by 2030 – using regulations (and subsidies) to promote electric vehicles and punitive regulations to make internal combustion engines less competitive.[147] The European Union has mandated a 100% market share to electric vehicles by banning internal combustion by 2035.[148]

[146] **25 Best-Selling Cars, Trucks, and SUVs of 2019** – Joey Capparella – Car and Driver – 6 June 2020; and
Best Selling Cars in the UK – Tristan Shale-Hester – AutoExpress – 5 February 2020
[147] **Biden proposes toughest auto emissions rules yet to dramatically boost EV sales** – Emma Newburger – CNBC – 12 April 2023
[148] **EU ban on the sale of new petrol and diesel cars from 2035 explained** – News European Parliament – 13 February 2022

Electric batteries represent the hearts of electric vehicles and represent 40% of the costs of an electric vehicle;[149] however, there is not a single US or European company amongst the world's top-10 electric vehicle battery manufacturers.[150] Western auto makers may be able to put their brands on electric vehicles, but they have no competitive standing in the sector.

It is noteworthy that intense competition and private initiatives have resulted in the West dominating internal combustion engine technology. In contrast, Western governments have championed green energy through supportive policy measures, regulations and subsidies; notably, the West is uncompetitive on the global stage in the respect of electric vehicles, electric batteries, wind power and solar power.

It is noteworthy that the only Western company that has any global competitive presence in electrical vehicles is Tesla, and it is telling that Elon Musk, the founder of Tesla, is intensely focused on product development and openly against governments deciding who wins and who losses. Elon Musk commented in relation to President Biden's bill to provide $7,500 of tax credits for each electrical vehicle purchase: "Honestly, I would just can this whole bill, don't pass it" stating that government should "get rid of all subsidies."[151] He explained that in his view, governments should act as impartial referee's serving the public interest.[152]

For reference, to get a scale of the degree to which China dominates electric batteries and therefore electric cars, China based Cotemporary Amperex Technology Co. Limited, or CATL, alone manufactures more than one third of the batteries installed in electric vehicles globally.[153]

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[149] **How did China come to dominate the world of electric cars?** – Yezi Yang – MIT Technology Review – 21 February 2023

[150] **The Top 10 EV Battery Manufacturers in 2022** – Bruno Venditti – Visual Capital – https://www.visualcapitalist.com – Accessed: April 2023

[151] **Elon Musk on Biden's infrastructure plan: 'just can this whole bill'** – Joseph Guzman – thehill.com – 7 December 2021

[152] **Tesla as the World's Biggest Robot Company:' Elon Musk on AI and U.S. Innovation** – You Tube – Wall Street Journal CEO Council, Washington DC, USA – December 2022

[153] **One third of the world's EV batteries come from CATL** – Chris Randall – electrive – 8 August 2022

China based Build Your Dreams Auto Co, or BYD, is manufacturing electric vehicle that sell for $10,000 – a fraction of the price of an electric vehicle of comparable quality built in the West.[154]

In association with the West's ambitions to displace conventional vehicles with electric vehicles, it is noteworthy that the two most indebted companies in the world are Toyota and Volkswagen, which companies have very embedded strengths in respect of internal combustion engines, which support their credit worthiness.[155] The point is that there is no guarantee that that strength will translate into competitive leadership in the electric vehicle market. A deterioration in the creditworthiness of either Toyota or Volkswagen would have profoundly detrimental financial consequences that would be felt around the world and particularly in the West.

Implications of EVs on Demand for Oil, Natural Gas and Coal

More than half of all electric vehicle sold globally are sold in the Chinese market[156] and 66.5% of China's electricity is derived from coal.[157] It is a mistake to dissociate the success of the growth in electric vehicle use in China from the affordability, reliability and scale of the electrical energy sourced from coal in China.

We will look at the sources of electricity in detail later (Table 7) for the USA, the EU, China and globally. The key point to retain is that electric vehicles can be expected to be adopted in markets where electricity can be supplied reliably, in large-scale at a price that is significantly less expensive per unit of energy than oil. From that perspective, coal and natural gas for the purpose of generating electricity to charge electric vehicles represent a threat to the market share of oil.

[154] **A Chinese Company is Releasing an Ultra-Cheap EV that costs less than almost any new car in America** – Jeremiah Budin – thecooldown.com – 31 July 2023

[155] **Toyota is the most indebted company in the world** – Elenor Kling – LatestCarNews – 8 January 2023

[156] **China Has Shot at Seizing 60% Share of Global EV Sales This Year** – Colin McKerracher – Bloomberg – 15 November 2022

[157] **China's Power Use Up 3.6% in 2022** – China Power Use The State Council of Information Office The People's Republic of China – 25 January 2023

Nevertheless, taking a step backwards can serve to gain some perspective on the extent to which demand for oil might evolve in a context of the growing use of electric vehicles.

Based on the economic analysis of BP, a reasonable rule of thumb premised on current global demographics and global economic growth is that the fleet of cars on the road will double about every 20 years.[158] So even as electric vehicles gain market share demand for oil from cars might increase over the decades ahead.

Moreover, the observed loss in demand for oil from increasing the market share of electric vehicles is perplexingly inconsequential. Norway can serve as an example. That country, blessed with oil, is the one of the wealthiest countries on the planet on a per capita basis. With only 5.4 million inhabitants, the Norwegian government is paying $1.8 billion per annum to increase the market share of electric vehicles.[159] Due to subsidies and governmental regulations, Norway's electric vehicle sales grew from 3% of the market in 2012 to almost 80% of the market in 2022; however, that has not translated into a meaningful reduction in Norway's oil demand.[160] While electric vehicles sales have increased, diesel demand for long haul trucking, industry and farming have been resilient.[161] Norway today is consuming 34,000 barrels per day less than its peak all-time oil consumption, which represents a statistically meaningless reduction in oil demand – less than 0.04% of global oil demand.[162] Moreover, according to research on the very modest decline in Norwegian oil demand, most of that decline is attributable to efficiency gains, not to electric vehicle adoption.[163] So far, the correlation between electric vehicle adoption and reduced oil consumption appears to be paradoxically weak, even in a country where oil wealth has allowed electric vehicle subsidies that would not be possible in most countries.

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[158] **Back to the future: electric vehicles and oil demand** – Spencer Dale and Thomas D. Smith – BP – 2016

[159] **Oil is Hard to Quit, Even in Norway Where Electric Cars Rule the Road** – Kari Lundgren and Stephen Treloar – Bloomberg – 7 July 2003

[160] **Oil is Hard to Quit, Even in Norway Where Electric Cars Rule the Road** – Kari Lundgren and Stephen Treloar – Bloomberg – 7 July 2003

[161] **Oil is Hard to Quit, Even in Norway Where Electric Cars Rule the Road** – Kari Lundgren and Stephen Treloar – Bloomberg – 7 July 2003

[162] **Statistical Review of World Energy** – Energy Institute – 2023

[163] **Norway Oil Demand Resilient to EV Surge, For Now** – Ronan Kavanagh – Energy Intelligence – 19 January 2023

As the number of electric vehicles has increased in Norway, the substantive entirety of the work, particularly the heavy lifting, it seems, is still being done by oil.

Although it is perhaps early days to draw definitive conclusions, the evidence is mounting that electric vehicles are most suited for urban environments and small-runabout jobs, particularly when they are designed for that purpose with light batteries.[164] What is clear is that electric vehicles have not had a discernable impact on global oil demand because people, apparently, are not using electric vehicles for tasks that displace significant oil consumption. It has become apparent that simply increasing the number of electric vehicles on the road, will not, in itself, reduce demand for oil.

It is also a consideration that the manufacturing of electric vehicles is considerably more fossil fuel intensive than the manufacturing of conventional vehicles.[165]

For further perspective, cars consume approximately 6.2% of global energy and 20% of global oil demand.[166] Global demand for energy is growing at circa 2% per annum.[167] If, hypothetically, cars were not used at all, three years later we would be using the same amount of global energy based on the trajectory of growth in global energy demand.

For additional perspective, as we have seen, electrical batteries are not a source of energy, only a store of energy. The growth in electric vehicles is significantly increasing demand for coal and natural gas for the purposes of generating low-cost, reliable electricity. The growing demand for natural gas and coal to generate sufficient reliable electricity to charge electrical vehicles may significantly increase the prices of those forms of energy.

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[164] **Europe Needs Small, Cheap Electric Cars To Thwart China** – Neil Winton – Forbes – 18 September 2023

[165] **From the well to the wheel** – Volkswagen Group – https://www.volkswagenag.com – Accessed: May 2023

[166] **Back to the future: electric vehicles and oil demand** – Spencer Dale and Thomas D. Smith – BP – 2016; and
Key World Energy Statistics 2021 - International Energy Agency - September 2021

[167] **Key World Energy Statistics 2021 (date for 2019)** – International Energy Agency – September 2021

Oil is expensive relative to other forms of energy and therefore it is used almost exclusively in markets where only oil, for practical reasons, is capable of getting the job done. The price of oil, natural gas and coal in relative terms based on the energy content they contain is provided in Table 5. The low price of natural gas and coal, relative to oil, as seen in Table 5, have been the most significant drivers of oil's loss of market share in recent decades. In energy markets, price matters.

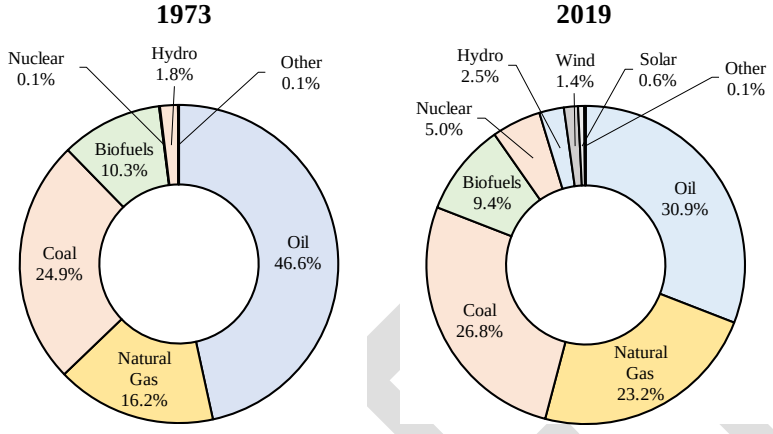
Average energy prices 2010-2020 ***Table 5***

	Price	Price per Barrel of Oil Equivalent	Price Relative to Price of Oil
Oil (Brent; $/barrel)	76.67	76.67	100%
Natural gas USA ($/mmbtu)	3.21	18.61	24%
Coal Rotterdam ($/metric ton)	82.87	20.20	26%

Source: Author, S&P Capital IQ

Technology has relentlessly enabled other forms of energy – cheaper forms of energy – to do the things that oil can do, which has slowly eroded the market share of oil, as seen in Figure 5. So intense competition, the loss of market share and rumors of its demise are business as usual for oil.

Market Share of Global Sources of Energy *Figure 5*



Source: International Energy Agency[168]

For reference, electric vehicles represent the latest technological development that exploits the low prices of coal and natural gas relative to oil.

Figure 5 shows the changes in the market share of the global sources of energy over the 46 years from 1973 to 2019. For reference, that represents an incredibly short period from the perspective of the history of human development, and yet over that short period the global demand for energy increased by 2.4 times, growing relentlessly at an average rate of 2% per year. As a result, even oil which has lost the most market share of all forms of energy continues to regularly break new record high levels of demand.

Oil in many respects has increased in competitiveness since 1973. The world today can achieve a lot more with a barrel of oil than it could back then. One can also appreciate that after almost half a century of losing market share to less expensive forms of energy, for the uses where oil has retained market share it has very significant competitive advantages.

If nothing else, an absolutely key point to retain is the rate of growth in global demand for energy. This is particularly critical for the West to appreciate because we do not see this from day to day. The

[168] **Key World Energy Statistics 2021 (date for 2019)** – International Energy Agency – September 2021

demographic and economic forces at play in developing countries are driving colossal and relentless additions to energy demand every year.

Perspectives on Oil Demand

Fatih Birol, the Executive Director of the International Energy (IEA), stated: "The shift to a clean energy economy is picking up pace, with a peak in global oil demand in sight before the end of this decade as electric vehicles, energy efficiency and other technologies advance."[169]

The International Energy Agency reported that "The amount of money allocated by governments to support clean energy investment since 2020 has risen to USD 1.34 trillion."[170] That agency also stated that to keep on track to achieve a successful Energy Transition, that figure must rise to $5 trillion by 2030.[171]

Essentially, the International Energy Agency is advocating that global wealth should be invested in green energy projects and not into ensuring future supplies of fossil fuel, on the basis that if sufficient investments are made in green energy, fossil fuels will not be required in the future.

Cornerstone Analytics, led by Mike Rothman, has been recognized for four decades as a provider of industry leading energy research. For decades, Rothman and the team at Cornerstone Analytics have tracked and forecasted global demand for oil. They have been advising their clients not to believe the International Energy Agency's oil demand forecasts on the grounds that they are politically motivated and agenda driven.[172] That is now being increasingly recognized and oil demand forecasts have increasingly become contentious.

In response to the International Energy Agency's predictions of an imminent peak in global oil demand, the Organization of Petroleum Exporting Countries (OPEC) made the formal statement: "It is an

[169] **Growth in global oil demand is set to slow** – International Energy Agency – 14 June 2023
[170] **Worldwide, governments have allocated USD 1.34 trillion to clean energy since 2020** – International Energy Agency – 2 June 2023
[171] **Worldwide, governments have allocated USD 1.34 trillion to clean energy since 2020** – International Energy Agency – 2 June 2023
[172] **Global Energy Markets** – Oliver Parsons of Cornerstone Analytics; Podcast: Place Your Trades hosted by Tracy Shuchart – 13 September 2023

extremely risky and impractical narrative to dismiss fossil fuels, or to suggest that they are at the beginning of their end. In past decades, there were often calls of peak supply, and in more recent ones, peak demand, but evidently neither has materialized. The difference today, and what makes such predictions so dangerous, is that they are often accompanied by calls to stop investing in new oil and gas projects. This thinking on fossil fuels is ideologically driven, rather than fact-based."[173]

OPEC Secretary General, HE Haitham Al Ghais added: "Such narratives only set the global energy system up to fail spectacularly. It would lead to energy chaos on a potentially unprecedented scale, with dire consequences for economies and billions of people across the world."[174]

In contrast to the International Energy Agency's forecasts, demand for oil grew by over 2.4 million barrels per day in 2023 to approximately 102.0 million barrels per day – setting a new record high.[175] The data and the narrative of the International Energy Agency are in contradiction.

For reference, global demand for oil has grown relentlessly for most of the last century. Only the worst recessions have been capable of temporarily causing a reprieve in the growth in global demand for oil. From 2010 to present, global oil demand grew every year except in 2020, during which year there was a severe economic contraction caused by the COVID-19 lockdowns.[176]

Lessons from the Second World War

Each form of energy has particular characteristics. The best means of understanding the true – and still largely unique – economic and social advantages of oil is provided by taking the perspective of the role it played in the most pivotal challenge of the last century, namely, the Second World War.

[173] **OPEC Statement on peak fossil fuel demand** – Organization of Petroleum Exporting Countries – 14 September 2023
[174] **OPEC Statement on peak fossil fuel demand** – Organization of Petroleum Exporting Countries – 14 September 2023
[175] **OPEC Monthly Oil Market Report** – September 2023
[176] **Statistical Review of World Energy** – Energy Institute – 2023

According to historians, the Second World War was defined by the struggle for a single resource – oil.[177] Importantly, nations do not fight wars over oil simply for its own sake, but rather to accomplish the tasks that require oil.[178]

According to the US Department of Energy: "The leaders of the Second World War, on both sides, knew that an army's lifeblood was petroleum."[179] For reference, Germany was, and remains, dependent on oil imports. Nazi Germany was relentlessly focused before and during the Second World War on developing technologies that would replace oil, knowing that energy represented Germany's weak link. That effort brought them back to coal. German chemists devised a means of transforming coal into synthetic fuel that had properties similar to oil. More than 92% of Germany's aviation fuel and half of its total petroleum during the Second World War was from synthetic fuel plants. At its peak in early 1944, the German synthetic fuels effort produced more than 124,000 barrels per day of synfuel from 25 plants.[180] With the bombing of those plants, it was clear that Germany would lose the war. From the beginning to the end of the Second World War Germany was absolutely focused on means of saving oil, finding oil and creating oil using coal or any other means possible.

Hitler's "blitzkrieg" or lightning war strategy had to be fierce but short before Germany ran out of oil. Germany invaded Russia to gain access to eastern oilfields. However, that strategy failed and resulted in the further depletion of Germany's oil stocks. As a result, according to Captain Mawn of the United States Navy, "The German Army had the greatest use of equestrian transport of any military conflict in history. Typically, in the last two years of the war, German Luftwaffe airplanes were pulled to runways from aviation hangers and parking

[177] **How Oil Defeated the Nazis** – Gregory Brew – https://oilprice.com – 5 June 2019 – Accessed: August 2020
[178] **Oil & The Great Powers, Britain & Germany, 1914-1945** – Anand Toprani – Oxford University Press – 2019
[179] **Early Days of Coal Research** – US Department of Energy – https://www.energy.gov – Accessed: April 2023
[180] **Oil and War** – Captain Paul E. Mawn – https://defense.info/ – 24 October 2018 – Accessed: August 2020

locations by horses, cows and oxen."[181] During the Second World War Germany ran out of oil.

In contrast, the victorious Allies were well supplied with American oil and the success of their efforts was linked to the logistics of getting that oil to the front lines. General Patton, who drove the United States Third Army across France to Germany after the Allied Invasion of Normandy in June 1944, told President Eisenhower, "My men can eat their belts, but my tanks have gotta have gas."[182] Frustrated by insufficient oil supplies as he advanced his army towards Germany, he wrote, "If I could only steal some gas, I could win this war."[183]

Captain Mawn makes the point about as clearly as possible: "Without American oil, the Second World War would not have been won by the Allies."[184]

Just as Winston Churchill switched the United Kingdom's Royal Navy from coal to oil, we can expect the leading armies and navies of the world to be extremely progressive when it comes to adopting advantageous forms of energy. For purposes where another form of energy is superior to oil, oil has already been replaced. For example, the United States Navy launched the first nuclear powered submarine, the USS Nautilus, in 1954, four years before the construction of the first American civilian nuclear power station – we will know that a better fuel than oil has arrived when we see the leading armies and navies of the world aggressively adopting it.

It is noteworthy that no major army, navy or air force has given any serious consideration to running their military programs using wind power, solar power or electric vehicles. Although it is always worth keeping an eye on the horizon for change, for now, the verdict concerning what form of energy wins when it really matters is crystal clear.

[181] **Oil and War** – Captain Paul E. Mawn – https://defense.info/ – 24 October 2018 – Accessed: August 2020
[182] **The Prize** – Daniel Yergin – Simon & Schuster – 1991
[183] **The Prize** – Daniel Yergin – Simon & Schuster – 1991
[184] **Oil and War** – Captain Paul E. Mawn – https://defense.info/ – 24 October 2018 – Accessed: August 2020

The High Price of Oil Reflects its Heavy Tax Burden

Oil is being priced out of many markets because it represents an expensive form of energy relative to other forms of energy, namely, coal and natural gas. The relatively high cost of oil reflects that it is heavily taxed relatively to other forms of energy.

Table 6 details the duty taxes paid at the pump by consumers of gasoline as a percentage of the total price paid. In many jurisdictions there is an additional sales tax that must be paid at the pump. In contrast, although electric vehicles use the same roads as internal combustion engines, they are exempt from comparable taxes.

Gasoline Tax Duties (Paid at the Pump) ***Table 6***

	Fuel Duty Tax as Percent of Retail Price
USA	19.9%
UK	65.5%
Canada	32.0%
Australia	36.2%
France	63.9%
Germany	63.6%
Average of all OECD countries	**55.1%**

Source: OECD[185]

The oil & gas industry in the United States and Canada pays corporate tax on profits like all corporations. Unlike any other industry of its kind, there are also significant royalties paid at the wellhead to the state (to the province in the case of Canada) and to the federal government. These taxes represent a direct tax applied to the revenues of oil & gas companies.

To provide a singular example of a royalty tax, the royalty tax at the wellhead for oil production in the state of Alaska is 12.5% on legacy

[185] **Taxation of premium unleaded (94-96 RON) gasoline (per litre), 2017** – OECD Tax Data Base – www.oecd.org – Accessed: September 2020

leases (16.67% on most new leases).[186] Many oil producers in Canada and the US actually pay a higher royalty rate than in Alaska.[187]

In contradiction to many people's perceptions the oil industry makes an important social contribution by paying corporate taxes, taxes at the wellhead (royalties) and taxes at the gas station (duty taxes).

In contrast, rather than providing funding to governments, the growth in the market share of many forms of green energy has been dependent on the financial support provided by governments – often in the form of direct subsidies.

Oil Production has Modest Environmental Impacts

Habitat loss is recognized as being the number-one threat to wildlife globally relative to all other threats.[188]

Importantly, oil can be produced with a negligible amount of land, which frees land for wildlife habitat. For example, northern Alaska has produced, cumulatively, more oil through a single pipeline than all the oil produced by all countries combined during the last year of the Second World War.[189] That pipeline is designed to allow animals to graze underneath it (Figure 6). Alaska's surface area is 4.8 times greater than that of Germany – one pipeline represents an insignificant amount of land in that context. Modern oil drilling operations in Alaska recover underground resources that have an area that is 6,500 times greater than the actual amount of land required on the surface (Figure 6).[190] In practical terms, for moose, grizzly bear and fish,

[186] **Interior Department report seeks more revenue from oil and gas on federal land** – Elwood Brehmer – Alaska Journal of Commerce – 1 December 2021

[187] **Interior Department report seeks more revenue from oil and gas on federal land** – Elwood Brehmer – Alaska Journal of Commerce – 1 December 2021; **Frequently Asked Questions: How provincial royalties account for higher commodity prices** – Canadian Association of Petroleum Producers – 29 July 2022 – https://www.capp.ca – Accessed: February 2023

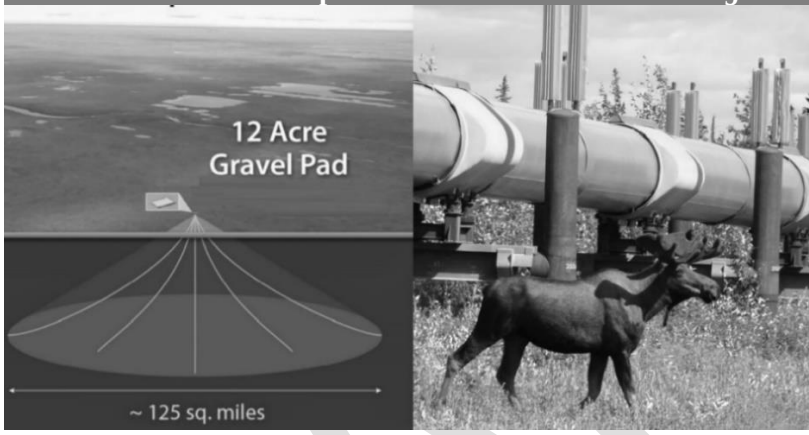
[188] **Nature's Dangerous Decline 'Unprecedented' Species Extinction Rates 'Accelerating'** – United Nations, Intergovernmental Science-Policy on Biodiversity and Ecosystem Services – 6 May 2019

[189] **Oil & The Great Powers, Britain & Germany, 1914-1945** – Anand Toprani – Oxford University Press – 2019; and **Alaska Field Production of Crude Oil** – US Energy Information Administration – https://www.eia.gov – Accessed: March 2021

[190] **ConocoPhillips Alaska: Investing in Alaska in Changing Times, Investor Presentation** – Joe Marushack – ConocoPhillips – 12 January 2017

humans have no presence at all in the oil producing regions of Alaska. Alaskan oil production not only protects wildlife habitat in Alaska, but globally, because Alaskan oil production averts the need to use extensive amounts of land elsewhere to meet our needs in energy and materials.

Minimal land use – oil operations in Alaska ***Figure 6***



Source: Image Credit: ConocoPhillips (adapted; left) and US Bureau of Land Managemen (right)

Relative to the scale of the energy it provides, the provision of oil has a modest surface footprint on our Earth.

Oil, Final Thoughts

Oil represents the modern embodiment of our ancient ally, combustion, in the most useful fuel known to humankind, and it is abundant and provided at a negligible cost relative to its fundamental utility.

Providing the world with the oil it demands is a prerequisite for advancing human prosperity and economic growth, it is also the best means of winning the war against hunger and poverty – not a theoretical consideration for the 828 million people who are currently

suffering from hunger[191] or for the 4 billion people living on less than $7 per day.[192]

Natural Gas: From Blue Flames, Blue Skies

Natural Gas, Fuel of the 21st Century

Natural gas provides 23.2% of global energy.[193]

In recent decades, growth in natural gas consumption has simply overwhelmed other dynamics that have occurred in energy markets.[194] Looking forward out to 2050, it is obvious that growth in demand for natural gas will continue to overwhelmingly dominate all other changes in energy markets.[195] There are two reasons that natural gas has, and will continue to, dominate growth in energy markets: Firstly, US-led technological gains have unlocked almost a century's worth of low-cost natural gas;[196] secondly, technological breakthroughs have allowed for the international transportation of seaborne natural gas as a dense super-cooled liquid.

Global energy demand from all sources increased by 2.4 times from 1973 to 2019, representing an average annual growth rate of 2% over that 46-year period.[197] Natural gas not only kept pace with growing energy demand, it increased its market share from 16% to 23%.[198] No other form of energy increased its market share by 7% over that

[191] **The State of Food Security and Nutrition in the World 2022** – Food and Agriculture Organization of the United Nations – 2022
[192] **Half of the global population lives on less than US$6.85 per person per day** – Marta Schoch, Samuel Kofi Tetteh Baah, Christoph Lakner and Jed Friedman – World Bank – 8 December 2022
[193] **Key World Energy Statistics 2021 (Data for 2019)** – International Energy Agency – September 2021
[194] **Key World Energy Statistics 2021 (Data for 2019)** – International Energy Agency – September 2021
[195] **2022 Outlook for Energy - Perspective to 2050** – ExxonMobil
[196] **Annual Energy Outlook 2022** – US Energy Information Administration – 3 March 2023
[197] **Key World Energy Statistics 2021 (Data for 2019)** – International Energy Agency – September 2021
[198] **Key World Energy Statistics 2021 (Data for 2019)** – International Energy Agency – September 2021

period. The runner up was nuclear energy, which increased its market share by 4%.

Currently, coal overwhelmingly dominates the provision of electricity to charge electric vehicles by virtue of the importance of the Chinese market. Over the decades ahead it is possible that as electric vehicles gain market share in other regions, natural gas will displace coal as the most important source of electricity to charge electric vehicles.

The Geological Origins of Natural Gas

Natural gas is formed very similarly to oil. If the natural processes that transform organic plant matter into oil occur deep enough in the Earth, the increased temperatures at which the processes occur start to create a combination of oil and natural gas. If these processes occur at extreme depths, no oil is produced and only natural gas is produced.[199]

The Practical Characteristics of Natural Gas

The principal difference between natural gas and oil is just that, at normal temperatures natural gas is in a gaseous form. The volume required to store natural gas is 868 times greater than the volume required to store an equivalent amount of gasoline.[200] That high volume represents the principal drawback of natural gas; it is otherwise a near-perfect fuel.

Compared to burning coal, burning natural gas emits 43% less carbon dioxide to produce the same amount of energy, albeit that estimate will vary depending on the type of coal.[201] In recent decades, the switching from coal to natural gas has underpinned the reduction in the carbon intensity of Western economies.

Natural gas liquifies at minus 162° Celsius (minus 260° Fahrenheit) and the cooling process shrinks the gas by a factor of 600 times. Since

[199] **Elements of Petroleum Geology** – Richard C. Selley and Stephen A. Sonnenberg – Elsevier – 2014
[200] **Units and calculators explained** – US Energy Information Administration – https://www.eia.gov/ – Accessed: August 2020
[201] **How much carbon dioxide is produced when different fuels are burned?** – US Energy Information Administration – https://www.eia.gov/ – Accessed: August 2020

1964, liquified natural gas has been transported on ships.[202] The liquefaction of natural gas is an example of an energy-related technology that completely transformed the relative competitiveness of a fuel. The abundance of natural gas in the US has meant that a tremendous amount of low-cost, clean-burning energy is available to supply the American market and, once liquified, markets around the world.

The chemical composition of natural gas makes it combust perfectly, making it a fuel that can be exploited by combustion, our oldest ally, without any of the smoke, soot or particulate pollution associated with combustion. Burning natural gas emits only water vapor and carbon dioxide.[203] As a result of its perfect combustion natural gas burns with a blue flame.

For reference, propane is also one of the exceptional fuels that burns perfectly. It too burns with a blue flame and emits only water vapor and carbon dioxide.

From Blue Flames, Blue Skies

The market share of natural gas for electricity generation in the United States overtook that of coal in 2016.[204] Adult Americans are currently enjoying the cleanest air of their lifetimes. Between 1970 and 2019 the combined emissions of the six most common pollutants dropped by 77%.[205] The increased use of clean-burning natural gas has been a key driver of improved air quality – from blue flames, blue skies.

For the average person globally, the level of fine particle pollution peaked in 2014. Since then, for the average person, fine particle pollution has fallen by 10%.[206] The air is becoming cleaner at an extraordinary pace. Cleaner burning internal combustion engines and

[202] **Liquified Natural Gas (LNG)** – Shell – https://www.shell.com – Accessed: January 2021
[203] **Natural Gas** – National Geographic Encyclopaedia – https://www.nationalgeographic.org/ – Accessed: March 2021
[204] **Electricity in the United States** – US Energy Information Association – https://www.eia.gov – Accessed: January 2021
[205] **Our Nation's Air, Air Quality Improves as America Grows** – United States Environmental Protection Agency – https://gispub.epa.gov/air/trendsreport/2020 – Accessed: August 2020
[206] **State of Global Air/2020** – Health Effects Institute – 2020

the growth in the market share of natural gas are the drivers of that change.

Natural Gas Underpins Efficient Farming

Natural gas and coal are not only useful for the purposes of creating heat. 6% of the natural gas supplied globally and 2% of the coal supplied globally are used as chemical feedstock to produce hydrogen.[207] In turn, hydrogen is used mainly to create plant fertilizer, specifically, ammonia (NH_3).[208]

The world record crop yield for wheat was beaten four times in the seven years up to 2022. It now stands at 17.96 metric tons of wheat from a hectare of land (267.2 bushels per acre).[209] It is not sufficient for agricultural yields to remain high; they must increase to keep pace with the rising human population, which is expected to grow from 8.0 billion today to 9.8 billion by 2050.[210] Fertilizer derived from natural gas (and coal) is a key driver of increasing agricultural yields. Higher agricultural yields reduce the amount of land required for farming and thereby provide more land for wildlife. Whether wildlife has land, or not, is by far the most critical factor upon which the fortunes of wildlife hinge.[211] Most importantly, increasing crop yields is the most effective and time-proven means of i) reducing poverty and ii) reducing hunger.[212]

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[207] **The Future of Hydrogen** – The International Energy Agency, Technology Report – June 2019

[208] **Hydrogen in Industry** – Hydrogen Europe – https://hydrogeneurope.eu – Accessed: March 2021

[209] **Highest Wheat Yield** – Guinness World Records – https://www.guinnessworldrecords.com – Accessed: February 2023

[210] **World Population Prospects** – United Nations – 2017 Edition

[211] **Nature's Dangerous Decline 'Unprecedented' Species Extinction Rates 'Accelerating'** – United Nations, Intergovernmental Science-Policy on Biodiversity and Ecosystem Service – 6 May 2019

[212] **Agriculture and Food** – The World Bank – https://www.worldbank.org – Accessed: March 2021;
Ending Extreme Poverty – Interview of Ana Revenga by Amy Frykholm – 8 June 2016 – The World Bank (as first published by the Christian Century); and
Crop Selection and International Differences in Aggregate Agricultural Productivity – Jorge A. Alvarez and Claudia N. Berg – IMF Working Paper – August 2019

Russia invaded Ukraine on the 24th of February 2022.

On the 30th of August 2023, the Financial Times ran a story headlined: "EU imports record volumes of liquified natural gas from Russia"[213] detailing that after the Russian invasion of Ukraine, Europe has increased its imports of Russian liquified natural gas.

For reference, at the time that the Financial Time's article was written, it was estimated that the number of casualties in the war in Ukraine amounted to approximately 500,000 people either killed or wounded.[214]

European countries broadly have obligations under the NATO alliance to protect Europe against a Russian invasion. Remarkably, European NATO members are actually funding Russia's war in Ukraine through the importation of Russian natural gas.

In that context, it is likewise remarkable that after the Russian invasion of Ukraine, Canada's Prime Minister, Justin Trudeau, blocked Canadian projects intended to increase the export of liquified natural gas to Germany on the grounds that the war in Ukraine shows "the world needs to accelerate its ending of dependency on oil and gas in general."[215] Ultimately, Trudeau and Olaf Sholz, the German Chancellor, announced together that it would be better to prioritize investments in green energy.[216] As a result, Canada, which is also a NATO member, has also made a decision that that will strengthen Russia financially by extending Europe's dependence on Russian fossil fuel imports. Likewise, Canada's decision, as agreed with Germany, will also reduce the energy security of European NATO countries.

[213] **EU imports record volumes of liquefied natural gas from Russia** – Alice Hancock and Shotaro Tani – Financial Times – 30 August 2023
[214] **Battlefield deaths in Ukraine have risen sharply this year, say US officials** – Andrew Roth – The Guardian – 18 August 2023
[215] **Trudeau, Germany's Scholz cool to the idea of exporting Canadian natural gas to Europe** – John Paul Tasker – CBC News – 23 August 2022
[216] **Trudeau, Germany's Scholz cool to the idea of exporting Canadian natural gas to Europe** – John Paul Tasker – CBC News – 23 August 2022

Due to its abundance and low costs, natural gas represents a compelling means of ensuring that more people benefit from reliable, affordable and clean energy. It also represents a core contributor to rising agricultural yields, which is the most time proven means of means of reducing poverty and hunger.[217]

Liquid Bio-fuel: Farmed Fuel

Liquid Biofuels are Foods that Can be Burned for Energy

Liquid bio-fuels are blended with gasoline and diesel and burned in internal combustion engines.

In 2021, bio-fuels accounted for 3.6% of global transport energy consumed.[218]

The two most important liquid bio-fuels are alcohol (ethanol), which is mixed into gasoline, and bio-diesel, which is mixed into diesel.

Alcohol for bio-fuel is derived from sweet and starchy crops such as corn and sugar cane. Bio-diesel is derived from organic fats and vegetable oil. The main crops that produce bio-diesel are palm oil and soybean.

Liquid bio-fuels represent transformations of food crops into fuels.

For reference, ethanol only has about two-thirds of the energy content of gasoline by volume and it is more corrosive than gasoline, it is also

[217] **Agriculture and Food** – The World Bank – https://www.worldbank.org – Accessed: March 2021;
Ending Extreme Poverty – Interview of Ana Revenga by Amy Frykholm – 8 June 2016 – The World Bank (as first published by the Christian Century); and
Crop Selection and International Differences in Aggregate Agricultural Productivity – Jorge A. Alvarez and Claudia N. Berg – IMF Working Paper – August 2019

[218] **Biofuels** – International Energy Agency – September 2022

prone to picking up water which is harmful to engines.[219] Biodiesel has about 9% less energy by volume than diesel.[220]

Some of the first diesel engines invented by Rudolph Diesel in the 1890s actually ran on peanut oil.[221] Diesel fuel derived from petroleum quickly replaced vegetable-based fuels because it costs less and is more abundant.

Biofuel Markets Are Created by Regulations

Liquid bio-fuels are associated with heavy social burdens – costs – and are uncompetitive relative to gasoline and diesel. Liquid bio-fuels exist due to governmental interventions in markets; specifically, governments have fixed the market share for bio-fuels through regulations.

The United States Environmental Protection Agency mandated that in 2020 the equivalent of 11.0% of the Unites States' transportation fuel supply must be supplied by biofuel.[222]

The EU mandated that by 2030 14% of the transport fuel consumed by its member countries must be from renewable sources, which it defines to include bio-fuels.[223]

Biofuels are the Keystone of the EU Renewable Energy Strategy

Based on the accounting methodologies of the EU, biofuels are deemed to be completely free of carbon dioxide emissions.

The EU labels biofuels as a renewable source of energy for the purposes of its energy statistics.

[219] **Find out the pros and cons of biofuels** – The AA – https://www.theaa.com – Accessed: May 2023
[220] **Biodiesel: A Renewable, Domestic Energy Resource** – Dennis E. Buffington – Penn State Extension – 9 March 2023
[221] **Biodiesel: A Renewable, Domestic Energy Resource** – Dennis E. Buffington – Penn State Extension – 9 March 2023
[222] **US refiners required to blend 20.09 billion gallons renewable fuel in 2020: EPA** – Meghan Gordon – S&P Global, Platts – 19 December 2020
[223] **Renewable Energy** – Recast to 2030 (RED II) – European Commission – https://ec.europa.eu/ – Accessed: August 2020

The overriding priority of EU energy policy is to increase the market share of renewable energy – a statistical goal.[224]

Based on the current state of technologies available in the energy sector, assuming they could be supplied in sufficient quantities, biofuels represent the only theoretical means for the EU to source 100% of its energy from renewable energy. That is because biofuels can be used to provide energy when the wind is not blowing, the sun is not shining and the supply of hydro power runs out. For that reason, in contrast to the media focus on wind power and solar power, biofuels dominate the provision of renewable energy in Europe.

Specifically, according to the International Energy Agency, biofuels (inclusive of both liquid biofuels and wood) provide 9.8% of the EU's energy[225] – representing about half of the amount of energy required to meet the EU's goal of sourcing 20% of its energy from renewable energy by 2020. In comparison, wind power and solar power combined provide only 2.9% of the EU's energy (Table 1).[226]

Biofuels Take Land from Wilderness

In 2016, 4% of the world's agricultural land and 3-4% of its fresh water were being used to grow bio-fuel.[227]

That land in its entirety was necessarily taken from wilderness and transformed into farmland. Wild animals need land on which to live and food to eat – habitat. Habitat loss is the primary threat to wildlife globally.[228]

[224] **Renewable energy targets** – European Commission – https://energy.ec.europa.eu – Accessed: October 2023
[225] **European Energy Policy Review** – International Energy Agency – June 2020
[226] **European Energy Policy Review** – International Energy Agency – June 2020
[227] **Fuel or Food? Study sees increasing competition for land, water and resources** – Fariss Samarrai – University of Virginia (UVA Today) – 3 March 2016
[228] **Nature's Dangerous Decline 'Unprecedented' Species Extinction Rates 'Accelerating'** – United Nations, Intergovernmental Science-Policy on Biodiversity and Ecosystem Services – 6 May 2019

53% of the EU's bio-diesel is derived from imported crops.[229] 58% of the EU's palm oil imports are used as bio-diesel feedstock.[230]

The primary suppliers of European bio-diesel are developing countries located in the Tropics that are growing palm oil.[231] Palm oil is grown exclusively on deforested tropical rainforests.[232]

From 1980 to 2022, driven by green energy policies mandating the use of green bio-fuel, an area of tropical rainforest amounting to more than half the size of Germany has been deforested to make way for palm plantations (189,000 square kilometers; 73,000 square miles).[233]

Tropical rainforests are exceptionally diverse ecosystems. To focus on a single species of animal that lives in rainforests, known for their red fluffy fur and long arms, orangutans are the largest mammal that lives primarily in trees. Due to habitat loss, for every four orangutangs living in the wild one hundred years ago, today, only one orangutang exists in the wild.[234] The most significant species of orangutang has had its habitat reduced by at least 55% over the last 20 years alone.[235]

[229] **Around half of EU production of crop biodiesel is based on imports, not crops grown by EU farmers, new analysis** – Transport and Environment – 16 October 2017

[230] **10 years of EU fuels policy increased EU's reliance on unsustainable biofuels** – Transport & Environment – July 2021

[231] **The water-land-food nexus of first-generation biofuels** – Maria Cristina Rulli, Davide Bellomi, Andrea Cazzoli, Giulia De Carolis & Paolo D'Odorico – Scientific Reports – 3 March 2016

[232] **Questions and answers about palm oil** – Rainforest Rescue – https://www.rainforest-rescue.org – Accessed March 2023

[233] Calculationa based on i) 2022 Palm Oil Production: 77.5 Mt, ii) 1980 Palm Oil Production, and iii) 4.5Mt; Average Palm Oil Yield Globally: 3.8Mt/hectare; sources:
Palm Oil 2022 World Production - USDA Foreign Agricultural Service - February 2023;
Palm oil and biodiversity - IUCN - June 2018 - https://www.iucn.org - Accessed February 2023

[234] **Orangutang** – Global Conservation – https://globalconservation.org – Accessed March 2023

[235] **Borneo Orangutang Facts** – World Wildlife Fund – https://www.worldwildlife.org – Accessed March 2023

Young Orangutang in Tree – Indonesia, Borneo ***Figure 7***

Photo Licensor: iStock by Getty Images

Biofuels Emit More Carbon Dioxide Than Conventional Fuels

To a very large extent Orangutangs, and other species, have lost their habitat to provide the farmland required to grow biofuel for the EU – premised on the assumption that biofuels do not increase atmospheric concentrations of carbon dioxide.

In contradiction to the assumption, Transport & Environment, a leading advocate for clean energy for transportation, determined that palm oil emits three times as much carbon dioxide as regular diesel.[236]

[236] **Why is palm oil bad?** – Transport & Environment – https://www.transportenvironment.org – Accessed February 2023

Alternatives to Combustion

Alternatives to Combustion

So far, we have concentrated our attention on fuels that release their energy in the way of heat when they combust or burn. As a reminder, fossil fuels, namely, coal, oil and natural gas provide 80.9% of the energy consumed globally.[237] Bio-fuels and fossil fuels combined provide 90.3% of the energy consumed globally.[238] The entirety of that energy is released by way of combustion – fire. We will now look at forms of energy that do not involve combustion.

Alternatives to combustion provide approximately one-tenth of global energy (Table 1).[239]

Alternatives to Combustion Only Produce Electricity

It is critical to appreciate that alternatives to fossil fuels produce electricity – and only electricity. The practical utility of electricity as a form of energy is growing constantly with technological progress. Currently, the practical limitations of electricity have limited its market share to 19.7% of global energy consumption. The amount of global energy consumption carried by electricity has grown constantly since the 1880s when its market share was close to 0%.

Sources of Electrical Energy

As we have seen, electricity is only a carrier of energy, not a source of energy. Table 7 provides the sources of electrical energy in the US, the EU, China and globally.

[237] **Key World Energy Statistics 2021 (Data for 2019)** – International Energy Agency – September 2021
[238] **Key World Energy Statistics 2021 (Data for 2019)** – International Energy Agency – September 2021
[239] **Key World Energy Statistics 2021 (Data for 2019)** – International Energy Agency – September 2021

Sources of Electrical Energy				*Table 7*
	USA	**EU**	**China**	**Global**
Coal	19.5%			36.4%
Natural gas	39.8%	36.0%	66.5%	23.2%
Oil	0.9%			2.9%
Hydro power	6.2%	13.0%	15.3%	16.1%
Nuclear	18.2%	25.0%	4.7%	10.4%
Wind	10.2%	14.0%	8.6%	5.2%
Biofuel	1.3%	6.0%	0.0%	2.6%
Solar	3.4%	5.0%	4.8%	2.7%
Geothermal, tide and other	0.5%	1.0%	0.0%	0.5%
Total	**100.0%**	**100.0%**	**100.0%**	**100.0%**
Year of publication	2023	2022	2023	2020
Source:	*EIA*	*EU*	*PRC*	*IEA*

Source: various[240]

Comparing Electricity Use Globally

Table 8 shows the amount electricity consumed in the USA, the EU, China and globally, in addition to other key comparators. China consumes 37.6% of the world's electricity. China consumed 1.6kWh of electricity for every barrel of oil it consumes, that is a very high figure and it reflects that China is a voracious consumer of electricity and a parsimonious user of oil, relative to the scale of its economy. Coal underpins every aspect of China's energy strategy, from its heavy consumption of electricity to its parsimonious consumption of oil.

[240] **Global Energy Review 2019** – International Energy Agency – April 2020;
Shedding light on energy in the EU, 2022 – Eurostat – 2022
U.S. utility-scale electricity generation by source, amount, and share of total in 2022 – US Energy Information Administration – February 2023; and
Statistical Communique of the People's Republic of China on the 2022 National Economic and Social Development – National Bureau of Statistics of China – 28 February 2023

Electricity Consumption and Key Comparators				*Table 8*
	USA	**EU**	**China**	**Global**
Electricity consumption (tWh/yr)	4.2	2.8	8.6	22.8
Population (million)	334.7	447.7	1,426.0	7,968.1
Electricity per person (kWh/yr)	12.5	6.3	6.0	2.9
Oil consumption (bn bbl/yr)	7.0	2.4	5.4	36.3
Consumption kWh/bbl of oil	0.6	1.1	1.6	0.6
% global oil consumption	19.3%	6.7%	14.9%	100.0%
% global electric. consumption	18.4%	12.3%	37.6%	100.0%
GDP ($trillion; 2022)	25.5	16.6	18.0	100.6
GDP per capita (k$/person)	76.4	37.1	13.8	12.6

Source: various[241]

We will now turn our attention to hydro power, nuclear power, wind power and solar power, before looking at electrical batteries and hydrogen.

Hydro Power: It Is What It Says on the Tin

Quietly Delivering

Hydro power supplies 16.1% of electricity globally.[242]

[241] **Electricity consumption** – International Energy Agency – https://www.iea.org – Accessed: May 2023
Shedding light on energy in the EU, 2022 – Eurostat – 2022
U.S. utility-scale electricity generation by source, amount, and share of total in 2022 – US Energy Information Administration – February 2023;
Statistical Communique of the People's Republic of China on the 2022 National Economic and Social Development – National Bureau of Statistics of China – 28 February 2023;
Oil and oil products a statistical overview – Eurostat – data for 2021 – https://ec.europa.eu – Accessed: May 2023;
OPEC Monthly Oil Market Report April – OPEC – 13 April 2023;
GDP per Capita – World Bank – https://data.worldbank.org – Accessed: May 2023; and
GDP – World Bank – https://data.worldbank.org – Accessed: May 2023
[242] **Key World Energy Statistics 2021 (Data for 2019)** – International Energy Agency – September 2021

The Origins of Hydro Power

Harnessing the power of moving water has ancient origins. Much of the earliest documented use of water as a source of power is from China and dated to the Han Dynasty (206BC-220CE).[243] Based on an inventory made in 1086, England, at that time, had 6,000 water mills.[244] By the 16th century, water power was the most important source of motive power in Europe.[245]

Modern hydro power was the product of two inventions. Firstly, in 1737, Bernard Forest de Bélidor of France published the mathematical principles of hydraulics and based on those principles invented the modern water turbine. In 1882, Nikola Tesla, who was born in Croatia before emigrating to the US, invented an electrical generator capable of turning rotational power into electricity. Thanks to those inventions, it is possible to turn the energy of flowing rivers into electrical energy that can be transported via copper wires to places where that energy is most useful.

Practical Considerations in Respect of Hydro Power

Rivers flow with tremendous power and with much more regularity than the wind blows or the sun shines. Moreover, water dams create a reservoir of energy that can be used when required.

Of course, all human activity affects our environment and so too does hydro power. The specific trade-offs of hydro power are best considered at the local level.

Canada generates an astounding 60% of its electricity from hydro power.[246] That is because my country has a huge land mass, is blessed with an abundance of powerful rivers and it has a very low population density. Although hydro power does provide a very hefty percentage of our global needs in electricity, its scope to supply the entirety of the

[243] **Did you know: Who invented hydropower?** – renewablenews.com – Accessed: March 2022
[244] **Did you know: Who invented hydropower?** – renewablenews.com – Accessed: March 2022
[245] **Did you know: Who invented hydropower?** – renewablenews.com – Accessed: March 2022
[246] **Provincial and Territorial Energy Profiles Canada (data for 2019)** – Canada Energy Regulator – https://www.cer-rec.gc.ca – Accessed March 2023

world's needs in electricity is limited by the availability of appropriate rivers and by the distances that electrical energy can be efficiently transmitted over copper wires to where the energy is actually needed.

Today, hydro power quietly provides more than twice as much electrical energy as wind power and solar power combined. As mentioned, hydro power can be stored and is therefore immeasurably more reliable – and therefore useful – than wind power and solar power.

The carbon dioxide emissions associated with hydro power are very low, and actually lower than the emissions associated with solar power.[247]

Hydro dams can be built to last eternally. At the end of this century, the entirety of the wind turbines and solar panels that are currently being built will have long-since ceased to be operational.[248] Also at that time, the world's oldest hydro dams will be essentially brand new and ready to serve humankind for centuries to come.

Nuclear Power: It Is What It Says on the Tin

Reliably Powering the World

Nuclear power supplies 10.4% of electricity globally.[249]

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[247] **Carbon emissions from hydropower reservoirs: facts and myths** – International Hydropower Association – https://www.hydropower.org – Accessed: March 2023

[248] **Solar Panels Information and FAQs** – Department of Toxic Substance Control, State of California – https://dtsc.ca.gov – Accessed: October 2020;
If Solar Panels Are So Clean, Why Do They Produce So Much Toxic Waste? – Michael Shellenberger – Forbes – 23 May 2018;
End-of-Life-Management Solar Photovoltaic Panels – International Renewable Energy Agency – June 2016;
Wind Turbine Blades Can't Be Recycled, So They're Piling Up in Landfills – Chris Martin – Bloomberg – 5 February 2020
Recycling turbine blades: the Achilles heel of wind power – Monica Pinna – euronews – 27 June 2021

[249] **Key World Energy Statistics 2021 (Data for 2019)** – International Energy Agency – September 2021

Although France produces more nuclear energy as a percent of its total electricity consumption than any other country (68%),[250] the US is the largest producer of nuclear energy in absolute terms, China is ranked second and France is ranked third. Nuclear energy reliably provides 18% of the electricity consumed in the US and 5% of the electricity consumed in China.[251] In total, 32 countries rely on nuclear power to dependably generate electricity.[252]

Einstein and the Origins of Nuclear Power

Nuclear power is premised on the theory of relativity as formulated by Albert Einstein. In 1905, he determined that energy is equivalent to mass multiplied by the speed of light squared ($e = mc^2$). The implication of this formula is that mass can be converted into energy. Nuclear power plants exploit this by converting uranium into energy, specifically into heat energy.

Practical Considerations in Respect of Nuclear Power

For all the complexity of nuclear power, it is essential to appreciate that nuclear power simply produces heat – like combustion. That heat is used to create steam, which is then used to turn turbines that generate electricity. Once the heat is created, a nuclear power plant is conceptually no different than a fossil fuel powered steam driven electricity generator.

Nuclear reactors involve self-sustaining chain reactions of nuclear material, which must be constantly monitored and balanced to ensure their safe operations. Due to the significant systems required to ensure the safety of nuclear power, nuclear power facilities are large scale,

[250] **Nuclear power plants generated 68% of France's electricity in 2021** – Elesia Fasching – International Energy Agency – 23 January 2023;
Nuclear Energy in France – US Embassy of France – 2 December 2007 – https://franceintheus.org – Accessed: March 2023
[251] **What is U.S. electricity generation by energy source?** (data for 2022) – US Energy Information Administration – https://www.eia.gov – Accessed March 2023; and
Electricity Mix in China – International Energy Agency – https://www.iea.org – Accessed: March 2023
[252] **Nuclear Power in the World Today** – World Nuclear Association – https://world-nuclear.org – Accessed: March 2023

stationary, electrical power plants. Admittedly, nuclear powered submarines represent an exception to that generalization.

Nuclear energy produces radioactive waste, which must be managed either by long-term storage or recycling (reusing spent nuclear fuel).[253] For perspective, on average, the waste from a nuclear reactor supplying a person's electrical needs for a year would be about the size of a brick, of which only a very small amount weighing about the amount of a sheet of paper (5g; a fifth of an ounce) would be highly radioactive.[254] The safe disposal of nuclear waste is an intrinsic component of nuclear power facility management. The nuclear power industry manages its nuclear waste and funds that waste management.

Nuclear power, net of all considerations, emits less carbon dioxide than solar power and about the same amount of carbon dioxide emissions as wind power.[255]

For reference, based on the actual or known life-extensions of existing nuclear power plants, they can operate for at least 80 years if well maintained.[256] That represents between three and four times the lifespan of solar power and wind power facilities, meaning that the costs and environmental impacts of solar power and wind power must be multiplied by at least three to four times to compare them on a like-for-like basis to nuclear power.

France, the Fallen King of Nuclear

Unlike wind power and solar power, nuclear energy is reliable. For those reasons, nuclear power represents the greatest threat, as a low-carbon source of energy, to the flow of subsidies supporting the wind power and solar power sectors; therefore, the elimination of political

[253] **Radioactive Waste** – United States Nuclear Regulatory Commission, Office of Public Affairs – June 2019

[254] **What is nuclear waste, and what do we do with it?** – World Nuclear Association – https://world-nuclear.org – Accessed: March 2023; and **Understanding future emissions from low-carbon power systems by integration of life-cycle assessment and integrated energy modelling** – Michaja Pehl, Anders Arvesen, Florian Humpenöder, Alexander Popp, Edgar G. Hertwich and Gunnar Luderer – Energy Nature – December 2017

[255] **Over its lifetime a nuclear power station's carbon footprint is the same as wind power** – EDF – https://www.edfenergy.com – Accessed: March 2023

[256] **What's the Lifespan for a Nuclear Reactor? Much Longer Than You Might Think** – Office of Nuclear Energy – 16 April 2020

support for nuclear power has been essential to promote the interests of wind power and solar power developers.

The history of France's nuclear energy program is instructive. France, today, generates 68% of its electricity from nuclear power, down from 78% in 2003.[257] France turned to nuclear power in the 1970s and 1980s and essentially became self-sufficient for electrical power despite it not having an abundance of fossil fuel resources. Not only was France able to reliably supply its needs in domestic energy, it was able to reliably export energy to its neighbors when in need.

What happened?

Citing directly from one of France's most trusted news agencies: "Ahead of the 2012 presidential elections, Socialist François Hollande cut a deal with the Greens in exchange for their support. He vowed to shut the two reactors at Fessenheim, France's oldest nuclear plant, and cut to 50 percent the proportion of French energy nuclear generates by 2025."[258]

That policy, combined with the energy policies of the EU, have left France's once proud nuclear energy sector in disarray. Rather than being maintained, France's nuclear facilities and the expert engineers required to run a world-leading nuclear energy program have been managed into retirement.

As a result of the deal struck to gain the political support of the Greens, there have been many consequences, specifically: i) Electricité de France, once the crown jewel of Europe's electrical energy sector, is in acute financial distress;[259] ii) rather than exporting electrical energy, France must import electrical energy;[260] and iii) given the inherent

[257] **Nuclear power plants generated 68% of France's electricity in 2021** – Elesia Fasching – International Energy Agency – 23 January 2023;
Nuclear Energy in France – US Embassy of France – 2 December 2007 – https://franceintheus.org – Accessed: March 2023
[258] **How France's prized nuclear sector stalled in Europe's hour of need** – Tom Wheeldon – France24 – 5 January 2023
[259] **French energy group EDF records €5.3bn loss ahead of renationalisation** – Sarah White – Financial Times – 28 July 2022
[260] **How France's prized nuclear sector stalled in Europe's hour of need** – Tom Wheeldon – France24 – 5 January 2023

unreliability of wind power and solar power, France has been required to increase its consumption of coal.[261]

China Dominates Growth in Nuclear Power

Focusing on China, that country has by far the youngest fleet of nuclear power plants, with 80% of its fleet less than 10 years old.[262] In comparison, 90% of the US nuclear fleet and 83% of the EU's nuclear fleet is over 30 years old.[263] Since 2000, China has increased the number of its operating nuclear energy reactors by over 10 times.[264] For reference, in 2022, China produced twice as much electricity as the US.[265] Given the scale and the growth rate of China's nuclear ambitions it is estimated that China will take the lead in nuclear power from the US in 2030.[266]

Notably, China's ambitions for nuclear power are global as it also intends to export its nuclear power reactors in the future.[267] China knows that there is a growing demand for nuclear power in India, the Middle East and elsewhere.

It is critical to appreciate that the economies of scale are much more pronounced for nuclear energy than other forms of energy. It is very costly to design, build and maintain a single nuclear power facility; however, taking the approach that China has taken results in significantly lower costs.

[261] **France looking at using more winter coal as nuclear output lags** – Forrest Crellin – Reuters – 27 January 2022
[262] **Age profile of nuclear power capacity in selected regions, 2019** – International Energy Agency – https://www.iea.org – Accessed: March 2023
[263] **Age profile of nuclear power capacity in selected regions, 2019** – International Energy Agency – https://www.iea.org – Accessed: March 2023
[264] **How China has Become the World's Fastest Expanding Nuclear Power Producer** – Laura Gil – International Atomic Energy Agency – November 2017
[265] **US Energy Information Administration Short Term Energy Outlook** – 7 March 2023 (US electricity consumption in 2022: 4.2tkWh);
China's Power Use Up 3.6% in 2022 – China Power Use The State Council of Information Office The People's Republic of China – 25 January 2023 (China electricity consumption in 2022: 8.6 tkWh)
[266] **China on course to lead in nuclear by 2030, says IEA** – World Nuclear News – 3 March 2021
[267] **How China has Become the World's Fastest Expanding Nuclear Power Producer** – Laura Gil – International Atomic Energy Agency – November 2017

Nuclear fusion represents a new form of nuclear energy that does not produce long-term radioactive waste. Nuclear fusion replicates the nuclear reactions that occur on the Sun that provide the Earth with its energy. Nuclear fusion essentially fuses hydrogen into helium, an inert gas, which process produces heat. Nuclear fusion is not the product of chain reactions which makes it one of the safest forms of energy and potentially a lower cost form of energy. The challenge in respect of nuclear fusion lies in replicating the extreme temperatures and pressures that exist on the Sun. As a result of those challenges, there are currently no commercial prospects for nuclear fusion. Taking a long-term perspective, over the centuries ahead, nuclear fusion could completely transform the generation of electricity.

Wind Power: Turbulence Ahead

Wind Power

Wind power provides 1.4% of global energy and 5.2% of electricity globally.[268]

Wind power is best appreciated in its broader context and in association with i) solar power, ii) electrical batteries, and iii) the architecture of our electrical systems. For that reason, this section will extend broadly to cover those topics.

The Origins of Wind Power

The origins of wind power as a means of generating electricity provide the most critical insight into the potential of, and the challenges for, wind power. The origins of wind power take us back again to Scotland. In the late 1800s, electricity and electrical batteries were an intense focus of technological innovation and media attention. In 1887, James Blyth, a professor of Natural Philosophy, installed the first electricity-generating wind turbine in his hometown of Marykirk, Scotland. Using a lead-acid battery of French design, Professor Blyth

[268] **Global Energy Review 2019** – International Energy Agency - April 2020; and **Key World Energy Statistics 2021** – International Energy Agency – September 2021

charged his batteries when the wind was blowing in order to produce reliable lighting with electrical power.[269]

Notably, his system was an independent off-grid system and it was associated with a dedicated electrical battery to provide reliable power. It was not intended to replace the fireplace for heat or the stove for cooking, but for the lighter load of providing lighting, technically, it worked.

In the words of one of the greatest scientists of that time, Lord Kelvin, the system was simply economically infeasible, at least until "inventions not yet made".[270] Therefore, the project of Professor Blyth was essentially anecdotal and of no consequence.

Professor Blyth's energy system simply did not work nearly as well as coal or as economically as coal; therefore, coal consumption continued to grow from that time forward to the present.

As a non-trivial result of its increased use of coal and other fossil fuels, the life expectancy in Britain increased by 35.8 years from the 1880s to present.[271]

Wind, Solar and Electrical Batteries

The inventor of wind powered electricity generation, Professor Blyth, recognized that an intermittent source of electricity, depending on whether the wind is blowing or not, is of limited utility in the absence of a means of storing electricity.

With an electrical battery, the utility of wind power is immeasurably more valuable. Imagine the utility of any electrical device or motor that only works when the wind is blowing. Imagine if the lights only worked when the wind is blowing – that would not be a satisfactory system. In contrast, a wind powered system, including an electrical battery, would be capable of storing electricity generated by a wind turbine for use when required. It's the difference between the lights going on or not. The difference between having reliable energy or not.

[269] **Papers of James Blyth** – Kirsteen Croll – University of Strathclyde Glasgow – https://www.strath.ac.uk – Accessed January 2021
[270] **July 1887: James Blyth Harnesses the Wind for Electricity** – Daniel Garisto – APS News – July/August 2022
[271] **UK Office of National Statistics**

The simple system devised by Professor Blyth represents the only conceptual system that allows reliable energy to be provided by wind power and solar power.

Energy storage is the unique keystone that has the conceptual ability to transform unreliable sources of energy into reliable sources of energy – this is a critical point to retain.

Conceptually coherent wind-solar-electrical battery systems, like the system of Professor Blyth, are necessarily i) extremely simple and ii) off-grid. For reference, off-grid refers to the fact that the systems are not connected to high-voltage electricity distribution networks – grids that carry electrical energy over large distances. Everywhere there is wind and sunshine the system devised by Professor Blyth allows for electricity to be reliably supplied, there is no need to transport electricity over long distances on costly, inefficient high-voltage networks.

To reiterate an essential point, energy storage is a necessary, required component of any reliable energy system that is powered entirely by wind power and solar power.

In contrast to systems comparable to that of Professor Blyth, the systems that our governments have created to promote wind power and solar power are complex on-grid systems. What is going on? Given the straightforward realities required to provide electricity reliably from wind power and solar power, why has the logic of Professor Blyth not been implemented?

The system of Professor Blyth has been essentially ignored in its entirety in favor of the promotion of highly complex grid-based systems for one reason: costs.

Combining wind power and solar power with electrical batteries is conceptually feasible; however, such systems are too expensive for the large-scale provision of affordable electricity.

For reference, in addition to low-cost wind power and solar power, such systems would need low-cost electrical batteries. Specifically, it has been estimated that for wind-solar-electrical battery systems to be

feasible, the cost of electrical batteries must be lower than $20/kWh[272] – more than five times lower than the industry's hoped-for-objective of lowering costs to $100/kWh.

Critically, it is always important to remember that if batteries can be manufactured for less than $20/kWh, that does not imply that they will be sufficiently inexpensive for the purposes of making Professor Blythe's invention economically viable. Costs need to include installation and operational costs. Most critically, costs must also reflect the costs of remediating any environmental damage related to the manufacturing of electrical batteries and the recycling of those batteries at the end of their useful lives.

From the most straightforward perspective, there is no need to do calculations to assess whether the system of Professor Blyth is economically viable: We will simply observe the proliferation of such systems globally as soon as they are economic. They will become economically viable firstly on remote Tropical islands with plenty of sun and wind, which are currently using extremely high-cost diesel fuel to generate electricity. These islands have very low industrial needs for electricity and low risks of inhabitants freezing to death during blackouts. Tropical Islands are the perfect places to develop systems comparable to the system developed by Professor Blyth in 1887. The demand for such systems has existed since 1887; however, energy must be economically viable – that reality too has not changed since 1887.

For now, wind-solar-electrical battery storage systems are very clearly simply too expensive. For that reason, the only conceptual strategy to run our electrical systems entirely on wind power and solar power was abandoned at the very beginning of the green energy movement. Instead, a new, on-grid system was designed by governments that is the antithesis of the simplicity of Professor Blyth's system.

Wind, Solar and the Architecture of Our Electrical Systems

Rather than promoting simple, self-sufficient, off-grid wind-solar-battery systems, due to their high costs, governments designed a grid-

[272] **Storage Requirements and Costs of Shaping Renewable Energy Toward Grid Decarbonization** – Micah S. Ziegler, Joshua M. Mueller, Gonçalo D. Pereira, Marco Ferrara, Yet-Ming Chiang and Jessika E. Trancik – Joule – 7 August 2019

based electrical system architecture to favor growth in wind power and solar power.

During the depths of the COVID-19 crisis, coal companies, oil companies, natural gas companies, nuclear power companies and hydro power companies were all under extreme financial stress because the demand for energy collapsed as did the price of energy commodities; however, the Financial Times published an article entitled: "Clean energy groups dodge coronavirus crisis," reporting that the profits for the renewable energy sector, unlike those for all other sectors of the economy, were unaffected by the drastic economic contraction that occurred from the COVID-19 lockdowns.[273]

The article explained that one of the key reasons for this is that wind power and solar power developers have priority access to the market. The system is set up so that grid operators are obliged to purchase electricity firstly from wind power and solar power providers – variability in demand for energy is not their concern, whatever they produce is guaranteed to be sold. That means that the risks related to the variability in demand for electricity, for example, due to COVID-19 lockdowns, are concentrated and magnified on the other participants in the market. The other participants in the market must also accommodate the variability of supply caused by the unreliability of wind power and solar power.

Wind power and solar power developers are also unconcerned with price risk, that too is borne by others: Ørsted, the number-one ranked developer of offshore wind projects globally, stated in its 2019 annual report, "Our offshore wind farms are largely subject to regulated prices, implying a high degree of revenue certainty."[274] So wind power (and solar power) developers don't need to concern themselves with risks related to demand, supply or prices.

In this way, during the worst period of the coronavirus crisis, when most energy companies were facing acute financial difficulty, Henrik Poulsen, the CEO of Ørsted, reported to the Financial Times "We see no impact from Covid on our production numbers."[275] By the end of

[273] **Clean energy groups dodge coronavirus crisis** – Lelie Hook – Financial Times – 29 April 2022
[274] **Ørsted Annual Report 2019** – https://orstedcdn.azureedge.net
[275] **Clean energy groups dodge coronavirus crisis** – Leslie Hook – Financial Times – 29 April 2020

the day on April 29th 2020, the date on which the Financial Times wrote its article, Ørsted's share price had increased by 40% relative to its price a year earlier. The increase in value represented a gain of $11.4 billion for the shareholders of that company. In comparison, broad equity market indices had collapsed as the economy ground to a halt under coronavirus restrictions. For reference, in the same month that the CEO of Ørsted stated that his company's revenues had not been affected by the COVID-19 lockdowns, the price of crude oil went negative for the first time in history.

The point is that regardless of the price of energy or the demand for energy, wind power and solar power developers will generate steady revenues.

Sheltering wind power and solar power from risks is achieved by transferring those risks onto both governments and competitors.

There are three key critical takeaway points relating to the architecture of electrical systems that have been chosen to promote wind power and solar power: Firstly, reliable sources of electrical energy form the backbone of the system; secondly, the risks and costs created by adding unreliable sources of energy are borne by governments and competitors of wind power and solar power; thirdly, it is relatively easy to add modest contributions from wind power and solar power to an existing energy system that was built to be resilient, while the risks and associated costs of relying on unreliable energy increase exponentially as they contribute more to the system.

The Key Economic Variable for Wind Power

Subsidies are not the most important economic assistance provided to wind power and solar power developers.

The most important economic advantage provided to wind power and solar power developers by governments and regulators is the sheltering of wind power and solar power projects from all risks related to supply, demand and price.

Why?

Without bearing any risks related to supply, demand or price, wind power and solar power projects are funded up to 80% with debt.[276]

It is critical to appreciate that the expansion of green energy was made possible by extremely high levels of debt to fund projects combined with the extremely low interest rates that existed up until 2022.

Energy projects involve significant upfront costs and generate revenues for decades after they start producing energy. The return on investment links the upfront costs with the future expected cashflows from the project. When interest rates on debt are near 0% and the substantial entirety of the funding is provided by debt, the required return on investment is also going to be very low.

Imagine the difference between a 20-year project that must generate a reasonable economic return of 10% compared to a similar project that is financed in such a way that it must generate a return close to 0%. That advantage, namely, low funding costs, has been the overwhelming driver of growth in solar power, wind power and green energy developments broadly.

When one contemplates the competitiveness of wind power and solar power in terms of the price of electricity required for wind power and solar power to breakeven economically, it is important to consider the background relating to how wind power and solar power projects are funded.

Given that wind power and solar power projects are funded up to 80% with debt, interest rates are the key economic variable upon which the fortunes of wind power and solar power depend.

ESG Finance

It is critical to appreciate that the expansion of green energy was made possible by extremely high levels of debt to fund projects combined with the extremely low interest rates that existed up until 2022. "Free money" had been made wildly abundant by Western central banks until the onset of uncontrolled inflation in 2022. That "free money" flowed like one of the greatest rivers of money ever known to humankind into green energy projects.

[276] **Lower Debt Ratios Likely for Unsubsidized Green Energy** – Angus McCrone – Bloomberg NEF – 29 August 2017

It is critical to appreciate that there is a whole financial ecosystem that exists to lower the financial costs of green energy projects. Based on research funded by the European Commission, the cost of capital for onshore wind projects in Europe fell so low that if a project could return a 3% return on invested capital it was deemed economically viable.[277] Adjusted for inflation, the real economic returns from those projects would be quite close to 0%. That means that if society invests one dollar in such green energy projects, after decades of investment, society gets nothing more than the original dollar back in real inflation-adjusted value.

It is remarkable that bankers and regulators are intensely transfixed on lowering the costs of capital for green energy projects. This is remarkable because successful and prosperous economies have the opposite objective, namely, to invest in the projects that generate the highest returns possible.

Emmanuel Macron, the President of France, declared to his country that the age of abundance is over.[278] This reflects that rather than investing in projects that create wealth and prosperity, Western societies have been focusing on means of lowering the wealth and prosperity created by their investments.

These low-return money flows have become the biggest express highways in finance today, labelled ESG finance for "environmental, social and governance," although the acronym itself has no real significance.

The Governor of Texas, Greg Abbot, is leading an outspoken group of American Governors that are pushing back against ESG investing. Texas has banned state entities from doing business with firms that promote ESG investment practices.[279] Texas Controller, Glenn Hagar stated: "The environmental, social and corporate governance (ESG) movement has produced an opaque and perverse system in which some financial companies no longer make decisions in the best interest of their shareholders or their clients, but instead use their

[277] **Renewable energy financing conditions in Europe: survey and impact analysis** – AURES II (funded research by the European Commission) – March 2021
[278] **Macron warns of 'end of abundance' as France faces difficult winter** – Kim Willsher – The Guardian – 24 August 2022
[279] **Governor Abbott Denounces ESG Standards Harmful To U.S. Energy Sector** – Office of the Texas Governor, Greg Abbott – 16 March 2023

financial clout to push a social and political agenda shrouded in secrecy." The US states of Arizona, Florida, Idaho, Indiana, Kentucky, Louisiana, Minnesota, North Dakota, Oklahoma, Pennsylvania, South Carolina, Utah and West Virginia have enacted similar anti-ESG legislation.[280]

Notably, ESG investing is a practice the exists exclusively in Western financial markets.

Disconnect Between the Marketing and the Reality

Wind power and solar power have been characterized in the media as good sources of energy, whereas fossil fuels and nuclear power have been characterized in the media as bad sources of energy.

A typical narrative as put forward by the Secretary General of the United Nations is that fossil fuels have "opened the gates of hell,"[281] only renewables can serve as the "lifeline"[282] because ""without renewables, there can be no future." [283] This leads to his conclusion that we must "stop using fossil fuels."[284]

The critical point to understand is that the architecture of electricity markets that has been adopted to promote wind power and solar power was never designed to eliminate the use of fossil fuels and nuclear power, they form the backbone of the system that supports wind power and solar power.

There is a widely mediatized antagonistic narrative between fossil fuels and nuclear power on one side and wind power and solar power on the other side. The marketing of wind power and solar power has been premised on the increased use of wind power and solar power in

[280] **The "anti-ESG" movement: Balancing conflicting stakeholder concerns and inconsistent regulatory regimes** – Brooke Goodlett, Deanna Reitman, Noah Schottenstein, Michael Mapp and Victoria McGuire – DLA Piper – 21 February 2023

[281] "**Humanity has opened the gates to hell" warns Guterres as climate coalition demands action** – United Nations – Press Release – 20 September 2023

[282] **Five ways to jump-start the renewable energy transition now** – United Nations – https://www.un.org- Accessed: 25 September 2023

[283] **Five ways to jump-start the renewable energy transition now** – United Nations – https://www.un.org- Accessed: 25 September 2023

[284] **Guterres tells world leaders to fight climate change by stop using fossil fuels** – Lauren Sommer – NPR – 21 September 2023

order to entirely eradicate our use fossil fuels and nuclear power. In contradiction to that narrative, the electrical system that has been chosen to promote the growth of wind power and solar power requires fossil fuels or nuclear to cover for wind power and solar power when they are unable to provide electricity.

The only conceptual basis to have an electrical system that is 100% sourced from wind power and solar power is to adopt the off-grid system of Professor Blythe involving battery storage. That would involve starting from scratch, abandoning our grid-based system and the reliable, affordable energy it provides.

Perspectives of Developing Countries

Critically, the emotional characterization of forms of energy is strictly a Western phenomenon. In developing countries, pragmatism prevails.

As energy politics create tectonic fracture lines between the West and developing countries, a very significant amount of that tension relates to the rejection by developing countries of the demonization of fossil fuels and nuclear power.

For reference, China has built an electrical system that provides 3.1 times as much electrical energy as all of the EU countries combined and about 2.1 times as much electrical energy as the US.[285] It has done so by encouraging rapid growth in all sources of electricity, and, importantly, it has created a system where the characteristics of various sources of energy are used complimentarily.

For example, the use of wind power and solar power modestly reduces China's coal imports and thereby modestly increases its energy security; however, China has rejected the West's demands to phase out fossil fuels on the grounds that it is "not realistic."[286] For reference,

[285] **China's Power Use Up 3.6% in 2022, China Power** – Use The State Council of Information Office The People's Republic of China – 25 January 2023 (China electricity consumption in 2022: 8.6 tkWh);
Electricity production, consumption and market overview - Eurostat - February 2023 (EU electricity consumption in 2021: 2.8tkWh);
US Energy Information Administration Short Term Energy Outlook – 7 March 2023 (US electricity consumption in 2022: 4.2tkWh);
[286] China opposes 'not realistic' global fossil fuel phase-out – Joe Lo – Climate Home News – 21 September 2023

coal provided 66.5% of China's electrical energy in 2022.[287] Coal fired electricity is the backbone of China's electrical system, a system that is at the epicenter of the electric vehicle revolution.

In contradiction to the mediatized narratives that exist in the West, wind power and solar power are not capable of providing electrical grids with the entirety of their needs in energy, and developing countries recognize that.

That is not to say that developing countries are rejecting wind power or solar power – they are not. China believes that both wind power and solar power can contribute advantageously at the periphery of its electrical system. Wind power provides 8.6% of China's electricity and 2.0% of China's total energy consumption (Table 7 and Table 1). Solar power provides 4.8% of China's electricity and 1.1% of China's total energy consumption (Table 7 and Table 1).

One might reasonably put forward the argument that China's energy policies reflect logical reasoning and are devoid of emotional motivations to favor one form of energy over another.

The Materials for Wind Power are Made from Fossil Fuels

The figures in Table 9 are based on the data of the US National Renewable Energy Laboratory and show that to manufacture a 14MW wind turbine requires the consumption of 1,430 metric tons (1,577 US short tons) of coal just for the steel required for that turbine – ignoring the coal required for the cement and assuming a very efficient coal to steel conversion ratio. If that amount of coal were put in large railcars, they would have a combined length of approximately 240 meters (260 yards). For reference, that coal train would be longer than the height of the wind turbine's tower. That figure ignores everything except the coal required in a blast furnace to create steel. If one considers the energy consumed by the supply chains from the mine to the end-of-life site remediation, it becomes even more evident that wind power is one of the heaviest industries on the planet and particularly dependent upon fossil fuels. The reality is that entire coal mines, iron

[287] **Statistical Communique of the People's Republic of China on the 2022 National Economic and Social Development** – National Bureau of Statistics of China – 28 February 2023

mines and copper mines are required simply to provide the basic feedstock in metals for wind turbines.

Coal consumed per 14MW wind turbine *Table 9*

	Mass/ Power (kg/kW)	Estimated Total Mass (Mt)	Coal per Mt of Steel (Mt)	Coal Required for Steel per Turbine (Mt)
Steel in turbine	97.2	1,361	0.77	1,048
Fibreglass blades for turbine	18.0	252	n.a.	n.a.
Iron in turbine	14.0	196	0.77	151
Copper in turbine	1.2	17	n.a.	n.a.
Aluminium in turbine	1.1	15	n.a.	n.a.
Total in turbine	131.5	1,841		1,199
Steel in foundation		300	0.77	231
Concrete in foundation		5,702	n.a.	n.a.
Total in foundation		6,003		231
Total for turbine and foundation		7,843		**1,430**

Sources: various[288]; Mt = metric ton

It is important to appreciate that the wind industry in the US and Europe is reliant on steel produced in China and Russia, because the high costs of energy have made the US and European steel industries uncompetitive. According to the CEO of Nordex, a leading wind turbine manufacturer, 85% of the wind industry's components come from China.[289]

Wind Power, Turbulence Ahead

After a prolonged period of low interest rates, the Federal Reserve, the central bank of the US, raised its target interest rate from 0.25% to 5.50% over the period from March 2022 to July 2023.[290] That change

[288] **2015 Cost of Wind Energy Review – National Renewable Energy Review** – Christopher Mone, Maureen Hand, Mark Bolinger, Joseph Rand, Donna Heimiller and Jonathan Ho – Revised May 2017
Metallurgical Coal – BHP Billiton – https://www.bhp.com – Accessed March 2023
[289] **We're all in trouble' | Wind turbine makers selling at a loss and in a 'self-destructive loop', bosses admit –** Bernd Radowitz – Recharge – 5 April 2022
[290] **Federal Funds Target Range** – Upper Limit – FRED Economic Research, St. Louis Federal Reserve Bank – https://fred.stlouisfed.org – Accessed: November 2023

represents an extraordinary increase in interest rates from "free money" to a level closer to historical norms.[291]

As we have seen, the driver of growth in wind power and solar power was premised, above all else, on very low funding costs. The end of free money will necessarily upend the prospects for all green energy projects.

How are these changes affecting wind power?

Due to the pressure to lower costs, wind turbine manufacturers can no longer afford the materials required to make high-quality wind turbines that will last. Wind turbine manufacturers indicate a wind turbine might operate for 20+ years, after which a new replacement wind turbine must be built.[292] In practice, the newer, bigger wind turbines are failing at unexpected rates and prematurely. According to Bloomberg, "Wind turbines taller than the Statue of Liberty are falling over."[293] What is going on? As wind turbines have become bigger, they need more steel, more cement and more fiber glass; however, the wind industry cannot afford these materials and it is skimping on quality. Turbines built by the three largest manufacturers, namely, GE, Vestas and Siemens Gamesa, are not delivering the reliability that had been promised.[294] Insurers are concerned because they observe that the failures are happening more quickly on the newer, bigger turbines.[295] Investors in wind manufacturers are concerned because warranty liabilities are rising as unexpected rates of early failure increase.[296]

Today, according to the wind manufacturing industry itself, "We're all in trouble" because they are in a "self-destructive loop."[297] "Every

[291] **Economic Data** – St Louis Fed – https://fred.stlouisfed.org – Accessed: May 2023
[292] **Life Cycle Stages of a Wind Power Plant** – Siemens Gamesa – https://www.siemensgamesa.com – Accessed: March 2023
[293] **Wind Turbines Taller Than the Statue of Liberty Are Falling Over** – Ryan Beene and Josh Saul – Bloomberg – 23 January 2023
[294] **Wind Turbines Taller Than the Statue of Liberty Are Falling Over** – Ryan Beene and Josh Saul – Bloomberg – 23 January 2023
[295] **Wind Turbines Taller Than the Statue of Liberty Are Falling Over** – Ryan Beene and Josh Saul – Bloomberg – 23 January 2023
[296] **Wind Turbines Taller Than the Statue of Liberty Are Falling Over** – Ryan Beene and Josh Saul – Bloomberg – 23 January 2023
[297] **We're all in trouble' | Wind turbine makers selling at a loss and in a 'self-destructive loop', bosses admit –** Bernd Radowitz – Recharge – 5 April 2022

time we sell a turbine, we lose 8 percent" stated Henrik Anderson, the Chief Executive of Vestas, a leading manufacturer of wind turbines.[298] What is going on? According to the same CEO the wind energy industry promoted itself on the basis that it could reduce costs to the point of generating electricity for free and that: "We created the perception to some extent. So we are to blame for it. That was a mistake."[299] Behind the scenes, the costs of borrowing are going up from near 0% and the costs of materials made from fossil fuels are rocketing – those are the only two ingredients that fundamentally matter for the economics of wind turbines.

The Chief Operating Officer of Siemens Gamesa gets to the point: "It's not sustainable. We cannot continue making losses." He also provides the solution from governments that the wind energy sector needs: "direct support, I would say cash."[300]

It is noteworthy that at the same time that wind power manufacturers were suggesting that they would need more direct support in the form of cash from governments to become profitable, the President of the United States, Joe Biden, stated that it was "cheaper to generate electricity from wind and solar than it is from coal and oil – literally cheaper, not a joke."[301]

Ironically, the challenges being faced by wind turbines have been compounded by the reduced supply of fossil fuels, which was driven largely by the green agenda. Due to a reduced supply of fossil fuels the cost of the materials used to manufacture wind turbines has risen: Sheri Hiscock, the CEO of GE Renewable Energy, makes the point about as clearly as possible: "We have an inflationary market that is beyond what anybody anticipated even last year. Steel is going up

[298] **Europe's Wind Industry Is Stumbling When It's Needed Most** – Stanley Reed – The New York Times – 22 November 2022
[299] **Renewable Power's Big Mistake Was a Promise to Always Get Cheaper** – Will Mathis – Bloomberg – 7 November 2022
[300] **We need 'cash support': wind giant's riposte as Germany seeks massive production boost** – Bernd Radowitz – recharge.news.com – 25 April 2023
[301] **Coal miners slam Biden as White House walks back 'shut down' pledge: 'Trying to destroy the country'** – Thomas Catenacci – Fox Business – 10 November 2022

three times. Steel for offshore wind towers is currently being purchased at over $2,000 per tonne."[302]

Wind Power, Solar Power and Wood

Reliable energy forms the backbone of the architecture of the electrical systems designed to promote the growth of wind power and solar power.

That means that growing the market share of wind power and solar power becomes an exponentially costly and risky exercise as the market share of wind power and solar power grow.

That creates huge political problems in a context where the public has been sold on the promise that green energy has potential to replace fossil fuels and nuclear power in their entirety.

In this context, the strategy devised to promote the growth in the market share of renewable energy in the European Union has been to relabel wood as "renewable" and then to use wood to replace fossil fuels and nuclear power for the provision of reliable energy.

That is why Europe has an inordinate reliance on bio-fuels. A staggering 6.0% of Europe's electricity is produced from bio-fuels,[303] which is completely off the charts relative to international norms (Table 7).

The New York Times published an article in 2022 entitled "Europe is Sacrificing Its Ancient Forests for Energy", which followed the large-scale destruction of Europe's forests, including old growth forests to provide wood pellets to fuel furnaces in the most advanced countries of that continent.[304]

As with the destruction of Tropical rainforests to procure palm oil for bio-diesel, the deforestation of Europe for wood pellets is in large part illegal and it falls outside of the statistical analysis or enquiry of the European Union.

[302] **We're all in trouble' | Wind turbine makers selling at a loss and in a 'self-destructive loop', bosses admit –** Bernd Radowitz – Recharge – 5 April 2022
[303] **Shedding light on energy in the EU, 2022** – Eurostat – 2022
[304] **Europe Is Sacrificing Its Ancient Forests for Energy** – Sarah Hurtes and Weiyi Cai – The New York Times – 7 September 2022

The scale of Europe's hunger for wood pellets hit-home for me when the Canadian Broadcasting Corporation published an article entitled "Wood from B.C. forests is being burned for electricity billed as green," which provided direct evidence that Canada's old growth forests in British Columbia are under attack to feed Europe's green energy furnaces.[305]

Wind Power, Solar Power, Electrical Grids and Batteries

Is it beneficial to combine systems comparable to that of Professor Blyth with regional, high-voltage electrical grids?

The only obvious benefit of combining wind-solar-electrical battery systems with regional electric grids is that it would hide the real cost-benefits of those systems, relative to simply creating stand-alone systems comparable to that of Professor Blyth.

Wind Power, Renewable?

Is renewable energy actually renewable or is it just a label?

It is important to appreciate that wind turbines have relatively short lifespans of 20+ years, therefore they must be replaced on a regular basis.

At the current time, there is no practical or economic means of recycling the blades of wind turbines. With turbine blades longer than the wings of 747 jet planes, it is already an issue with over 8,000 blades expected to be taken down in each of the next four years.[306] Europe has about half of that amount.[307] According to the American Wind Energy Association the cheapest thing to do is to leave them in commercial and municipal dumps unrecycled.[308]

For context, energy regulators require all energy projects to have appropriate end-of-life planning inclusive of secured funding for end-

[305] **Wood from B.C. forests is being burned for electricity billed as green, but critics say that's deceptive** – Lyndsay Duncombe, Harvey Cashore, Lynette Fortune – CBC Fifth Estate – 9 October 2022

[306] **Wind Turbine Blades Can't Be Recycled, So They're Piling Up in Landfills** – Chris Martin – Bloomberg – 5 February 2020

[307] **Wind Turbine Blades Can't Be Recycled, So They're Piling Up in Landfills** – Chris Martin – Bloomberg – 5 February 2020

[308] **Wind Turbine Blades Can't Be Recycled, So They're Piling Up in Landfills** – Chris Martin – Bloomberg – 5 February 2020

of-life remediation costs before an energy project is allowed to start, except for wind power and solar power projects for which no plan or funding is required.[309]

If you follow energy news, you will likely read that new breakthroughs are being made on a regular basis that will make it easy and affordable to recycle wind turbine blades. The Guardian, one of the most-read UK newspapers ran a headline stating that scientists have unlocked the secret to recycling wind turbine blades by turning them into gummy bears.[310] Meanwhile, retired turbine blades continue to pile up.

Wind Power, Sustainable?

The wind power industry is inordinately dependent on fossil fuels, high levels of debt, low-interest rates, subsidies, an electrical grid architecture that creates acute risks, short wind turbine replacement cycles (20 years) and there are no practical means of recycling wind turbine blades.

Nevertheless, Ørsted, the world's leading wind power developer won an award in 2019 for being the "World's Most Sustainable Company."[311]

Remarkably, the most sustainable company in the world in 2019 is now the leader of an industry that its bosses characterize as being "in a self-destructive loop," suggesting that perhaps the wind energy industry is not quite as sustainable as promised.[312]

Today, after decades, of subsidies and "policy support" that favor wind power, it provides 1.4% of global energy.

[309] **What happens to all the old wind turbines?** – Padraig Belton – BBC – 7 February 2020
[310] **Wind turbine blades could be recycled into gummy bears, scientists say** – Chelsie Henshaw – The Guardian – 23 August 2022
[311] **Ørsted named the world's most sustainable company** – Jessica Paige – Power Technology – 21 January 2020
[312] **We're all in trouble' | Wind turbine makers selling at a loss and in a 'self-destructive loop', bosses admit –** Bernd Radowitz – Recharge – 5 April 2022

Conceptually, wind power can contribute positively to our electrical energy mix through the supply of intermittent electricity, supported by reliable forms of energy when the wind is not blowing.

By the admission of its industry leaders, the wind power sector has been promoted too aggressively relative to its potential; therefore, it is likely that the wind power sector will experience a challenging period as it struggles to reconcile the promises of its public relations campaigns with the realities of wind power.

Solar Power: Clean Tech, Toxic Regulations

Solar Power

Solar power provides 0.6% of global energy and 2.7% of electricity globally.[313]

More than 80% of solar panels are made in China.[314]

The Origins of Solar Power

In 1839, Frenchman Alexandre Edmond Becquerel arranged a metallic apparatus in an acidic solution. Unexpectedly, when the sun was shining on his apparatus, he observed that it created an electrical current. With that observation solar power was born; however, his apparatus had no commercial applications because it captured less than 1% of the energy in sunlight.

In the 1940s, Russell Shoemaker Ohl at Bell Laboratories in the US noticed that a silicon semiconductor that had been accidentally cracked similarly produced an electrical current when exposed to sunlight – only this current was more powerful. Adaptations of this system captured about 1% of the energy in sunlight.[315]

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[313] **Global Energy Review 2019** – International Energy Agency - April 2020; and **Key World Energy Statistics 2021** – International Energy Agency – September 2021

[314] **China currently dominates global solar PV supply chains** – International Energy Agency – https://www.iea.org – Accessed April 2023

[315] **April 25, 1954: Bell Labs Demonstrates the First Practical Silicon Solar Cell, This Month in Physics History** – APS News – April 2009

In 2006, 13.2%-14.7% of the energy in sunlight was being captured by commercial solar panels. By 2019, that had risen to 17%-18%.[316] As at December 2022, the highest solar conversion efficiency for commercial solar panels was 26.4%.[317]

Wind power has a single lever to increase efficiency, namely, by increasing scale, which is why wind turbines have taken on gargantuan proportions.

It is essential to appreciate how fundamentally different solar power is from wind power, to the extent that solar power is driven by technological progress. The gains in the fundamental efficiency of solar power are impressive.

Solar power could benefit appreciably from future technological advances that could i) lower solar panel costs, ii) capture more energy from sunlight, and iii) improve the end-of-life hazards of solar panels.

Likewise, solar power, being driven by technology, has potential to adapt to more stringent environmental regulations.

Alternating Current vs. Direct Current

Electricity can be provided in two forms, namely, alternating current or direct current.

Solar power provides electricity in the form of direct current.

Wind power provides electricity in the form of alternating current.

Electrical batteries charge and discharge in direct current.

Converting electricity from one form to another creates inefficiencies.

Therefore, conceptually, solar power is a perfect match for the off-grid (direct) charging of electrical batteries. Likewise, the electricity

[316] **Future of Solar Photovoltaic** – International Renewable Energy Agency – November 2019.

[317] **JinkoSolar's High-efficiency N-Type Monocrystalline Silicon Solar Cell Sets Our New Record with Maximum Conversion Efficiency of 26.4%** – JinKO Solar – 12 December 2022

provided by solar power must be converted from direct current into alternating current to be carried on power grids.

From that perspective, solar power would be a primary beneficiary of extremely significant improvements in electrical batteries over the decades ahead, to the extent that off-grid solar-to-battery systems become viable. For now, costs remain the primary challenges for such systems to supplant the grid-based provision of electricity, which is why, today, solar power provides electricity primarily into electrical grids.

The Law of Diminishing Returns Applies to Unreliable Sources of Electricity

Solar radiance is concentrated in the Tropics, making it the most ideal place on the planet for solar power (Figure 8).

Solar radiance by latitude ***Figure 8***

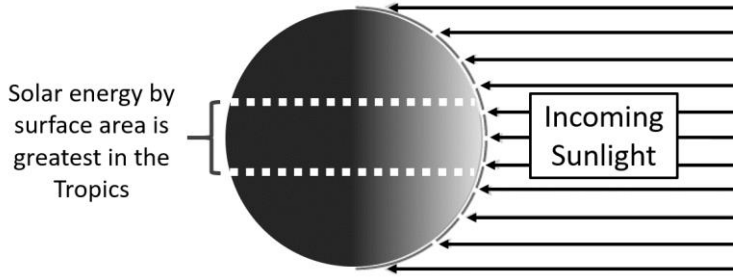

Photo Credit: Author

Since 2008, the State of Hawaii, USA has been targeting the obtainment of sourcing 100% of its electricity from renewable sources. In 2022, 29% of the state's electricity came from renewable energy.[318] In that year, solar power produced 17% of the state's electricity.[319] Most of the state's solar power generation is from small-scale customer-sited solar panels. Although Hawaii has successfully increased the market share of renewable electricity, in 2022 it also had

[318] **Hawaii State Energy Profile** – US Energy Information Administration – https://www.eia.gov – Accessed: May 2023
[319] **Hawaii State Energy Profile** – US Energy Information Administration – https://www.eia.gov – Accessed: May 2023

the most expensive electricity in the US.[320] Moreover, the more Hawaii relies on unreliable renewable electricity, the harder it has become to increase the market share of unreliable renewable electricity: Its current goal to switch entirely to renewable electricity has been extended to 2045.[321]

Hawaii's push into solar power is running up against the law of diminishing returns, which applies generally to all sources of unreliable electricity.

To understand how the law of diminishing returns applies to unreliable sources of energy that rely on the weather or the time of day, one can consider the following examples. If, hypothetically, Hawaii was completely covered in solar panels, most of those solar panels would be overkill – they would not be required or used. Likewise, if Hawaii were to install enough solar panels to run its electrical grid on cloudy overcast days, then on clear sunny days many solar panels would represent overkill – they would not be required or used. For that reason, as more solar panels are installed, the economic value and utility of each newly installed solar panel goes down. The law of diminishing returns applies to all unreliable sources of energy.

For reference, Hawaii is something of a perfect case study for advancing solar-based energy systems because i) it is a tropical island with plenty of intense sunlight, ii) it has relatively modest needs in electrical energy because of its climate and lack of heavy industry, and iii) it is a state within the most powerful country in the world with extraordinary financial resources. It would be a mistake to suggest that other regions are as well suited to solar power.

Solar's Land Requirements

Habitat loss due to human land use is the number-one reason that wildlife globally is in decline.[322] However, there are no national or

[320] **Hawaii had highest electric bills nationwide in 2022, report finds** – Sophia Compton – Pacific Business News – 6 January 2023

[321] **Hawaii Clean Energy Initiative** – US Department of Energy, Office of Electricity – https://www.energy.gov – Accessed: April 2023

[322] **"Habitat Loss Poses the Greatest Threat to Species" Habitat Loss** – World Wildlife Fund – https://wwf.panda.org/ – Accessed: July 2020;
Threats to Wildlife – The National Wildlife Federation – https://www.nwf.org/ – Accessed: July 2020; and

global statistics available on the amount of the Earth's surface area that is being used for solar power projects. High-resolution commercial satellites can provide images with a resolution of 30 centimeters (11.8 inches).[323] However, for the time being, computers are not sufficiently intelligent to determine using satellite data how much land is occupied globally by solar power developments.[324] At some point that data will be provided and the scale of the habitat loss due to solar power projects will be quantified. At the current time, our energy regulators do not publish information on the amount of land that is used by solar power developments.

Solar, Environmental Considerations

The best working assumption for the longevity of solar panels is 25 years.[325] That is a relatively short duration and focuses attention on the sustainability and ease with which solar panels can be recycled because after a relatively short period of less than 25 years they need to be replaced.

Solar panels are costly and difficult to recycle, which is problematic because solar panels contain high volumes of lead, cancerogenic cadmium and other toxic metals. When solar panels are damaged prematurely or once they are retired these toxins leach freely out into the ground water and into the water system.[326]

In the US, the Environmental Protection Agency has essentially stated that if a solar panel is deemed to be hazardous it must be treated as hazardous waste, otherwise it's essentially open season, the solar panel can be disposed of in universal waste facilities. There are currently no specific guidelines as to which panels are hazardous and

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Nature's Dangerous Decline 'Unprecedented' Species Extinction Rates 'Accelerating' – United Nations, Intergovernmental Science-Policy on Biodiversity and Ecosystem Service – 6 May 2019

[323] **The Power of 30cm** – European Space Imaging – https://www.euspaceimaging.com – Accessed: March 2021

[324] **Distributed solar photovoltaic array location and extent dataset for remote sensing object identification** – Kyle Bradbury, Raghav Saboo, Timothy L. Johnson, Jordan M. Malof, Arjun Devarajan, Wuming Zhang, Leslie M. Collins & Richard G. Newell – Scientific Data – 6 December 2016

[325] **Solar Panel Lifespan Explained** – Akshay VR – The Solar Labs – https://thesolarlabs.com – Accessed: March 2023

[326] **End-of-Life Solar Panels: Regulations and Management** – United States Environmental Protection Agency – https://www.epa.gov – Accessed: April 2023

which are not.[327] It's a bit of a trial-and-error exercise: If they are known to leak toxic waste, they are labelled as hazardous, but otherwise probably ok.

Industry experts and recyclers on the ground estimate that one in ten solar panels is being recycled, and for the rest, where they end up, we don't know – no tracking.[328] We do know that 99% of solar panels are damaged when they are taken down and transported away from their original site, meaning that they will leak toxicity into rainwater.[329]

The EU is attempting to regulate the recycling of solar panels through its laws relating to electrical waste, or e-waste.[330] That is not reassuring in a context where e-waste is already flooding from the developed world into poorer countries of the developing world. For reference, e-waste, such as old mobile phones and retired electronic equipment, is being exported, mostly illegally, to countries where it is manually torn apart for scrap. To provide a scale of the problem, according to the World Health Organization, 18 million children and adolescents are working in e-waste dumps, the toxicity of which is particularly harmful to children.[331]

How do we know that solar panels, like other e-waste, will end up in the waste dumps of the developing world? It costs $20-$30 to recycle a solar panel, but they contain only $2-$4 of valuable scrap. That means they are uneconomic to recycle. The reason that they are not being recycled is because nobody wants to foot the bill and our regulators have failed to bind the end-of-life financial obligations on those who benefited financially from the solar panels.[332]

Energy project developers are the financial beneficiaries of their projects and therefore are responsible for funding the related end-of-

[327] **End-of-Life Solar Panels: Regulations and Management** – United States Environmental Protection Agency – https://www.epa.gov – Accessed: April 2023
[328] **California went big on rooftop solar. Now that's a problem for landfills** – Rachel Kisela – Los Angeles Times – 14 July 2022
[329] **Solar Waste / European WEEE Initiative** – http://www.solarwaste.eu – Accessed: March 2023
[330] **Solar Waste / European WEEE Initiative** – http://www.solarwaste.eu – Accessed: March 2023
[331] **Soaring e-waste affects the health of millions of children, WHO warns** – World Health Organization – 15 June 2021
[332] **California went big on rooftop solar. Now that's a problem for landfills** – Rachel Kisela – Los Angeles Times – 14 July 2022

life reclamation and recycling costs. That is standard industry practice across the entire energy sector, with the notable exception of green energy projects. The EU has taken the extra measure of explicitly mandating that solar power developers in the EU are to be absolved of their responsibilities to fund solar panel recycling costs. The EU has done this in conjunction with another mandate that requires the original manufacturers of solar panels to "take back" and recycle the used solar panels that they manufactured.[333] The Chinese solar panel manufacturers that do "take back" their solar panels after several decades of use in the EU will have the choice of either shipping them to the newly forming e-wastelands of the poor developing world or funding large-scale, costly recycling programs. The EU will have limited, if any, oversight over the eventual outcome. In 2022, the US blocked 1,000 shipments of solar panels from China worth hundreds of millions of dollars on the grounds that they were being produced using slave labor in Uyghur detention camps in Xinjiang.[334] The EU recycling program is premised on trusting the very same solar panel manufacturers to conscientiously fund the costly recycling of the solar panels that they manufacture.

We have learned from the floods of e-waste into poor developing countries that headline laws are irrelevant. There needs to be a robust concerted system to ensure that solar panels are dealt with appropriately at the end of their lives.

For reference, by the 2050s, it is estimated that waste from solar panels will amount to 5.5 to 6.0 million metric tons per year.[335]

Recycling solutions for solar panels are straightforward. If the same standards were applied to the solar industry as other sectors of the energy industry, i) each solar panel would be individually tracked until recycled, ii) recycling responsibilities would be clearly established, and iii) there would be a requirement to have satisfactory proofs of the means of funding end-of-life recycling before projects get regulatory approval.

[333] **Solar Waste / European WEEE Initiative** – http://www.solarwaste.eu – Accessed: March 2023
[334] **U.S. blocks more than 1,000 solar shipments over Chinese slave labor concerns** – Nichola Groom – Reuters – 11 November 2022
[335] **End-of-Life-Management Solar Photovoltaic Panels** – International Renewable Energy Agency – June 2016

Oddly, for an industry that exists due to governmental regulations, solar panel recycling is essentially unregulated, or arguably worse to the extent that it is regulated in such a way as to explicitly absolve the beneficiaries of solar projects from their environmental responsibilities.[336]

Sam Vanderhoof, is a solar power expert and the CEO of a company that is attempting to manage the ramp up of solar panel waste in California, where some of the first solar panels installed in the US are reaching the end of their useful lives. Based on his first hand knowledge of the scale of the toxic waste being created by solar panels, he states: "The industry is supposed to be green, but in reality, it's all about the money."[337]

Solar, Concluding Thoughts

Unlike wind power, solar power has tremendous scope to become more efficient and more environmentally responsible because it is a technologically driven sector.

Although the lack of regulatory oversight for solar power may increase the sector's short-term profits; arguably, from a longer-term perspective, the solar power industry is being disserviced by lax regulatory oversight. That is because the lack of environmental and end-of-life regulations for solar power is resulting in a large-scale toxic waste issue that is increasingly difficult to reconcile with solar power as a clean source of energy. For an industry that is not sufficiently profitable to exist without governmental support, and by extension public support, the creation of millions of tons of toxic waste cannot be helpful for the sector's long-term prospects.

For a visionary looking into the decades and centuries ahead, the fortunes of solar power could be completely transformed by very significant technological improvements such that electrical grids could be displaced by off-grid, solar-to-battery systems, starting in sunny, tropical climates. For now, there is no realistic scope to expect

[336] **Solar Panels Information and FAQs** – Department of Toxic Substance Control, State of California – https://dtsc.ca.gov – Accessed: October 2020; and
If Solar Panels Are So Clean, Why Do They Produce So Much Toxic Waste? – Michael Shellenberger – Forbes – 23 May 2018

[337] **California went big on rooftop solar. Now that's a problem for landfills** – Rachel Kisela – Los Angeles Times – 14 July 2022

that we will be able to displace our electrical grids in the next half-century; that said, solar-to-battery systems are arguably the front-runners in terms of being contenders to eventually displace our need for electrical grids.

The recent technological progress of solar power has been impressive in terms of both cost reductions and gains in solar efficiency.

Based on the state of technology today and based on the scope for technological improvements that one might reasonably expect for the decades ahead, solar power can be expected to provide electricity on an intermittent basis on the periphery of our electrical grids, supported by reliable forms of energy when the sun is not shining.

As a reminder, electricity represents approximately one-fifth of global energy consumption. Outside of the electricity market, solar power has no practical scope to replace forms of energy that provide intense heat on an affordable, reliable and large-scale basis able to support an industrialized, modern civilization.

As with wind power, forcing the expansion of solar power will result in escalating costs and increased energy precarity as a result of the law of diminishing returns, which applies to all forms of intermittent energy. Arguably, the sustainability of that strategy is already testing the limits of the financial capacity of western governments.

Electrical Batteries: The Biggest Game Changer, and Not

Energy Storage in Context

Fossil fuels and bio-fuels represent both a source of energy and a means of storing energy.

In particular, oil and the products derived from oil can be stored indefinitely, transported around the world, and transferred from one storage tank to another easily and with no material costs or loss of energy content. Oil is said to be fungible, which means that it can be converted readily into cash. The fungibility of oil is intrinsically linked to the ease with which it can be stored. Oil's fungibility underpins a global logistical network that reliably supplies oil and oil products everywhere there is human activity globally. Critically, oil's fungibility also underpins the trade finance and banking system that support those flows of energy, all of which is premised on the ability

to store oil. Oil essentially has characteristics that make it comparable in many ways to money itself.

The key is to appreciate that the ease, or difficulty, with which a form of energy can be stored makes all the difference.

As a reminder, electricity is not a source of energy, but rather a means of transporting energy over copper wires from where the energy is sourced to where it is consumed.

Electrical batteries provide a means of i) storing electrical energy and ii) freeing electrical energy from the copper wires or grids used to transport electricity.

However, electricity is miles away from being fungible, like oil. That is because storing electricity requires electrical batteries, the price of which makes them prohibitively costly containers for the storage of generic, industrial-scale electrical energy.

The Origins of the Electrical Battery

It is remarkable that much like the tribal energy camps that exist today, during the last quarter of the 18th century, the scientific community was divided into two tribe-like camps which were in a fierce debate. The leaders of those respective groups were Luigi Galvani and Allesandro Volta.

Despite the intensity of their dispute, Galvani's gentle temperament and the high principles of Volta precluded any hostile argumentation between them; rather, their logical, reasoned approach led to both parties undertaking fundamental experiments to support their respective hypotheses; these investigations led to, amongst other developments, the first electrical battery.

Submerged in salt water, Galvani was able to induce a dissected frog's leg to twitch by touching it with bronze and iron metals. Science was in agreement that electricity was causing the frog's leg to twitch, but what was the source of the electricity? Galvani argued that it came from within the frog. Volta argued that it came from the metals.

Volta undertook to prove his argument. To do so he placed a piece of salt water soaked cardboard between a copper disc and a zinc disc. He found that if the copper and zinc metals were then connected by a metallic wire, electricity would flow in the wire – he was right,

electricity had been coming from the metals. To prove his hypothesis, Volta had invented an electrical battery. To increase battery power, he stacked multiple discs in copper-cardboard-zinc series on top of each other in a pile.

The Components of Electrical Batteries

We now understand why Volta's batteries work: Firstly, in a conductive material free electrons flow from where they are in relative abundance to where they are in relative scarcity, which creates an electrical current; secondly, copper and zinc react chemically with salty water in such a way that it creates an imbalance in the electron concentrations between the two metals.

The three core components that constitute electrical batteries today replicate the functions of zinc, copper and saltwater; they are termed respectively the anode, cathode and electrolyte of an electrical battery.

For most of the last two centuries, battery technology progressed slowly as new materials for anodes, cathodes and electrolytes were tested, largely by trial and error.

Key Breakthroughs in Electrical Battery Technology

Three developments completely revolutionized battery technology and a third potential key development is currently being progressed:

i) Firstly, in 1859, Gaston Planté of France invented the first rechargeable electrical battery, which used lead (instead of zinc), lead-dioxide (instead of copper) and sulfuric acid (instead of salt water). These so-called lead-acid rechargeable batteries are reliable and remain in widespread use today; however, their limited concentration of energy relative to their size and weight reduces their utility for many applications.

ii) Secondly, in 1991, Sony Corporation commercialized a revolutionary rechargeable battery concept based on the movement of lithium-ions within a battery. The increased energy density of these batteries reduced the weight and volume of rechargeable batteries while increasing their operational life. The first commercial lithium-ion batteries

were used in Sony video camcorders; however, today, lithium-ion batteries are ubiquitous: Almost all mobile electric devices from smart phones to electric vehicles run on lithium-ion batteries.

iii) Thirdly, the recent commercial launch of sodium-ion batteries by leading battery manufacturers is paving the way for a potential transformation in battery technology. Initial estimates suggest that sodium-ion batteries are expected to cost 30% less than lithium-ion batteries[338]. Essentially, sodium is a widely abundant mineral in contrast to lithium which is exceptionally scarce and a limiting factor on the scale-up of battery manufacturing. Sodium-ion batteries are safer than lithium-ion batteries and operate in temperatures as low as 80° Celsius (-112° Fahrenheit).[339] In contrast, if you have taken your mobile phone out in the freezing cold, you will likely have appreciated that lithium-ion batteries do not operate well in freezing conditions. Based on current technologies, sodium-ion batteries are modestly heavier than lithium-ion batteries, that is their single competitive disadvantage relative to lithium-ion batteries.

Comparing an Electrical Battery to a Barrel of Oil

Electrical batteries are containers in which electrical energy can be stored – comparable to a barrel or a tank in which oil can be stored.

Oil in a standard 42-gallon (159.1 liter) barrel of oil contains 1,668 kWh of energy.[340] In 2022, the US Department of Energy Estimated that the average cost of a lithium-ion battery was $153/kWh.[341] Therefore, the cost of purchasing an electrical battery that can store as

[338] **The automaker using CATL's sodium batteries with amazing results 200kWh** – Sam Evans, the Electric Viking – on YouTube – 17 April 2023

[339] **Extending the low-temperature operation of sodium metal batteries combining linear and cyclic ether-based electrolyte solutions** – Chuanlong Wang, Akila C. Thenuwara, Jianmin Luo, Pralav P. Shetty, Matthew T. McDowell, Haoyu Zhu, Sergio Posada-Pérez, Hui Xiong, Geoffroy Hautier and Weiyang Li – Nature – 22 August 2022

[340] **Btu content of energy units** – US Energy Information Administration – https://www.eia.gov – Accessed: May 2023

[341] **Electric Vehicle Battery Pack Costs in 2022 Are Nearly 90% Lower than in 2008, according to DOE Estimates** – US Department of Energy – 9 January 2023

much energy as a barrel of oil in 2022 was approximately $261,000. This is shown in Figure 9.

For reference, the average price of oil in the US in that same year was $95 per barrel.[342] Therefore in 2022, lithium-ion electrical battery capacity cost 2,747 times more than the equivalent amount of energy in a barrel of oil.

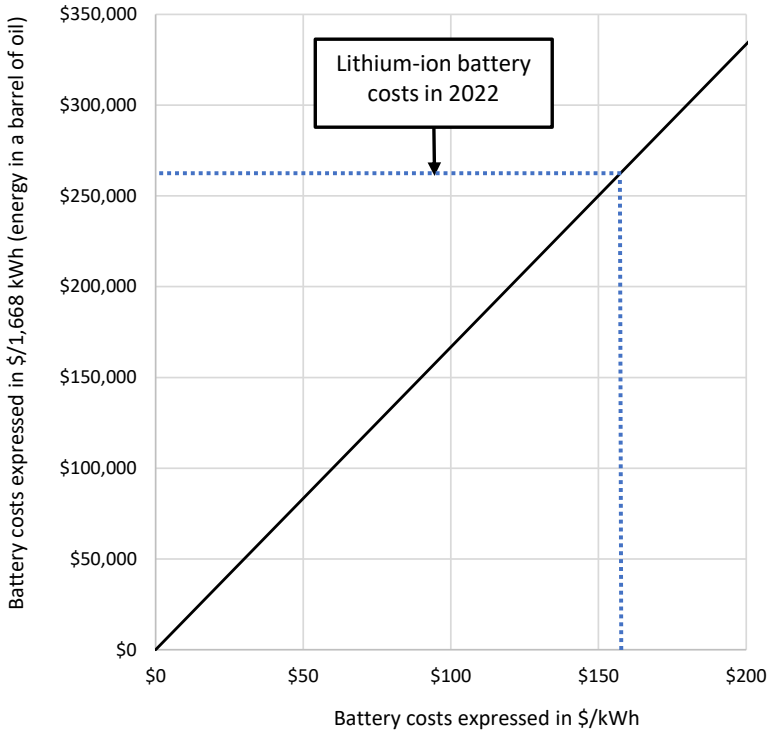
The point is to appreciate the extent to which electrical batteries are expensive containers in which to store energy.

The best electrical batteries can be charged and discharged 3,000 times;[343] therefore, they cannot be compared on a like for like basis with fuels, which are consumed only once. However, it is obvious that even under the hypothetical case of electricity being given away for free, the cost of electrical batteries would be a significant consideration for many applications.

The key point is to appreciate that storing oil and other fuels that combust involves negligible costs, whereas, storing electricity requires the use of costly containers, namely, electrical batteries.

[342] **Spot Prices Crude Oil** – US Energy Information Administration – https://www.eia.gov – Accessed: May 2023
[343] **CATL Battery** – https://www.evlithium.com – Accessed: May 2023

Battery Cost Able to Store 1,668 kWh of Energy ***Figure 9***



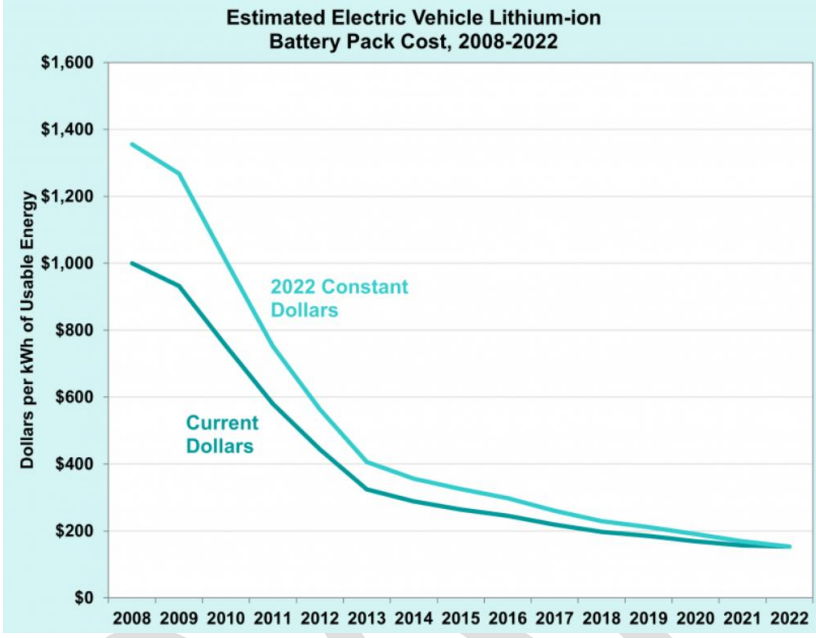
Source: Author

Battery Costs are Falling

The decline in battery costs as estimated by the US Department of Energy is provided in Figure 10.[344]

[344] **Electric Vehicle Battery Pack Costs in 2022 Are Nearly 90% Lower than in 2008, according to DOE Estimates** – US Department of Energy – 9 January 2023

Battery cost estimates *Figure 10*



Source: US Department of Energy[345]

Practical Considerations in Respect of Electrical Batteries

Today, commercial electrical batteries have the merit of being able to usefully discharge up to 96% of the energy used to charge them,[346] making them highly efficient on a round-trip basis. Although, for the purposes of providing stationary utility-scale power, in practice, the US Energy Information Administration estimates that the round-trip efficiency of electrical batteries is 82%, highlighting that electrical batteries do lose their charge over time and the effects of other inefficiencies.[347]

[345] **Electric Vehicle Battery Pack Costs in 2022 Are Nearly 90% Lower than in 2008, according to DOE Estimates** – US Department of Energy – 9 January 2023
[346] **Product datasheet: Intesium® Max+ 20M** – SAFT – https://www.saftbatteries.com – Accessed: December 2020
[347] **Utility-scale batteries and pumped storage return about 80% of the electricity they store (data for 2019)** – US Energy Information Administration – https://www.eia.gov – Accessed: May 2023

At the present time, electrical batteries are most suited for premium applications that involve regular and short charge-discharge cycles for which the value added from mobility is significant. For these applications the high upfront costs of electrical batteries are worth paying.

Mobile phones and electric vehicles are examples of premium products that are well suited to exploit the advantages of electrical batteries.

It Is Simply a Myth that EVs Reduce CO_2 Emissions

According to the International Energy Agency electric vehicles require 6.2 times more minerals than conventional vehicles.[348] That implies that the upstream mining operations for electric vehicles will be significantly greater than for conventional vehicles. That increases both the environmental footprint and the carbon dioxide emissions of electric vehicles relative to conventional vehicles.

Volkswagen assessed that to manufacture an electrical vehicle emits more than twice as much carbon dioxide as emitted from manufacturing a comparable conventional vehicle.[349]

Volkswagen determined that based on the sources of electricity used to charge electric vehicles in the US and Germany after 200,000km (124,000 miles) of use an electric vehicle would actually have emitted more carbon dioxide than a conventional vehicle.[350]

More than half of all electric vehicle sold globally are sold in the Chinese market[351] and 66.5% of China's electricity is derived from coal.[352]

Volkswagen determined that in addition to the more than doubling of carbon dioxide emissions from manufacturing an electrical vehicle

[348] **Minerals used in electric cars compared to conventional cars** – International Energy Agency – 26 October 2022 – https://www.iea.org – Accessed: May 2022
[349] **From the well to the wheel** – Volkswagen Group – https://www.volkswagenag.com – Accessed: May 2023
[350] **From the well to the wheel** – Volkswagen Group – https://www.volkswagenag.com – Accessed: May 2023
[351] **China Has Shot at Seizing 60% Share of Global EV Sales This Year** – Colin McKerracher – Bloomberg – 15 November 2022
[352] **China's Power Use Up 3.6% in 2022** – China Power Use The State Council of Information Office The People's Republic of China – 25 January 2023

relative to a conventional vehicle, each mile travelled in an electric vehicle in China emits 26% more carbon dioxide than a conventional vehicle.[353]

It is important to appreciate that electric vehicles are gaining market share because they are increasingly affordable to buy and affordable to charge – fossil fuels are the reason electric vehicles are affordable to buy and affordable to charge. To be clear, electric vehicles are existentially dependent on fossil fuels and there is no prospect for that to change based on the technologies currently available or under commercialization.

In 2020, the Kiel Institute, a globally recognized, independent and not-for-profit organization based in Kiel Germany, came to the same conclusion to that of Volkswagen, namely, that electric vehicles emit more carbon dioxide than conventional vehicles.[354]

The narrative that electric vehicles reduce carbon dioxide emissions is inconsistent with both the heavy carbon dioxide emissions related to manufacturing and driving electric vehicles.

Electrical Batteries, Environmental Considerations

The mining footprint for electrical vehicles, relative to conventional vehicles, will necessarily reflect that they require 6.2 times more minerals than conventional vehicles[355] – a staggering difference in terms of the increased environmental costs caused by electrical vehicles.

Moreover, the mining processes for electrical batteries cause inordinate environmental harm.

Mining for lithium, the key component of lithium-ion batteries, is particularly energy intensive and involves the pollution of regional waterways with toxic metals.[356]

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[353] **From the well to the wheel** – Volkswagen Group – https://www.volkswagenag.com – Accessed: May 2023
[354] **Electric Mobility and Climate Protection: A Substantial Miscalculation** – Ulrich Schmidt – Kiel Policy Brief – June 2020
[355] **Minerals used in electric cars compared to conventional cars** – International Energy Agency – 26 October 2022 – https://www.iea.org – Accessed: May 2022
[356] **The Environmental Impacts of Lithium and Cobalt Mining** – March Zheng – Earth.Org – 31 March 2023

Cobalt too is an essential mineral for lithium-ion batteries. It is toxic to touch and breath. 60-70% of the world's cobalt is from the Democratic Republic of Congo.[357] There, it is dug up by hand in dangerous and degrading conditions involving both modern day slavery and child labor.[358] The forests and landscapes of the country are being ravaged and clouds of toxic cobalt dust are negatively affecting the health of communities across the whole country.[359]

It is critical to appreciate that there are no practical means of recycling lithium-ion batteries.[360] The metals contained in electrical batteries are highly toxic even in small quantities.[361] The majority of lithium-ion electrical batteries are disposed of in landfills.[362] There, rainwater is causing electrical batteries to leak, contaminating groundwater and even starting underground fires.[363]

Our energy regulators have no coherent plan to manage or fund the inevitable end of life issues for the batteries in electric vehicles.

Hydrogen: Future-Fuel?

Background on Hydrogen Fuel

Hydrogen as a fuel refers to molecules of hydrogen, consisting of two hydrogen atoms (H_2).

[357] **The Environmental Impacts of Lithium and Cobalt Mining** – March Zheng – Earth.Org – 31 March 2023
[358] **How 'modern-day slavery' in the Congo powers the rechargeable battery economy** – Terry Gross – NPR – 1 February 2023
[359] **How 'modern-day slavery' in the Congo powers the rechargeable battery economy** – Terry Gross – NPR – 1 February 2023
[360] **Recycling lithium-ion batteries from electric vehicles** – Gavin Harper, Roberto Sommerville, Emma Kendrick, Laura Driscoll, Peter Slater, Rustam Stolkin, Allan Walton, Paul Christensen, Oliver Heidrich, Si -mon Lambert, Andrew Abbott, Karl Ryder, Linda Gaines and Paul Anderson – Nature – 6 November 2019
[361] **The Environmental Impacts of Lithium and Cobalt Mining** – March Zheng – Earth.Org – 31 March 2023
[362] **The Environmental Impacts of Lithium and Cobalt Mining** – March Zheng – Earth.Org – 31 March 2023
[363] **The Environmental Impacts of Lithium and Cobalt Mining** – March Zheng – Earth.Org – 31 March 2023

In nature, hydrogen molecules combust spontaneously with oxygen to form water; therefore, hydrogen molecules (H_2) do not exist in our atmosphere naturally.

Hydrogen as a fuel must be created through synthetic processes.

Therefore, hydrogen is not a source of energy, but rather a means of storing energy in the form of a synthetically created fuel.

Hydrogen can be produced by splitting water (H_2O) into oxygen (O_2) and hydrogen (H_2) using electricity in a process called electrolysis. Today, less than 0.1% of hydrogen is produced from electrolysis.[364] The remainder, essentially all hydrogen currently produced, is derived from fossil fuels.

As we have seen, 6% of the natural gas produced globally and 2% of the coal produced globally is used as feedstock to produce hydrogen to make fertilizer.[365] Essentially, today, hydrogen exists through the reformulation of fossil fuels mainly for the purposes of making fertilizer.

Hydrogen can release heat energy through combustion, like any other fuel.

However, hydrogen produced from electrolysis is intended to provide the energy to power fuel cells. Fuel cells produce electricity directly without combustion.

Hydrogen, whether burned or consumed in a fuel cell, emits only water as a by-product. Consuming hydrogen does not emit carbon dioxide.

Practical Considerations in Respect of Hydrogen

Hydrogen has the advantage of providing 2.7 times more energy than gasoline by weight.[366] However, it is voluminous; even when

[364] **The Future of Hydrogen** – International Energy Agency – June 2019
[365] **The Future of Hydrogen** – The International Energy Agency, Technology Report – June 2019
[366] **Hydrogen Storage** – US Office of Energy Efficiency and Renewable Energy – https://www.energy.gov/ – Accessed: August 2020

compressed to 700 times atmospheric pressure it requires 5.7 times more volume than gasoline for the same amount of energy.[367]

Compressing hydrogen consumes an amount of energy equivalent to 12%-15% of the energy so compressed.[368]

Unlike the energy in electrical batteries, the energy stored in hydrogen remains constant over time – a critical advantage.

However, currently, using hydrogen to store electricity loses about 64% of the initial energy in the process of converting electricity into hydrogen and back into electricity.[369] This increases the cost of energy stored in hydrogen by 2.7 times relative to the cost of the initial electrical energy (ignoring equipment and compression costs).[370]

The molecular structure of hydrogen (H_2) is infinitesimally small relative to other molecules. It is so small that hydrogen molecules can seep through metal storage tanks. It is estimated that an economy run on hydrogen would lose between 2.7% and 5.6% of its energy simply through leakage.[371]

Hydrogen embrittles metals and increases the risk that metals crack.[372]

Hydrogen combusts upon contact with oxygen, which increases the handling risks of this form of energy, particularly when it is under pressure.

Fuel cells require hydrogen that is exceptionally pure (99.999% pure), to avoid their premature degradation. That requirement significantly

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[367] **Hydrogen - A sustainable energy carrier** – Kasper T. Møller, Torben R. Jensen, Etsuo Akiba and Hai-wen Li – Progress in Natural Science: Materials International – 27(2017)

[368] **Green Hydrogen in Developing Countries** – World Bank, ESMAP – 2020

[369] **Product datasheet: HgasXMW Product Specification** – ITM Power – https://www.itm-power.com – Accessed: October 2020; and
Green Hydrogen in Developing Countries – World Bank, ESMAP – 2020

[370] **Solid Oxide Electrolysis** – Ceres Power – Final Results – 17 March 2021

[371] **Hydrogen Leakage: A Potential Risk for the Hydrogen Economy** – Zhiyuan Fan, Hadia Sheerazi, Amar Bhardwaj, Anne-Sophie Corbeau, Kathryn Longobardi, Adalberto Castaneda, Ann-Kathrin Merz, Caleb M. Woodall, Mahak Agrawal, Sebastian Orozco-Sanchez, Julio Friedmann – Columbia SIPA, Centre on Global Energy Policy – July 2022

[372] **Hydrogen Permeation and Hydrogen-Induced Cracking** – Branko N. Popov, Jong-Won Lee, Milos B. Djukic – Handbook of Environmental Degradation of Materials – 2018

increases the associated costs of creating and handling hydrogen for fuel cells.

Hydrogen, Future Fuel?

Conceptually, hydrogen is put forward as a competitor to electric batteries as a means of storing energy from wind power and solar power.

In practice, currently, electrical batteries have a significant competitive lead as a means of storing energy.

Hydrogen's molecular structure (H_2) is quite similar to that of methane (CH_4), the primary constituent of natural gas; however, in practice hydrogen is considerably more challenging to handle than natural gas. Over that last century, technology overcame many of the hurdles in respect of the handling of natural gas, which is currently growing its market share faster than any other source of energy. Likewise, it is conceivable that with technological progress hydrogen will become a future-fuel; however, it is not at all obvious that it will.

Conclusions in Respect of Modern Energy

The Miracle of Modern Energy

The miracle of modern energy is that it allows 8 billion people to exist and to be fed, while providing the foundation of our modern economies and way of life.

The scale of the affordable, reliable and practical energy provided by fossil fuels is the foundation of the modern world created since the Industrial Revolution. Fossil fuels provide 80.8% of our global needs in energy.[373]

Heat from combustion, inclusive of the heat energy from burning fossil fuels, wood and other biofuels, provides 90.3% of our global needs in energy.[374]

Where is the Energy Transition?

In 2022, $1.4 trillion was channeled into green energy projects.[375] Wind power and solar combined provide only 2.0% of global energy.[376]

Higher interest rates and significant cost pressures, driven in large part by shortages of fossil fuels, have abruptly deteriorated the outlook for wind power and solar power. The heavy subsidy burdens funded by tax payers to sustain wind power and solar power projects are weighing heavily on over-indebted Western governments. That has already drastically changed the politics and economics of the Energy Transition.

[373] **Key World Energy Statistics 2021 (Data for 2019)** – International Energy Agency – September 2021
[374] **Key World Energy Statistics 2021 (Data for 2019)** – International Energy Agency – September 2021
[375] **World Energy Investment 2022** – International Energy Agency – June 2022
[376] **Key World Energy Statistics 2021 (Data for 2019)** – International Energy Agency – September 2021

BlackRock is the world's largest money manager, managing $9.4 trillion of financial assets,[377] of which $4 trillion is invested in sustainable or ESG investments.[378] The Chairman and Chief Executive Officer of BlackRock, Larry Fink, has been one of the most forceful advocates of green energy and ESG finance on the global stage.[379]

Reflecting the economic realities that are clearly surfacing, after more than a decade of promoting green energy and ESG finance, in 2023, Fink made a shocking statement that reflects the core reality of the Energy Transition: "Let's be clear, we are not going to have a transition unless we can find technologies to bring down the competitive cost of renewables, we cannot do that." [380]

It is notable that Fink's assessment is almost identical to that of Lord Kelvin's assessment of the feasibility of replacing coal with wind power and electrical batteries in the 1880s, which was that it would require "inventions not yet made."[381]

Today, it is not obvious that we are closer to replacing fossil fuels with renewable energy as we were in the 1880s. Arguably, the challenge of replacing fossil fuels with a substitute has grown significantly since the 1880s; that is because, i) the human population has increased by five times,[382] ii) our lifestyles are significantly more energy intensive than they were in the 1880s, and iii) we are significantly less dependent on wood and significantly more dependent on fossil fuels than we were in the 1880s. For reference, the demand for energy

[377] **BlackRock is wrestling with succession planning** – Rebecca Ungarino – Business Insider – 3 September 2023
[378] **BlackRock is wrestling with succession planning** – Rebecca Ungarino – Business Insider – 3 September 2023
[379] **The Power of Capitalism** – Larry Fink's 2022 Letter to CEOs – Blackrock; **Larry Fink's Chairman's Letter 2022** – Blackrock – 24 March 2022; and **A Fundamental Reshaping of Finance** – Larry Fink's 2020 Letter to CEOs – Blackrock
[380] **Larry Fink Interview with Dani Burger** – Bloomberg – 29 September 2023
[381] **July 1887: James Blyth Harnesses the Wind for Electricity** – Daniel Garisto – APS News – July/August 2022
[382] **How many people on earth? World population 1800-1938** – Giovanni Federico and Antonio Tena Junguito – CEPR – 20 February 2023

globally – and the energy challenge – has grown by 2% every year on average for the last half century, with no sign of letting up.[383]

Today, as in the 1880s, eliminating fossil fuels would result in the catastrophic reduction in our capacity to sustain the existence of the human population. To be clear on this point, without fossil fuels most humans alive would precipitously perish, mostly by starvation. Today, there is no alternative form of comparably reliable, affordable, useful and abundant energy that could prevent humanity from immediate starvation in the absence of fossil fuels.

Electrical Batteries – The Biggest Game Changer, and Not

Electrical batteries are technological marvels that have and will continue to transform the energy landscape; however, electrical batteries are not sources of energy, but rather means of storing electrical energy.

Agriculture, the Keystone of Human Prosperity

Positively, the increased availability of affordable fossil fuels, particularly in developing countries, would increase agricultural yields – the keystone of both poverty reduction[384] and the increased availability of land for wilderness.

All decisions in respect of energy can be best considered in terms of their impacts on agricultural yields – fundamentally that has been what has mattered for human development since the emergence of our first civilizations. Our policy makers have been unwise to ignore that reality, which is now resulting in increased global hunger and human suffering.

Sustainable Prosperity

It is difficult to conceive how developed and developing countries will enjoy any sustainable prosperity without firstly recognizing that fossil

[383] **Key World Energy Statistics 2021 (date for 2019)** – International Energy Agency – September 2021

[384] **Ending Extreme Poverty** – Interview of Ana Revenga by Amy Frykholm – 8 June 2016 – The World Bank (as first published by the Christian Century)

fuels, and before that wood, have been the foundation of the entirety of the material prosperity of humankind.

The Real Question

The provision of reliable, affordable, abundant and useful energy has potential to increase the quality of life of life for the 4 billion people living on less than $7 per day,[385] the 2.4 billion humans currently cooking with wood,[386] the 828 million humans currently suffering from hunger[387] and the 774 million people who do not even have access to the most generic form of energy – electricity.[388]

More specifically, the unimpeded provision of fossil fuels to developing countries would create optimism and prosperity in those countries and stop the tragic flow of economic refugees leaving destitute regions suffering from energy poverty.

In wealthy countries fossil fuels have potential to replace acute energy precarity, the cost-of-living crisis and financial distress with energy security, wealth creation, economic strength, low-inflation, prosperity and optimism.

From that perspective, the real question related to energy is fundamentally more about values than energy strictly speaking; specifically, should we prioritize human development or should we prioritize the obtainment of an energy mix that we favor in a context of the risks of carbon dioxide induced global warming. In relation to that question, the West might ask whether it has the right to impose its values on developing countries. Likewise, the developing countries might ask the same question, quite possibly arriving at a different conclusion.

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[385] **Half of the global population lives on less than US$6.85 per person per day** – Marta Schoch, Samuel Kofi Tetteh Baah, Christoph Lakner and Jed Friedman – World Bank – 8 December 2022

[386] **The State of the World's Forests 2018** – Food and Agricultural Organization of the United Nations – 2018

[387] **The State of Food Security and Nutrition in the World 2022** – Food and Agriculture Organization of the United Nations – 2022

[388] **For the first time in decades, the number of people without access to electricity is set to increase in 2022** – Laura Cozzi, Daniel Wetzel, Gianluca Tonolo, Sub-Saharan, Jacob Hyppolite II – International Energy Agency – 3 November 2022

2. The Science of Carbon Dioxide in Upheaval

Preamble

Rationale for the Energy Transition, The Demonization of CO_2

President Joe Biden stated that the carbon dioxide emitted by fossil fuels poses a greater danger than nuclear war.[389] The Secretary General of the United Nations stated that the carbon dioxide emitted by fossil fuels has "opened the gates of hell."[390]

The demonization of carbon dioxide is supporting governmental regulations that are channeling $1.4 trillion annually into green energy businesses via ESG finance,[391] while fomenting public opinion against the use of coal, oil and natural gas.

From the period between 2016 and 2019, directly observed satellite observations are providing new perspectives relating to how increasing concentrations of carbon dioxide in the atmosphere are affecting our Earth.

[389] **Biden Says Climate Change Poses Greater Threat Than Nuclear War** – Jordan Fabian and Akayla Gardner – Bloomberg – 10 September 2023
[390] "**Humanity has opened the gates to hell" warns Guterres as climate coalition demands action** – United Nations – Press Release – 20 September 2023
[391] **World Energy Investment 2022** – International Energy Agency – June 2022

New Science: More CO_2 Is Fertilizing a 2.3% Increase in the Green Area of The Earth Per Decade

Satellites Have Changed Everything

Launched in 1999, NASA's Terra satellite has just been in orbit long enough to provide meaningful data showing how the Earth is actually changing over time. Since 2016, publications revealing how our Earth is actually changing based on satellite data have been astonishing. Specifically, carbon dioxide is fertilizing the growth of vegetation on a scale that can only be described as staggering.

Historical Perspective

The most important discoveries ever made in respect of how carbon dioxide affects our Earth were not made in 1859 when John Tyndall determined that carbon dioxide is a greenhouse gas: The most important discoveries ever made in respect of carbon dioxide were made between 2016 and 2019.

Increasing the Amount of Carbon Dioxide in the Atmosphere Fertilizes Plant Growth

In 2016, a team of 32 scientists from 24 globally recognized institutions discovered that increasing the concentrations of carbon dioxide in the atmosphere is fertilizing plant growth.[392] Their discovery completely upends our understanding of the Earth and the effects of carbon dioxide. For reference, carbon dioxide fertilization explains 70% of the observed greening trend on our Earth, followed

[392] **Carbon Dioxide Fertilization Greening Earth, Study Finds** – NASA – https://www.nasa.gov – Accessed: March 2021; and
Greening of the Earth and its Drivers – Zaichun Zhu and 31 additional authors – Nature Climate Change – 25 April 2016

by nitrogen deposition (9%), climate change (8%) and land cover change (4%).[393]

The Scale of Carbon Dioxide's Fertilization Effect is Staggering

In 2019, satellite data from NASA's Terra satellite was published indicating the staggering scale of carbon dioxide's fertilization effect. According to the satellite data, the green leaf area of the Earth increased by 5.4 million square kilometers (2.1 million square miles) over the 18 years to 2017.[394] That represents a staggering increase of 2.3% in the Earth's green leaf area, net of losses, per decade.

For reference, one third of all vegetated land on Earth exhibited greening and only 5% exhibited browning over the period of the study.[395]

The rates at which our Earth is greening over various measures of time and surface area are provided in Table 10.

[393] **Greening of the Earth and its Drivers** – Zaichun Zhu and 31 additional authors – Nature Climate Change – 25 April 2016

[394] **China and India Lead the Way in Greening** – Abby Tabor – NASA Earth Observatory – https://earthobservatory.nasa.gov – Accessed: March 2021; and **China and India lead in greening of the world through land-use management** – Chi Chen, Taejin Park, Xuhui Wang, Shilong Piao, Baodong Xu, Rajiv K. Chaturvedi, Richard Fuchs, Victor Brovkin, Philippe Ciais, Rasmus Fensholt, Hans Tømmervik, Govindasamy Bala, Zaichun Zhu, Ramakrishna R. Nemani & Ranga B. Myneni – Nature Sustainability – 11 February 2019

[395] **China and India lead in greening of the world through land-use management** – Chi Chen, Taejin Park, Xuhui Wang, Shilong Piao, Baodong Xu, Rajiv K. Chaturvedi, Richard Fuchs, Victor Brovkin, Philippe Ciais, Rasmus Fensholt, Hans Tømmervik, Govindasamy Bala, Zaichun Zhu, Ramakrishna R. Nemani & Ranga B. Myneni – Nature Sustainability – 11 February 2019

Rate of increase in the Earth's greening *Table 10*

	American Football Fields	Square Kilometers	Square Miles
Per year	55,887,385.3	300,000.0	115,830.6
Per day	153,023.0	821.4	317.2
Per hour	6,376.0	34.2	13.2
Per minute	106.3	0.6	0.2
Per second	1.8	0.0	0.0

Source: Nature Sustainability [396]

Table 10 shows that every minute an amount of land equivalent to 106 American football fields is turned green on our Earth due to the fertilization effect from a higher concentration of carbon dioxide in the atmosphere.

The rate of growth in the Earth's newly green surface area, due principally to the fertilization effect of increased atmospheric concentrations of carbon dioxide, equates to 37% of the surface area of the Lower-48 States of the United States every ten years – we are talking about an astounding amount of newly green surface area.

The Satellite Data is Broadly Corroborated by Other Sciences

Satellite data represents direct observation and as such does not need to be corroborated, it supersedes all other data available in terms of quality and reliability. Nevertheless, it is fascinating that other scientific disciplines have independently arrived at the same conclusion. Three examples of other scientific disciplines that arrive at the same conclusion are interesting in their own right:

Firstly, vegetation has existed on the surface of the Earth from the Silurian Period (444-419 million years ago) to present.[397] However, grasses are a relatively new form of vegetation that emerged on Earth only about 35 million years ago. In 2019, it was determined that based

[396] **China and India lead in greening of the world through land-use management** – Chi Chen, Taejin Park, Xuhui Wang, Shilong Piao, Baodong Xu, Rajiv K. Chaturvedi, Richard Fuchs, Victor Brovkin, Philippe Ciais, Rasmus Fensholt, Hans Tømmervik, Govindasamy Bala, Zaichun Zhu, Ramakrishna R. Nemani & Ranga B. Myneni – Nature Sustainability – 11 February 2019

[397] **Charcoal in the Silurian as evidence for the earliest wildfire** – Ian Glasspool, Dianne Edwards and Lindsey Axe – Geology – May 2004

on the geological record, green leafy vegetation is advantaged relative to grasses during periods of increased carbon dioxide concentrations in the atmosphere. On the other hand, during periods of carbon dioxide starvation in the atmosphere, grasses are advantaged relative to green leafy plants.[398] The geological record is consistent with the observation that carbon dioxide emissions from the use of coal, oil and natural gas are increasing the amount of green leaf area on Earth.

Secondly, the highest-precision geological data into the distant past has only been available since 2016. That data suggests that carbon dioxide concentrations in the atmosphere affect the amount of vegetation on Earth and that the amount of vegetation on Earth can in turn affect the climate.[399]

Thirdly, recent agricultural research published in 2021 from the US Bureau of Economic Research determined that: "We consistently find a large CO_2 fertilization effect: a 1 ppm increase in CO_2 equates to a 0.4%, 0.6%, 1% yield increase for corn, soybeans, and wheat, respectively."[400] Effectively, based on agricultural research the extraordinary increases in crop yields from the time of the Second World War is largely attributable to the fertilization effect from increased levels of carbon dioxide in the atmosphere.[401] Not an insignificant finding given that, today, 828 million people are suffering from hunger.[402]

[398] **Synchronous rise of African C4 ecosystems 10 million years ago in the absence of aridification** – Pratigya J. Polissar, Cassaundra Rose, Kevin T. Uno, Samuel R. Phelps & Peter deMenocal – Nature Geoscience volume – 22 July 2019
[399] **Climate, pCO2 and terrestrial carbon cycle linkages during late Palaeozoic glacial–interglacial cycles** – Isabel P. Montañez, Jennifer C. McElwain, Christopher J. Poulsen, Joseph D. White, William A. DiMichele, Jonathan P. Wilson, Galen Griggs and Michael T. Hren – Nature Geoscience – 24 October 2016
[400] **Environmental Drivers of Agricultural Productivity Growth: CO_2 Fertilization of US Field Crops** – Charles A. Taylor and Wolfram Schlenker – National Bureau of Economic Research – October 2021
[401] **Environmental Drivers of Agricultural Productivity Growth: CO_2 Fertilization of US Field Crops** – Charles A. Taylor and Wolfram Schlenker – National Bureau of Economic Research – October 2021
[402] **The State of Food Security and Nutrition in the World 2022** – Food and Agriculture Organization of the United Nations – 2022

Based on these assessments, carbon dioxide emitted by the combustion of fossil fuels is the driving force that is making our Earth greener.

Carbon dioxide, more than anything else, is the regulator of life on our Earth: The more carbon dioxide, the more life.

New Science: More CO_2 Is Fertilizing a 2.0% Increase in the Forested Area of The Earth Per Decade

Satellites Observe Massive Forest Growth

The third game-changing discovery relating to carbon dioxide was made in 2018 when a team of scientists, including many from NASA itself, published a report, based on satellite data, indicating that "contrary to the prevailing view that forest area has declined globally," the Earth's forested surface area increased by 2.24 million square kilometers (864 thousand square miles), net of losses, over the 35 years to 2016.[403] That change represents an astounding increase of 2.0% of the Earth's forested surface area, net of losses, per decade.

That discovery underscores the value of accurate, unbiased satellite data.

The rates at which our Earth is increasing in forested surface area, net of losses, over various measures of time and surface area are provided in Table 11.

[403]**Global land change from 1982 to 2016** – Xiao-Peng Song, Matthew C. Hansen, Stephen V. Stehman, Peter V. Potapov, Alexandra Tyukavina, Eric F. Vermote & John R. Townshend – Nature – 8 August 2018

Rate of increase in the Earth's forested area *Table 11*

	American Football Fields	Square Kilometers	Square Miles
Per year	11,922,642.2	64,000.0	24,710.5
Per day	32,644.3	175.2	67.7
Per hour	1,360.2	7.3	2.8
Per minute	22.7	0.1	0.0
Per second	0.4	0.0	0.0

Source: Nature[404]

Table 11 shows that every minute on Earth an area of land equivalent to 23 American football fields is being newly covered with forest growth due to one key driver, namely, the fertilization effect of increasing the atmospheric concentrations of carbon dioxide – we are talking about an absolutely astounding rate of forest growth.

That reference is net of forest losses due to deforestation; therefore, that figure would be even higher in the absence of deforestation. Effectively, as forests have been deforested in the Tropics, due to green energy policies, forests elsewhere in the world have grown due to carbon dioxide fertilization.

The rate of growth in the Earth's forested surface area, net of losses, equates to 92% of the surface area of the state of Texas, USA, every ten years.

Forests Absorb More Heat from Sunlight

Not only do forests emit water vapor, the most important greenhouse gas, forests absorb more thermal radiation from the Sun, this is shown in Figure 11. To the extent that there is a link between increased volumes of carbon dioxide in the atmosphere and increased global temperatures, that link is significantly biological and related to increased forest growth and the greening of our Earth.

[404] **Global land change from 1982 to 2016** – Xiao-Peng Song, Matthew C. Hansen, Stephen V. Stehman, Peter V. Potapov, Alexandra Tyukavina, Eric F. Vermote & John R. Townshend – Nature – 8 August 2018

Forests absorb more of the sun's thermal energy ***Figure 11***

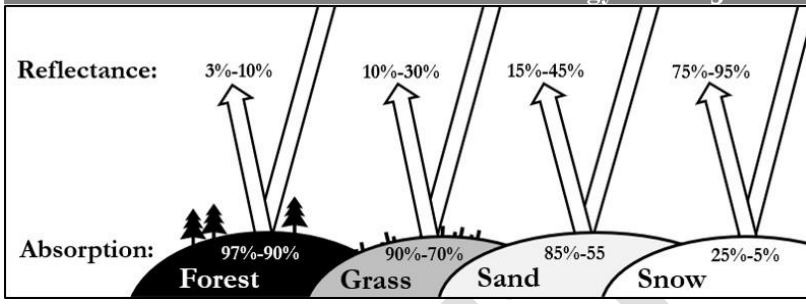


Image Credit: Author; data source: Goddard Institute for Space Studies NASA[405]

Where Forests Grow, The Earth is Warming

Areas of the Earth that are becoming more forested are increasing in warmth.[406] In effect, based on satellite data, we can see that forest growth has been particularly pronounced in the high northern latitudes, greater than 50° North[407] – in those newly forested regions temperatures are increasing.[408] This is shown in Figure 12.

[405] **NASA Goddard Institute for Space Studies (GISS) Climate Change Research Initiative (CCRI) Applied Research STEM Curriculum Unit Portfolio; Unit: Earth's Energy Budget** – Nicole Dulaney, Allegra LeGrande and Matthew Pearce – https://www.giss.nasa.gov/ – Accessed: September 2020

[406] **Interhemispheric Temperature Asymmetry over the Twentieth Century and in Future Projections** – Andrew R. Friedman, Yen-Ting Hwang, John C. H. Chiang and Dargan M. W. Frierson – Journal of Climate – 1 August 2013

[407] **Global land change from 1982 to 2016** – Xiao-Peng Song, Matthew C. Hansen, Stephen V. Stehman, Peter V. Potapov, Alexandra Tyukavina, Eric F. Vermote & John R. Townshend – Nature – 8 August 2018

[408] **Characteristics, drivers and feedbacks of global greening** – Shilong Piao, Xuhui Wang, Taejin Park, Chi Chen, Xu Lian, Yue He, Jarle W. Bjerke, Anping Chen, Philippe Ciais, Hans Tømmervik, Ramakrishna R. Nemani and Ranga B. Myneni – Nature Reviews Earth and Environment; Nature – December 2019

1880-2019 temperature change *Figure 12*

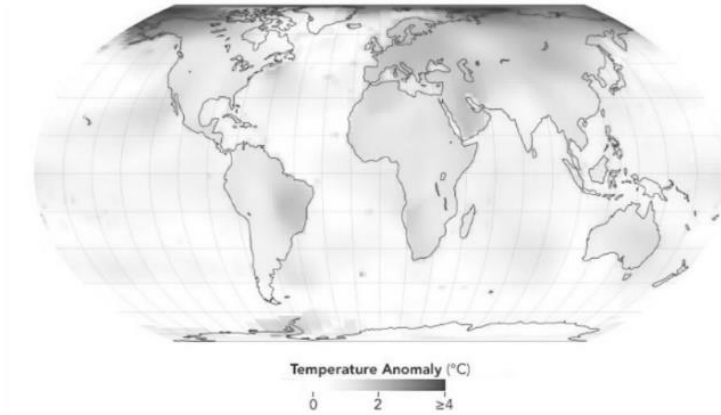


Image Credit: NASA Earth Observatory[409]

The United Nations's Forest Data Diverges from the Satellite Data

The United Nations reported in 2020 that, "In absolute terms, the global forest area *decreased* by 1.78 million square kilometers (0.69 million square miles) between 1990 and 2020."[410] That statement is in direct contradiction to the satellite data. What is going on?

The United Nations defines forests as a "land use" category based on socio-economic considerations not on objective criteria such as tree cover.[411]

Well, That Changes Just About Everything

For birds, squirrels and forest dwelling animals, every tree matters. Imagine the impact on wildlife from 2.24 million square kilometers (864 thousand square miles) of newly forested land due to the fertilization effect of increasing concentrations of carbon dioxide in the atmosphere.

[409] **World of Change: Global Temperatures** – NASA Earth Observatory – https://earthobservatory.nasa.gov – Accessed February 2021
[410] **The State of the World's Forests 2020** – United Nations Food and Agricultural Organization – 2020
[411] **Forest vs. Tree Cover: What is the Difference, The State of the World's Forests 2020** – United Nations Food and Agricultural Organization – 2020

The new satellite data is not just changing the world for birds, squirrels and forest dwelling animals – all wildlife is being affected by the increased productivity of vegetation, the base of our food chain, due to the fertilization effect of carbon dioxide.

Not only are forest changing. In broad terms, many of our fundamental assumptions relation to how Earth systems work will likely be reassessed due to the discoveries made by satellites between 2016 and 2019, which established the connection between increased carbon dioxide in the atmosphere and increased plant growth.

New Science: CO_2 Regulates the Amount of Life on Earth

Perspective on the Various Effects of Carbon Dioxide on Our Earth

To gain perspective on the changes that are occurring on our Earth we can compare how over a period of one decade, on average, the rates of change in i) atmospheric concentrations of carbon dioxide (CO_2), ii) the forested area of the Earth (net of losses due to deforestation), iii) the green area of Earth (net of losses) and iv) global surface temperatures. This can be seen in Table 12, which shows changes to our Earth occurring per decade.

Changes: CO_2, greening, forests & warming ***Table 12***

	Increase per Decade
Atmospheric concentrations of CO_2	5.1%
Forested area of Earth (net of losses)	2.0%
Green area of Earth (net of losses)	2.3%
Global surface temperatures	0.15-0.20°C (0.27-0.36°F)

Source: Various[412]

As can be seen in Table 12, to the extent that carbon dioxide is causing global warming, it is a minor ancillary dynamic relative to the tremendous scale of increased vegetation – life – on Earth.

[412] **Monthly Average Mauna Loa CO_2** – US National Oceanographic and Atmospheric Administration – https://www.esrl.noaa.gov – Accessed: March 2021;
Global land change from 1982 to 2016 – Xiao-Peng Song, Matthew C. Hansen, Stephen V. Stehman, Peter V. Potapov, Alexandra Tyukavina, Eric F. Vermote & John R. Townshend – Nature – 8 August 2018;
China and India lead in greening of the world through land-use management – Chi Chen, Taejin Park, Xuhui Wang, Shilong Piao, Baodong Xu, Rajiv K. Chaturvedi, Richard Fuchs, Victor Brovkin, Philippe Ciais, Rasmus Fensholt, Hans Tømmervik, Govindasamy Bala, Zaichun Zhu, Ramakrishna R. Nemani & Ranga B. Myneni – Nature Sustainability – 11 February 2019; and
World of Change: Global Temperatures – NASA Earth Observatory – https://earthobservatory.nasa.gov – Accessed February 2021

So what are the experts saying?

Douglas Sheil, a globally recognized expert in the water dynamics of forests, summarizes, "We know enough to recognize that our picture of how the global climate system works is very different than how it was viewed even a few years ago … Expect surprises."[413]

In 2019, a paper published in Nature by 12 globally leading climate scientists laid out the explicit links between carbon dioxide concentrations in the atmosphere, carbon dioxide's fertilization effect on vegetation, and the impact of vegetation on the climate.[414] The team determined that climate models are incapable of capturing the new complexities driven by the fertilization effect of carbon dioxide.[415]

That is partly because the new reality of Earth Sciences must consider that landscapes and vegetation affect the climate and that landscapes are greatly influenced directly by human activity, in addition to being influenced by carbon dioxide emissions and the related fertilization effect of carbon dioxide.

CO_2, Geological Perspectives

The discovery of the unexpected reaction of plants and forests, specifically, the scale of their increased growth, due to increasing concentrations of carbon dioxide in the atmosphere has upended the Earth Sciences in broad terms. Geology too will be transformed by the surprising discoveries made between 2016 and 2019.

The realm of geology and the realm of biology interface when organic material is captured by the Earth before it decomposes. When this

[413] **Forests, atmospheric water and an uncertain future: the new biology of the global water cycle** – Douglas Sheil – Forest Ecosystems – 20 March 2018
[414] **Characteristics, drivers and feedbacks of global greening** – Shilong Piao, Xuhui Wang, Taejin Park, Chi Chen, Xu Lian, Yue He, Jarle W. Bjerke, Anping Chen, Philippe Ciais, Hans Tømmervik, Ramakrishna R. Nemani and Ranga B. Myneni – Nature Reviews Earth and Environment; Nature – December 2019
[415] **Characteristics, drivers and feedbacks of global greening** – Shilong Piao, Xuhui Wang, Taejin Park, Chi Chen, Xu Lian, Yue He, Jarle W. Bjerke, Anping Chen, Philippe Ciais, Hans Tømmervik, Ramakrishna R. Nemani and Ranga B. Myneni – Nature Reviews Earth and Environment; Nature – December 2019

occurs it captures the carbon in organic material and thereby serves to reduce the amount of carbon dioxide in the atmosphere.

For background, we know that plants require carbon dioxide to survive and that they capture carbon dioxide from the atmosphere. Through the process of photosynthesis, plants transform carbon dioxide into carbon bearing organic material.

For further background, when organic material dies it decomposes and the carbon within the organic material is released back into the atmosphere in the form of carbon dioxide; however, not all organic material decomposes, a fraction of it is consumed by the Earth before it decomposes. For example, if a river carries dead organic material into a sea, the organic material can settle on the seabed in the mud and if there is insufficient oxygen in the water it will not decompose. Instead, the organic material will become a component of the Earth's sedimentation. Over geological timescales, the organic sediments can become a permanent component of the Earth's geology – a rock, containing carbon that would have otherwise been released back into the atmosphere.[416]

It is logical to suggest that the more organic material growing on Earth, other things being equal, the more organic material and carbon will be captured within sediments accumulating on Earth.

Linking plant growth to carbon dioxide levels, one might speculate that carbon dioxide levels struggle to rise over geological timescales because i) the more carbon dioxide there is in the atmosphere, the more organic growth there is on Earth, ii) therefore, more organic material and associated carbon gets captured in the Earth, and iii) that would serve to constantly keep carbon dioxide levels at low levels relative to more abundant molecules in the atmosphere.

In more prosaic terms, one might speculate, based on the newly known link between carbon dioxide and plant growth, that plants starve themselves of carbon dioxide when plant material is transformed into sediments trapped within the Earth.

[416] **The Elements of Petroleum Geology** – Richard C. Selley – Academic Press – 1985

For reference, carbon dioxide comprises 0.0419% of the atmosphere[417] and carbon dioxide concentrations vary significantly over geological timescales. In comparison, oxygen comprises 21% of the atmosphere[418] and oxygen concentrations have been remarkably steady for 2.3 billion years.[419]

To reiterate a point of speculation, it is possible that carbon dioxide concentrations are so low and variable because i) plants have competed genetically to become exceptionally well adapted to capturing the scarce volumes of carbon dioxide in our atmosphere, and ii) a fraction of all plant material, inclusive of the carbon within plant material, is perpetually being captured in our Earth through natural sedimentary and geological processes.

Without suggesting that that speculative hypothesis has been confirmed by the science geology, one thing can be said with absolute certainty: Due to the discoveries made between 2016 and 2019, carbon dioxide is not only newly in the limelight in the realm of biology, but also in the realm of geology.

[417] **Monthly Average Mauna Loa CO_2** – US National Oceanographic and Atmospheric Administration – https://www.esrl.noaa.gov – Accessed: March 2021
[418] **Earth Facts** – NASA – https://science.nasa.gov – Accessed: July 2024
[419] **The History of Air** – Riley Black – The Smithsonian – 18 April 2020

The Global Warming Paradigm of the United Nations

Caveat

In this section we will take a detailed look at the doctrine of carbon dioxide induced global warming according to the United Nations' Intergovernmental Panel on Climate Change. For reference, this doctrine forms the basis for the $1.4 trillion invested annually in green energy.

As a caveat, the doctrine of global warming that is detailed in this section is deficient because it does not recognize the biological importance of carbon dioxide.

For the purposes of providing a wholistic and historical perspective on the subject of our knowledge and beliefs in respect of carbon dioxide, the paradigm of carbon dioxide induced global warming as developed and promoted by the United Nations' Intergovernmental Panel on Climate Change is provided here in its entirety for the sake of completeness.

Background on Thermal Radiation

Thermal radiation is emitted by all things that have a temperature above minus 273° Celsius (minus 460° Fahrenheit; 0° Kelvin), which is defined as absolute zero. Above that temperature the energy in matter causes all particles to vibrate, which results in the emission of thermal energy. The Sun emits thermal energy because it is hot; likewise, the Earth emits thermal energy too because it is hotter than absolute zero. The most well-known form of thermal radiation is light because it is visible. Light, and all thermal radiation, consists of waves. Our eyes are capable of seeing thermal radiation that has wavelengths between 0.4 microns (blue/violet) and 0.7 microns (red); thermal radiation with wavelengths shorter than 0.4 microns is referred to as ultraviolet radiation and with wavelengths longer than 0.7 microns, infrared radiation. For reference, a micron is one millionth of a meter. Hot, high-energy objects, like the sun, tend to emit high-intensity, short-wave thermal radiation. Cooler objects emit

longer-wave thermal radiation. Matter emits thermal radiation across a spectrum of wavelengths, not just a single wavelength.

Greenhouse Gases

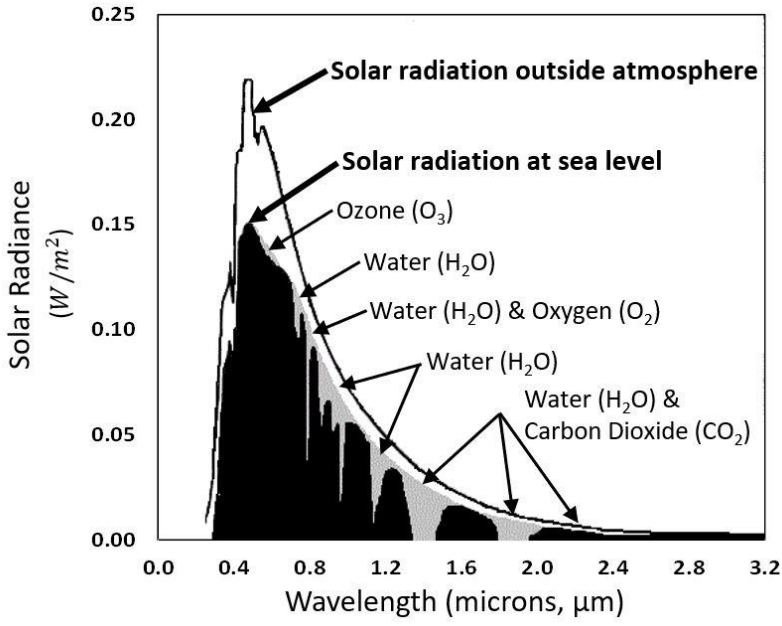
In 1859, John Tyndall discovered that some gases let thermal radiation, such as light, pass through them and that other gases absorb thermal radiation, which has the effect of blocking the passage of that thermal radiation. Closer to his own words, he determined that there were differences in the abilities of "perfectly colorless and invisible gases and vapors" to absorb heat.[420]

Gases that absorb thermal radiation do so when the thermal radiation has specific wavelengths. Several gases in our atmosphere, such as water vapor (H_2O), carbon dioxide (CO_2), oxygen (O_2), ozone (O_3), methane (CH_4), nitrogen oxide (N_2O) and carbon monoxide (CO) absorb thermal radiation to varying degrees depending on the thermal radiation's wavelengths; on the other hand, certain gases do not absorb thermal radiation; for example, nitrogen (N_2) constitutes 78.1% of our atmosphere and it does not absorb thermal radiation.

John Tyndall invented an apparatus to measure the absorptive powers of various gases called a spectrophotometer. With this instrument it is possible to determine which wavelengths of thermal energy get absorbed by which gases. Atmospheric gases, in general, absorb less short-wave thermal radiation than long-wave thermal radiation; as a result, short-wave thermal radiation from the sun tends to reach the surface of the Earth without it being absorbed in large quantities by atmospheric gases. Thermal radiation from the Sun is also altered by i) passing through the Sun's atmosphere and ii) scattering or reflectance by the Earth's atmosphere inclusive of reflectance from clouds. Figure 13 provides an indication of i) the amount of thermal radiation that enters our atmosphere and ii) the amount of thermal radiation that reaches the surface of the Earth. In Figure 13, the area shaded in grey represents the thermal radiation that is absorbed by gases in our atmosphere; the gases that are the most important absorbers of this thermal radiation have been labelled.

[420] **John Tyndall (1820-1893)** – Steve Graham – NASA Earth Observatory – 8 October 1999 – https://earthobservatory.nasa.gov/ – Accessed: 12 September 2020

Indicative Absorption of Solar Radiance *Figure 13*



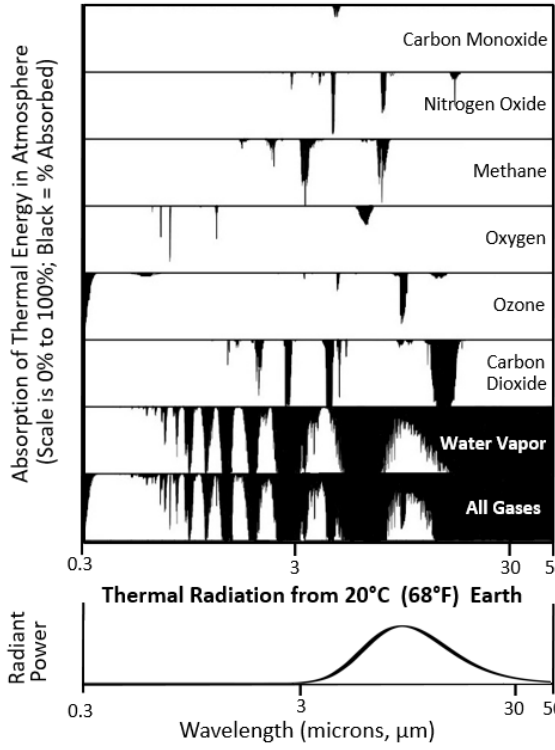
Source: Author (adapted from Boeing/NASA[421])

The schematic provided in Figure 13 gives a good indication of the thermal radiance at the top of the atmosphere and at the surface of the Earth. It is a reproduction of a schematic used by Boeing and NASA to provide a basis for the design of equipment; however, it is important to recognise that the schematic is indicative. Solar radiance changes throughout the day and the season; even the amount of solar radiation emitted by the sun varies slightly over time. The atmosphere is also far too complex to be accurately simplified into a single schematic. Figure 13 is simply intended only to provide a characterisation of the solar radiance that reaches the Earth's surface.

The Earth, like the Sun, emits thermal radiation, albeit the Earth's radiation has longer wavelengths than that of the Sun. The percentage of thermal radiation that is absorbed by various gases in the atmosphere is shown in Figure 14 for various thermal radiation wavelengths. In Figure 14, the bottom-most absorption graph

[421] **J.J. Thompson** – Space Station Advanced EVA Systems Design Requirements Boeing Aerospace Company (in NASA MAN-Systems Integration Standards) – 1986

represents the total absorption of thermal radiation by all gases in the atmosphere for various wavelengths. At the very bottom of Figure 14 another graph indicates the amount of thermal radiation that would be emitted by a perfectly uniform planet with a temperature of 20°C (68°F), this is based on an equation; the simplifying equation is useful to appreciate that the Earth's thermal radiation is relatively long-wave radiation. Combined, the graphs in Figure 14 show that, to a great extent, thermal radiation emitted from the surface of the Earth gets absorbed by the atmosphere rather than radiating directly out into space.



Source: Author (adapted from various[422])

Figure 14, like Figure 13, is a representative simplification of the thermal radiance absorbed by our atmosphere.

When a gas molecule absorbs thermal radiation, that energy makes it vibrate, which in turn transmits thermal radiation in all directions, until the energy dissipates. As a result, thermal radiation absorbed by

[422] **Adapted by Author from: Handbook of Geophysics and Space Environments** – Shea L. Valley – McGraw Hill – 1965;
Radiation Transmitted by the Atmosphere – Wikipedia (Accessed: September 2020);
Global Warming Art – Robert Rohde – via Climate Forcings and Global Warming – NASA Earth Observatory – https://Earthobservatory.nasa.gov – Accessed: September 2020); and
Black Body Radiation Equation – Courtesy of Professor Kurt Hollocher – Geology Department, Union College, New York

gases in the atmosphere are partially re-radiated back to Earth, which increases the surface temperature of the Earth.

Ultimately, thermal radiation from the surface of the earth makes its way out of the atmosphere and into space; in this way, the Earth's incoming thermal radiation matches its outgoing thermal radiation.

John Tyndall's discovery explained what has become known as the greenhouse effect; the heat-absorbing gases in our atmosphere have become known as greenhouse gases. John Tyndall concluded that amongst the greenhouse gases water vapor is the strongest absorber of radiant heat and is therefore the most important gas controlling the Earth's surface temperature. He determined that without water vapor, the Earth's surface would be "held fast in the iron grip of frost."[423] It has been estimated that without greenhouse gases in our atmosphere the Earth would be 33° Celsius (59° Fahrenheit) colder.[424] Based on the estimates of the NASA Goddard Institute of Space Studies, the relative contributions of atmospheric constituents to this 33° Celsius (59° Fahrenheit) increase in the Earth's surface temperature are as follows: water vapor, 50%; clouds, 25%; carbon dioxide, 20% and; other constituents, 5%.[425]

This phenomenon was understood long-before John Tyndall explained its root cause: Cloudy, humid nights are warmer than clear, dry nights. Looking at deserts provides another example of this phenomenon: During the day the average temperature in deserts globally is 38° Celsius (100° Fahrenheit); however, at night the average temperature in deserts is minus 3.9° Celsius (25° Fahrenheit).[426] The extreme temperature reductions in deserts at night are the result of their dryness: With reduced amounts of water vapor

[423] **John Tyndall** – Steve Graham – NASA Earth Observatory – 8 October 1999 – https://earthobservatory.nasa.gov – Accessed 5 September 2020

[424] **Climate Change, the IPCC Scientific Assessment** – World Meteorological Organization/United Nations Environment Programme, Intergovernmental Panel on Climate Change – Editors: J.T. Houghton, G.J. Jenkins and J.J. Ephraums – Cambridge University Press – 1990

[425] **Attribution of the present-day total greenhouse effect** – Gavin A. Schmidt , A. Ruedy. Ron L. Miller, Andy A. Lacis – Journal of Geophysical Research – 16 October 2010

[426] **Desert** – NASA Earth Observatory – https://earthobservatory.nasa.gov – Accessed: 5 September 2020

in the air, more of the Earth's thermal energy is radiated directly into space, making the surface of the Earth colder.

Thus far, the science of greenhouse gases that has been detailed is founded on scientific principles that are universally accepted and unlikely to change. Thus far, a static climate framework has been elaborated, which explains why the Earth is 33° Celsius (59° Fahrenheit) warmer than it would be without greenhouse gases in the atmosphere; however, it does not explain climate change, which as the name implies, is a dynamic process.

Global Warming is Dynamic

In 1896, Svante Arrhenius, a Swedish scientist with a background in electrochemistry became the first person to suggest that the carbon dioxide from burning considerable amounts of coal would increase the surface temperature of the Earth.[427] The conceptual basis for this assertion was that increased carbon dioxide levels in the atmosphere would increase the amount of thermal radiation re-radiated back to Earth. This would involve a change to the graphs presented in Figure 14. Guy Calendar, who was born in Canada but lived as an adult in England collected temperature measurements and determined, in 1938, that the Earth had warmed and further suggested that this was the result of human emissions of carbon dioxide. Both Arrhenius and Calendar developed mathematical models to develop their conclusions.

Today, climate models estimate both i) the direct effect on surface temperatures from increasing atmospheric levels of carbon dioxide ii) the feedback effects of rising surface temperatures, which further increase surface temperatures.

Foundational Assumption of the CO_2 Induced Climate Change Dogma

The foundational assumption of the global warming doctrine is spelled out clearly in the inaugural report published by the United Nation's Intergovernmental Panel on Climate Change: "Water vapor

[427] **On the Influence of Carbonic Acid in the Air upon the Temperature of the Ground** – Svante Arrhenius – Philosophical Magazine and Journal of Science – April 1896

has the largest greenhouse effect, but its concentration in the troposphere is determined internally within the climate system, and, on a global scale, is not affected by human sources and sinks. Water vapor will increase in response to global warming and further enhance it, this process is included in climate models." This assumption is critical, as it means that carbon dioxide dynamics, and heat-related feedback effects, are the root causes of all changes to the amount of water vapor in the Earth's atmosphere.

To clarify this assumption the United Nation's Intergovernmental Panel on Climate Change stated explicitly that: "There are no field data from whole ecosystem studies of forests that demonstrate a CO_2 fertilization effect."[428]

That assumption is fundamental to the carbon dioxide induced global warming paradigm because it reduces carbon dioxide to an inert gas.

The physicists that devised the carbon dioxide induced global warming paradigm recognized that carbon dioxide was too weak as a greenhouse gas to directly account for the entirety of the rise in the Earth's temperature. They therefore introduced the concept of temperature driven feedback effects involving increased water vapor in the atmosphere.

According to the doctrine of carbon dioxide induced global warming, increasing the concentration of carbon dioxide in the atmosphere is directly responsible for only 20% of global warming, other greenhouse gas emissions from human activity, mainly methane, are assumed to directly cause 5% of global warming and 75% of global warming is attributable to increased water vapor in the atmosphere. Critically, the increased water vapor in the atmosphere is assumed to result exclusively from heat related feedback effects, according to the doctrine of global warming.[429]

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[428] **Climate Change, the IPCC Scientific Assessment** – United Nations Intergovernmental Panel on Climate Change – 1990

[429] **CO2: The Thermostat that Controls Earth's Temperature** – Andrew Lacis – NASA Goddard Institute for Space Studies – October 2020 – https://www.giss.nasa.gov/ – Accessed: 12 September 2020; and **Attribution of the present-day total greenhouse effe**ct – Gavin A. Schmidt , A. Ruedy. Ron L. Miller, Andy A. Lacis – Journal of Geophysical Research – 16 October 2010

Comparing the Greenhouse Gas Effect of Water Vapor to that of Carbon Dioxide

To appreciate the relative weakness of carbon dioxide as a greenhouse gas relative to water vapor we can contemplate Figure 15. It compares the weak greenhouse gas properties of carbon dioxide relative to the strong greenhouse gas properties of water vapor across a range of frequencies of thermal radiation.

For further reference, the mass of water in our atmosphere is four time greater than the mass of carbon dioxide. The water in our atmosphere is estimated to have an average mass 12.7 trillion metric tons.[430] That compares to a reasonable estimate for the mass of carbon dioxide in our atmosphere of 3.2 trillion metric tons, up from a reasonable estimate of 2.2 trillion metric tons prior to the Industrial Revolution (assuming an atmospheric concentration of carbon dioxide of 410 parts per million today and 280 parts per million prior to the Industrial Revolution; a 46% increase).[431]

For reference, it is estimated that since the Industrial Revolution, human activity has emitted approximately 1.5 trillion metric tons of carbon dioxide into the atmosphere,[432] of which 31% is estimated to have been absorbed by the oceans.[433]

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[430] **The Mass of the Atmosphere: A Constraint on Global Analyses** – Kevin E. Trenberth and Lesley Smith – Journal of Climate – 15 March 2005

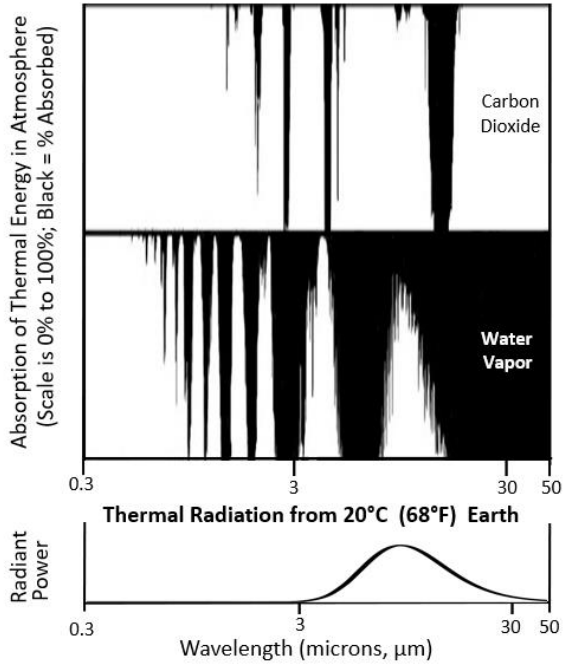
[431] **Author estimate** premised on the assumption that the CO2 concentration in the atmosphere is constant at all elevations (a simplifying assumption; for reference, the Mona Loa station where CO2 concentrations are measured has an elevation of 3,397meters/11,135 feet above sea level) and the assumption that the average molecular mass of dry air in the atmosphere is 28.96 g/mol. For reference, carbon dioxide has a molar mass of 44.01 g/mol.
Sources:
Molar Mass of Dry Air in Mass Meteorology – N. Khélifa, M. Lecollinet and M. Himbert – Conservatoire National des Arts et Métiers, Paris; and
Mauna Loa Baseline Observatory – US National Oceanic and Atmospheric Administration – https://www.ncei.noaa.gov – Accessed: June 2023

[432] **Carbon dioxide now more than 50% higher than pre-industrial levels** – US National Oceanic and Atmospheric Administration – https://www.ncei.noaa.gov – Accessed: June 2023

[433] **Carbon dioxide now more than 50% higher than pre-industrial levels** – US National Oceanic and Atmospheric Administration – https://www.ncei.noaa.gov – Accessed: June 2023

The point being emphasized here is that carbon dioxide is a relatively weak greenhouse gas compared to water vapor. For that reason, increased water vapor (feedback effects from a warming Earth) is assumed to account for 75% of global warming, according to the carbon dioxide induced global warming paradigm.

Atmospheric Absorption of Thermal Energy *Figure 15*



Source: Author (adapted from various[434])

The Science of Greenhouse Gases is Not the Science of Global Warming

It is important to distinguish the foundational scientific premises upon which the global warming paradigm is based, from the science of

[434] Adapted by Author from: **Handbook of Geophysics and Space Environments** – Shea L. Valley – McGraw Hill – 1965;
Radiation Transmitted by the Atmosphere – Wikipedia (accessed: 12 September 2020); and

global warming. The foundational science is static, whereas warming is a dynamic process involving changes to the Earth.

From a dynamic perspective, the science of global warming and the strength of the relationship between changing carbon dioxide levels in the atmosphere and increased global surface temperatures resides within quantitative climate models – computer models.

The approach taken by the United Nations' Intergovernmental Panel on Climate Change is to rely on multiple computer models; for example, for the "high CO_2 scenario" in the 2014 Climate Change Synthesis Report, 39 computer models were used to provide projections for global average surface temperature changes to the year 2100.[435]

The Global Warming Paradigm Ignores Biology

The carbon dioxide induced global warming of paradigm of the United Nations' Intergovernmental Panel on Climate Change ignores the biological effect of increasing the concentrations of carbon dioxide in the atmosphere, namely, the fertilization of plant growth.

Robert Rohde – **Global Warming Art** (via Climate Forcings and Global Warming – NASA Earth Observatory – https://earthobservatory.nasa.gov – Accessed 12 September 2020)

[435] **Climate Change 2014, Synthesis Report** – Editors: Rajendra K. Pachauri, Leo Meyer and Core Writing Team – Fifth Assessment Report of the Intergovernmental Panel on Climate Change – 2015

New Science: The Water Cycle Rethought

Preamble

According the carbon dioxide induced global warming paradigm heat-related feedback effects, namely, increased water vapor in the atmosphere, are responsible for 75% of global warming.[436]

In light of the extraordinary increase is the amount of the Earth's green surface area, its vegetative cover and forested area, due to the fertilization of carbon dioxide, it is interesting to assess the newly discovered scientific understandings relating to vegetation and the amount of water vapor in the atmosphere. [437]

In effect, it has become apparent that vegetation humidifies the atmosphere on a scale that was never before imagined possible. The implication is that the increased vegetive cover of the Earth, due to carbon dioxide's fertilization effect, must be significantly contributing to the rise in the amount of water vapor in the atmosphere.

[436] **CO2: The Thermostat that Controls Earth's Temperature** – Andrew Lacis – NASA Goddard Institute for Space Studies – October 2020 – https://www.giss.nasa.gov/ – Accessed: September 2020; and
Attribution of the present-day total greenhouse effect – Gavin A. Schmidt, A. Ruedy. Ron L. Miller, Andy A. Lacis – Journal of Geophysical Research – 16 October 2010

[437] **Carbon Dioxide Fertilization Greening Earth, Study Finds** – NASA – https://www.nasa.gov – Accessed: March 2021;
Greening of the Earth and its Drivers – Zaichun Zhu and 31 additional authors – Nature Climate Change – 25 April 2016;
China and India Lead the Way in Greening – Abby Tabor – NASA Earth Observatory – https://earthobservatory.nasa.gov – Accessed: March 2021;
China and India lead in greening of the world through land-use management – Chi Chen, Taejin Park, Xuhui Wang, Shilong Piao, Baodong Xu, Rajiv K. Chaturvedi, Richard Fuchs, Victor Brovkin, Philippe Ciais, Rasmus Fensholt, Hans Tømmervik, Govindasamy Bala, Zaichun Zhu, Ramakrishna R. Nemani & Ranga B. Myneni – Nature Sustainability – 11 February 2019; and
Global land change from 1982 to 2016 – Xiao-Peng Song, Matthew C. Hansen, Stephen V. Stehman, Peter V. Potapov, Alexandra Tyukavina, Eric F. Vermote & John R. Townshend – Nature – 8 August 2018

On average the atmosphere globally contains the equivalent of 2.5 centimeters (1.0 inches) of water in the form of vapor.[438] By weight 1% of the atmosphere consists of water.[439]

Scientists studying the water cycle began quantifying the amount of water vapor emitted by trees in 2009. The results were completely surprising and indeed shocking.

Knowledge of the astonishing degree to which vegetation emits water vapor has turned many of our fundamental assumptions on the workings of the climate on their heads.

In 2009, it was determined that the trees of the Amazon Basin emit more water into the atmosphere than the Amazon River drains into the Atlantic Ocean. It is now recognized that the trees of the Amazon Basin create their own rain.[440]

For reference, the Amazon River flows for more than 6,600 kilometers (4,100 miles) and it discharges more water into our oceans than any other river[441] providing 17% of the freshwater discharge into oceans and 50% of the freshwater discharge into the Atlantic Ocean.[442] Yet the transpiration of water vapor into the atmosphere by vegetation in the Amazon Basin vastly exceeds the flow of water from the Amazon River.[443] Nobody predicted it, and it changes everything.

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[438] **The Atmosphere and the Water Cycle** – US Geological Survey – https://www.usgs.gov – Accessed: March 2021

[439] **Forests, atmospheric water and an uncertain future: the new biology of the global water cycle** – Douglas Sheil – Forest Ecosystems – 20 March 2018

[440] **The land–atmosphere water flux in the tropics** – Fisher JB, Malhi Y, Bonal D, Da Rocha HR, De Araújo AC, Gamo M, Goulden ML, Rano TH, Huete AR, Kondo H, Kumagai T, Loescher HW, Miller S, Nobre AD, Nouvellon Y, Oberbauer SF, Panuthai S, Roupsard O, Saleska S, Tanaka K – Global Change Biology – (15) 2009

[441] **The Amazon Basin Forest** – Global Forest Atlas – Yale School of Forestry

[442] **Long-term impact of Amazon river runoff on northern hemispheric climate** – S. Jahfer, P. N. Vinayachandran and Ravi S. Nanjundiah – Scientific Reports – 8 September 2017

[443] **The largest river on Earth is invisible** — and airborne – Dan Kedmey – Science – 24 November 2015; and
Study shows the Amazon makes its own rainy season – Carol Rasmussen – NASA's Jet Propulsion Laboratory – 17 July 2017

To gain some perspective of the scale of this discovery, if the amount of water vapor emitted by the Amazon Basin per year was measured as rain in reverse, or measured as a liquid column of water, it would amount to 1.37 meters (4.5 feet) of liquid water.[444] That gives some perspective on the shocking and unpredicted extent to which vegetation humidifies the atmosphere.

One of the scientists that has been on the forefront of scientific knowledge on the subject of water vapor emitted by vegetation stated poetically that the greatest rivers that flow out of forests are not rivers of water running on the surface of the earth, but rivers of water vapor in the atmosphere.[445]

Shocking Realities of Water Transpiration from Vegetation

Since the discovery of the amount of water vapor emitted by trees in the Amazon Basin was made in 2009, forestry experts and Earth scientists began to quantify the global scale of water vapor emitted by vegetation. The results were staggering.

Much like wet clothes drying on a clothes rack, trees and vegetation have large surface areas that are in contact with the atmosphere. This draws moisture in the way of water vapor from vegetation. It is now recognized that forests emit more water vapor into the atmosphere than open water.[446]

The largest river on Earth is invisible and airborne – Dan Kedmey – Science – 24 November 2015

[444] **The land–atmosphere water flux in the tropics** – Fisher JB, Malhi Y, Bonal D, Da Rocha HR, De Araújo AC, Gamo M, Goulden ML, Rano TH, Huete AR, Kondo H, Kumagai T, Loescher HW, Miller S, Nobre AD, Nouvellon Y, Oberbauer SF, Panuthai S, Roupsard O, Saleska S, Tanaka K – Global Change Biology – (15) 2009

[445] **The largest river on Earth is invisible** — and airborne – Dan Kedmey – Science – 24 November 2015; and
Study shows the Amazon makes its own rainy season – Carol Rasmussen – NASA's Jet Propulsion Laboratory – 17 July 2017
The largest river on Earth is invisible and airborne – Dan Kedmey – Science – 24 November 2015

[446] **Forests, atmospheric water and an uncertain future: the new biology of the global water cycle** – Douglas Sheil – Forest Ecosystems – 20 March 2018

In 2017, it was estimated that 61% of the rain that falls on land is derived from land evaporation and that only 39% is derived from oceanic evaporation.[447]

In 2011, moisture evaporated from land was estimated to typically travel 500 to 5,000 kilometers (300 to 3,000 miles) before returning to the Earth, with recycle times of 3 to 20 days.[448]

Although these critical estimates are evolving, their conceptual implications are obvious: vegetation emits colossal amounts of water vapor.

Even in the latitudes far away from the Tropics vegetation hugely humidifies the atmosphere. This is shown in the photo provided in Figure 16, which was taken of a forest in Poland at a latitude of 49° North. It shows the interaction between forests and water vapor in the atmosphere.

Trees emit water vapor ***Figure 16***

Photo Credit: Marek Piwnicki on Unsplash (Location: Bieszczady Mountains, Poland)

Based on satellite data, the amount of water vapor being emitted by vegetation into the atmosphere is rising every decade as a result of the Earth's increasing green and forested surface areas.[449]

[447] **Evaluating the Hydrological Cycle over Land Using the Newly-Corrected Precipitation Climatology from the Global Precipitation Climatology Centre** – Udo Schneider, Peter Finger, Anja Meyer-Christoffer, Elke Rustemeier, Markus Ziese and Andreas Becker – Atmosphere – 3 March 2017

[448] **Length and time scales of atmospheric moisture recycling** – R. J. van der Ent and H. H. G. Savenije – Atmospheric Chemistry and Physics – 1 March 2011

[449] **Responses of land evapotranspiration to Earth's greening in CMIP5 Earth System Models** – Zhenzhong Zeng, Zaichun Zhu, Xu Lian,a Laurent Z X Li,

The increased amount of lush green vegetation on our planet, caused by carbon dioxide fertilization, is causing the amount of water in the atmosphere to increase.

The Global Warming Paradigm

The global warming paradigm of the United Nations' Intergovernmental Panel on Climate change attributes 75% of global warming to water vapor.[450]

According to that paradigm, heat related feedback effects increase the amount of water vapor in the atmosphere, which, according to that paradigm, in turn causes 75% of global warming.

We now know that increased carbon dioxide concentrations in the atmosphere are causing the leafy green vegetated area of the Earth to increase by 2.3% per decade and the forested area of the Earth to increase by 2.0% per decade.[451]

Anping Chen, Xiaogang He and Shilong Piao – Environmental Research Letters – 3 October 2016

[450] **CO2: The Thermostat that Controls Earth's Temperature** – Andrew Lacis – NASA Goddard Institute for Space Studies – October 2020 – https://www.giss.nasa.gov/ – Accessed: 12 September 2020; and **Attribution of the present-day total greenhouse effe**ct – Gavin A. Schmidt , A. Ruedy. Ron L. Miller, Andy A. Lacis – Journal of Geophysical Research – 16 October 2010

[451] **China and India lead in greening of the world through land-use management** – Chi Chen, Taejin Park, Xuhui Wang, Shilong Piao, Baodong Xu, Rajiv K. Chaturvedi, Richard Fuchs, Victor Brovkin, Philippe Ciais, Rasmus Fensholt, Hans Tømmervik, Govindasamy Bala, Zaichun Zhu, Ramakrishna R. Nemani & Ranga B. Myneni – Nature Sustainability – 11 February 2019;
Greening of the Earth and its Drivers – Zaichun Zhu and 31 additional authors – Nature Climate Change – 25 April 2016;
Global land change from 1982 to 2016 – Xiao-Peng Song, Matthew C. Hansen, Stephen V. Stehman, Peter V. Potapov, Alexandra Tyukavina, Eric F. Vermote & John R. Townshend – Nature – 8 August 2018
Environmental Drivers of Agricultural Productivity Growth: CO_2 Fertilization of US Field Crops – Charles A. Taylor and Wolfram Schlenker – National Bureau of Economic Research – October 2021
China and India Lead the Way in Greening – Abby Tabor – NASA Earth Observatory – https://earthobservatory.nasa.gov – Accessed: March 2021; and
Carbon Dioxide Fertilization Greening Earth, Study Finds – NASA – https://www.nasa.gov – Accessed: March 2021

Combining that knowledge with the newly gained knowledge relating to the extent to which vegetation increases the amount of water vapor in the atmosphere, would suggest that the global warming paradigm is deficient to the extent that it ignores the entirety of the biological effects of increasing concentrations of carbon dioxide in the atmosphere inclusive of i) increased plant growth and ii) increased water vapor in the atmosphere from that increased plant growth.

Clouds

For broader reference, water in the atmosphere may take the form of water vapor or clouds, which consist of tiny water droplets. Clouds serve to both retain the warmth of the Earth and to reflect thermal radiation from the sun back into space before it reaches the Earth. In effect, clouds can serve to both heat and to cool the Earth. Earth scientists are still confounded by the complexity of the links between clouds and the climate.[452]

Conclusions

Based on discoveries made between 2016 and 2019, premised on directly observed satellite data, we now know that carbon dioxide concentrations in the atmosphere regulate the amount of vegetation – life – on Earth.[453]

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[452] **The Importance of Understanding Clouds** – NASA Fact Sheet – 2005;
An underestimated negative cloud feedback from cloud lifetime changes – Johannes Mülmenstädt, Marc Salzmann, Jennifer E. Kay, Mark D. Zelinka, Po-Lun Ma, Christine Nam, Jan Kretzschmar, Sabine Hörnig & Johannes Quaas – Nature and Climate Change – 2021; and
The Effect of Clouds on Climate: A Key Mystery for Researchers – Michael Lemonick – Yale Environment 360 – August 2010

[453] **China and India lead in greening of the world through land-use management** – Chi Chen, Taejin Park, Xuhui Wang, Shilong Piao, Baodong Xu, Rajiv K. Chaturvedi, Richard Fuchs, Victor Brovkin, Philippe Ciais, Rasmus Fensholt, Hans Tømmervik, Govindasamy Bala, Zaichun Zhu, Ramakrishna R. Nemani & Ranga B. Myneni – Nature Sustainability – 11 February 2019;
Greening of the Earth and its Drivers – Zaichun Zhu and 31 additional authors – Nature Climate Change – 25 April 2016;
Global land change from 1982 to 2016 – Xiao-Peng Song, Matthew C. Hansen, Stephen V. Stehman, Peter V. Potapov, Alexandra Tyukavina, Eric F. Vermote & John R. Townshend – Nature – 8 August 2018

Our understanding of the water cycle has been transformed in recent decades, based on the newly gained knowledge of the scale of the water vapor emitted by vegetation.

The interactions between carbon dioxide, vegetation, water vapor, clouds and climate are complex and not fully understood.

We now know that the Earth's vegetative landscapes affect the amount of water vapor in the atmosphere and the climate significantly more than was previously assumed. The full implications of these discoveries create confounding complexities for climate models.

Environmental Drivers of Agricultural Productivity Growth: CO_2 Fertilization of US Field Crops – Charles A. Taylor and Wolfram Schlenker – National Bureau of Economic Research – October 2021
China and India Lead the Way in Greening – Abby Tabor – NASA Earth Observatory – https://earthobservatory.nasa.gov – Accessed: March 2021; and **Carbon Dioxide Fertilization Greening Earth, Study Finds** – NASA – https://www.nasa.gov – Accessed: March 2021

3. Energy and Carbon Dioxide in Context

Breathing Emits Carbon Dioxide

Breathing Emits Colossal Volumes of Carbon Dioxide

Each human emits on average 1.0kg (2.3lbs) of carbon dioxide into the atmosphere every day through breathing.[454]

Depending on a variety of factors the breath exhaled by humans consists of between 4-6% carbon dioxide.[455] More active people emit more carbon dioxide.

In total, the 8.0 billion human population emits 2.9 billion metric tons of carbon dioxide into the atmosphere every year. The International Energy Agency estimates that energy related carbon dioxide emissions from fossil fuels amounted 36.8 billion metric tons in 2022.[456] Therefore, human breath emits the equivalent of 7.9% of the carbon dioxide emitted by the consumption of fossil fuels for energy.

Carbon dioxide emissions from human breath are not included in any statistics related to human caused carbon dioxide emissions.

Carbon Dioxide, Labelled a Pollutant

Canada has labelled carbon dioxide as a pollutant and, on that basis, has begun taxing the emissions of carbon dioxide.[457]

The Canadian Government, under its Prime Minister Justin Trudeau, intends to increase the amount of the pollution tax on carbon dioxide by a factor of eight times relative to its initial level.[458]

[454] **Do We Exhale Carbon?** – Brian Palmner – Natural Resources Defense Council – 19 May 2015
[455] **Human metabolic emissions of carbon dioxide and methane and their implications for carbon emissions** – Mengze Li, Gabriel Bekö, Nora Zannoni, Giovanni Pugliese, Mariana Carrito, Nicoletta Cera, Catarina Moura, Pawel Wargocki, Priscila Vasconcelos, Pedro Nobre, Nijing Wang, Lisa Ernle, Jonathan Williams – Science of The Total Environment – 10 August 2022
[456] **CO2 Emissions in 2022** – International Energy Agency – March 2023
[457] **How Canada Rolled out a Carbon Tax Without Calling It One** – Akshat Rathi – Bloomberg – 18 July 2023
[458] **How Canada Rolled out a Carbon Tax Without Calling It One** – Akshat Rathi – Bloomberg – 18 July 2023

A carbon dioxide molecule in the atmosphere will have the same impact regardless of its source.

The pollution tax levied on carbon dioxide emissions in Canada applies to industrial emissions and it does not apply to breathing; nevertheless, the tax can be considered a potential risk from a humanistic perspective, to the extent that governments are making decisions concerting which carbon dioxide emissions are pollutants and which carbon dioxide emissions are permissible in a context where humans do emit carbon dioxide when they breath.

The UN Says: "Urgent Action is Required to Remedy the Situation"

According to the United Nations, the greenhouse gases emitted from cows is unnatural and therefore problematic.[459] For reference, according to the United Nations cows emit 14.5% of human-caused greenhouse gases.[460]

As result of that determination, the United Nations is advocating in respect of the existence of cows that: "Urgent action is required to remedy the situation."[461]

The United Nations is urging a move away from meat and dairy to restrict the existence of cows and the greenhouse gases emitted by cows.[462]

In light of the fact that humans too emit greenhouse gases, from a humanistic perspective, it noteworthy that organizations such as the United Nations are making decision relating to which emissions of greenhouse gases are acceptable and which emissions are not.

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[459] **Rearing cattle produces more greenhouse gases than driving cars, UN report warns** – Henning Steinfeld –
United Nations Food and Agriculture Organization – 29 November 2006
[460] **Major reductions of greenhouse gas emissions from livestock within reach** – UN News – United Nations – 26 September 2013
[461] **Rearing cattle produces more greenhouse gases than driving cars, UN report warns** – Henning Steinfeld –
United Nations Food and Agriculture Organization – 29 November 2006
[462] **UN urges global move to meat and dairy-free diet – Felicity Carus** – The Guardian – 2 June 2010

In light of the increased threats by governments against internal combustion engines, it is worth considering the degree to which humans are similar to internal combustion engines in the way that we use energy and emit carbon dioxide.

The energy in our food, like the energy in coal, oil and natural gas is sourced, at its origins, from the sun and captured by plants via photosynthesis. The process of photosynthesis absorbs carbon dioxide from the atmosphere. The use of the energy captured via photosynthesis releases carbon dioxide back into the atmosphere. As a result, energy consumed biologically and energy consumed by internal combustion engines both emit carbon dioxide back into the atmosphere.

It is not a coincidence that the word "carbohydrates" which designates the main source of human energy sounds so much like the word "hydrocarbons", which is another word for fossil fuels. The molecular structures in human food that provide us with energy are similar to those in fossil fuels – both consist mainly of hydrogen and carbon atoms.

To be clear on this point, the emissions of carbon dioxide through breathing is similar, in some ways, to the emissions of carbon dioxide from the exhaust of internal combustion engines.

The similarity between the way humans consume energy and emit carbon dioxide with that of internal combustion engines is also made evident by the fact that internal combustion engines can be run on human food: Some of the first diesel engines invented by Rudolph Diesel in the 1890s ran on peanut oil.[463] Today, liquid biofuels such as bio-diesel (vegetable oil) and bio-gasoline (alcohol, derived mainly from corn) are reformulated human foods.

Is Human Food Actually Carbon Neutral?

The carbon dioxide emitted by human breath is assumed to be part of a natural carbon cycle, unlike the carbon dioxide emitted by internal combustion engines. This distinction is the premise for which humans,

[463] **Biodiesel: A Renewable, Domestic Energy Resource** – Dennis E. Buffington – Penn State Extension – 9 March 2023

unlike internal combustion engines, are not subject to governmental suppression.

For reference, if, hypothetically, a human were to pick some berries grown in nature without any human interference the carbon dioxide related to the consumption of the energy in those berries would be perfectly carbon neutral – in exact equilibrium with amount of carbon dioxide taken from the atmosphere to create the berries.

According to a global energy and agricultural expert, Vaclav Smil, without fertilizers, derived from fossil fuels, we would only have enough food for half of the world's 8 billion people.[464] The point is that our food and the energy within our food is significantly derived from fertilizers that are derived from fossil fuels. By implication, the production of our food is not carbon neutral.

In one considers the full carbon emissions from the procurement of our food, starting with the deforestation to clear farmland, the provision of our food would be wildly in carbon disequilibrium.

To be truly carbon neutral in the procurement of our food would require humanity to live as pre-agricultural hunter-gatherers.

Admittedly, there is some merit in the concept that the carbon dioxide we exhale is significantly taken from the atmosphere when the energy in our food is originally captured from the sun by way of photosynthesis; however, upon a deeper analysis the carbon neutrality of our food and of our breathing is not as clean cut as often assumed.

Potential for Negative Outcomes

The broad point is that arbitrary decisions must necessarily be made in a context of deciding which greenhouse gases should be taxed or eliminated and which greenhouse gases are permissible. If decision making by our governments and by organizations such as the United Nations is not being made in good faith, or worse should it be politicized or abusive, there are risks of negative outcomes.

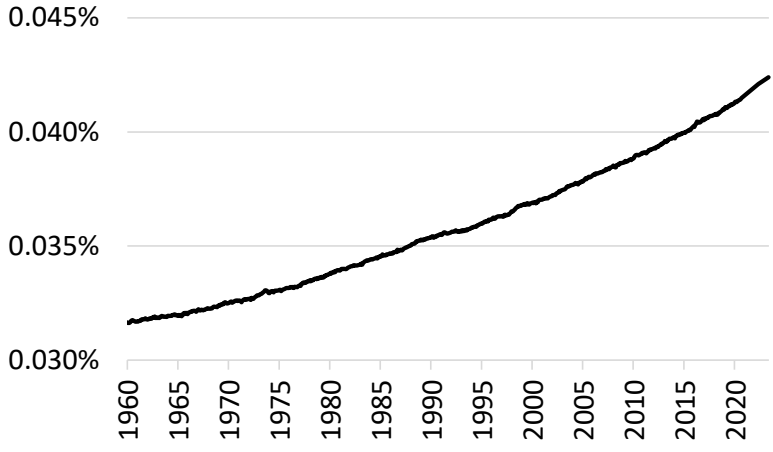
[464] **How The World Really Works** – Vaclav Smil – Penguin Books – 2022

Atmospheric Concentrations of CO_2

No Discernable Impact

The Energy Transition has not had a discernible impact on the amount of carbon dioxide in the atmosphere (Figure 17).

Atmospheric concentrations of CO_2 (%) ***Figure 17***



Source: US National Oceanic and Atmospheric Administration (deseasonalized data)[465]

There is no established statistical correlation between the investments made in the Energy Transition and atmospheric concentrations of carbon dioxide.

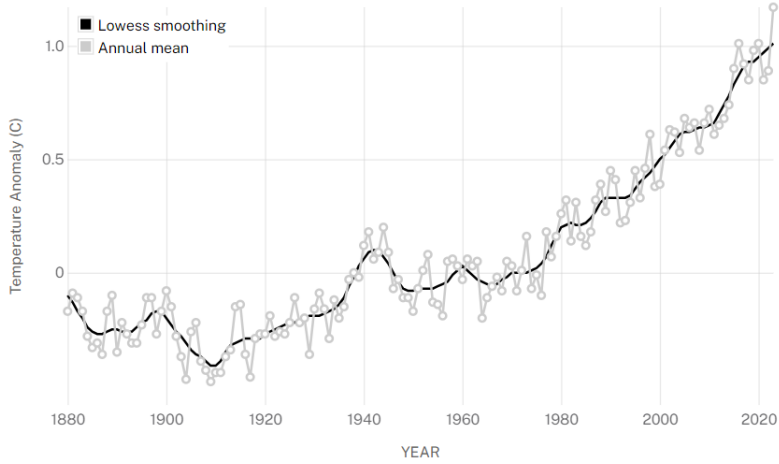
[465] **Monthly Average Mauna Loa CO_2** – US National Oceanographic and Atmospheric Administration – https://www.esrl.noaa.gov – Accessed: June 2023

Additional Perspectives on Global Warming

Surface Temperatures, NASA's Estimates

According to NASA, the planet's average surface temperature has risen by approximately 0.9° Celsius (1.62° Fahrenheit) since the late 1800s and most of the warming has occurred in the past 35 years.[466] The global temperature index prepared by NASA's Goddard Institute for Space Studies is provided in Figure 18.

Global Land-Ocean Temperature Index ***Figure 18***



Source: NASA's Goddard Institute for Space Studies[467]

For reference, global temperatures started rising about 15,000 years ago. At that time, what is now the city of New York was entirely covered in ice sheets. Those ice sheets – glaciers – are estimated to have been higher than the skyscrapers that now give that city its

[466] **Climate Change: How Do We Know?** – Global Climate Change, NASA – https://climate.nasa.gov – Accessed 19 September 2020
[467] **Global Land-Ocean Temperature Index** – NASA Goddard Institute for Space Studies – https://climate.nasa.gov – Accessed: June 2025

skyline.[468] The most detailed ice models currently available suggest that currently habitable lands in the Northern Hemisphere were free of ice only around 11,700 years ago.[469] The point is to appreciate that there are dynamics on Earth, namely, the retreat of remnant glaciers that are unstoppable in the absence of a return to a period of glaciation. Glaciers are simply snow and frost that are trapped by the cold, their weight compacts them into solid ice. Glaciers are not static; they are either growing or shrinking. Even in the absence of human existence, remnant glaciers would continue to melt and sea levels would slowly rise because global temperatures are significantly higher than the temperatures required for ice-sheets to grow in surface area on our Earth. This is shown in the chart in Figure 19, which has been published by the US National Oceanic and Atmospheric Administration. Notably the short interglacial periods have been shaded in that chart.

[468] **How the Ice Age Shaped New York** – William J. Broad – New York Times – 5 June 2018

[469] **BRITICE Glacial Map, version 2: a map and GIS database of glacial landforms of the last British–Irish Ice Sheet** – Chris D. Clark, Jeremy C. Ely, Sarah L. Greenwood, Anna L. C. Hughes, Robert Meehan, Iestyn D. Barr, Mark D. Bateman, Tom Bradwell, Jenny Doole, David J. A. Evans, Colm J. Jordan, Xavier Monteys, Xavier M. Pellicer, Michael Sheehy – BOREAS An International Journal of Quaternary Research – 29 August 2017

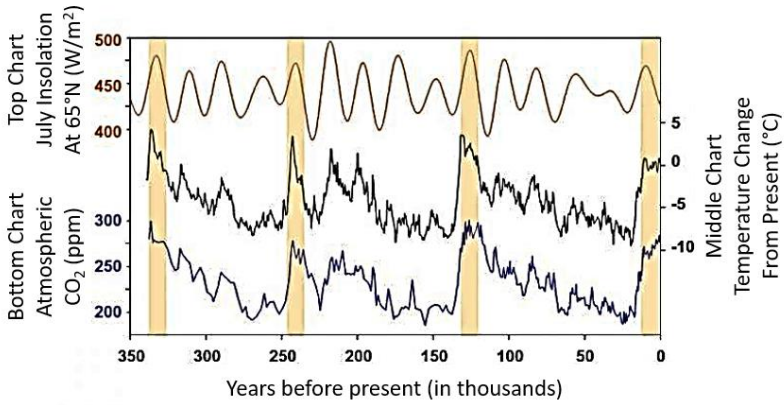


Image Credit: US National Oceanic and Atmospheric Administration[470]

Additional Perspectives

For additional critical perspective, it is interesting to consider that thermometers are a new invention in relation to the history of the Earth and that many of our oldest series of temperature measurements are from urban areas. Urban areas are hotter than undeveloped areas due to the heat island effect of cities. It is plausible that as urban areas have grown, the urban heat island effect has increased, which has increased the appearance that our Earth as a whole is increasing in temperature because of where temperature records have been made. Research from the University of Guelph and the Cato Institute determined that more than half of the reported increase in global temperature measurement is attributable to the heat island effect.[471]

For further critical perspective, in respect of temperature measurements, it has also become apparent that at least in some cases temperature data has been misrepresented and contaminated by scientists.[472]

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[470] **Glacial-Interglacial Cycles** – National Oceanic and Atmospheric Administration – https://www.ncdc.noaa.gov – Accessed: July 2020

[471] **Quantifying the influence of anthropogenic surface processes and inhomogeneities on gridded global climate data** – Ross R. McKitrick and Patrick J. Michaels – Journal of Geophysical Research, Atmospheres – December 2007

[472] **Socioeconomic Patterns in Climate Data** – Ross McKitrick and Nicolas Nierenberg – Journal of Economic and Social Measurement – December 2010

An additional perspective was established in 2016, when a team of scientists from the National Space Institute at the Technical University of Denmark and the Racah Institute of Physics at the Hebrew University of Jerusalem linked large solar eruptions to changes in Earth's cloud cover in a study based on over 25 years of satellite observations. The authors explained that "Earth is under constant bombardment by particles from space called galactic cosmic rays. Violent eruptions at the Sun's surface can blow these cosmic rays away from Earth for about a week. Our study has shown that when the cosmic rays are reduced in this way there is a corresponding reduction in Earth's cloud cover."[473] Since clouds are an important factor in controlling the temperature on Earth the study indicates that variability in solar eruptions has direct implications on clouds and the climate.

There are many excellent books and references that explain additional factors that drive climate change, such as *Inconvenient Facts* written by Gregory Wrightstone[474] and *Unsettled* by Steven Koonin.[475]

[473] **The response of clouds and aerosols to cosmic ray decreases** – J. Svensmark, M. B. Enghoff, N. J. Shaviv, H. Svensmark – ournal of Geophysical Research: Space Physics – 2016

[474] **Inconvenient Facts** – Gregory Wrightstone – Silver Crown Productions – 2017

[475] **Unsettled** – Steven E. Koonin – BenBella Books – 2021

Efficient Farming: The Key to Prosperity and Wildlife Conservation

Farming Is the Foundation of Human Civilization

Introduction to the Importance of Farming

Farming is the foundation of human civilization and prosperity. Agriculture has been completely ignored in discussions related to the Energy Transition – an oversight that is increasing global hunger. This section will explain the importance of farming.

Most importantly, this section will make the point that the ultimate litmus test to assess various energy policies and to compare the benefits of various forms of energy is to assess how they will change agricultural yields. A constant for over 10 millennia is that increasing agricultural yields reduces poverty, reduces hunger and increases human prosperity.

Increasing agricultural yields also directly frees land for wildlife habitat. The less land we use for farming, the more land is made available for wildlife.

Looking back at the timeline of human development, the combustion of wood and charcoal underpinned the production of the bronze and the iron of the Bronze Age and the Iron Age, respectively. Improvements in bronze and iron farm equipment were the core drivers that increased agricultural yields and, therefore, human prosperity and development during those pulses of human development – all premised on our use of heat energy from combustion.

Today, the most important benefit of the use of fossil fuels, by far, is that fossil fuels underpin the high agricultural yields achieved by modern farming. To ignore that, as the green energy and ESG agendas do, is to fail to understand the primary role of energy in the modern world, the foundation of human civilization and the primary reason for which the prosperity of humankind has increased so considerably since the beginning of the Industrial Revolution.

Since the acquisition of language some 80,000 years ago, the most significant development in our human trajectory has been the development of agriculture – farming. The most significant and clearly evidenced cause of the Agricultural Revolution was the end of the most recent ice age. If we accept that humans have been present in our current anatomical form for the last 300,000 years, we would have spent the vast majority of our existence struggling to survive against cold and ice. This is known because the last 300,000 years have generally been glacial periods. Prior to about 18,000 years ago, global temperatures, as estimated by the US National Oceanic and Atmospheric Administration, were as much as 7.5° Celsius (13.5° Fahrenheit) colder than they are today.[476]

As we have seen, glaciers occur when snow does not melt away in the summer over many years, which allows them to accumulate, compact and turn into ice. Over the years, as more snow accumulates and is transformed into ice, glaciers can thicken into massive ice sheets several kilometers high.

The maximum extent of the most recent ice sheets occurred some 22,000 years ago.[477] However, around 15,000 years ago global temperatures began to rise significantly. As they did, great areas of the Earth that had been covered by ice were transformed into fertile forests and grasslands.

The beginning of the Agricultural Revolution could not have been triggered only by a warmer climate because there were two prior interglacial periods over the last 300,000 years during which estimated temperatures were actually higher than they are today

[476] **Glacial-Interglacial Cycles** – National Oceanic and Atmospheric Administration – https://www.ncdc.noaa.gov – Accessed: July 2020

[477] **BRITICE Glacial Map, version 2: a map and GIS database of glacial landforms of the last British–Irish Ice Sheet** – Chris D. Clark, Jeremy C. Ely, Sarah L. Greenwood, Anna L. C. Hughes, Robert Meehan, Iestyn D. Barr, Mark D. Bateman, Tom Bradwell, Jenny Doole, David J. A. Evans, Colm J. Jordan, Xavier Monteys, Xavier M. Pellicer, Michael Sheehy – BOREAS An International Journal of Quaternary Research – 29 August 2017

(Figure 19), but there is no evidence of a shift to farming during any of the prior interglacial periods.[478]

As we have seen, we acquired language (the cognitive ability to code ideas in our minds) some 80,000 years ago. The first interglacial period to have occurred since acquiring language is the one in which we are currently living. Having acquired language, all that was needed to kick-start the Agricultural Revolution and the emergence of human civilizations was a change in global temperatures and the corresponding retreat of ice sheets.

Prior to the end of the last ice age, humans lived in small nomadic hunter-gatherer communities. 23,000 years ago, the European-wide human population was less than 200,000 by some estimates.[479]

From that statistic alone we know that survival was not to be taken for granted during the last ice age. The combination of less food and considerably colder temperatures would have made life extremely difficult indeed.

As the ice sheets retreated, humans were thriving. Food sources became more plentiful and our hunting skills were honed to make the most of the opportunity. Human population levels increased during this period. However, at some point, the trend of rising human population levels created an existential threat for many humans: There was simply not enough food to support a continuously growing population.

Land is limited and hunting and gathering requires a tremendous amount of land to support a limited number of people. By some

[478] **Glacial-Interglacial Cycles** – National Oceanic and Atmospheric Administration – https://www.ncdc.noaa.gov – Accessed: July 2020; and **Northern Hemisphere forcing of climatic cycles in Antarctica over the past 360,000 years** – Kenji Kawamura, Frédéric Parrenin, Lorraine Lisiecki, Ryu Uemura, Françoise Vimeux, Jeffrey P. Severinghaus, Manuel A. Hutterli, Takakiyo Nakazawa, Shuji Aoki, Jean Jouzel, Maureen E. Raymo, Koji Matsumoto, Hisakazu Nakata, Hideaki Motoyama, Shuji Fujita, Kumiko Goto-Azuma, Yoshiyuki Fujii & Okitsugu Watanabe – Nature – 23 August 2007

[479] **Human population dynamics in Europe over the Last Glacial Maximum** – Miikka Tallavaara, Miska Luoto, Natalia Korhonen, Heikki Järvinen and Heikki Seppä – Proceedings of the National Academy of Sciences of the United States of America – 7 July 2015

estimates, our Earth can support a population of only 10 million hunter-gatherers.[480]

From the time that humans acquired language to 1,000 years ago, 177 large mammals went extinct in what is known as the global Megafaunal Extinction.[481] This extinction event started well before the transition from hunter-gatherers to farmers began; however, it would surely have been intensified by rising populations of hungry hunter-gatherers.[482] As a result of these extinctions, hunter-gatherers lost sources of food.

With insufficient food to support their growing populations and with sources of food diminishing, many humans were at risk of perishing.

From experimental origins and across the world, societies gave up their nomadic ways to become sedentary agriculturalists because agriculture provided a means of ensuring that growing human populations would have enough food. There is no evidence to suggest that the quality of food or the lifestyles of early farmers was better than it had been for hunter-gatherers. However, farming reduced the risks of hunger and starvation. Agriculture supported ever-increasing human populations making a return to nomadic ways impractical.

The earliest farming communities emerged in:[483]

i) the eastern Mediterranean, from which area farming extended quickly to adjacent areas with fertile land;

ii) Central Mexico; and

iii) the middle Yangtze River region in China.

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[480] **Hunter-gatherer populations inform modern ecology** – Joseph R. Burger and Trevor S. Fristoe – Proceedings of the National Academy of Sciences of the United States of America – 6 February 2016

[481] **Global late Quaternary megafauna extinctions linked to humans, not climate change** – Christopher Sandom, Søren Faurby, Brody Sandel and Jens-Christian Svenning – Proceedings of the Royal Society – 22 July 2014; and **Extinction of large mammals in the Late Quaternary Ice Age** – Adrian Lister – Natural History Museum – https://www.nhm.ac.uk – Accessed: February 2021

[482] **Population reconstructions for humans and megafauna suggest mixed causes for North American Pleistocene extinctions** – Jack M. Broughton and Elic M. Weitzel – Nature Communications – 21 December 2018

[483] **The Natufian Culture in the Levant, Threshold to the Origins of Agriculture** – Ofer Bar-Yosef – Evolutionary Anthropology – 7 December 1998

The archaeological evidence from the eastern Mediterranean region provides the best record of the early transition of hunter-gatherers into sedentary farmers. The transition to a sedentary lifestyle was a slow transition which started with the harvesting of wild cereals. Cereal grains keep for a long time, which is critically advantageous. The possibility of storing large amounts of grain would have been one important reason to have abandoned an entirely nomadic existence. The first settled people of the area, the Early Natufians, lived 12,500 to 11,000 years ago and they built stone houses that had a resemblance to modern houses.[484]

As an important anecdotal point, as an example of evidence that the Earth experiences natural climactic change that can have devastating regional consequences, the region with the best archeological record of early farming has become an arid desert that cannot, today, support farming. Dorothy Garrod famously excavated and discovered the archeological remnants of the Natufians in 1928, the photographs of her discovery show barren lands devoid of agricultural potential. That is why satellite data which covers the entirety of the Earth is the only means of getting a balanced understanding of Earth dynamics. There will always be areas of the Earth where changes can be construed negatively, focusing exclusively on those areas misrepresents the changes occurring on the Earth as a whole.

The Agricultural Revolution consisted of applying human ingenuity to increase food production from a limited area of land. For example, the primitive Natufian sickles increased yields by reducing waste.

The first farmers intended only to produce enough food to sustain their communities, but soon they were creating a surplus of food. This allowed people to engage in other specialist activities and to move to newly emerging towns. From these towns and from the freedom provided by a surplus of food rose social structures, commerce, armies, professional clergy, specialization of labor and governments. Indeed, the great civilizations of antiquity all rose up as a product of the Agricultural Revolution – as have our own.

[484] **The Natufian Culture in the Levant, Threshold to the Origins of Agriculture** – Ofer Bar-Yosef – Evolutionary Anthropology – 7 December 1998

Why are we spending so much time discussing the importance of agricultural yields in a book about energy?

As we have seen, fossil fuels provide the foundation for modern agriculture. In turn, modern agriculture provides the means for our current human population of 8 billion people and our modern civilizations to exist. Despite being completely ignored in discussion related to the Energy Transition, agriculture must be central to any serious discussion relating to changes to our sources of energy.

As we have seen, copper, bronze and iron farm equipment propelled the prosperity of ancient civilizations upwards. Today, technologically advanced farm equipment, such as modern combines, continues to push agricultural yields and human prosperity upwards.

The mathematical logic of agricultural yields and land use can be shown by example. In 2021, the global average yield for wheat fields was 3.50 metric tons per hectare and for rice that figure was 3.15 metric tons per hectare. For reference, a hectare is an area of land equal to 100 meters by 100 meters or roughly 2.5 acres. In the same year, the world consumed 769.7 million metric tons of wheat and 516.3 million metric tons of rice.[485] For any particular food, dividing the amount of food we need by the agricultural yield for that food indicates how much land we need to satisfy our requirements. To satisfy our needs in wheat, we need 2.2 million square kilometers (849 thousand square miles) of farmland – equivalent to 3.2 times the surface area of the state of Texas, USA. To satisfy our needs in rice, we need 1.6 million square kilometers (633 thousand square miles) of farmland – equivalent to 2.4 times the surface area of the state of Texas, USA.

The human population has grown to 8.0 billion and is expected to grow by a further 30% by the year 2100.[486] If agricultural yields do not increase correspondingly by that time, in order to grow enough food, we will need more farmland. In effect, agricultural yields must increase over the next century to avert i) an increase in global hunger

[485] **Agricultural Outlook 2022-2031** – OECD/Food and Agricultural Organization UN – https://stats.oecd.org – Accessed: June 2023

[486] **World Population Prospects 2019** – United Nations – Department of Economic and Social Affairs

and ii) the destruction of wildlife on a colossal scale as wilderness is turned into farmland in order to feed growing numbers of humans.

Farmland Is Taken from Wilderness

Global Land Use

63% of the Earth's land surface is suitable for the growth of forests or grasslands. Of that land, humans have permanently settled 56%.[487]

We use 93% of the land we have permanently settled for agriculture and the remaining 7% for urban and infrastructure related purposes. 30% of agricultural land is used for crops and the remaining 70% is used as pastureland for grazing livestock.[488]

By some estimates, three-quarters of the Earth's land environment has been significantly altered by human actions.[489]

Efficient Farming Reduces Habitat Loss

Since the beginning of the Agricultural Revolution some 12,500 years ago, the expansion of farmland and urbanization has displaced wildlife.

Habitat loss has been, is, and will be, the principal threat to terrestrial ecosystems – wildlife – because without land wildlife cannot exist.

Conservationists have long known that habitat loss is the single greatest threat to wildlife. The World Wildlife Fund and the National Wildlife Federation of the United States have both drawn attention to

[487] **Assessing Global Land Use** – Stefan Bringezu, Helmut Schütz, Walter Pengue, Meghan O´Brien, Fernando Garcia, Ralph Sims, Robert W. Howarth, Lea Kauppi, Mark Swilling and Jeffrey Herrick – United Nations Environment Programme – 2013

[488] **Assessing Global Land Use** – Stefan Bringezu, Helmut Schütz, Walter Pengue, Meghan O´Brien, Fernando Garcia, Ralph Sims, Robert W. Howarth, Lea Kauppi, Mark Swilling and Jeffrey Herrick – United Nations Environment Programme – 2013

[489] **Nature's Dangerous Decline 'Unprecedented' Species Extinction Rates 'Accelerating'** – United Nations, Intergovernmental Science-Policy on Biodiversity and Ecosystem Services – 6 May 2019

this issue by stating that habitat loss is the number-one threat to wildlife.[490]

In 2019, for the first time ever, the United Nations sponsored a global intergovernmental project to assess and rank risks to wildlife. That research group determined that globally the single most important risk to wildlife is habitat loss.[491]

Farming Without Fossil Fuels

Farming without Diesel, Steel and Fertilizer

Increasing agricultural yields is the most time proven means of increasing prosperity,[492] reducing hunger[493] and increasing the availability of land for wildlife.

Fossil fuels underpin the provision of abundant, low-cost energy, steel and fertilizer that underpin high agricultural yields.

To assess the implications of farming without the energy, steel and fertilizer provided by fossil fuels, we can look to countries that cannot afford those items. Tanzania is case in point.

Although Tanzania's land is fertile, Figure 20 shows that today Tanzania's wheat yield is comparable to that of the United Kingdom in the early 1800s. Tanzania's agricultural yields are low because Tanzanians cannot afford fossil fuels or the products derived from fossil fuels, namely, fertilizer and steel farm equipment.

Of no surprise for anyone who understands the importance of agricultural yields, Tanzania is one of the poorest countries on Earth

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[490] **"Habitat Loss Poses the Greatest Threat to Species" Habitat Loss** – World Wildlife Fund – https://wwf.panda.org/ – Accessed: July 2020; and
Threats to Wildlife – The National Wildlife Federation – https://www.nwf.org/ – Accessed: July 2020

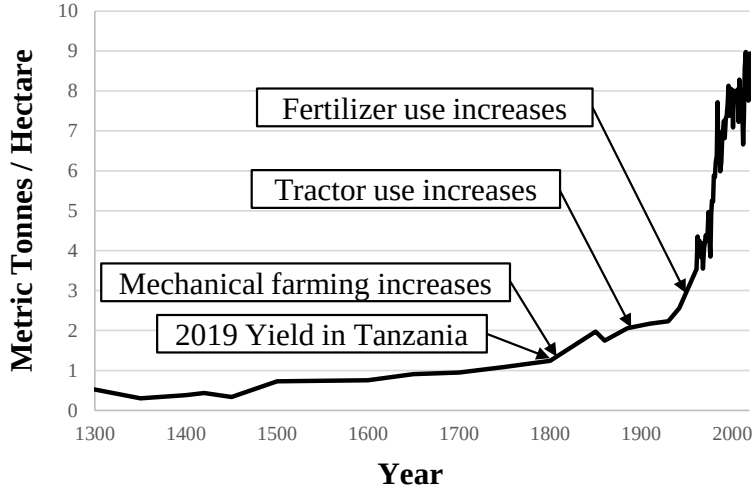
[491] **Nature's Dangerous Decline 'Unprecedented' Species Extinction Rates 'Accelerating'** – United Nations, Intergovernmental Science-Policy on Biodiversity and Ecosystem Service – 6 May 2019

[492] **Ending Extreme Poverty** – Interview of Ana Revenga by Amy Frykholm – 8 June 2016 – The World Bank (as first published by the Christian Century)

[493] **Ending Extreme Poverty** – Interview of Ana Revenga by Amy Frykholm – 8 June 2016 – The World Bank (as first published by the Christian Century)

with approximately half of the country's population living beneath the extreme poverty line of $1.90 per day.[494]

Evolution of UK wheat yields from 1300 *Figure 20*



Sources[495]

It is critical to appreciate that measures that reduce global supplies of fossil fuels are making it harder for farmers in developing countries to achieve high agricultural yields.

Perspectives on Our Economic Trajectory

No civilization is exempt from the importance of agricultural yields.

Without fossil fuels, the agricultural yields in wealthy countries would be comparable to those in Tanzania, which would result in economic destitution comparable to that experienced in Tanzania.

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[494] **Tanzania Poverty & Equity Brief** – World Bank – April 2020

[495] **British Economic Growth, 1270-1870: an output-based approach** – Stephen Broadberry, Bruce Campbell, Alexander Klein and Mark Overton and Bas Van Leeuwen – British Economic Growth – December 2011;
Output and technical change in twentieth-century British agriculture – Paul Brassley – The Agricultural History Review – 2000;
Food and Agricultural Organization of the United Nations – FOAStat – http://www.fao.org – Accessed: March 2021; and
Tanzania Grain and Feed Annual 2019 – Benjamin Mtaki – US Department of Agriculture Foreign Agricultural Service – 9 April 2019

It is not hard to find evidence that even in the sophisticated, advanced economies of the West the efficient provision of food and efficient farming remain essential to our economic and civilizational wellbeing.

In 2023, Sadiq Khan, the Mayor of London stated: "Food price rises have put huge pressure on Londoners' budgets, especially low-income Londoners who have to spend a higher proportion of their income on food. In the last few months, foodbanks have seen falling donations, rising energy costs, and consistently high demand, while being affected by price rises themselves."[496] His assessment accurately reflects the growing cost-of-living crisis in an iconic capital of Western Civilization.

The cost-of-living-crisis will necessarily amplify with the anti-fossil fuel agenda because fossil fuels are the means of providing the abundant, low-cost steel, fertilizer and energy required for efficient farming and the efficient provision of food.

Khan is likewise correct in assessing that the cost-of-living-crisis is hitting low-income households the hardest; however, the growth of the crisis implies that more people are falling into that category. In 2023, according to a survey of 6,000 police officers in the UK, one in five is missing meals to get by and almost 10 per cent were relying on food banks.[497] Another recent survey in the UK found that 30% of nurses had difficulty paying for food and that 14% were using food banks.[498] As food becomes more expensive, many of the most esteemed and valuable contributors to our societies are falling into the bracket of low-income earners.

The UK was governed by the Conservative Party from 2010 to 2024, which broadly supported the objectives of the Energy Transition. In 2019, Prime Minister Theresa May enacted a law committing the UK to the goal of Net Zero.[499] No UK government has linked the cost-of-food-crisis or the broader cost-of-living-crisis to the objective of

[496] **Cost of Food Crisis** – Mayor of London – 18 May 2023 – https://www.london.gov.uk – Accessed: July 2024

[497] **'Living hand to mouth': Record number of police officers turning to food banks** – Amy-Clare Martin – The Independent – 31 March 2024

[498] **Charity reports more than 500 nurses using food banks** – Emma Baines – Nursing Times – 12 January 2023

[499] **Theresa May commits to net zero UK carbon emissions by 2050** – Theresa May – The Guardian – Peter Walker, Rowena Mason and Damian Carrington

reducing global supplies of fossil fuels, which underpin efficient farming, high agricultural yields and the efficient provision of food.

In contrast to the prevailing perspectives of the main political parties in the UK, the former president of the US and presidential nominee Donald Trump stated perhaps as clearly as possible: "Inflation was caused by energy".[500]

The oldest and strongest economic constant of human civilization is that any change that increases the efficiency of farming will favor a civilization's prosperity; likewise, any change that reduces the efficiency of farming will reduce a civilization's prosperity. This constant is worth considering now more than ever as more people in the West are increasingly challenged by rising food prices.

Farming is Centre Stage for Energy Discussions

Global hunger fell significantly in the 1970s and 1980s. It is not a coincidence that as global priorities shifted from developmental goals to the Energy Transition the declining trajectory of global hunger was reversed, with global hunger now rising again. Currently, 828 million people suffer from hunger.[501]

While in absolute terms the number of people suffering from hunger is growing, many organizations present hunger statistics in terms of the percentage of the global population that is suffering from hunger, which downplays the urgency of the global hunger epidemic.

The key point is that farming and high agricultural yields – although largely ignored in discussions relating to the Energy Transition – are critical to consider when contemplating changes to our energy mix.

Positively, the provision of affordable, reliable, useful and abundant forms of energy has potential to emancipate 828 million people from hunger by increasing agricultural yields – the most time proven means of creating prosperity.

[500] **Donald Trump's Anti-Inflation Plan Risks Sparking Even More Price Hikes** – Christopher Condon – Bloomberg – 17 July 2024

[501] **The State of Food Security and Nutrition in the World 2022** – Food and Agriculture Organization of the United Nations – 2022

EU Energy Policy

Europe's Energy Crisis

Facing Europe's acute energy crisis, in 2022, Alexander De Croo, the Prime Minister of Belgium, stated: "We are risking a massive deindustrialization of the European continent and the long-term consequences of that might actually be very deep."[502]

In 2022, the governments of the European Union countries increased their indebtedness by €657 billion ($US624.8 billion) to fund direct cash payments to shelter their citizens from the full impact of Europe's acute energy crisis.[503]

European industry is reliant on the importation of essential materials such as steel, because according the European Commission itself, energy costs in Europe make European steel production uncompetitive.[504]

In 2024, after two years of war between Ukraine and Russia, energy prices in the European Union (and the UK) are being restrained only by the importation of record volumes of liquified natural gas into the European Union from Russia.[505] By importing record volumes of Russian liquified natural gas the countries of the European Union are funding Russia, while at the same time supporting Ukraine in a war against Russia.

What is going on? How did the European Union end up in this situation?

To understand energy in Europe requires an understanding of European history because over the last century energy has been intertwined with Europe's most pivotal turning points, its periods of

[502] **EU energy pact vital to avert industrial decline and unrest, says Belgian PM** – Alice Hancock and Valentina Pop – Financial Times – 6 October 2022
[503] **National fiscal policy responses to the energy crisis** – Giovanni Sgaravatti, Simone Tagliapietra, Cecilia Trasi Georg Zachmann – Bruegel – 24 March 2023
[504] **The EU steel industry** – European Commission – https://ec.europa.eu – Accessed: August 2020
[505] **EU imports record volumes of liquefied natural gas from Russia** – Alice Hancock and Shotaro Tani – Financial Times – 30 August 2023

peace and its wars. From that perspective, current events are consistent with the last century of European history.

A History of Energy Crises and Energy Related Wars

The Treaty of Versailles was signed in the summer of 1919 and it stipulated that Germany was responsible for the First World War and that accordingly Germany would cede to France the entirety of its coal mines in the Saar Basin and pay additional war reparations in the form of coal to France, Italy, Belgium and Luxemburg.[506] Without coal the German economy collapsed. Without coal Germany could not produce steel, which made an economic recovery all but impossible.

In dire straits, Germany was unable to pay the war reparations that were due under the Treaty of Versailles. As a result, French and Belgian soldiers occupied Germany's coal-rich Ruhr Valley in 1923 claiming rights on the coal from that area in lieu of the unpaid war reparations. In the chaos of 1923, Germany's economy did not generate sufficient tax revenues for the government to pay its bills; therefore, the government began printing money to fund its expenditures. In 1923, Germany's fledgling democratic government printed so much money that it caused hyperinflation – the value of money collapsed and with it the value of the life savings of the German people.

Germany's democratic Weimar Republic never recovered from the loss of credibility it suffered as a result of the chaos of this period – chaos that was caused fundamentally by restrictions on the use of coal. It was in this chaotic context that the Nazi Party vied for power. The poverty and desperation that resulted from the controls on the free flow of energy, specifically, coal, created the economic and social climate that the Nazis exploited to gain power. Restrictions on the use of coal were a significant underlying cause of the Second World War.

Arguably, if Germany had free access to affordable coal in the years between the Treaty of Versailles and Second World War, there would not have been a Second World War. That is because if Germany had been prosperous, as it would have been with free access to coal, it is unlikely that Adolf Hitler would have risen to power. Hitler's first attempt to overthrow the democratic government of Germany was

[506] **The Treaty of Versailles**

made in 1923 and his power base grew from that period forwards as he thrived on the chaos and deprivations caused by a lack of coal.

The European Union, Born to Ensure Free Trade in Coal

Having understood that restrictions on the trade in coal caused the Second World War, in 1952, in the aftermath of that war, Belgium, France, West Germany, Italy, Luxembourg and the Netherlands signed a treaty creating the European Coal and Steel Community, which was intended to ensure peace and prosperity in Europe. The treaty created a common market in the trade of coal and steel. The treaty stipulated:[507]

i) "The mission of the European Coal and Steel Community is to contribute to economic expansion, the development of employment and the improvement of the standard of living in the participating countries" through the development of a common market (Article 2);

ii) Members would seek to ensure adequate supplies of coal within the community (Article 3);

iii) Members would seek to establish throughout the community the lowest prices possible for coal by way of free trade within the community (Article 3);

iv) Members would seek to promote free and unimpeded trade in coal internationally with third party countries (Article 3);

v) Members would renounce and abolish "subsidies or state assistance, or special charges imposed by the state, in any form whatsoever" as well as all governmental interference in coal markets (Article 4);

The European Coal and Steel Community worked and the following three decades after the Second World War represented a golden period of European progress and optimism, referred to by the French as "Les Trentes Glorieuses" – thirty years of glory.

The treaty created the High Authority – the most powerful institution in Europe. The treaty went into force in 1952 and, having an agreed

[507] **Treaty Creating the European Coal and Steel Community**

duration of 50 years, expired in 2002. The institutions created by the European Coal and Steel Community, including the High Authority, the Council and the Court of Justice morphed through subsequent treaties into the entities that today make up the European Union. The High Authority has become the European Commission, the president of which is the most powerful person in Europe.

Going down the list of foundational principles of the European Coal and Steel Community, one can consider if the European Union has retained the core principles on which it was founded. It is notable that, the European Union i) promotes an anti-coal agenda; ii) directly regulates the architecture of energy markets; iii) directly regulates the market shares of sources of energy, and iv) actively subsidizes favored energy sectors, while penalizing unfavored energy sectors.

Psychological Considerations of Energy in Europe

In broad terms it is important to understand the deep psychological impact that energy has had on the European psyche. Energy, specifically the deprivation of coal to Germany, was a significant underlying cause of the Second World War. Energy, specifically the unavailability of gasoline, diesel and jet fuel, was a significant underlying cause of Germany's defeat in the Second World War. Europe's history over the last century has been inextricably linked to energy.

Europe recognizes the importance of energy. Europeans also recognize that there is one thing that they lack that other countries have in abundance: fossil fuels.

In 2021, the European Union imported a staggering 55.5% of its energy from outside the European Union.[508] Europeans have a psychosis in relation to energy because energy has been inextricably associated with Europe's most tragic and pivotal historical events of the last 100 years and Europe therefore perceives that its greatest weakness is its lack of fossil fuels.

[508] **Energy Statistics, An Overview** – Eurostat – https://ec.europa.eu – Accessed: June 2023

In reality, Europe's lack of fossil fuels may not be as problematic as it might appear.

Europe's need to import fossil fuels simply ties Europe into a global trading system that benefits all regions.

Conceptually, Germany thrived for decades while it imported oil and exported Mercedes and BMWs. There was not a winner or a looser in that arrangement, everyone benefited.

Europe's acute energy crisis is not the result of having a reliance on imported fossil fuels.

Causes of the EU's Structural Energy Crisis

The most powerful entity within the European Union, the European Commission i) promoted an anti-fossil fuel agenda, ii) promoted the Energy Transition and communicated the success of the Energy Transition, while iii) Russian fossil fuels, not green energy, were underpinning the European Union's economic prosperity.

Electricité de France

The impact of European energy policy can be appreciated by assessing the history of Electricité de France or EDF. The history of EDF shows that the European Commission has not just promoted the Energy Transition, it has redesigned the structure of energy markets in Europe.

EDF was created after the Second World War as France's national energy company. It was the centerpiece of Les Trentes Glorieuses. It was the pride of France and, in its way, it was the greatest energy company globally for many decades, boldly redefining energy markets. EDF was at the forefront of nuclear technology globally and through nuclear energy transformed France into a provider of secure and affordable energy.

For context, in the early 1980s the wealth of France exceeded that of the US based on the metric of GDP per capita.[509]

Today, France has become a net importer of electricity for the first time in 30 years.[510] In 2022, EDF's nuclear output in France fell by 30% to its lowest level since 1988 as more than half of its 56 ageing nuclear power stations went offline for repairs.[511] EDF reported a loss of €17.9 billion in 2022, the third largest loss ever recorded in France's corporate history and the worst corporate loss for a French company in more than two decades.[512] The company's debt spiraled to €64.5 billion.[513] With EDF in financial distress, the French government announced plans to delist the company from the stock market in order to fully nationalize it.[514]

Nothing of the simplicity, efficiency, reliability or affordability of France's energy market remains from the 1970s and the 1980s. Without competitively priced reliable energy, it is no surprise that France has lost ground relative to the other industrialized nations. In contrast to the wealth enjoyed by France in the early 1980s relative to the US, today, the GDP per capita in France is 38% lower than that of the US.[515] France's deterioration in economic prosperity relative to the US over a such a short period of time is associated with the deterioration of the entity that provides France with its energy.

The European Union sees strong national energy companies as a threat to its European vision. The European Union took it upon itself to diminish the market share of EDF within France and has pressured EDF to divide its businesses into separate generation, transmission and distribution businesses. These policies have been applied all

[509] **GDP Per Capita** – World Bank – https://data.worldbank.org – Accessed: June 2023
[510] **How France's prized nuclear sector stalled in Europe's hour of need** – Tom Wheeldon – France 24 – 5 January 2023
[511] **EDF: French energy giant posts worst-ever results** – Hugh Schofield and Paul Kirby – BBC – 17 February 2023
[512] **EDF: French energy giant posts worst-ever results** – Hugh Schofield and Paul Kirby – BBC – 17 February 2023
[513] **EDF: French energy giant posts worst-ever results** – Hugh Schofield and Paul Kirby – BBC – 17 February 2023
[514] **Implementation of the Squeeze-Out Procedure for the shares and OCEANES of EDF** – The French State – 23 May 2023
[515] **GDP Per Capita** – World Bank – https://data.worldbank.org – Accessed: June 2023

throughout Europe through the directives and regulations of the European Union.

An Energy Market Architecture Regulated by the EU

Importantly, Europe has promoted the development of electricity distribution companies to weaken the power of strong national energy companies. These companies distribute or supply electricity to end users but they do not generate electricity. They are nothing more than dealers of electricity with no assets. The distribution companies have made significant profits and many have increased their profits by entering contracts on a speculative basis to fix the prices at which they bought and sold electricity. With the rapid escalation of the acute energy crises in Europe, energy prices have been volatile, which has caused many of the distribution companies to become insolvent. In 2022, Germany alone pledged €67 billion to bail out struggling energy suppliers with tax-payers' money.[516] It is remarkable that in principle these distribution companies are not even a necessary component of energy markets. They are nothing more than marketing agencies prescribed by a market architecture designed and implemented by European governments, in accordance with the directives and regulations of the European Union.

According to a former CEO of EDF during the 2022 energy crisis, things became "surreal" because EDF was required by the regulator to purchase electricity at €100 a unit and sell it to rivals at €46 a unit.[517] The former CEO lamented, many of these rivals were not even real players at all but simply market traders – the distribution companies introduced by the European Union to reduce the standing and presence of companies like EDF.[518]

[516] **Germany pledges €67bn to bolster struggling energy companies** – Guy Chazan – Financial Times – 13 September 2022
[517] **EDF: French energy giant posts worst-ever results** – Hugh Schofield and Paul Kirby – BBC – 17 February 2023
[518] **EDF: French energy giant posts worst-ever results** – Hugh Schofield and Paul Kirby – BBC – 17 February 2023

The primary point is that the European Commission took it upon itself to impose an energy paradigm on Europe, without a popular mandate to do so.

The Energy Transition is now the centerpiece of the European Commission's energy agenda, but the context of European energy politics is much broader and more deeply rooted than just the Energy Transition.

For reference, the political investment made by the European Union in energy is only superseded by its investment in the creation of a common currency, the euro. In other terms, since the creation of the euro in 1999, energy policy has been the European Union's absolute political priority.

Any political entity that makes transformational policy choices has a political interest in promoting the perception that its policies have been successful. From that perspective it is worth considering the European Commission's political interests in promoting the perception that its energy policies have been successful.

Russian Fossil Fuels Underpinned Europe's Economy

Unbeknownst to most Europeans, Russian oil and Russian natural gas was providing a staggering 24.4% of Europe's energy.[519]

After the European Union imposed sanctions on Russian energy imports, the CEO of German based BASF, the largest chemical company by sales globally, stated that Russian fossil fuels formed the "the basis of our industry's competitiveness."[520] With reduced supplies of Russian fossil fuels, BASF announced plans to downsize in Europe "as quickly as possible and also permanently."[521] While BASF has been reducing its presence in Europe due to the acute energy crisis, it has been expanding where fossil fuels are available,

[519] **Imports from Russia in gross available energy in 2020** – Eurostat – https://ec.europa.eu/eurostat - Accessed: June 2023
[520] **Germany confronts a broken business model** – Guy Chazan and Patricia Nilsson – Financial Times – 6 December 2022
[521] **Germany confronts a broken business model** – Guy Chazan and Patricia Nilsson – Financial Times – 6 December 2022

namely, in Southern China in which region it has decided to invest €10 billion in a chemical complex.[522]

NATO Allies Funding Russia During a War

The most prominent countries in Europe are all members of the NATO defensive alliance, which is there to protect against Russian aggression.

The NATO countries of Europe made themselves dependent on Russian energy imports. Russia's President, Vladimir Putin, aware of Europe's dependence on Russian fossil fuels and the limitations of the Energy Transition, calculated correctly that the European Union could not put up a meaningful resistance to Russia's invasion of Ukraine.

The European public seemingly had not idea that the European Union's energy policies significantly reduced Europe's deterrence threat against Russia. Russia knows that it has the upper hand because Europe depends upon Russia for the reliable, affordable, abundant and useful forms of energy it needs.

Most shockingly, almost two years after Russia's invasion of Ukraine, European countries are importing record high volumes of liquified natural gas from Russia.[523] In doing so they are funding Russia, while also supporting Ukraine in a war against Russia.

The EU's Primary Energy Strategy: Obtaining Statistical Goals

Statistics are at the heart of Europe's energy policies.

Critically, Eurostat confirmed that the European Union successfully achieved its goal of sourcing 20% of its energy from renewable sources by 2020.

[522] **BASF seeks 'permanent' cost cuts at European operations** – Ludwig Burger – Reuters – 26 October 2022;
[523] **EU imports record volumes of liquefied natural gas from Russia** – Alice Hancock and Shotaro Tani – The Financial Times – 30 August 2023

The European Union now intends to increase the share of renewable energy to 32% by 2030.[524] Provisionally, the EU is contemplating increasing its renewable energy target to as high as 42.5% by 2030.[525]

Eurostat Reports to the European Commission

Eurostat, which provides Europe with statistics on energy, reports directly into the European Commission.[526] Eurostat is an agency of the European Commission.

Europeans were seemingly not aware of their dependence on Russian energy imports until Russia invaded Ukraine.

Likewise, Europeans are seemingly not aware that renewable energy in Europe essentially consists of biofuels (wood, bio-gasoline and bio-diesel) and not wind power or solar power (Table 1).

Public Relations or Statistics?

The degree to which Eurostat is promotional of the Energy Transition can be appreciated by a recent press release headlined "Renewables: main source of energy production in 2021."[527] The article stated explicitly: "In 2021, the largest contributing source to primary energy production in the EU was renewable energy."

In fact, according to Eurostat's own statistics, fossil fuels account for 70% of the EU's total energy supply.[528]

[524] **Renewable Energy Directive** – March 2021 – European Parliament
[525] **Renewable Energy Targets** – European Commission – https://energy.ec.europa.eu – Accessed June 2023; and
EU countries to finalise 42.5% renewable energy target – Julia Payne – Reuters – 15 May 2023
[526] **Eurostat, European Commission Departments and Executive Agencies** – European Commission – https://commission.europa.eu – Accessed: June 2023
[527] **Renewables: main source of energy production in 2021** – Eurostat – 3 April 2023
[528] **Fossil fuels stabilised at 70% of energy use in 2021** – Eurostat – 30 January 2023

According to the estimates of the International Energy Agency, fossil fuels account for 71.7% of European Union's primary energy supply.[529]

The point is that the European media and European citizens are not reading the fine print, their beliefs are based on the public relations headlines published by Eurostat, which are often misleading.

Threats to Global Wildlife Habitat

The scale of the destruction of forests globally and the destruction of animal populations, such as orangutangs, due to the energy policies of the European Commission is not generally appreciated. That lack of awareness of the global destruction of forests is related to the lack of awareness of how the EU is procuring its energy.

Seemingly, European citizens do not appreciate that renewable energy in Europe consists essentially of biofuels (Table 1) any more than they appreciate their past and ongoing reliance on Russian fossil fuels.

Critically, in respect of the global deforestation being caused by the energy policies of the European Union, the issue is of global significance. If Europeans lack awareness of the harm the European Union's policies are causing to wildlife globally it is unlikely that Europeans will pressure the European Union for change; by implication, it is all the more important that concerned global citizens take measures to protect global wildlife habitat that is at risk from the European Union's energy policies.

The European Commission is Institutionally Aligned with the Energy Transition

It is important to appreciate that the President of the European Commission, the most powerful person in Europe, is not directly elected by Europeans. The President of the European Commission is chosen by member states and appointed by a majority vote in the

[529] **EU: European Energy Policy Review** – International Energy Agency – June 2020

European Parliament.[530] As a technocrat, her power and the power of the institution over which she presides is immense.

Advancing the Energy Transition would appear to be the primary policy objective of the European Commission, by far superseding goals such as winning the war with Russia in Ukraine, protecting global wildlife habitat or fostering sustainable, competitive industrial growth in Europe through the provision of reliable, affordable and useful energy.

The European Commission itself has been at the forefront of the Energy Transition in Europe and its political investment in the Energy Transition has been second to none since the creation of the Euro currency in 1999. The European Commission is institutionally aligned with the Energy Transition. By implication, it is not obvious that the European Commission will change the longstanding trajectory of its energy policies unless there are unprecedented changes in Europe.

[530] **How are the Commission President and Commissioners appointed?** – European Parliament – https://www.europarl.europa.eu – Accessed: June 2023

Oil & Lessons from Collapsed Civilizations

Oil Today is Comparable to Tin During the Bronze Age

Tin was the scarce commodity that made the first Bronze Age civilizations possible in the area of the Mediterranean. As a reminder, bronze is an alloy created by mixing molten copper and tin; the most common mixing ratio in antiquity was one part tin to ten parts bronze by weight.[531] Although copper was abundant in the area of the Mediterranean, tin in the volumes required to support thriving Bronze Age civilizations could only be supplied by the mines of the Badakhshan region in modern-day Afghanistan.[532]

The advantages derived from having bronze were so considerable that the civilizations that existed in the area of the Mediterranean were essentially compelled into trading with each other in order to acquire the copper and tin required to make bronze. By the end of the Bronze Age, these independent civilizations consisted of the Egyptian, Babylonian, Assyrian, Canaanite, Cypriot, Mitanni, Hittite, Minoan and Mycenaean civilizations. The advantages of bronze combined with the benefits of international trade created a golden era of prosperity for all nine of those civilizations.

Bronze axes significantly increased agricultural yields. The use of ploughs became widespread for the first time due to their resistance to breaking when reinforced with bronze. Higher agricultural yields resulting from the use of bronze agricultural equipment created a surplus of food, which allowed for more urbanization and created the basis for the development of prosperity.

Carol Bell, a research associate at the University of London's Institute of Archaeology, made the point that the strategic importance of tin in

[531] **Fire** – Brendan Long – 2021
[532] **1177 BC, The Year Civilization Collapsed** – Eric H. Cline – Princeton University Press – 2014

supporting the prosperity of Bronze Age civilizations was comparable to the strategic importance of oil today.[533]

Oil, today, is by far the most strategic global commodity. It is a fundamental prerequisite for societies to enjoy economic, agricultural and social prosperity.

That requirement has compelled all countries of the world into global trade. Countries that sell oil purchase goods and services from the countries that buy oil – forcing large scale global exchanges. In that manner, oil underpins the global economy. It is the one commodity that is found in abundance everywhere there is a human presence – nothing else comes remotely close and nothing else has done more to ensure global trade flows. That global trade in turn promotes goodwill and peace between the regions of the world: The economies of the world need each other and oil underpins that need.

Oil is the most valuable traded commodity today because of what it allows us to do. The value of oil resides in what it is able to achieve. No other commodity or form of energy comes close to being able to achieve the tasks that oil achieves on a gargantuan global scale every day all year round.

Cutting the Supply of Tin Caused the Collapse of Bronze Age Civilizations

Cutting the supply of tin resulted in the collapse of the entirety of the most powerful civilizations of the Bronze Age. Without tin, the Babylonian, Assyrian, Canaanite, Cypriot, Mitanni, Hittite, Minoan and Mycean civilizations were wiped off the face of the Earth, never to be seen or heard from again. Only the Egyptian civilization survived in a greatly diminished state of weakness just able to limp forwards as a weakened shadow of its former glory – Egypt would never come close to building anything like the pyramids after tin supplies were cut.[534]

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[533] **The merchants of Ugarit: oligarchs of the Late Bronze Age trade in metals?** – Carol Bell – in Eastern Mediterranean Metallurgy and Metalwork in the Second Millennium BC – Oxbow Books – May 2012

[534] **1177 BC, The Year Civilization Collapsed** – Eric H. Cline – Princeton University Press – 2014

Strife, war, violence and hordes of desperate refugees seeking food and resources, left only ruins of what had been the most magnificent civilizations on Earth up until that time.[535] Effectively, with the withdrawal of tin, the cultures, writing, languages, religions, economies and political structures of the Bronze Age civilizations were wiped off the face of the Earth never to return.

The period that followed the precipitous collapse of the Bronze Age civilizations was a period of utter destitution, illiteracy, brutishness, poverty and hunger – it was not an uplifting "transition" into the Iron Age. After the collapse in the Bronze Age civilizations of the Mediterranean, the period of brutishness lasted for five centuries – 500 years of misery.

Not All Transitions are Positive

In respect of the Energy Transition, it is critical to learn from history that a transition from one technology to another technology – even a supposedly better technology – can end in centuries of destitution waiting for the promises of the theoretically superior technology to have any practical utility. Iron is better than bronze and more abundant than copper and tin; however, the technologies to create iron from iron ore and to turn iron into steel were not sufficiently developed to allow iron to substitute for bronze at the time of the collapse of the Bronze Age civilizations.

In the case of wind power and solar power, it is not obvious that even after 500 years they will be able to replace our need for fossil fuels.

Oil, the Critical Global Commodity

The evidence suggests that the assessment of Carol Bell, a research associate at the University of London's Institute of Archaeology, is poignant:[536] Oil today is in many ways comparable to tin during the Bronze Age. Oil, and fossil fuels, are the miracles that make our civilizations work, they even make green energy possible. Take them

[535] **1177 BC, The Year Civilization Collapsed** – Eric H. Cline – Princeton University Press – 2014

[536] **The merchants of Ugarit: oligarchs of the Late Bronze Age trade in metals?** – Carol Bell – in Eastern Mediterranean Metallurgy and Metalwork in the Second Millennium BC – Oxbow Books – May 2012

away, or even attempt to take them away, and our civilizations immediately begin to collapse.

The Human Tragedy of Taking Tin out of the Bronze Age and the Oil out of the Modern Age

It is noteworthy that the headline news today is almost an exact replica of what occurred during the collapse of the Bronze Age civilizations.

Without tin, poverty and desperation increased, causing an increase in the number of refugees, known to historians as the "Sea Peoples" of the Mediterranean. The Sea Peoples made desperate forays into the crumbling civilizations of the Bronze Age for food and resources.

We have looked at the hopelessness and damage caused by promoting the anti-fossil fuel agenda in South Africa: Consider that that is only one country in a context where the anti-fossil fuel agenda has had global ramifications.

It is a historical parallel that as policies to suppress the global supply of oil have been implemented, people are fleeing from hopelessness and despair, just as they did during the collapse of the Bronze Age civilizations when tin supplies fell: At least 22,400 people are estimated to have lost their lives trying to enter Europe since the year 2000, mostly in the Mediterranean Sea[537] – the exact sea from which the Sea Peoples also made their forays into the civilizations of the Bronze Age.

The death count in the Mediterranean Sea is symbolic because it is replicating exactly the developments that occurred during the collapse of the Bronze Age civilizations; however, uncontrolled human migration has become a risk to civilizations globally. Currently, it is estimated that 11.0 million unauthorized people are living in the US,[538] creating huge social, economic and security risks.

[537] **Fatal Journeys, Tracking Lives Lost during Migration** – Editors: Tara Brian and Frank Laczko – International Organization for Migration – 2014
[538] **Profile of the Unauthorized Population: United States – Migration Policy Institute** – https://www.migrationpolicy.org – Accessed: November 2023

Oil Underpins the Global Trading System, as Did Tin

The global trading system that emerged after the Second World War reflected an understanding that energy, and particularly oil, was equivalent to tin during the Bronze Age. Everyone needed tin, therefore the Bronze Age civilizations put aside their differences in values, religions and interests to seek peaceful trading relations: Since the end of the Second World War, it has been acknowledged that everyone needs oil and that understanding has underpinned an inclusive global trading system that has encouraged peaceful relations between nations; however, today, an international order is evolving based on the belief that oil has lost its relevance.

Both Janet Yellen, US Secretary of the Treasury, and Christine Lagarde, President of the European Central Bank, have recognized that the post-war era of globalization based on trade with the entire community of nations is being dismantled in favor of a new system based on trade only with close friends and allies who share the same values.[539]

That outlook reflects that global leaders do not understand that humanity's reliance on oil is incompatible with a fragmented global trading system divided into blocks of nations that trade only amongst themselves.

Rather than promoting broad global trade with all nations, cooperation and peace, the emerging system is a recipe for economic supply shocks, reduced global prosperity and military conflict.

In reality, a lack of awareness of the fundamental role that oil still plays in achieving humanity's goals is causing global insecurity and increasing the chances of oil supply disruptions. These are exactly the chaotic, hostile trading conditions under which the civilizations of the Bronze Age collapsed after tin supplies were cut: Hostilities caused by a lack of tin, put further pressure on the trade routes required to source and distribute tin.[540]

[539] **Yellen, Lagarde, and the death of the global trade system** – Stephen Olsen – Hinrich Foundation – 4 May 2022
[540] **1177 BC, The Year Civilization Collapsed** – Eric H. Cline – Princeton University Press – 2014

The Petrodollar has Underpinned Global Peace and Global Trade

The dominance of the US dollar as a reserve currency is intrinsically linked to its ability to serve as a "petro-dollar" facilitating the global trade in oil. Everywhere oil goes, you need US dollars to pay for that oil. That means everyone everywhere needs US dollars, making the US dollar the natural reserve currency of the world.

The system of peace, global trade and prosperity including the US dollar as the currency of global trade, is premised on the recognition of humanity's need for oil.

A great credit to the US, the US dollar and the global trading system underpinned by US policy since the Second World War is that it has facilitated the supply of oil to all nations of the world.

If the US ceases to recognize the importance of oil in its foreign policy that could jeopardize the role of the US dollar as the currency of global trade and the world's dominant reserve currency. In doing so we would put at risk a pillar that has supported peaceful global trading relations and bring us closer to replicating the demise in global trade that occurred when the Bronze Age civilizations collapsed.

Civilizations That Last are Strong and Resilient

As in current times, the civilizations of the Bronze Age were stressed periodically with environmental challenges. Droughts and earthquakes were specific challenges faced by the Bronze Age civilizations.[541] The lesson is that civilizations must be strong enough to face inevitable challenges. Without tin the Bronze Age civilizations were too weak to face unexpected challenges. Likewise, without oil our civilizations will be precarious and unable to face environmental challenges and unforeseeable events.

A World Without Oil

For reference on a critical point, without oil a complete collapse of all human civilization into utter ruin would be instantaneous; specifically, the collapse would be measurable in hours and days, not

[541] **1177 BC, The Year Civilization Collapsed** – Eric H. Cline – Princeton University Press – 2014

in months. We would starve before having the chance to engage in global conflict; however, if the supplies of oil are reduced slowly over periods measured in years, then, it is possible that the resulting collapse of our civilizations would be similar to that of the Bronze Age civilizations when they lost tin.

Is History Repeating?

Carol Bell, a research associate at the University of London's Institute of Archaeology, made the point that the strategic importance of tin in supporting the prosperity of Bronze Age civilizations was comparable to the strategic importance of oil today.[542]

From that perspective and in the context of an agenda to suppress the supply of oil, it is worth observing the global landscape to consider whether history is repeating.

[542] **The merchants of Ugarit: oligarchs of the Late Bronze Age trade in metals?** – Carol Bell – in Eastern Mediterranean Metallurgy and Metalwork in the Second Millennium BC – Oxbow Books – May 2012

Carbon Markets

What are Carbon Markets?

John Kerry is the US Special Envoy on Climate within President Joe Biden's Administration and represents the US at the United Nations, Davos and globally. Kerry was challenged by the statement from Greenpeace that flying into Davos on a private jet to discuss climate alarmism was a "masterclass in hypocrisy,"[543] Kerry defended the practice on the basis that carbon credits can be purchased to offset the extraordinary volumes of carbon dioxide emissions created by travelling on a private jet.[544] But how can flying on private jets not emit carbon dioxide?

The carbon credit system allows companies or individuals to purchase so-called credits from entities that remove or reduce greenhouse gas emissions. A company (or a person) that would like to advertise or communicate that it does not emit carbon dioxide can voluntarily purchase carbon credits until it is satisfied it can make that claim.

Alternatively, a company might be required by green energy regulations to limit its carbon dioxide emissions and might therefore wish to purchase carbon credits so that it achieves its regulated carbon dioxide emissions reductions, net of the offsets provided by the purchased carbon credits.

One tradable carbon credit equals one metric ton of carbon dioxide emissions reduced, sequestered or avoided.[545]

A cap-and-trade system is a different system premised on a regulator i) caping the amount of carbon dioxide companies can emit and ii) allowing companies that emit over their prescribed emission limits to purchase so-called permits from companies that emit under their prescribed emission limits.

[543] **Private jet emissions quadrupled during 2022 World Economic Forum** – Klara Maria Schenk – Greenpeace – 13 January 2023
[544] **'They Are Working Harder': John Kerry Defends Climate Activists Who Fly Private to Davos** – Ari Blaff – National Review – 27 March 2023
[545] **What are carbon markets and why are they important?** – United Nations Climate Promise – 18 May 2022

According to the Economist, there is a "mindbogglingly complex patchwork" of different varieties of systems and regulations for carbon markets globally.[546] Enforcement mechanisms, regulations and penalties vary enormously from one region to the next. Critically, quantifying the amount of carbon dioxide emissions associated with specific economic activities and the emissions reduced by carbon dioxide reduction schemes is inherently complex and necessarily involves arbitrary and discretionary decision making. It is no surprise that cheating and corruption are rampant in carbon markets.

Carbon Markets, Fraud Markets?

According to the Guardian, research into Vera, the world's leading certifier of carbon credits, has found that 90% of their rainforest credits are "worthless" and could actually increase emissions of greenhouse gases.[547] According to the article, Verra is used by Disney, Shell and Gucci and many other global businesses to certify carbon dioxide emissions reductions.

A carbon credit exchange program in Zimbabwe plans on selling carbon offsets created in former Soviet states. According to Bloomberg, the frontman for the project is former South African President Jacob Zuma, who is currently on trial for corruption related to arms dealing.[548]

Zuma presided over a United Nations Framework Convention on Climate Change meeting in 2011. That put him at the core of a carbon market framework devised by the United Nations, namely, the UN Joint Implementation system.

Analysis by researchers at the Stockholm Environment Institute determined that 75% of carbon dioxide offsets generated under the UN Joint Implementation system are likely to have been frauds.

[546] **How do Carbon Markets Work** – Vijay Vaitheeswaran – The Economist – YouTube – 1 October 2021

[547] **Revealed: more than 90% of rainforest carbon offsets by biggest certifier are worthless, analysis shows** – Patrick Greenfield – The Guardian – 18 January 2023

[548] **Russian CO2 Credits Find Pathway to Western Trading Via Zimbabwe** – Ray Ndlovu, Antony Sguazzin, and Natasha White – Bloomberg – 11 July 2023

According to the research, the fraud related to that system may amount to 600 million tons of carbon dioxide, the bulk of which were related to schemes in Ukraine and Russia.[549] According to the author of the study, the UN Joint Implementation system is "maybe the worst mechanism that ever existed in terms of integrity."[550]

For reference, according to research undertaken for the UK Parliament, energy used in computing, information technology, information networks and user devices consumes an estimated 4-6% of electricity generated globally.[551] Companies such as Microsoft have actively promoted the expansion of carbon markets and intend to increase their purchases of carbon offsets to advertise that they are carbon negative.[552]

Bloomberg estimates that the market for carbon trading could grow to reach $1 trillion.[553]

According to Greenpeace, "carbon offsetting is truly a scammer's dream scheme."[554]

According to the assessment of Greenpeace, the carbon offsetting fraud is built on many of the hallmarks of a classic con including i) greed ii) feigned compassion iii) preying on fear, and iv) taking advantage of uncertainty.[555]

[549] **Russian CO2 Credits Find Pathway to Western Trading Via Zimbabwe** – Ray Ndlovu, Antony Sguazzin, and Natasha White – Bloomberg – 11 July 2023
[550] **Russian CO2 Credits Find Pathway to Western Trading Via Zimbabwe** – Ray Ndlovu, Antony Sguazzin, and Natasha White – Bloomberg – 11 July 2023
[551] **Energy Consumption of ICT** – Aimee Ross and Lorna Christie – The Parliamentary Office of Science and Technology, UK – September 2022
[552] **Microsoft buys 1.3 million carbon offsets in 2021 portfolio** – Frank Watson – S&P Global – 29 January 2021
[553] **Carbon Offset Market Could Reach $1 Trillion With Right Rules** – Kerri Chyka – Bloomberg – 23 January 2023
[554] **Carbon offsets are a scam** – Chris Greenberg – Greenpeace – 10 November 2021
[555] **Carbon offsets are a scam** – Chris Greenberg – Greenpeace – 10 November 2021

Game Changer: The End of Free Money

The Growth Driver of Wind & Solar: Free Money

Wind power and solar power projects, like most energy projects, are long-term projects. The cost of the initial investment in the project is paid off over decades with the cashflows generated from the project. The link between a project's costs and its future cashflows is the return on investment.

Regulations and a market architecture that shelters solar power and wind power projects from supply, demand and price risks allows them to be financed up to 80% with debt.[556] Between 2008 and 2022, interest rates were exceptionally low – close to zero. Combined, that allowed wind power and solar power projects to be substantially funded with something close to free money.

In essence, the minimum return on investment thresholds to make wind power and solar power projects feasible were exceptionally low. Even if they generated very low returns, it did not matter.

Wind power and solar power have increased their combined market share to 2.0% of the global energy market. Free money to fund wind power and solar power has been overwhelmingly the primary driver of that increase in market share.[557]

2008-2022 A Period of Record-Low Interest Rates

The interest rates on US Treasury Bills (US Government debt) maturing in one year adjusted for inflation are shown in Figure 21. That figure shows that for an extended period of time benchmark interest rates adjusted for inflation have been close to zero and often negative.

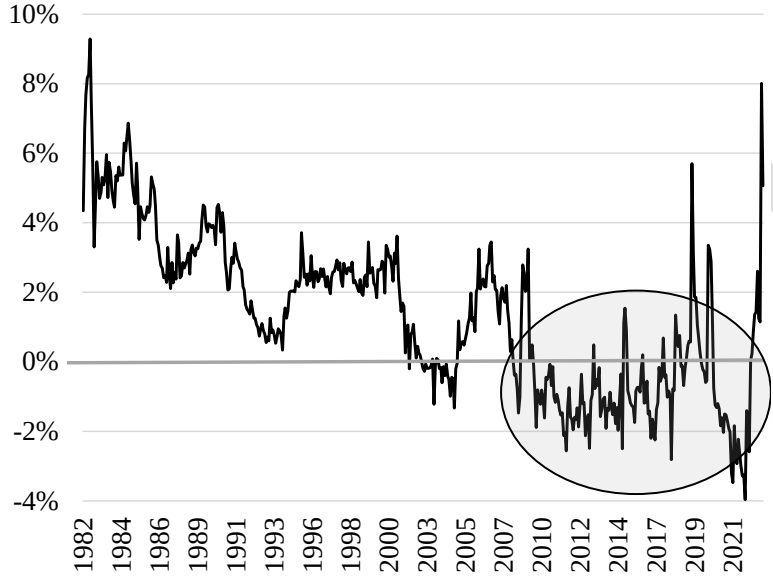
[556] **Lower Debt Ratios Likely for Unsubsidized Green Energy** – Angus McCrone – Bloomberg NEF – 29 August 2017

[557] **Key World Energy Statistics 2021** - International Energy Agency - September 2021

For reference, the interest rates shown in Figure 21 represent the lowest interest rates since the beginning of recorded history.[558]

The key point is to appreciate the extent to which wind power and solar power projects have been funded with something close to free money due to i) exceptionally low interest rates and ii) the regulations that sheltered those projects from risk, allowing them to be funded almost entirely with debt.

Real Interest Rates on 1-yr US Government Debt ***Figure 21***



Source: Federal Reserve Bank of St. Louis

Central Banks Printed the Money to Fund The Energy Transition

Importantly, since 2008, the central bank of the US, the Federal Reserve, has been purchasing US Government debt and other debt in the open market and paying for that debt by creating credit in the US Federal Reserve's electronic ledger accounts of major US financial institutions. Effectively, the US Federal Reserve has been funding the

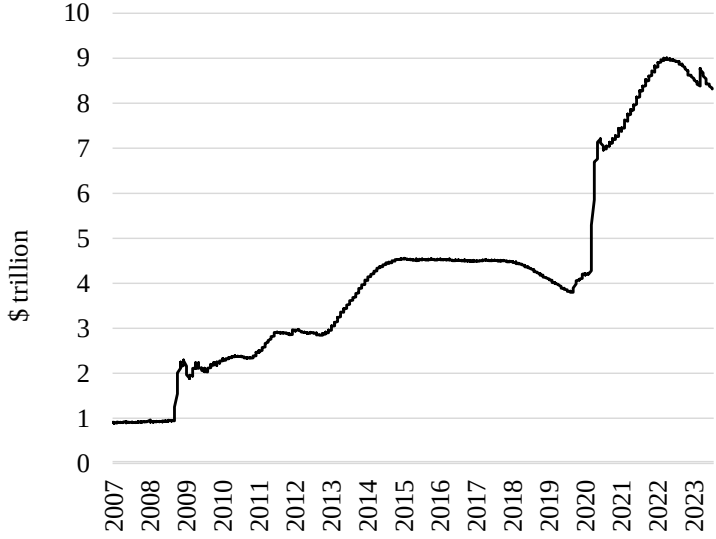
[558] **Living With the Lowest Interest Rates in History** – Barry Ritholtz – Bloomberg – 21 August 2018

purchase of US Government debt by performing the electronic equivalent of printing money.

These financial operations are referred to as quantitative easing operations.

From 2008 to 2022, the US Federal Reserve purchased $9.0 trillion of debt in this way, which translated into the creation of an equivalent amount of money – printed electronically by the Federal Reserve. The scale of that money creation is shown in Figure 22.

Cumulative Federal Reserve asset purchases (net) ***Figure 22***



Source: US Federal Reserve Bank

For reference, to consider the scale of the quantitative easing of the US Federal Reserve in Figure 22, the output of the entire US economy amounted to $25.5 trillion in 2022[559] – the scale of quantitative easing has been staggering.

By buying US Government debt, the Federal Reserve has bid up the market price for US debt instruments, which has correspondingly had the effect of keeping interest rates exceptionally low – actually negative, net of the effects of inflation.

[559] **Gross Domestic Product, Fourth Quarter and Year 2022** – US Bureau of Economic Analysis – 30 March 2023

The central banks in most Western countries have undertaken similar quantitative easing operations.

To a significant extent, that newly created money, channeled through ESG finance networks, flowed into green energy projects.

It is critical to appreciate that the boom in green energy projects since 2008 has been inextricably associated with low interest rates and the floods of money printed electronically by Western central banks.

Western Civilization in Financial Distress

Ray Dalio was a founder of Bridgewater Associates, which he grew into the world's largest hedge fund. He is a student of history, economic history and the rise and decline of great powers. He retired from Bridgewater in 2022 and has since focused extensively on raising public awareness of the financial risks facing the US. Specifically, Dalio warns: "We are at the beginning of a late, big-cycle debt crisis when you are producing too much debt and have a shortage of buyers."[560]

For reference, the US Government is expected to spend $1.6 trillion more than its revenues in 2024 according to the Congressional Budget Office.[561] That funding shortfall is expected to amount to 6.1% of the size of the economic output of the US. The US government will fund that shortfall by raising its debt through the sale of Treasury Bills. Going forwards, the Federal Reserve does not intend to purchase new issues of US public debt by creating money in its electronic ledger accounts, recognizing that printing the equivalent of electric dollars to fund the deficits of the US Government is unsustainable and risks debasing the value of the US dollar.

Going forwards, after an anomalous and unsustainable period, the new buyers of US debt will be interest rate sensitive and credit risk sensitive, a big change that will entail a normalization of interest rates at higher levels.

[560] **Ray Dalio Says US at Beginning of 'Late, Big-Cycle Debt Crisis'** – Katherine Burton – 7 June 2023

[561] **The Budget and Economic Outlook: 2023 to 2033** – Congressional Budget Office – February 2023

Europe, In Worse Shape

Europe is significantly poorer than the US based on economic output per person and likewise precariously over-indebted, suffering from the risks of an energy crisis and an associated deindustrialization, while it is incapable of defending its borders against Russia's aggression without the assistance from the US.

Game Changer

Central banks cannot print money indefinitely. Likewise central banks cannot hold interest rates near zero indefinitely. If they do, they will create too much inflation – as the value of money declines.

Similarly, there are limits regarding the amount of debt Western governments can incur to support the Energy Transition before causing a financial collapse. Those limits are currently being tested, possibly it is too late to fix the damage done.

One thing is certain: The financial conditions that supported the flow of money, measured in trillions of dollars per annum, into projects that generate low returns has come to an abrupt end as interest rates have increased and central banks have reversed their quantitative easing operations to control inflationary pressures.

After a prolonged period of low interest rates, the Federal Reserve raised its target interest rate from 0.25% to 5.50% over the period from March 2022 to July 2023 – representing the most aggressive increase in interest rates in 40 years.[562]

The normalization of interest rates to higher, sustainable levels will necessarily and forever change the fortunes of wind power and solar power.

[562] **Federal Funds Target Range** – Upper Limit – FRED Economic Research, St. Louis Federal Reserve Bank – https://fred.stlouisfed.org – Accessed: November 2023

The Philosophical Basis of Net Zero

Humanity Separated and Isolated from Nature

Net Zero means cutting carbon dioxide emissions to zero.[563]

The explicit goal of Net Zero is to have no influence – zero influence – on our natural world.

Guillaume Blanc is a widely acclaimed university lecturer in contemporary history specializing in environmental history. He has extensively researched the origin of the concept that humanity and nature are isolated and separate and that it is morally wrong for humanity to influence nature.

In his book entitled *The Invention of Green Colonialism*, Blanc explains that that concept was invented by the colonialists of Africa to evict Africans from their own lands in order to provide colonialists with protected hunting grounds and nature reserves.[564]

Selective Application of a Spuriously Invented Philosophy

Blanc argues that the concept that it is morally wrong for human activity to interact with and influence our natural world is a recently invented concept that contradicts the entire natural history of the human species.

From that perspective, it is worth considering whether Net Zero is being advanced by the selective application of a philosophy that has spurious origins.

[563] **For a livable climate: Net-zero commitments must be backed by credible action** – United Nations – https://www.un.org – Accessed November 2023
[564] **The Invention of Green Colonialism** – Guillaume Blanc – Willey – 2022

Elephants & Bison: Habitat Matters, Not CO_2

Similar Population Numbers, Opposite Trajectories

Bison, also called buffalo, are the largest mammals in North America.[565] Bull bison stand as tall as 1.8 meters (6 feet) and weigh as much 900 kg (2,000 lbs).[566] African elephants are the world's largest land-dwelling animal.[567] African bull elephants stand on average 3.0 meters high (10 feet) and weigh 2,000 kg (4,400 lbs).[568] Large mammals are dangerous, destructive and incompatible with farming.

There are 415,000 elephants living in Africa[569] and there are 350,000 bison living in North America.[570] Like ships crossing in the night, their population numbers have come from far away to land almost exactly on the same spot. A century ago, bison in North America were on the verge of extinction; in contrast, at the same time there were 10 million elephants living in Africa.[571] Much can be learned about what matters, and about what doesn't, for wild animals, wilderness and nature by understanding the contrasting fortunes of North American bison and African elephants.

[565] **15 Facts About Our National Mammal: The American Bison** – US Department of the Interior – 11 March 2022 – https://www.doi.gov – Accessed: August 2023
[566] **15 Facts About Our National Mammal: The American Bison** – US Department of the Interior – 11 March 2022 – https://www.doi.gov – Accessed: August 2023
[567] **Top 10 Facts about Elephants** – World Wildlife Fund – https://www.wwf.org.uk – Accessed: August 2023
[568] **Top 10 Facts about Elephants** – World Wildlife Fund – https://www.wwf.org.uk – Accessed: August 2023
[569] **The Status of African elephants** – World Wildlife Fund Magazine – Winter 2018 – https://www.worldwildlife.org – Accessed: January 2021
[570] **Meet the American Bison** – The Nature Conservancy – https://www.nature.org – Accessed 24 January 2021
[571] **The Status of African elephants** – World Wildlife Fund Magazine – Winter 2018 – https://www.worldwildlife.org – Accessed: January 2021

The bison population fell precipitously over the course of the 19th century as the Great Plains were settled for agriculture. Realizing the scale of the bison losses, in 1887, the American Museum of Natural History, based in New York, sent an expedition to the state of Montana to obtain one of the last remaining specimens – none was found.[572]

However, from near extinction, the bison population in North America has strengthened immensely since 1887.

Why?

One reason: Bison were given back land on which to live. With habitat, the bison herds of North America prospered. According to the Yellowstone National Park, the strength of bison populations depends on "how well we negotiate space for them and how well we actually manage wild bison when they leave the national park."[573] Critically, the park adds that "There's no doubt that bison need to be managed because they compete directly with humans for habitat."[574]

Since the beginning of the Agricultural Revolution 12,000 years ago, whenever people have been poor and hungry, they have turned wilderness into farmland to grow food and to increase their prosperity. Another constant since the beginning of the Agricultural Revolution is that as societies increase their agricultural yields, they become prosperous. As we have also seen, efficient farming has formed the foundation of every human civilization that has ever existed – without exception. The US was not always the prosperous country that it is today. The foundational strength of the US economy has come from efficient farming. In 1800, 73.7% of the US labor force worked on

[572] **Timeline of the American Bison** – United Stated Fish and Wildlife Service – Accessed: June 2020

[573] **Conserving Wild Bison: Finding Space for an American Icon, History of Bison Management** – US National Parks Service – https://www.nps.gov – Accessed: August 2023

[574] **Conserving Wild Bison: Finding Space for an American Icon, History of Bison Management** – US National Parks Service – https://www.nps.gov – Accessed: August 2023

farms.[575] In 2021, 1.3% of the US labor force worked on farms.[576] The efficiency of modern farming is the miracle that underpins the prosperity of modern civilizations.

In the year 1887, when the bison were on the verge of extinction, American farms grew 1.5 metric tons of corn per hectare (21.9 bushels per acre).[577] In 2021, American farms grew 11.9 metric tons of corn per hectare (177.0 bushels per acre) – 8.1 times more corn than in 1887: To stress that point, modern US farms are able to produce 8.1 times as much corn from any given area of land compared to in 1887.[578] Efficient farming has provided food and prosperity to the US, while freeing land for wilderness.

The reality is that rising agricultural yields have underpinned the regrowth of the North American bison population, by reducing the amount of land used in the US required to grow food.

[575] **Output, Employment, and Productivity in the United States after 1800** – Dorothy S. Brady – National Bureau of Economic Research – 1966 (Chapter 1: Labor Force and Employment, 1800-1960; Stanley Lebergott)
[576] **Ag and Food Sectors and the Economy** – USDA Economic Research Service – https://www.ers.usda.gov – Accessed: August 2023
[577] **Crop Production Historical Track Records** – USDA – April 2019
[578] **Corn and soybean production up in 2021, USDA Reports, Corn and soybean stocks up from year earlier, Winter Wheat Seedings up for 2022** – USDA – Press Release – 12 January 2022

The North American Bison ***Figure 23***

Photo Credit: iStock

The Story of the African Elephants

Over the last century, the North American bison population has soared from near extinction; in contrast, for every 20 wild African elephants alive in 1930 only one is alive today.[579] African elephants have been decimated over the last century.

What is going on?

African elephants live in 37 countries south of the Sahara Desert.[580] Corn is the most important cereal crop grown in Sub Saharan Africa.[581]

[579] **The Status of African elephants** – World Wildlife Fund Magazine – Winter 2018 – https://www.worldwildlife.org – Accessed: January 2021
[580] **Where do African Elephants Live?** – World Wildlife Fundd – https://www.wwf.org.uk – Accessed: August 2023
[581] **What are the Most Produced Cash Crops in Africa?** – Zainab Ayodimeji – Visual Capitalist – 27 April 2022 – https://www.visualcapitalist.com – Accessed: August 2023

Farms in Sub-Saharan Africa are growing 1.9 metric tons of corn per hectare (28.3 bushels per acre).[582] Farms in Sub-Saharan Africa need 6.3 times as much land as American farms to grow the same amount of food. That in a nutshell is why African wildlife has been, and continues to be, decimated.

It is important to appreciate that if the human population grows faster than agricultural yields, more farmland must be taken from wilderness in order to provide each human with the same quantity and quality of food. For reference, the global population is growing at 0.8% per annum and Sub-Saharan Africa's population is growing at 2.5% per annum.[583]

Focusing on Tanzania, home of the iconic Serengeti National Park, provides a more granular perspective on the dynamics that are at play across Africa – and that have been at play globally since the beginning of the Agricultural Revolution some 12,000 years ago.

For reference, Tanzania's corn yield is actually 20% lower than the average corn yield for Sub-Saharan Africa.[584] By coincidence, Tanzania's corn yield today is identical to that of the US in 1887 – the year the US bison population reached its low point. Tanzanian farms require 8.1 times more land than modern American farms to grow the same amount of food. The country is simply running out of land.

Tanzania is 59 times poorer than the US as measured by GDP per capita.[585] That figure should not surprise anyone who understands the importance of agricultural yields.

Elephants did not inhabit the Serengeti of Tanzania when that grassland was first observed by a European in 1892;[586] however, today, 7,000 elephants live in the Serengeti National Park of Tanzania

[582] **Low Growth in Corn Yields Has Dragged Down Sub-Saharan African Corn Production** – Getachew Nigatu and James Hansen – US Department of Agriculture – 4 November 2019
[583] **Population Growth (% Annual)** – World Bank – Data for 2022 – https://data.worldbank.org – Accessed: August 2023
[584] **Tanzania Corn Yield (2022/2023 year)** – USDA Foreign Agricultural Service – https://ipad.fas.usda.gov – Accessed: August 2023
[585] **GDP per Capita (Current US$; 2022)** – World Bank – https://data.worldbank.org – Accessed: August 2023
[586] **History Serengeti National Park** – The Serengeti National Park – https://www.serengetiparktanzania.com – Accessed February 2021

because they have been forced out of their ancestral habitats[587] – their land was effectively taken away from them by farmers and they had nowhere else to go.

In the case of the Serengeti there is detailed satellite data that clearly shows that farming is encroaching on wildlife habitat all around the Serengeti National Park.[588] Sadly, the area's wild grasslands are increasingly overgrazed by cattle, occupied by crops or simply fenced-off.[589] Farmers and herds of domestic livestock are constantly taking more land from wilderness. When the farms of Tanzania are damaged by encroaching elephants, farmers often retaliate by destroying elephants.[590]

Figure 24 shows a photo of elephants grazing in the Serengeti National Park of Tanzania. From the perspective of hungry, impoverished and desperate Tanzanians, the grassland on which those elephants are grazing represents fertile farmland. That perspective is as old as the Agricultural Revolution, which started approximately 12,000 years ago. Increasing agricultural yields – and prosperity – is the only long-term hope for Africa's wilderness.

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[587] **Tanzania: Elephant, Buffalo Populations On the Rise in Serengeti National Park** (citing: Tanzania Wildlife Research Institute) – Mugini Jacob – Tanzania Daily News – 12 June 2021

[588] **Anthropogenic modifications to fire regimes in the wider Serengeti-Mara ecosystem** – James R. Probert, Catherine L. Parr, Ricardo M. Holdo T. Michael Anderson Sally Archibald, Colin J. Courtney Mustaphi, Andrew P. Dobson, Jason E. Donaldson, Grant C. Hopcraft, Gareth P. Hempson, Thomas A. Morrison, Colin M. Beale – Global Change Biology – 8 July 2019;
Threats to the Serengeti - Andrew M. Sugden – Science – 29 March 2019; and
Cross-boundary human impacts compromise the Serengeti-Mara ecosystem - Michiel P. Veldhuis, Mark E. Ritchie, Joseph O. Ogutu, Thomas A. Morrison, Colin M. Beale, Anna B. Estes, William Mwakilema, Gordon O. Ojwang, Catherine L. Parr, James Probert, Patrick W. Wargute, J. Grant C. Hopcraft, Han Olff – Science – 29 March 2019

[589] **Threats to the Serengeti** - Andrew M. Sugden – Science – 29 March 2019; and
Cross-boundary human impacts compromise the Serengeti-Mara ecosystem - Michiel P. Veldhuis, Mark E. Ritchie, Joseph O. Ogutu, Thomas A. Morrison, Colin M. Beale, Anna B. Estes, William Mwakilema, Gordon O. Ojwang, Catherine L. Parr, James Probert, Patrick W. Wargute, J. Grant C. Hopcraft, Han Olff – Science – 29 March 2019

[590] **An Assessment of Human-Elephant Conflict in the Western Serengeti** – Matt Walpole, Yannick Ndoinyo, Rosina Kibasa, Charles Masanja, Mjungu Somba, Benjamin Sungura – Tanzania National Parks and Frankfurt Zoological Society – July 2004

Elephants in the Serengeti National Park ***Figure 24***

Photo Credit: iStock

Our Choice, High or Low Agricultural Yields?

The African Elephant population is down 20 to 1 in only a century and the North American bison population is up like a rocket over the same period due to habitat loss and habitat gain, respectively.

It would be a tremendous disservice to wildlife to suggest that carbon dioxide emissions have had any bearing whatsoever of the fortunes of either African Elephants or North American Bison.

Land – habitat – is the issue upon which the fortunes of wildlife depend.

Humans use 93% of the land we have permanently settled for agriculture.[591]

[591] **Assessing Global Land Use** – Stefan Bringezu, Helmut Schütz, Walter Pengue, Meghan O´Brien, Fernando Garcia, Ralph Sims, Robert W. Howarth, Lea Kauppi, Mark Swilling and Jeffrey Herrick – United Nations Environment Programme – 2013

Fossil fuels underpin high agricultural yields, which reduce the amount of land required for farming. Fossil fuels ensure wildlife has land on which to live.

The Energy Transition risks lowering agricultural yields which would result in increased land use for farming and therefore increased loss of habitat for wildlife.

Psychological Considerations

Cognitive Dissonance

According to the American Psychological Association, cognitive dissonance is a psychological state resulting from inconsistency between two or more elements in a cognitive system.[592] Believing in contradictory elements of a cognitive system creates cognitive dissonance.

Viewed as a whole, the cognitive system supporting the Energy Transition consists of many elements that are inconsistent, illogical and incoherent: Measures taken to reduce carbon dioxide emissions, have the opposite effect; Measures taken for the good of the environment are having devastating environmental impacts; Measures taken to protect humanity are harming humanity.

Cognitive systems that are internally inconsistent are prone to dysfunctional outcomes. That should be of concern to everyone who is interested in achieving any goals of any kind related to the Energy Transition.

Classic psychological biases are likely contributing to the heightened prevalence of dissonance in the cognitive system supporting the Energy System. These include incentive biases, confirmation biases, biases that deny unwanted realities, herd biases in the face of uncertain complex situations, biases to deference towards authority, biases to react more to fear than to positive outcomes, biases related to political views, biases related to the belonging to certain groups of people, and biases to prefer quick resolve and certainty over complexity.

Self-Reinforcing Emotional Narratives

An additional psychological factor that is likely to be contributing to the cognitive dissonance in relation to the Energy Transition is that it has been supported by two self-reinforcing emotional narratives.

[592] Cognitive Dissonance – American Psychological Association – https://dictionary.apa.org – Accessed: July 2024

One narrative is based on science and the other narrative is based on economics.

According to the first emotional narrative supporting the energy transition, green energy is clean, virtuous, good, cheap, abundant, environmental and sustainable and fossil fuels are dirty, expensive, polluting, harmful, dangerous and evil.

Examples of this narrative include: President Biden's statement that its "cheaper to generate electricity from wind and solar than it is from coal and oil – literally cheaper, not a joke"; Antonio Guterez, the Managing Director of the United Nations statement that fossil fuels have "opened the gates of hell"[593] and that only renewables can serve as the "lifeline"[594] because "without renewables, there can be no future." [595]; John Kerry, the Special Envoy on Climate within President Biden's Administration statement that fossil fuels kill people – 10 to 15 million people every year.[596] Whether you agree with these statements or not, most people will appreciate that these are ere emotive statements.

For reference, Protect the Public's Trust, a nonpartisan, nonprofit group that aims to promote ethics in the US Government and to restore the public's trust in US Government officials, stated that Kerry's claim is hysterical and has no basis.[597]

According to the second emotional narrative, carbon dioxide is causing an immediate climate apocalypse. Kerry uses terms such as "beast,"[598] and "existential" threat,[599] and "the world's most fearsome

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[593] "**Humanity has opened the gates to hell" warns Guterres as climate coalition demands action** – United Nations – Press Release – 20 September 2023

[594] **Five ways to jump-start the renewable energy transition now** – United Nations – https://www.un.org- Accessed: 25 September 2023

[595] **Five ways to jump-start the renewable energy transition now** – United Nations – https://www.un.org- Accessed: 25 September 2023

[596] **Remarks by Special Presidential Envoy for Climate John Kerry** – US Embassy in Egypt – 21 February 2022 – https://eg.usembassy.gov – Accessed July 2023

[597] **John Kerry's Claim Climate Change Kills 15 Million A Year Draws Ethics Complaint** – Kevin Killough – Cowboy State Daily – 23 June 2023

[598] **John Kerry: Global Climate Change Puts 'Life Itself at Risk'** – Angela Nelson – TuftsNow – 1 October 2021 – https://now.tufts.edu/ – Accessed July 2023

[599] **John Kerry Says Climate Change Is An 'Existential' Crisis** – Ari Shapiro – NPR – 23 April 2021

weapon of mass destruction"[600] to describe global warming. Biden stated that global warming poses a greater threat nuclear war.[601] Greta Thunberg's message has been mediatized globally: "I want you to panic!"[602] Whether you agree with these statements or not, most people will appreciate that these are ere emotive statements.

The broader point being made is that two, independent and emotional narratives have overlain the cognitive system supporting the Energy Transition. These independent, emotional narratives are outlined in Figure 25.

[600] **John Kerry's Phony Climate War** – Rich Lowry – Politico Magazine – 19 February 2014
[601] **Biden Says Climate Change Poses Greater Threat Than Nuclear War** – Jordan Fabian and Akayla Gardner – Bloomberg – 10 September 2023
[602] **'I want you to panic': 16-year-old issues climate warning at Davos**– The Guardian – 25 January 2019

Two Self-Reinforcing Emotional Narratives ***Figure 25***

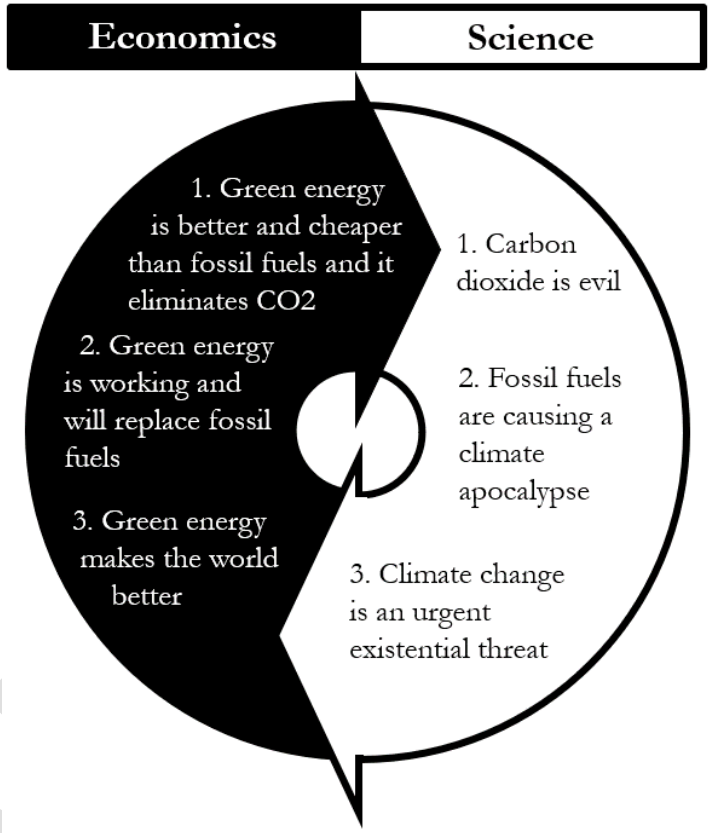


Image Credit: Author

Attempts to apply logical reasoning to one of the two narratives is prone to being highly influenced by the emotional, psychological biases created by the other narrative.

The human mind is faced with the choice of either embarking on the cognitive challenge of analyzing the entirety of this cognitive system, covering the complexities of science and economics, or taking emotional short-cuts.

Fear

It is also important to appreciate that the narratives that support the Energy Transition are based on fear and anxiety. Fear and anxiety

suppress logical, reasoned analysis; therefore, they facilitate cognitive dissonance.

In effect, fear and anxiety are exceptionally powerful emotions because they have strong physiological effects that limit our capacity to reason.[603] Specifically, fear and anxiety affect human cognition in the following ways:

i) Fear and anxiety cause us to lose rational, well-judged control of our threat detection systems, making us hyper-sensitive to anything that could potentially be perceived as threatening, whether or not it actually is.[604]

ii) Fear and anxiety disrupt rational decision making and lead to poor choices.[605]

iii) Fear and anxiety cause us to i) overreact to uncertainty and ii) exaggerate threat significance and likelihood.[606]

Brené Brown, a research professor at the University of Houston, distilled a breadth of social research into a succinct conclusion: "Anxiety is contagious."[607]

[603] **Neurobiological Correlates of Cognitions in Fear and Anxiety: A Cognitive-Neurobiological Information Processing Model** – Stefan G. Hofmann, Kristen K. Ellard and Greg J. Siegle – National Institute of Health – 1 February 2013

[604] **How anxiety warps your perception** – Bobby Azarian – In Depth, Psychology, BBC – 29 September 2016; and
The Principles of Psychology – William James – Henry Holt and Company – 1890

[605] **How Does Anxiety Short Circuit the Decision-Making Process?** – Christopher Bergland – https://www.psychologytoday.com – 17 March 2016 – Accessed: September 2020; and
Anxiety Evokes Hypofrontality and Disrupts Rule-Relevant Encoding by Dorsomedial Prefrontal Cortex Neurons – Junchol Park, Jesse Wood, Corina Bondi, Alberto Del Arco and Bita Moghaddam – Journal of Neuroscience – March 2016

[606] **5 Ways Anxious Feeling Changes the Way We Think, Irrational responses to uncertainty** – Shahram Heshmat – https://www.psychologytoday.com – 23 April 2015 – Accessed: September 2020

[607] **The psychology of mass panic and collective calm** – Kate Raynes-Goldie – medicalpress.com – 9 April 2020 – Accessed: September 2020

Wildfires

By way of background, my interest in combustion led me to write a book on the subject of fire, entitled *Fire*, which covered the topic of wildfires. Having gained an understanding on the subject, there are some core understandings that would be known to anyone who has any interest in the subject of wildfires. These are listed below:

i) Wildfires are beneficial and essential to most ecosystems;
ii) Direct human activity overwhelmingly dominates changes to wildfires regimes;
iii) Extremely intense and dangerous forest fires occur when either i) humans suppress wildfires for decades or ii) the climate is particularly cold and wet for decades, allowing fuel loads to build up, followed by a particularly hot, dry and windy summer – extreme wildfires are not caused by a warmer climate, a warmer climate would encourage more frequent and less extreme wildfires. For example, Canada's Miramichi Fire of 1825 burned a forest area half of the size of Switzerland in two days, sparing nothing; notably, the fuel loads for that fire were built up over many cold and wet years, followed by a hot, dry and windy summer.[608]

Some interesting facts that would not surprise anyone who has spent any time studying wildfires are as follows:

i) Satellite data from NASA's Terra satellite indicates that over the 18-year period ending in 2015 the amount of surface area burned globally by wildfires decreased by 24.3% – wildfire burn areas are in staggering global decline.[609]

[608] **State Area Measurements** – United States Census – https://www.census.gov – Accessed: February 2021; and
Surface Area Switzerland – Word Bank – https://data.worldbank.org – Accessed: February 2021
[609] **A human-driven decline in global burned area** – N. Andela, D. C. Morton, L. Giglio, Y. Chen, G. R. van der Werf, P. S. Kasibhatla, R. S. DeFries, G. J. Collatz,

ii) Tree rings from a 2,210-year-old tree from Sequoia National Park, California, indicated that it experienced, on average, a fire every 18 years over its lifetime.[610] Wildfires in California's sequoia forests became abruptly less frequent after California's 1849 Gold Rush, which brought European settlers and wildfire suppression strategies to the region – an example of direct human activity changing wildfire regimes.[611]

iii) From the 1970s, there has been a profound shift in attitude away from wildfire suppression strategies to wildfire management strategies, recognizing the positive impact of wildfires on ecosystems and the dangers of letting fuel loads build up through the suppression of wildfires – another example of direct human activity upending forest fire regimes.[612]

iv) Australia's highly combustible eucalyptus trees were introduced by humans to California in the 1860s and to Portugal in the mid-19th century. Eucalyptus trees completely dominate ecosystems and they spread by fire (Figure 26) and encourage wildfires – another example of direct human activity upending forest fire regimes.[613]

S. Hantson, S. Kloster, D. Bachelet, M. Forrest, G. Lasslop, F. Li, S. Mangeon, J. R. Melton, C. Yue, J. T. Randerson – Science – 30 June 2017

[610] **Multi-Millennial Fire History of the Giant Forest, Sequoia National Park, California, USA** – Thomas W. Swetnam, Christopher H. Baisan, Anthony C. Caprio, Peter M. Brown, Ramzi Touchan, R. Scott Anderson & Douglas J. Hallett – Fire Ecology – 1 December 2009

[611] **Multi-Millennial Fire History of the Giant Forest, Sequoia National Park, California, USA** – Thomas W. Swetnam, Christopher H. Baisan, Anthony C. Caprio, Peter M. Brown, Ramzi Touchan, R. Scott Anderson & Douglas J. Hallett – Fire Ecology – 1 December 2009

[612] **Fire Management, An Attitude Shift** – Natural Resources Canada – https://www.nrcan.gc.ca – Accessed: March 2021

[613] **Fire** – Brendan Long – Copyright Brendan Long – 2021;
Geographical spatial distribution and productivity dynamic change of eucalyptus plantations in China – YuXing Zhang and XueJun Wang – Scientific Reports – 5 October 2021;
Historical Development of the Portuguese Forest: The Introduction of Invasive Species – Leonel J. R. Nunes, Catarina I. R. Meireles, Carlos J. Pinto Gomes and Nuno M. C. Almeida Ribeiro – Forests – 4 November 2019; and
Portugal's 'killer forest' – Paul Ames – Politico – 19 June 2017

Spread of eucalyptus trees in California *Figure 26*

Source: US Forest Service[614]

v) The Peshtigo Fire of October 1871 killed at least 1,200 people and remains the most devastating fire in the history of the United States.[615] The Miramichi Fire of 1825 remains the most devastating fire in Canadian history with fatality estimates ranging from 200 to 500 people.[616]

vi) Finally, nearly 85% of wildfires in the US are started by humans.[617]

Wildfires are in decline and wildfire regimes are overwhelmingly dominated by direct human influence.

In contradiction to the entire body of knowledge related to wildfires, the United Nations Intergovernmental Panel on Climate Change determined "with very high confidence" that global warming is causing extreme wildfires that are causing harm to humans and ecosystems.[618]

[614] **Eucalyptus Globulus, Fire Effects Information System** – US Forestry Service – https://www.fs.fed.us – Accessed: October 2020

[615] **The Great Midwest Wildfires of 1871** – Tom Hultquist – US National Weather Service – https://www.weather.gov/grb/peshtigofire – Accessed: June 2020

[616] **Forest Fires** – The Canadian Encyclopaedia – https://thecanadianencyclopedia.ca – Accessed: June 2020

[617] **Wildfire Causes and Evaluations** – US National Parks Service – https://www.nps.gov – Accessed: August 2023 (citing: Wildland Fire Management Information and US Forest Service Research Data Archive)

[618] **Climate Change 2014, Synthesis Report** – Editors: Rajendra K. Pachauri, Leo Meyer and Core Writing Team – Fifth Assessment Report of the Intergovernmental Panel on Climate Change – 2015

The images in Figure 27 provide an indication of how the statements in relation to wildfires by the United Nations Intergovernmental Panel on Climate Change are mediatized.

Media Portrayal of Wildfire Risks ***Figure 27***

Sources: The Guardian and TIME Magazine[619]

There is Always a Wildfire Burning Somewhere

It is noteworthy that according to NASA's satellite data on a typical day of summer there are 10,000 wildfires actively burning globally at any one time.[620] That means that if the media so chooses it can focus on isolated events and create the impression that wildfire risks are rising.

US Wildfire Data

Sometime between 2021 and 2023, during the Biden Presidency, the US National Interagency Fire Centre, which is overseen by the federal government of the US, changed its data series relating to the wildfire burn areas. According to the website of the US National Interagency

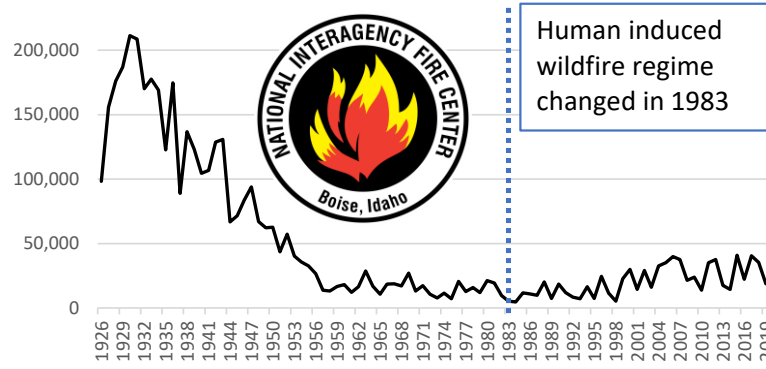
[619] **'Relentless' climate crisis intensified in 2020, says UN report** – Damian Carrington – The Guardian – 19 April 2021; and
TIME Magazine Cover – Edward Felsenthal, Editor-in-Chief and CEO of TIME – 26 April 2021

[620] **Building a Long-Term Record of Fire** – Adam Voiland – NASA Earth Observatory – https://earthobservatory.nasa.gov – Accessed: September 2023

Fire Centre: "Prior to 1983, the federal wildland fire agencies did not track official wildfire data using current reporting processes. As a result, there is no official data prior to 1983 posted on this site."[621]

Having accessed that data in 2021 for my book entitled *Fire*, I have retained the entirety of the data series, which is provided in Figure 28.

USA Wildfire Burn Areas (1926-2022; km²/yr) ***Figure 28***



Source: US National Interagency Fire Center – https://www.nifc.gov – Accessed 2021 and 202

The data series now being made available omits the data from 1926 to 1983 and is now aligned with the narrative that wildfire risks are increasing.

Declines in Truth, Trust and the Rule of Law

According to Ray Dalio, the founder of Bridgewater Associates the world's largest hedge fund and a globally recognized thought leader in the study of the growth and collapse of empires: "Declines of truth, trust, and the rule of law have throughout history led to, and are now leading to, disorder."[622] By exaggerating threats and modifying underlying data to align with particular narratives our authorities are contributing to the declines in trust observed by Dalio.

[621] **US National Interagency Fire Center** – https://www.nifc.gov – Accessed 2021 and 2023

[622] **Ray Dalio** – LinkedIn – 22 August 2023

"Goodbye Gasoline, I've Found Someone New, Someone Better Than You"

Jennifer Granholm, the US Secretary of Energy within President Biden's Administration, appeared in a 2018 music video entitled "Goodbye Gasoline" singing about the need to keep "fossil fools" in the ground.[623]

In 2020, Biden pledged: "No more drilling on federal lands. No more drilling, including offshore. No ability for the oil industry to continue to drill, period."[624]

While promoting an anti-fossil fuel agenda in the West, in order to avert an energy supply crisis and associated high energy costs, the Biden Administration has encouraged fossil fuel production from Russia, Iran and Venezuela.

In all three cases, Russia, Iran and Venezuela have interpreted the actions of the Biden Administration as US weakness. All three countries have taken hostile actions against the interests of the US.

Russia and Ukraine

The Biden Administration has encouraged Russian fossil fuel exports even after the Russian invasion of Ukraine in the midst of an ongoing war in which the US is funding the Ukrainian war effort against Russia.

According to one headline: "Analysts say that the rise in the movement of oil in contravention of western sanctions is often happening with the full knowledge of the US government."[625]

[623] **Gasoline, Gasoline (The World is Aflame)** – Coltura Moving Beyond Gasoline – available on Available on iTunes, Spotify, Google Play, Amazon, and other networks – 2018

[624] **Biden tries to bolster his climate credentials as activists push for more urgency** – Kevin Liptak, Arlette Saenz and Betsy Klein – CNN – 9 August 2023

[625] **The trade in sanctioned oil is booming as the US turns a blind eye** – Jonathan Yerushalmy – The Guardian – 26 September 2023

According to Bloomberg, by turning a blind eye to the trade in Russian oil, the Biden Administration has created an $11 billion black market[626] that is undermining American law while increasing Russia's financial capacity to wage war against Ukraine. According to the article, the black market for Russian oil inclusive of an armada of dedicated shipping vessels has become "mainstream".

In August 2023, the Financial Times ran a story headlined: "EU imports record volumes of liquified natural gas from Russia"[627] detailing that after the Russian invasion of Ukraine, Europe has increased its imports of Russian liquified natural gas – all overseen by the President of the United States who was ostensibly leading the war effort in support of Ukraine against Russia.

Iran, Hamas, Houthis and Israel

While actively promoting an anti-fossil fuel agenda in the US and in the West, the Biden Administration has encouraged increased oil production from Iran, despite the existence of US sanctions against Iran. A related headline in January 2023 read: "White House Turns a Blind Eye to Iran's Surging Oil Sales."[628]

Due to the relaxation of sanctions against Iran, that country was able to increase oil production by 504,000 barrels of oil per day in 2023 compared to production levels in 2022.[629]

According to Helima Croft, one of the most widely followed energy and geopolitical analysts, Iran is "the bank" of Hamas.[630]

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[626] **How Russia Punched an $11 Billion Hole in the West's Oil Sanctions** – Alaric Nightingale, Julian Lee and Alex Longley – Bloomberg – 6 December 2023
[627] **EU imports record volumes of liquefied natural gas from Russia** – Alice Hancock and Shotaro Tani – Financial Times – 30 August 2023
[628] **White House Turns a Blind Eye to Iran's Surging Oil Sales** – Javier Blas – Bloomberg – 19 January 2023
[629] **OPEC Monthly Oil Market Report** – 12 October 2023
[630] **U.S. likely to tighten sanctions on Iran crude oil amid Israel-Hamas war, RBC's Helima Croft says** – Ruxandra Iordache and Sam Meredith – CNN – 25 October 2023

On October 7th 2023, Hamas, a proxy for Iran, brutally attacked Israel killing at least 1,400 people.[631]

In the month that followed that attack, according to the Pentagon and official sources, 40 separate drone and rocket attacks were launched at US forces in Iraq and Syria by Iranian backed militias.[632]

Iranian backed Houthis subsequently attacked cargo and tanker vessels traveling in the Red Sea, a key shipping lane.[633]

Iran can see that the US is turning a blind eye to the black markets that have developed for Russian oil and for the refined products derived from Russian oil. Iran can also see that the White House is ignoring US sanctions on Iranian oil exports.

Having suppressed its own fossil fuel production, the West needs Iranian oil to flow into the global market to keep global oil prices low.

Iran knows that in that context it has tremendous scope to harass the interests of the US and the West.

Pursuant to its energy policies the US and its allies have failed to contain conflict in the Middle East. It is now possible that war spreads and breaks out into the nearby Persian Gulf, the Strait of Hormuz and the Gulf of Oman. Unlike the Rea Sea, those seaways represent key arteries for the trade in oil and liquified natural gas.

In 2022, 21 million barrels of oil and refined oil products were transited through the Strait of Hormuz every day, representing 21% of global oil consumption. Also in that year, 10.9 billion cubic feet of natural gas, in the form of liquified natural gas or LNG, transited through the Strait of Hormuz, representing 21% of the global trade in LNG.[634] If that trade artery, as circled in Figure 29, is blocked it would create unprecedented global chaos and economic harm.

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[631] **These charts show the scale of loss in the Israel-Hamas war** – Rachel Wilson, Rosa de Acosta, Alex Leeds Matthews and Alex Newman – CNN – 7 November 2023

[632] **US forces under fire in Middle East as America slides towards brink** – Phil Stewart, Idrees Ali and Ahmed Rasheed – Reuters – 9 November 2023

[633] **US and UK hint at military action after largest Houthi attack in Red Sea** – David Gritten – BBC News – 12 January 2024

[634] **The Strait of Hormuz is the world's most important oil transit chokepoint** – US Energy Information Administration – 21 November 2023

The most important artery for energy trade *Figure 29*

Source: CIA World Factbook

Venezuela

On October 18th 2023, President Biden withdrew oil sanctions against Venezuela to encourage growth in Venezuelan oil exports in return for an agreement that there would be fair elections in that country.[635]

On October 31st 2023, Reuters reported: "Venezuela's Supreme Justice Tribunal said on Monday it has suspended the results of an opposition presidential primary that took place this month, despite an electoral deal between the government and the opposition that allows each side to choose its candidate."[636]

[635] **US broadly eases Venezuela oil sanctions after election deal** – Matt Spetalnick and Marianna Parraga – Reuters – 19 October 2023

[636] **Venezuela's top court suspends results of opposition presidential primary** – Mayela Armas and Vivian Sequara – Reuters – 31 October 2023

On December 5th 2023, Venezuela announced measures to annex territory from Guyana, a US ally with significant reserves in energy.[637]

Energy, Peace and War

The failure of Energy Transition is perhaps best appreciated by the increase in global conflict against the interests of the West. It is essential to appreciate that the energy policies of the US and its allies, notably, the promotion of the belief that we do not need fossil fuels and the suppression of domestic fossil fuel production, have created unprecedented scope for Russia, Iran and Venezuela to take actions against the interest of the West. That is because Russia, Iran and Venezuela can see that we are in an energy crisis of our own making and that, as a result, we are reliant on their fossil fuel exports to keep global energy prices low. Our deterrence threat has been reduced by the governmental policies that have promoted the Energy Transition and Russia, Iran and Venezuela have taken advantage of that.

US President Reagan said: "Peace is not the absence of conflict, but the ability to cope with conflict by peaceful means"[638] and that "We know only too well that war comes not when the forces of freedom are strong, but when they are weak. It is then that tyrants are tempted."[639]

Notably, President Reagan took office in 1981 during a deep recession associated to the energy crises of the 1970s – the US was weak, losing its standing in the world and was being rivalled by up-and-coming powers. At the end of Reagan's presidency in the late 1980s, the US had won the Cold War – peacefully – and was the unrivalled global super power. A major contributing factor to the change in fortunes of the US was the rise in oil production from the North Slope of Alaska from no production in the mid-1970s to a record high of over 2 million barrels of oil per day in 1988[640] – equating to colossal daily cash

[637] **Venezuela's president orders creation of new state and map including land from Guyana** – Osmary Hernández, Fernando Almánzar and Mia Alberti – CNN – 6 December 2023

[638] **Handling Conflict by Peaceful Means** – J. Robin West – United States Institute of Peace – 29 November 2011

[639] **Peace Through Strength** – Ronald Reagan – Republican National Convention – 17 July 1980

[640] **Oil production in Alaska reaches lowest level in more than 40 years** – Brett Marohl – US Energy Information – 21 April 2021

injections into the US economy, strengthened US geopolitical power, and the ability for the US to complete the tasks that only oil can accomplish, and, therefore, to global peace.

From another perspective, according to historians, nations do not fight wars over oil simply for its own sake, but rather to accomplish the tasks that require oil.[641] When oil and fossil fuels are made abundant, the means of achieving the tasks that only fossil fuels can accomplish are also made abundant, which can create a supportive backdrop for global peace.

As with so many things, the question for the West is really one of values and prioritization. President Biden began his Administration stating: "Climate change is the existential threat to humanity" and adding that in terms of priorities "it's the number one issue facing humanity and it's the number one issue for me."[642] In contrast, President Reagan began his Administration stating: "Peace is the highest aspiration of the American People."[643]

No matter how the US and its allies might prioritize goals, it is important to understand that the provision of energy and global peace cannot be considered in isolation from each other, they are viscerally intertwined.

[641] **Oil & The Great Powers, Britain & Germany, 1914-1945** – Anand Toprani – Oxford University Press – 2019

[642] **Joe Biden calls climate change the 'number one issue facing humanity'** – Emma Newburger – CNBC – 24 October 2020

[643] **Inaugural Adress, President Ronald Reagan** – 20 January 1981 – sourced from: Ronald Reagan Presidential Foundation & Institute

Energy and the Role of Government

Green Energy and ESG Have Changed the Role of Government

The International Monetary Fund has written guidelines for communist state-controlled economies to successfully transform themselves into successful free market economies. Specifically, the International Monetary Fund states:

> "To function well, market economies need governments that can establish and enforce the 'rules of the game.' When the necessary public institutions do not exist or, if they do exist, when the incentives for their managers are perverse, the government can easily become an impediment to economic activity because it ends up being used by individuals for their own ends. This is what normally happens in a corrupt system, where parts of the government apparatus are privatized for the gains of individuals or special interest groups. In such a system, the achievement of social objectives is difficult and some of the government's actions may appear predatory."[644]

From that perspective, due to the fear associated with carbon dioxide induced global warming, Western societies have knowingly accepted the transformation of our system from a free market system into a system with many of the attributes of a state-controlled system.

[644] **Transition and the Changing Role of Government** – Vito Tanzi – Finance and Development, International Monetary Fund – June 1999

Has PR Gone Too Far?

Declining Trust in the Media

According to the Pew Research Centre, trust is essential to democracy, but people do not think that the news is trustworthy.[645]

In 1972, 72% of Americans trusted the mass media, but today only 34% of Americans trust the mass media.[646]

According to the Pew Research Center manufactured misinformation in the news is creating confusion and distrust.[647]

Today, eight-in-ten Americans believe news organizations favor one side when presenting the news on political and social issues, only approximately two-in-ten Americans believe that the news is presented fairly without a bias.[648]

Public Relations

According to the Public Relations and Communications Association, which is the largest professional body representing public relations professionals: "Public Relations, or 'PR', is all about the way organizations communicate with the public, promote themselves, and build a positive reputation and public image."[649] PR professionals try to influence the media in a way that benefits the interests of the organizations they represent.

Public relations professionals hold themselves to high ethical and professional standards to avoid abuse and negative impacts.

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[645] **Do Americans Trust the News Media?** – Katarina Eva Matsa and Lee Rainee – Pew Research Centre – 5 January 2022 – YouTube

[646] **Americans' Trust in Mass Media, 1972-2022** – Gallup – https://news.gallup.com – Accessed: December 2023

[647] **Do Americans Trust the News Media?** – Katarina Eva Matsa and Lee Rainee – Pew Research Centre – 5 January 2022 – YouTube

[648] **Americans blame unfair news coverage on media outlets, not the journalists who work for them** – Mason Walker and Jeffrey Gottfried – Pew Research Center – 28 October 2020

[649] **What is PR?** – The Public Relations and Communications Association – https://www.prca.org.uk – Accessed: December 2023

However, in practice, opaque charities, foundations and non-governmental organizations that advance public relations campaigns are not held to the same standards. According to one expert, an unethical strategy that is used by unscrupulous organizations is to flood the information landscape with alternative facts or manufactured truths.[650]

In practice, the public relations ecosystem of the Energy Transition includes, amongst others, scientists, academics, researchers, non-governmental organizations, environmental organizations, businesses, charities, foundations, litigation firms, energy experts, trade organizations, governments, governmental agencies and digital media content providers. These organizations are not all bound to act in accordance with the ethical standards of the PR profession.

PR Ecosystems Against Fossil Fuels

The Canadian Province of Alberta launched a public inquiry to investigate foreign funding of anti-fossil fuel campaigns. Stephens Allan was appointed Commissioner of the inquiry and he engaged i) Dentons Canada to serve as lead counsel, ii) Deloitte Forensic to serve as head of forensic investigation and iii) Rose LLP as litigation counsel.[651]

The inquiry provided one of the most detailed summaries of the degree to which opaque charities and foundations, funded significantly by foreign entities, are using unethical public relations tactics to promote negative public perceptions of fossil fuels.

The inquiry determined that there were multiple well-coordinated, well-funded public relations campaigns undertaken by charities, foundations and environmental non-governmental organizations that manufactured misinformation for the purposes of distorting the public's perception of reality.

A key recommendation of the inquiry was to increase the transparency, accountability and governance standards that apply to

[650] **How PR Firms Captured the Sustainability Agenda** – Melissa Aronczyk – Foreign Policy – 17 February 2022

[651] **Report of the Public Inquiry into Anti-Alberta Energy Campaigns** – Allan J. Stephens, Commissioner of Inquiry – Public Report Submitted to the Government of Alberta – 30 July 2021

charities, foundations and non-governmental organizations that are actively and intentionally influencing the public's perceptions of truth.

Agendas Dominate the Media, We Know It and are Seeking Alternative Sources of Information

It is interesting to see the extent to which governments, international governmental organizations and philanthropic organizations are shaping media coverage on issues related to the Energy Transition and the climate.

Although we will view this issue through the window of the Energy Transition and the climate, the implications are of broader significance because the underlying issue is the degree to which special interest groups and governments are influencing the mainstream media to align it with their own perspectives and interests.

The Associated Press is a not-for-profit news cooperative that provides news content to many of the most important media organizations – newspapers, broadcasters and other media platforms – globally. In 2022, the Associated Press announced through a press release it "will significantly expand its climate coverage, creating a standalone desk that will enhance the global understanding of climate change and its impact across the world," adding "the initiative will infuse the global media landscape with a new stream of quality climate journalism." That in itself is innocuous.

Of greater concern, the press release announcing the initiative stated, "the expansion is supported by several philanthropic organizations" including, amongst others, Quadrivium and the Rockefeller Foundation. Within the press release, Quadrivium stated: "Effectively communicating the threats of climate change and the opportunities of a clean energy transition is an essential precursor to building public will for policy change." Also, within the same press release, The Rockefeller Foundation added: "The more we shine a light on the very real-world dangers and effects of climate change, the more political leaders, businesses and civil society will come together on solutions."[652]

[652] **AP Announces Sweeping Climate Journalism Initiative** – The Associated Press – 15 February 2022

In effect, the Associated Press has acquiesced to allow special interest groups – philanthropies and media organizations with an overriding agenda to create public support for governmental policy change – to be permanently planted within it. In many industries, the conflicts of interest created by that arrangement would need to be disclosed; however, that is seemingly not the case for media organizations.

Increasingly, Western governments too are directly funding media organizations to promote narratives that are aligned with their interests: The International Press Institute is a global network of editors, media executives and journalists. It receives donations from the United Nations, the European Commission, the Canadian Government under Prime Minister Justin Trudeau, a host of foundations and other donors. It produces strategies to support and promote climate journalism. One 36-page strategic report begins with the statement: "The climate crisis is real and affects all of us."[653] Another report describes the duties of climate journalists: "Environmental and climate journalists shed light on corrupt practices and illegal activities linked to environmentally harmful businesses and disclose the vested interests that support polluting industries. They report on state authorities who enable or tolerate these practices. And they expose those who sow disinformation and doubt about the science behind climate change."[654]

That governments are directly funding the media and providing the media with guidelines and strategies to promote the Energy Transition is a red flag. That is because, according to the Center for Democracy and Governance, for democracies to function, the media must act as "watch dogs" that challenge and push back on the narratives of governments in order to keep them in check – the opposite of serving them as agents.[655]

The United Nations also funds the promotion of media content that is aligned with its views on climate threats, inclusive of the provision of

[653] **The Change We Need: Strategies to Support Climate and Environmental Journalism** – Barbara Trionfi – International Press Institute – October 2023

[654] **Climate and Environmental Journalism Under Fire** – Barbara Trionfi – International Press Institute – February 2023

[655] **The Role of Media in Democracy: A Strategic Approach – Center for Democracy and Governance** – U.S. Agency for International Development – June 1999

handbooks for journalists to "get the message across."[656] One report produced by the United Nations being used to advance the Energy Transition and the global warming model of the United Nations' Intergovernmental Panel on Climate Change is to suppress "disinformation" on the grounds that, according to the United Nations: "The ability to disseminate large-scale disinformation to undermine scientifically established facts poses an existential risk to humanity."[657]

The actions of the digital media heavyweight are of critical interest.

According to Global Witness, Facebook CEO, Mark Zuckerberg, stated during congressional testimony that climate disinformation is 'a big issue' on the platform and that Facebook has taken measures to combat this inclusive of the provision of a $1 million grant program to support organizations working to combat "climate misinformation".[658]

According to Google, their climate change policy prohibits ads from promoting false claims about the existence and causes of climate change, but ads intended to promote green initiatives are permitted.[659] Google's algorithms necessarily also determine the ease or difficulty of search engine results that are aligned, or not, with the narratives supporting the Energy Transition and the perspectives of the United Nations' Intergovernmental Panel on Climate Change.

It is noteworthy that governments, inclusive of the US Government under the Presidency of Joe Biden are explicitly combating

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[656] **Media is Hope: Japanese youth, media and the UN team up for climate action** – The United Nations – https://www.un.org – Accessed May 2024;
Training future journalists to think critically about climate change – UNDP Uzbekistan – https://www.undp.org/uzbekistan – Accessed May 2024;
Getting the Message Across – Reporting on Climate Change and Sustainable Development in Asia and the Pacific: A Handbook for Journalists – United Nations Educational, Scientific and Cultural Organisation – 2018

[657] **Our Common Agenda, Policy Brief 8, Information Integrity on Digital Platforms** – United Nations – June 2023

[658] **The climate divide: How Facebook's algorithm amplifies climate disinformation** – Global Witness – 28 March 2022

[659] **Pathways Alliance Paid Google to Advertise on 'Greenwashing' Searches** – Geoff Dembicki – DeSmog – 18 April 2024

"disinformation" in the media.[660] That puts tremendous pressures on media companies to comply with narratives and strategies that are aligned with the government's view of what is truthful.

No matter how one sits on important issues, it is, for many people, not the role of governments or agenda driven philanthropies, whether they are acting in good faith or not, to actively prescribe to the media what is truthful and what is not.

In a report entitled *Bias, Bullshit and Lies: Audience Perspectives on Low Trust in the Media*, researchers from the Reuters Institute of the Study of Journalism sought to understand why there is low trust in the media in nine countries (United States, United Kingdom, Ireland, Spain, Germany, Denmark, Australia, France, and Greece). The study determined that the main reason people do not trust the media relates to "bias, spin and agendas". According to the report: "Simply put, a significant proportion of the public feels that powerful people are using the media to push their own political or economic interests, rather than represent ordinary readers or viewers."[661]

Positive Media Outcomes

Agendas dominate the mainstream media, the public is aware of it and becoming more critical of information provided by the mainstream media while seeking alternative sources of information.

Positively, Elon Musk, a self-described free-speech absolutist and longtime critic of bias on media platforms, has made it easier for voices of all spectrums to proliferate on Twitter since he bought that platform for $44 billion and rebranded it as X. In relation to that change, alternative media platforms and direct streaming of content is circumventing the established mainstream media.[662]

Also positively, conscientious actors within the mainstream media are raising awareness of the issue of broken trust and are actively

[660] **Fueling the Climate Crisis: Exposing Big Oil's Disinformation Campaign to Prevent Climate Action** – House Committee Hearing – 117th Congress (2021-2022) – https://www.congress.gov – Accessed May 2024

[661] **Bias, Bullshit and Lies: Audience Perspectives on Low Trust in the Media** – Nic Newman and Richard Fletcher – Reuters Institute for the Study of Journalism with the support of the Google and the Digital News Initiative – 2017

[662] **News you consume is a lie': Tucker Carlson relaunches on Twitter** – Al Jazeera – 10 May 2023

developing strategies to provide better, more trustworthy mainstream media.[663]

[663] **Strategies for building trust in news: What the public say they want across four countries** – Sayan Banerjee, Camila Mont'Alverne, Amy Ross Arguedas, Benjamin Toff, Richard Fletcher and Rasmus Kleis Nielsen – The Reuters Institute for the Study of Journalism – 21 September 2023

Big Oil, Fighting the Energy Transition?

Is Big Oil Actually Fighting the Energy Transition?

The Secretary General of the United Nations, António Guterres, stated in 2024 that fossil fuel companies are spending billions on public relations campaigns that are "distorting the truth, deceiving the public, and sowing doubt" about climate change.[664]

In contradiction to these highly mediatized narratives, fossil fuel companies are not necessarily interested in funding and organizing global media campaigns of a scale required to meaningfully push back against the public relations efforts being made to advance the Energy Transition. There several reasons for this.

Fossil Fuel Companies Are Not Run by PR Professionals

Fossil fuel industries are led by engineers and geologists. At the end of 2023, the top five fossil fuel companies in the US by market capitalization were ExxonMobil, Chevron, ConocoPhillips, Schlumberger and EOG Resources.[665] Also at that time, the Chief Executive Officers of those companies were, respectively, Darren Woods, Mike Wirth, Ryan Lance, Olivier Le Peuch and Ezra Yacob. Three of those chief executive officers studied electrical engineering, one studied petroleum engineering, the other studied geology: The engineers and geologists that form the senior ranks of fossil fuel companies are not necessarily predisposed to, or trained to, run global public relations campaigns.

The point is that for most energy companies the business of energy is just that, the provision of reliable energy supplied responsibly and safely. The risk of harm, inclusive of the loss of life, to workers in the fossil fuel sector is always front of mind for the senior executives at

[664] **UN chief rebukes fossil fuel industry supporters as climate records break** – Valerie Volcovici – Reuters – 5 June 2024

[665] **Leading oil and gas companies in the United States based on market capitalization as of December 2023** – Statistica – https://www.statista.com – Accessed May 2024

fossil fuel companies. It is simply not prudent or safe for fossil fuel companies to be led by public relations experts.

Fossil Fuel Companies Sell Global Commodities

Moreover, fossil fuel companies sell commodities, namely, coal, oil and natural gas. Much like farmers produce commodities such as grain and rice, the producers of commodities do not necessarily believe it is their job to create a market for their product. The demand for coal, oil and natural gas grows every year, simply because that is a prerequisite for global economic growth. The largest fossil fuel company in the US, ExxonMobil, produces only about 2.4% of the world's oil.[666] Simply from a financial perspective, why would an American oil producer want to finance a global public relations campaign to promote global oil demand? It is comparable to asking a large farmer to fund a public c relations campaign for a global agricultural commodity such as wheat or rice – something that farmers and fossil fuel companies do not do because the market is too large relative to the scale of any one producer. By virtue of the fact that they produce commodities, fossil fuel companies are not nearly as active in marketing and public relations as one might suspect.

ExxonMobil

By most measures, ExxonMobil is the West's leading fossil fuel company. The statements of Rex Tillerson, the former Chairman and Chief Executive Officer of ExxonMobil, are instructive. He stated: "Scientists should be allowed to continue their work on global warming without fear that their funding will be cut off if they come to the wrong conclusion."[667] The views of Rex Tillerson can be summarized as "let's keep an open mind".[668]

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[666] **ExxonMobil 2023 Annual Report** and **OPEC Monthly Oil Market Report April 2024**

[667] **Rex Tillerson Questions Human Role in Halting Climate Change** – Rachel Adams-Heard and Akshat Rathi – Bloomberg – 4 February 2020

[668] **Exxon CEO Thinks You're All Overreacting to Climate Change** – Kate Sheppard – Mother Jones – 28 June 2012

Rex Tillerson: Risk Of Climate Change Does Exist – Senate Hearings – NBC News – 11 January 2017; and

Rex Tillerson's Record on Climate Change: Rhetoric vs. Reality – Neela Banerjee – Inside Climate News – 22 December 2016

For publicly putting forward that view, Rex Tillerson and ExxonMobil have been the subjects of public relations and legal attacks. Rex Tillerson's comments have been stigmatized as being "disinformation,"[669] and "climate change denial."[670]

PR Remit and PR Strategies of Fossil Fuel Companies

The scientific method requires that assumptions must be tested against new information when and if that information is made available.

From that perspective, Tillerson's suggestion that it is wise to keep an open mind is not necessarily intended to be provocative or confrontational, it is simply consistent with the requirements of the scientific method.

It is noteworthy that Tillerson's comments do not suggest that he or ExxonMobil have ever had any intention of funding or advancing a global public relations campaign to increase the public's support for the integrity of the scientific method: ExxonMobil has a corporate legacy extending beyond a century and it operates globally where cultural and religious beliefs vary. It is not at all obvious that ExxonMobil, or any other fossil fuel company, is interested in progressing public relations strategies that would challenge the core beliefs of the societies in which they operate.

Rather than attempting to influence the core beliefs of the societies in which they operate, fossil fuels companies seemingly take pains to adapt to the beliefs of the societies in which they operate. Notably, all the major Western fossil fuel companies have taken costly measures to reduce the carbon dioxide emissions of their operations. If you look at an investor presentation of any of the cited five largest American fossil fuel companies, or of any other large Wesstern fossil fuel company, it will communicate extensively on the extent to which the company has reduced the carbon dioxide emissions of its operations and their strategies to further reduce carbon dioxide emissions in the future. That, not fighting a PR campaign in support of the scientific

[669] **Calling Out Climate Lies for a Living** – Elliot Negin – The Union of Concerned Scientists – 29 April 2024

[670] **Rex Tillerson Doesn't Sound Like a Denier, But He Acts Like One** – Alleen Brown – The Intercept – 12 January 2017

method, is seemingly the strategy adopted by all major Western fossil fuel companies.

The Perspective of Coal Companies

Coal producers have their own perspective: Due to the particulate pollution associated with coal consumption, coal companies are resigned to the negative public perception of their product – despite the extraordinary role played by coal in elevating humanity's living standards. Coal producers are also aware that their product competes with other forms of energy based on price, not because it is considered to be a better product.

Coal companies are resigned to the reality that they are likely to lose market share in the US and Europe if natural gas is priced competitively relative to coal. The growth markets for coal are in developing countries where reducing carbon dioxide emissions is not a priority – China is the most obvious example.

Due to demand growth in developing countries, such as China, global coal demand regularly reaches new record highs – most recently in 2022.[671]

In respect of metallurgical coal for iron and steel production, coal companies are aware that there is no practical substitute for coal.

For a host of reasons, it was never particularly obvious that the coal industry would be interested in fronting the resistance against the growth in the strength of the public relations ecosystem that promotes the Energy Transition.

The Perspective of Natural Gas Companies

Natural gas companies too have a unique perspective: Contrary to many people's intuitions, for natural gas producers the Energy Transition and has potential to be advantageous.

[671] **The world's coal consumption is set to reach a new high in 2022 as the energy crisis shakes markets** – International Energy Agency – 16 December 2022

That is because coal emits 75% more carbon dioxide than natural gas for the same amount of energy produced.[672] For that reason, public relations campaigns promoting the Energy Transition and climate alarmism due to carbon dioxide emissions have created an opportunity for natural gas producers to gain tremendous market share from coal producers. For reference, coal has a 27% market share of global energy (Table 1).

In recent decades, growth in natural gas consumption has simply overwhelmed other dynamics that have occurred in energy markets.[673] Due to its clean burning nature and its low cost, it is obvious that natural gas will continue to grow market share faster than any other form of energy out to 2050.[674]

Natural gas companies are aware of these dynamics. It is likely that from their perspective the public relations campaigns against carbon dioxide can only accelerate future demand growth for natural gas by accelerating the replacement of coal with natural gas. Therefore, natural gas companies are not necessarily interested in funding and organizing a global public relations campaign to counteract the Energy Transition.

The Perspective of Oil Producers

Finally, assessing the perspective of oil producers is instructive to understand why they too might be reluctant to fund a global public relations campaign to counter that of the Energy Transition.

Oil is simply much more expensive than many other forms of reliable energy. For that reason, oil has been under intense competitive pressures for decades, during which time it has lost considerable market share; therefore, being under attack is business as usual for the oil sector.

Oil companies know that their product has survived within specific markets where it is difficult to be replaced.

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[672] **How much carbon dioxide is produced when different fuels are burned?** – US Energy Information Administration – https://www.eia.gov/ – Accessed: August 2020

[673] **Key World Energy Statistics 2021 (Data for 2019)** – International Energy Agency – September 2021

[674] **2022 Outlook for Energy - Perspective to 2050** – ExxonMobil

More fundamentally, oil companies know that oil is a prerequisite for the existence of 8 billion people (to avert starvation) and a prerequisite for global economic growth; therefore, it is not obvious that oil companies have been interested in engaging in public relations campaigns justifying the benefits of oil: Oil executives know that if society wants more hospitals, education, prosperity, longevity, travel and economic growth, that will necessarily create more demand for oil.

To make the point crystal clear, despite the public relations campaigns against fossil fuels, from 2010 to present, global oil demand grew every year except in 2020, during which year there was a severe economic contraction caused by the COVID-19 lockdowns.[675]

Within that context, it is not obvious that from the perspective of oil companies it is worthwhile or necessary to raise awareness of the benefits of oil or to resist public relations campaigns against oil companies or the emissions of carbon dioxide associated with oil consumption.

Green Energy Needs Fossil Fuels

The mining, refining, transportation, manufacturing and maintenance required for wind turbines, solar panels and electric vehicles all consume fossil fuels; therefore, rather than being perceived uniquely as a threat, it is possible that fossil fuel companies perceive the Energy Transition as a significant consumer of fossil fuels.

[675] **Statistical Review of World Energy** – Energy Institute – 2023

Perspectives on the UK

The UK, a Global Outlier on Energy Policy

The UK is a global outlier amongst fossil fuel producing nations and centers of global finance: The UK is the only major fossil fuel producing country globally that has impeded the production of its domestic fossil fuels to comply with the anti-fossil fuel agenda. The depth and breadth of the support for the ESG agenda is greater in the UK than in any other center of global finance.

For reference, in the five years from 2018 to 2023 the UK's oil production fell by 35%.[676] In stark contrast, oil production over that period increased by 18%[677] and 7%[678] respectively in the US and Canada – with both countries regularly setting new oil production records.

While US President Biden and the Canadian Prime Minister Trudeau have promoted explicitly anti-fossil agendas, their ability to discriminate against and impede the actions of fossil producers has been limited by property rights, constitutional protections and the powers held by states (provinces in the case of Canada). In broader terms, for economic and geopolitical reasons it is not obvious that the federal governments of either the US or Canada would actually wish to shut in their domestic fossil fuel production if they had the power to do so, despite their rhetoric against fossil fuels. The political context in the US and Canada is also broadly in stark contrast to that of the UK: It is not obvious that the US states or the Canadian provinces that produce fossil fuels would remain in their respective federative unions if the federal government imposed the shutting in of fossil fuels. Critically, in both the US and Canada mineral rights are generally held by individual property owners, not by the state; by implication, any attempts to shut in the production of oil and gas would be an inconceivable affront to the fundamental property rights of Americans and Canadians. Likewise, it would be unconstitutional in both the US

[676] **Crude oil and petroleum: production, imports and exports** – Statistical Data Set – UK Government

[677] **US Field Production of Crude Oil** – US Energy Information Administration

[678] **Estimated Production of Canadian Crude Oil and Equivalent** – Canada Energy Regulator – https://www.cer-rec.gc.ca – Accessed: August 2024

and Canada to impose a discriminatory federal corporate tax on the oil and gas sector.

It might be shocking for some British people to learn that amongst the major fossil fuel producing countries of the world, only the UK has willfully impeded the development of its fossil fuel resources. In the words of the UK's former Energy Secretary Claire Coutinho: "No other major economy is shutting down its domestic energy supply as the UK now is."[679]

The UK is also unique amongst major fossil fuel producing countries in that both of the UK's major political parties, namely the Conservative and Labour parties, have explicitly progressed agendas to reduce domestic fossil fuel production. In comparison, at least one major political party in both Canada and the US has been supportive of the fossil fuel industry and hostile to the ESG agenda.

The UK is also an outlier amongst global financial centers in terms of the extent to which it has embraced the ESG agenda and incorporated that agenda into its financial regulations. According to Politico, "The Bank of England governor (referencing former governor Mark Carney) is pushing banks and investors to take climate change seriously. And they listen, whether they want to or not"[680] adding that to advance the ESG agenda, "Carney isn't shy to use a big tool in his kit – regulation – to nudge banks and investors to change their ways. Some would say more than nudge."[681] In stark contrast, Jerome Powell, the Chair of the US Federal Reserve stated: "We are not climate change policy makers."[682] He added that climate change policies are the business of elected officials and that the US Federal Reserve is not a political institution for climate policy.[683] The point is that the UK is unique amongst global financial centers in terms of the

[679] **Miliband deals 'final blow' to North Sea oil after siding with Greenpeace** – Jonathan Leake – The Telegraph – 29 August 2024
[680] **Mark Carney, eco-warrior** – Silvia Sciorilli Borrelli, Kalina Oroschakoff and Cat Contiguglia – Politico – 24 October 2018
[681] **Mark Carney, eco-warrior** – Silvia Sciorilli Borrelli, Kalina Oroschakoff and Cat Contiguglia – Politico – 24 October 2018
[682] **Fed's Powell: Climate change real, but not focus of Fed's mission** – Michael S. Derby – Reuters – 6 March 2024
[683] **Chair Powell said Fed isn't a political institution for climate policy** – X Post – Bloomberg Business – 3 April 2024

depth and breadth with which ESG has been integrated into its financial regulations.

The Bank of England is not alone in using its position of authority in the UK to advance the green agenda. The Church of England too actively campaigns to progress the agenda of the United Nations on climate and green energy: Justin Welby, the Archbishop of Canterbury and the most senior cleric within the Church of England, likened the risks of climate change with those of a genocide adding that national leaders will be "cursed" if they do not achieve the climate goals of the United Nations.[684] The church's website provides a guidebook on how the followers of the church can use their voices to raise awareness of the United Nation's climate programs[685], stating that in relation to climate change: "As Christians we can pray and we can share our concerns with our local MP (Member of Parliament)."[686] In relation to the financial commitments of governments to support green energy Welby made the statement: "All moral thinking starts with the idea that if you're going to do the right thing, it needs action: money."[687]

According to the Church of England's website: "His Majesty the King is the Supreme Governor of the Church of England. The King appoints archbishops, bishops and deans of cathedrals on the advice of the Prime Minister. Our two archbishops and 24 other bishops sit in the House of Lords, making a major contribution to Parliament's work."[688] By implication on matters related to climate and green energy, the Church of England has a tremendous influence to shape the laws of the UK. Globally, there is no parallel for the institutional

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[684] **Archbishop of Canterbury apologizes for comparing climate change to Holocaust** – AFP and TOI Staff – Times of Israel – 1 November 2021;
Justin Welby apologises for likening clima te threat to Nazis – Peter Walker – The Guardian – 1 November 2021; and
Church of England Issues Strong Call for Long-term Climate Action – United Nations – 13 July 2015

[685] **How Christians can get involved with UN climate conference, COP28 (Church of England Environment Programme, Guide to COP28)** – The Church of England – 8 November 2023

[686] **How Christians can get involved with UN climate conference, COP28** – The Church of England – https://www.churchofengland.org – Accessed: August 2024

[687] **Justin Welby apologises for likening climate threat to Nazis** – Peter Walker – The Guardian – 1 November 2021

[688] **Leadership and governance** – The Church of England – https://www.churchofengland.org – Accessed: September 2024

support of the Church of England's advancement of the United Nation's agenda on climate and green energy.

For perspective, according to the Pew Research Center, in the US, 82% of the supporters of the Republican Party are Christian[689] and three quarters of Republicans do not believe that climate change is "an extremely or very serious problem".[690] Arguably, Christian American Republicans would disapprove of their church leaders working directly with the United Nations to advance climate alarmism and the green agenda.

The UK is also an outlier globally in that it has renamed both its Department of Energy and its oil and gas regulator to explicitly make the point that the UK is prioritizing the ESG agenda and Net Zero. Specifically, the UK's "Department of Energy" has been renamed the "Department of Energy Security and Net Zero"; the UK's "Oil & Gas Authority" has been renamed the "North Sea Transition Authority".

The UK is also a global outlier in that it is the only jurisdiction globally that has announced a series of tax increases discriminatorily against the oil and gas sector. Specifically, in May 2022, the Conservative Prime Minister Rishi Sunak increased the rate of taxation on oil and gas projects in the UK by 25%. His government then increased the rate of taxation by a further 10%.[691] Keir Starmer, the UK's current Prime Minister, increased the rate or taxation on oil and gas projects in the UK by a further 3%.[692] Combined, the resulting effective tax rate on oil and gas projects in the UK is 78%. Meanwhile, all other nations of the world that produce oil and gas are operating under the same tax regimes that existed prior to 2022.

The UK is also unique globally in that both of the most prominent non-governmental groups that are fundamentally committed to promoting the shutting in of fossil fuels are based in the UK, namely, Just Stop Oil and Extinction Rebellion.[693] Just Stop Oil promotes the

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[689] **Christians by political party** – Pew Research Center – https://www.pewresearch.org – Accessed: September 2024

[690] **Religious groups' views on climate change** – Becky A. Alper – Pew Research Center – 17 November 2022

[691] **Taxation of North Sea oil and gas** – Antony Seely – House of Commons Library – 28 May 2024

[692] **UK trade body warns of jobs and investment woes under Labour's windfall tax** – Smruthi Nadig – Offshore Technology – 23 August 2024

[693] **Just Stop Oil** – https://juststopoil.org/ – Accessed: August 2024

message that "Oil Kills".[694] Extinction Rebellion is advocating the achievement of Net Zero in 2025 while suggesting that carbon dioxide emissions from fossil fuels will cause a "mass extinction" event.

Also uniquely amongst the leading nations of the world, both of the major political parties in the UK, namely, the Conservative and Labour parties, are seemingly receptive to the influence of Extinction Rebellion. According to Extinction Rebellion, that organization successfully pressured the UK's Conservative parliament led by Prime Minister Theresa May, with the support of Micheal Gove, the UK's Secretary of State for the Environment, Food and Rural Affairs, to pass a motion without a division in the UK's Parliament put forward by the Leader of the Opposition, Jeremy Corbyn, to declare a state of "Climate Emergency"[695] – the first national parliament to do so globally.[696]

Although it is not necessarily appreciated by the UK public, the UK has become a lone global outlier amongst both i) major global financial centers and ii) major fossil fuel producers in terms of the breadth and depth of its adoption of the ESG agenda, inclusive of the anti-fossil fuel element of that agenda.

BP and Shell

BP and Shell are the most important fossil fuel companies based in the UK. They are amongst the largest companies listed on the London Stock Exchange as measured by their market capitalizations. Less than 5% of Shell's profits come from the UK and around 10% of BP's profits come from the UK – they are essentially global companies headquartered in London and listed on the London Stock Exchange.[697]

It is noteworthy to compare the fortunes of BP and Shell with the two largest oil and gas companies by market capitalization listed on the New York Stock Exchange, namely, Exxon Mobil and Chevron. Research by a team of recognized experts in financial and energy

[694] **Just Stop Oil** – https://juststopoil.org/ – Accessed: August 2024
[695] **About US, Extinction Rebellion** – https://extinctionrebellion.uk – Accessed: August 2024
[696] **"The most important issue of our time," Opposition calls to declare climate emergency** – UK Parliament – 1 May 20 19
[697] **Vast energy firm profits raise fresh questions over windfall tax** – Douglas Fraser – BBC – 8 February 2023

markets determined: "Over the last five years, outside ESG advocates have pressured some super-majors into decisions that hugely impacted financial performance. A considerable performance divergence has emerged between those companies that have bowed to ESG pressures and those that have not. Over the last five years, BP and Shell have actively pursued various ESG initiatives, while Exxon and Chevron have been more measured." The research determined that over the period of study Exxon and Chevron generated shareholder returns of 104% and 81%, respectively. In contrast, over the same period, BP and Shell generated shareholder returns of only 32% and 6%, respectively.[698]

According to another expert, "European oil and gas majors that have doubled down on ESG are underperforming their American peers. In the final analysis, it appears that Shell's and BP's ESG strategy is no longer a winning formula."

The key point is that because BP and Shell are headquartered in London and listed on the London Stock Exchange, both companies have been compelled under social, governmental and shareholder pressures to deviate from the strategies of their international peers to pursue ESG strategies.

Has ESG Affected the Standing of London as a Financial Capital?

According to financial experts, on average companies that are listed on the London Stock Exchange trade at a discount of 47% relative to US listed companies based on estimates of their underlying values.[699] In essence, the research suggests that by virtue of being listed on the London Stock Exchange, a company is worth 47% less than it would be if it were listed in the US.

In 2019, the UK was ranked fifth in the world for the amount of money raised through initial public offerings on the stock market.[700] In 2023,

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[698] **The Incredible Shrinking Super-Majors Part IV: What the Stock Market thinks of ESG** – Leigh R. Goehring and Adam A. Rozencwajg – Goehring & Rozencwajg Associates, LLC – 15 March 2023

[699] **UK's 'staggeringly cheap' stocks trade at record discount to US** – Roula Khalaf – Financial Times – 23 March 2024 (referencing the P/E ratio of the MSCI UK index relative to US indices according to asset manager Schroders)

[700] **Global IPO Watch 2023 and Outlook for 2024** – Stuart Newman and Stephen Wyrobisch – A PWC Global IPO Centre Publication – January 2024

the UK fell out of the league table of the top ten financial centers for monies raised from initial public offerings.[701] For further reference, in 2023, Turkey, which ranked 10th in terms of funds raised on the stock market for initial public offerings, outpaced the UK in terms of funds raised by 2.5 times.[702]

Although links of causality are hard to establish definitively, the deteriorating standing of London as a global financial center has coincided with a period during which the UK has distinguished itself as being at the vanguard of the ESG agenda globally.

In effect, to the extent that the ESG agenda is creating significant risks for companies listed on the London Stock Exchange, as was the case for both Shell and BP, financial markets can be expected to be adept at identifying and avoiding those risks.

Defections from the LSE and the UK?

In 2024, after 145 years, Chevron, the second largest US based oil and gas company, announced that it would be moving its headquarters from San Remon, California to Houston, Texas. Andy Walz, President of Americas Products at Chevron stated that California was a "tough place" for companies in the oil and gas business adding that: "I will tell you, in Texas, we're welcome."[703] That relocation has parallels for the UK.

Shell indicated that it is considering moving its headquarters and its main stock exchange listing to the US.[704] At the time of making that statement, Shell was the largest company on the London Stock Exchange by market capitalization.[705]

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[701] **Global IPO Watch 2023 and Outlook for 2024** – Stuart Newman and Stephen Wyrobisch – A PWC Global IPO Centre Publication – January 2024

[702] **Global IPO Watch 2023 and Outlook for 2024** – Stuart Newman and Stephen Wyrobisch – A PWC Global IPO Centre Publication – January 2024; and
London stock market IPO proceeds fell 40% in 2023 – Seetle Dool – Ernst & Young – 11 January 2024

[703] **Chevron exec explains HQ move from California to Texas: 'tough place to do business'** – Eric Revell – Fox News – 9 August 2024

[704] **Shell considers quitting London for New York** – Matt Oliver, James Warrington and Michael Bow – The Telegraph – 8 April 2024

[705] **Shell considers quitting London for New York** – Matt Oliver, James Warrington and Michael Bow – The Telegraph – 8 April 2024

According to the Energy Editor at the Telegraph, Jonathan Leake, if Shell were to delist from London and move its headquarters to the US "the dam would break" for migrations away from the London Stock Exchange.[706]

Has the UK Become Less Investible?

In the US and Canada constitutional protections eliminate the risk of selectively applying different federal corporate tax rates to specific industries; however, those constitutional protections do not exist in the UK.

Due to the trust in the UK Government, built up over centuries, energy companies have essentially invested in the UK's fossil fuel industry based on the confidence that the UK would enact fair taxes on its profits.

The UK's Conservative Government surprised the world by increasing the rate of taxation on oil and gas profits by 35%. The newly appointed Labour Government in the UK surprised the world by increasing the rate of taxation by a further 3%.

It is possible that changing the rate of taxation on oil and gas projects in the UK in a manner that has been discriminatory and excessive will have implications for all sectors of the UK's economy to the extent that confidence in the UK Government to act in good faith on matters of taxation may have been eroded.

That point can be made more clearly by way of example: The investment in a semi-conductor manufacturing facility would have an investment profile similar to that of a large energy project: It would require significant investments for many years with long payback periods measured in decades, during which time the investment would be essentially trapped in the country where the investment is made. Semi-conductor manufacturing companies might consider that for decades the UK Government celebrated and courted oil and gas companies; however, after considerable investments were made, excessive and discriminatory taxes were levied against oil and gas companies by the UK Government. Semi-conductor companies,

[706] **Why 'the dam would break' if Shell quit the FTSE** – Jonathan Leake – The Telegraph – 14 April 2024

amongst others, might reflect upon the risks of that occurring in the decades ahead to their own investments in the UK.

Arguably, it is a mistake to assume that financial markets and businesses outside of the fossil fuel sector will simply ignore the erratic, discriminatory and excessive tax changes that the UK government has imposed on the fossil fuel sector.

Geopolitical Risks Related to the UK's Energy Policies

By impeding the production of its domestic fossil fuels, the UK has become more dependent on imported fossil fuels: The UK has been transformed from a net exporter of energy into a net importer of energy – importing 40% of its energy in 2023.[707]

Historically, prior to the development of the UK's North Sea oil fields in the 1970s, the UK was reliant on imported oil; however, the UK took meticulous care to ensure it could import its oil through reliable supply lines, often owned and controlled by either UK interests or by allies of the UK.[708] Today, pursuant to its anti-fossil fuel agenda, the UK has not made energy security a priority.

Not only has the UK's anti-fossil agenda reduced the energy security and the geopolitical strength of the UK, it has increased the geopolitical strength of exporters of fossil fuels such as Russia and Iran. Sanctioning or blockading either Russia or Iran would cause harm to the UK's economy because it is reliant on the steady flow of fossil fuels into the international market in order to secure energy at affordable prices.

In relation to the UK the case of natural gas is worth specific attention: The UK's natural gas market is linked directly to the European natural gas market via pipelines, making it a single unified natural gas market. The ongoing record-high liquified natural gas imports into the EU from Russia – more than a year after Russia's invasion of Ukraine – are a necessity to avoid an energy crisis in both the EU *and* the UK. Belgium and Spain are the second and third most important importers of Russian liquified natural gas – only China imports more Russian

[707] **Why British motorists will be forced to rely on foreign oil imports at the pump** – Jonathan Leake – The Telegraph – 1 August 2023 (citing the UK Department of Energy & Net Zero)

[708] **The Prize** – Daniel Yergin – Simon & Schuster – 1991

liquified natural gas.[709] Those imports of liquified natural gas from Russia into the EU are necessary to reduce the cost of energy in the EU *and* the UK.

Reversing the Industrial Revolution

The UK is unique in that it led the Industrial Revolution by substituting wood with coal. Today, the UK is likewise unique in that it is leading the world in reversing that fundamental dynamic of the Industrial Revolution: Specifically, the UK is leading the world in terms of reverting back from the use of coal to the use of wood.

Wood is essential to growing the market share of energy labelled as green or renewable because, unlike wind power and solar power, burning wood reliably produces energy in the most useful form, namely, intense heat, which can be reliably transformed into other forms of energy such as electricity.

According to BiofuelWatch, the UK's electrical energy provider Drax Global plc burns more wood than any other company globally. Also, according to BiofuelWatch, in 2022 alone, Drax burned the equivalent of 115% of the UK's wood production to meet just 0.95% of the UK's energy needs.[710] According to that same entity, in 2022, Drax received £606.8 million ($US 748 million) in renewable energy subsidies. [711]

For reference, the only reason for which coal was used instead of wood to advance the Industrial Revolution is that coal can be sustainably supplied in sufficient volumes to support an industrial economy. It has been known from the earliest years of the Industrial Revolution that trees do not grow quickly enough to provide significant volumes of sustainable energy – that has not changed. Today, old-growth forests are being destroyed globally to supply the UK with wood pellets.[712]

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[709] **EU imports record volumes of liquefied natural gas from Russia** – Alice Hancock and Shotaro Tani – Financial Times – 30 August 2023

[710] **#AXEDRAX campaign** – biofuelwatch – biofuelwatch.org – Accessed: August 2024

[711] **#AXEDRAX campaign** – biofuelwatch – biofuelwatch.org – Accessed: August 2024

[712] **Drax: UK power station owner cuts down primary forests in Canada** – Joe Crowley and Tim Robinson – BBC – 3 October 2024

It is critical to appreciate that Drax is simply in the business of supplying the fundamentally necessary, reliable electricity the UK needs. The company has only conformed with the mandates of the UK Government and the ESG agenda in converting its coal fired plants into wood fired plants.

In conjunction with the anti-fossil fuel agenda of the UK and its associated de-industrialization, the UK is also losing its ability to produce the other key material of the Industrial Revolution, namely, steel. Headlines such as "British Steel to axe thousands of jobs despite £600m taxpayer handout – Company prepares to close blast furnaces at Scunthorpe amid push for greener steel"[713] are broadly indicative of the consequences of the UK's energy policies: increased governmental indebtedness combined with less competitive industries.

The UK's Carbon Impacts

Drax's wood burning power station is the single largest emitter of carbon dioxide emissions in the UK.[714] According to one non-governmental organization, burning wood is subsidized on the assumption that carbon dioxide "emissions released are offset by the growth of new trees to replace those harvested for burning. This assumption is widely shared by the EU and the UK government."[715] However, in contradiction to that assumption, in practice, it is widely acknowledged that destroying forests to supply wood pellets to displace the use of coal actually increases carbon dioxide emissions into the atmosphere.[716]

It is also known that the shutting in of steel production in the UK in favor of importing steel simply displaces the location at which carbon dioxide is emitted into the atmosphere – there is no absolute reduction in carbon dioxide emissions.

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[713] **British Steel to axe thousands of jobs despite £600m taxpayer handout** – Szu Ping Chan and Jonathan Leake – The Telegraph – 23 August 2024

[714] **Biomass power station produced four times emissions of UK coal plant, says report** – Jillian Ambrose – The Guardian – 9 August 2024

[715] **Biomass plant is UK's top emitter** – Tom Harrison and Harriet Fox – Ember – 31 July 2023

[716] **The climate impact of burning wood for energy** – Edward Robinson – Land and Climate Review – 10 August 2020

Ed Miliband, the current Secretary of State for Energy Security and Net Zero of the UK, stated that developing the domestic oil and gas fields in the UK North Sea would amount to "climate vandalism"[717]; however, that assessment is not supported by critical analysis: Due to the efficiency with which oil from the UK's North Sea can be produced, producing oil domestically in the UK actually reduces carbon dioxide emissions relative to importing oil into the UK.[718] In the case of importing liquified natural gas into the UK, the foreign natural gas must be liquified by compressing it and cooling it to minus 162° Celsius (minus 260° Fahrenheit), prior to shipping it as a super-cooled liquid to the UK where it is then regassified – all of which consumes energy and causes emissions of carbon dioxide. As a result, importing liquified natural gas emits almost four times more carbon dioxide than emitted by procuring domestically sourced natural gas from the UK.[719] For reference, the UK now imports 63% of its natural gas.[720]

According to the International Energy Agency, the UK's fuel consumption for energy emits less than 1% of global carbon dioxide emissions.[721]

[717] **Miliband deals 'final blow' to North Sea oil after siding with Greenpeace** – Jonathan Leake – The Telegraph – 29 August 2024

[718] **Global carbon intensity of crude oil production** – Mohammad S. Masnadi, Hassan M. El-Houjeiri, Dominik Schunack, Yunpo Li, Jacob G. Englander, Alhassan Badahdah, Jean-Christophe Monfort, James E. Anderson, Timothy J. Wallington, Joule A. Bergerson, Deborah Gordon, Jonathan Koomey, Steven Przesmitzki, Inês L. Azevedo, Xiaotao T. Bi, James E. Duffy, Garvin A. Heath, Gregory A. Keoleian, Christophe McGlade, D. Nathan Meehan, Sonia Yeh, Fengqi You, Michael Wang, and Adam R. Brandt – Science – 31 August 2018; and

Emissions Monitoring Report 2022 – UK North Sea Transition Authority – 2022

[719] **Carbon Footprint of UK Natural Gas Imports** – North Sea Transition Authority – July 2023

[720] **Carbon Footprint of UK Natural Gas Imports** – North Sea Transition Authority – July 2023

[721] **Energy-related CO2 emissions, United Kingdom, 2021** – International Energy Agency – https://www.iea.org – Accessed: August 2024; and

CO2 Emissions, Global Energy Review 2021– International Energy Agency – April 2021

Ed Miliband, the Secretary of State for Energy Security and Net Zero of the United Kingdom, asserted that wind power is nine times cheaper than gas powered electricity.[722]

Unfortunately for the British, the public relations promise of cheap green energy has not materialized – quite the opposite: Electricity in the UK costs 2.4 times more than in the US – despite the UK having a wealth of domestically available natural resources, namely, coal, oil and natural gas, comparable to the US.[723]

According to National Energy Action, a charity raising awareness of the UK's energy crisis, 5.6 million UK households (20% of UK households) are suffering from energy poverty. According to their assessment: "More people than ever before are struggling to afford the cost of heating and falling into debt. Sky-high bills and cold, damp homes threaten to become the new normal for millions of people."[724] A poll revealed that 5.3 million Britons have been forced into choosing between heating and purchasing groceries.[725]

Finally, it is notable that the progression of the green energy agenda in the UK has coincided with a deterioration in the British public's confidence in its democratic institutions: According to the National Centre for Social Research, trust and confidence in Britain's system of governance is at a record low.[726]

The UK's Energy Mix

The UK currently produces 39.9% of its electricity from sources labelled as renewable.[727] Biofuels, specifically wood and farmed

[722] **Miliband's empty energy promise** – Ross Clark – The Spectator – 7 September 2024
[723] **Miliband's empty energy promise** – Ross Clark – The Spectator – 7 September 2024
[724] **About National Energy Actio**n – National Energy Action – https://www.nea.org.uk – Accessed: September 2024
[725] **Cost of living crisis could push people to choose between heating and eating** – Danielle Lockett – Consumer Rights – consumerrights.org – 5 September 2022
[726] **Trust and confidence in Britain's system of government at record low** – National Centre for Social Research – 12 June 2024
[727] **United Kingdom (data for 2022)** – International Energy Agency https://www.iea.org – Accessed: August 2024

fuels, provide considerably more energy labelled as renewable in the UK than wind power and solar power combined.[728] In terms of the UK's total energy usage, 77.4% of the UK's energy is derived from fossil fuels.[729]

In contradiction to the public relations narrative that the Energy Transition is an opportunity for the UK, the UK now has highest electricity costs of all developed countries, with electricity costs skyrocketing in recent years as the Energy Transition has been advanced.[730] Moreover the Energy Transition has contributed to the scale and precarity of the UK's governmental indebtedness. Notably, the scale and precarity of the UK Government's indebtedness has been cited by that government as the reason for which it can no longer afford to fund winter fuel benefits for pensioners to ensure they are able to purchase the energy required to keep warm in the winter.[731]

It is noteworthy that the UK now has both the highest electricity costs of any developed country and the highest rate of homelessness of any OECD country[732] – that was not always the case and both are associated with a worsening of the economic prosperity of the UK during a time when the UK progressed the Energy Transition.

Arguably, the UK has lost the character of a country that is suitable to being a center of global finance. That would imply that efforts to reverse the decline of London as a global financial center might benefit from reconsidering the underlying attitudes towards the Energy Transition and the ESG agenda in the UK.

Looking forward, the evolution of the UK's energy mix will have a profound influence on the competitiveness of the UK, its geopolitical strength and an inordinate global environmental impact given the UK's reliance on wood pellets to grow the market share of energy labelled as renewable.

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[728] **United Kingdom (data for 2022)** – International Energy Agency https://www.iea.org – Accessed: August 2024

[729] **United Kingdom (data for 2022)** – International Energy Agency https://www.iea.org – Accessed: August 2024

[730] **Britain paying highest electricity prices in the world** – Matt Oliver – The Telegraph – 26 September 2024

[731] **Winter fuel payments scrapped for pensioners not on benefits, Reeves announces** – Francesca Gillett and Sean Seddon – BBC – 29 July 2024

[732] **Why Britain is the world's worst on homelessness** – John Burn-Murdoch – Financial Times – 17 May 2024

The Language of Green Energy

Chris Wright

Chris Wright is the CEO of one of the largest oil service companies in the United States, Liberty Energy Inc. Wright is an engineer with deep experience across many energy sectors.[733] Despite being an engineer focused on the practicalities of the provision of energy, he believes that our perceptions relating to the Energy Transition have very little to do with the practical realities of the provision of energy and everything to do with language.[734]

Wright believes that the word "transition" in Energy Transition is itself misleading because according to Wright, there is no "Energy Transition" but rather only "Energy Addition." He believes that we should stop using the "deceptive and destructive" term "Energy Transition" on the basis that, firstly, "it is simply wrong" because there is no evidence suggesting that an energy transition has actually begun and secondly because suggesting that our dependence on fossil fuels has been reduced is creating tremendous hardship in the real world for the seven billion people who are struggling to attain the standard of living enjoyed by the developed world – language matters.[735]

Linguistic Inversion

Likewise, Wright objects to the use of linguistic constructions such as "carbon pollution", "climate crisis", "clean energy", "dirty energy" and "renewable energy", amongst other – He believes that these terms are simply linguistic fabrications that have no substantive justification.[736]

[733] **About US, Chris Wright** – Liberty Energy – https://libertyenergy.com – Accessed: October 2024
[734] **Let's be honest** – Chris Wright – YouTube video – 18 January 2023
[735] **Q2 2024 Closing Remarks** – Liberty Energy – Liberty Energy – 18 July 2024
[736] **Let's be honest** – Chris Wright – YouTube video – 18 January 2023

Arguably, the Energy Transition is replete with linguistic terms that describe the inverse of what is actually truthful based on objective analysis.

Wind power and solar power are labelled as “carbon free energy”, “renewable energy” and “sustainable energy”; however, in contradiction to those labels they have harmful environmental impacts, depend upon fossil fuels and the emissions of carbon dioxide (Table 9 provides an example of coal volumes required to construct a wind turbine), depend upon unsustainably low interest rates, depend upon governmental subsidies from increasingly financially precarious Western governments, depend upon regulatory supports rather than free markets and are incapable of providing the affordable, reliable energy required to renew themselves after the short lifecycles of wind turbines and solar panels (every 20+ years), while they create significant unresolved end-of-life challenges, and in many cases their expansion deprives wildlife of habitat – while the energy they provide is unreliable, dependent on reliable forms of energy for back-up and available only in the form of electricity. In those respects, the labels used to define wind power and solar power are potentially misleading to the point of being linguistic inversions of the underlying reality.

A Green Spiritual War?

Green Energy, Part of a New Global Religion?

Elon Musk was asked to explain the growth of the increase in social mindsets that cause self-farm. He observed that we are experiencing a decline in traditional religion, adding that: "Nature abhors a vacuum. So when you have decline in religion, and an increase in the secular nature of society, for most people they need something to fill that void." According to Musk people are adopting new belief systems, which are in effect religions although they are not called religions. According to his observations, the advocates of these "woke" belief systems are waging a "holy war" against unbelievers.[737]

Not only are our societies potentially seeking new belief systems, seemingly, powerful institutions are motivated to promote new belief systems:

According to an intellectual "prophet"[738] of the United Nations, who served there for four decades becoming the assistant secretary-general of the United Nations: "Peace will be impossible without the taming of fundamentalism through a united religions that professes faithfulness only to the global spirituality and the health of this planet."[739] He indicated that it should be a goal to "steer our children toward global citizenship, earth-centered beliefs, socialist values and the collective mindset."[740]

It is also noteworthy, that the Archbishop of Canterbury, Justin Welby, who was appointed by the heads of state of the UK to serve as the most senior cleric within the Church of England, stated that: "God is green."[741] Moreover, according to his doctrine it is anti-Christian to

[737] **Elon Musk interview with Tucker Carlson** – Elon Musk – Tucker Carlson Network – 7 October 2024
[738] **Prophet - the Hatmaker's Son: The Life of Robert Muller** – Douglas Gillies – East Beach Press – 11 March 2003
[739] **The New World Religion, Part 10** – The John Akerberg Show – Ankerberg Theological Research Institute – 12 August 1999
[740] **The Dangers of the New Age Movement** – Carl Joseph – Carl Joseph Ministries – 14 September 2021
[741] **Archbishop of Canterbury Justin Welby: God is green, and denying climate change is anti-Christian** – The Independent – 22 September 2024

contest the accepted climate dogma, which has been elaborated by the United Nations.[742]

Comic Satire or Reality?

Jordan Peterson is a globally recognized leader in psychology and global affairs. Based on his assessment, the green energy and ESG agenda have taken on a dangerous religious structure. He states that the advocates of the belief system being used to promote green energy and the ESG agenda are "hypothetically well-meaning pseudo religious worshipers of the apocalypse."[743]

Based on Peterson's assessment, the new green religion is in opposition to and in contention with traditional Judeo-Christian beliefs; however, based on his assessment the underlying inspiration for the "new" belief system has its roots in antiquity.[744]

Citing directly from the European Parliament: "Ireland's Department of Agriculture has proposed to kill 200 000 cows to combat climate change and meet the EU's climate objectives."[745] As a reminder, according to the United Nations, cows emit 14.5% of human-caused greenhouse gases.[746] As result of which, the United Nations states in relation to cows that: "Urgent action is required to remedy the situation."[747] Peterson, observing the development took action to

[742] **Archbishop of Canterbury Justin Welby: God is green, and denying climate change is anti-Christian** – The Independent – 22 September 2024; and
Climate Change, the IPCC Scientific Assessment – United Nations Intergovernmental Panel on Climate Change – 1990

[743] **This is an Appalling Situation and It Will Get Worse** – Jordan Peterson – Tucker Carlson Tonight (Fox News) – 11 March 2023

[744] **Sacrifice to change the weather; Worship of Nature; Baal has returned with a vengeance; When God dies the demons spring forth** – Dr. Jordan Peterson – X Post – 17 August 2023

[745] Culling of cows and restriction of livestock farming in the EU – Silvia Sardone – Parliamentary question – European Parliament – 20 July 2023

[746] **Major reductions of greenhouse gas emissions from livestock within reach** – UN News – United Nations – 26 September 2013

[747] **Rearing cattle produces more greenhouse gases than driving cars, UN report warns** – Henning Steinfeld –
United Nations Food and Agriculture Organization – 29 November 2006

highlight that “Net zero has become a neo-pagan religion, sacrificing animals to appease the weather gods.”[748]

[748] **Sacrifice to change the weather; Worship of Nature; Baal has returned with a vengeance; When God dies the demons spring forth** – Dr. Jordan Peterson – X Post – 17 August 2023; citing
The return of animal sacrifice – Brendan O’Neill – Spiked! – 17 August 2023

Conclusions

CO_2 Regulates the Amount of Life on Earth

The most important discoveries ever made in respect carbon dioxide were not made in 1859 when John Tyndall determined that carbon dioxide is a greenhouse gas: The most important discoveries ever made in respect of carbon dioxide were made between 2016 and 2019 by satellites that had been in orbit long enough to ascertain how our Earth is actually changing over time based on direct observations.

Satellites have provided direct, unequivocal evidence that increasing the amount of carbon dioxide in the atmosphere has a staggering biological effect – it increases the amount of life on Earth. We now know that carbon dioxide concentrations in the atmosphere regulate the amount of vegetation – life – on our Earth.[749]

Specifically, rising concentrations of carbon dioxide in our atmosphere are i) fertilizing an increase of 2.3% in the green area of

[749] **China and India lead in greening of the world through land-use management** – Chi Chen, Taejin Park, Xuhui Wang, Shilong Piao, Baodong Xu, Rajiv K. Chaturvedi, Richard Fuchs, Victor Brovkin, Philippe Ciais, Rasmus Fensholt, Hans Tømmervik, Govindasamy Bala, Zaichun Zhu, Ramakrishna R. Nemani & Ranga B. Myneni – Nature Sustainability – 11 February 2019;
Greening of the Earth and its Drivers – Zaichun Zhu and 31 additional authors – Nature Climate Change – 25 April 2016;
Global land change from 1982 to 2016 – Xiao-Peng Song, Matthew C. Hansen, Stephen V. Stehman, Peter V. Potapov, Alexandra Tyukavina, Eric F. Vermote & John R. Townshend – Nature – 8 August 2018
Environmental Drivers of Agricultural Productivity Growth: CO_2 Fertilization of US Field Crops – Charles A. Taylor and Wolfram Schlenker – National Bureau of Economic Research – October 2021
China and India Lead the Way in Greening – Abby Tabor – NASA Earth Observatory – https://earthobservatory.nasa.gov – Accessed: March 2021; and
Carbon Dioxide Fertilization Greening Earth, Study Finds – NASA – https://www.nasa.gov – Accessed: March 2021

the Earth per decade,[750] and ii) fertilizing an increase of 2.0% in the forested area of the Earth per decade.[751]

This satellite data was not available in the 1990s when the United Nations elaborated its global warming paradigm.[752]

The Real Energy Challenge

According to the World Bank, the global population is growing at a rate of 0.9%[753] per annum and surpassed 8 billion in 2022.[754] Half of the global population lives on less than $7 per day.[755] Today, 2.4 billion people worldwide use wood for cooking meals, sterilizing drinking water and heating homes."[756] 828 million humans are currently suffering from hunger.[757] 774 million people do not even have access to the most generic form of energy – electricity.[758]

In contradiction to the introspective discussions relating to how the West might wish to procure its energy, the real energy challenge

[750] **China and India Lead the Way in Greening** – Abby Tabor – NASA Earth Observatory – https://earthobservatory.nasa.gov – Accessed: March 2021; and **China and India lead in greening of the world through land-use management** – Chi Chen, Taejin Park, Xuhui Wang, Shilong Piao, Baodong Xu, Rajiv K. Chaturvedi, Richard Fuchs, Victor Brovkin, Philippe Ciais, Rasmus Fensholt, Hans Tømmervik, Govindasamy Bala, Zaichun Zhu, Ramakrishna R. Nemani & Ranga B. Myneni – Nature Sustainability – 11 February 2019

[751] **Global land change from 1982 to 2016** – Xiao-Peng Song, Matthew C. Hansen, Stephen V. Stehman, Peter V. Potapov, Alexandra Tyukavina, Eric F. Vermote & John R. Townshend – Nature – 8 August 2018

[752] **Climate Change, the IPCC Scientific Assessment** – United Nations Intergovernmental Panel on Climate Change – 1990

[753] **Population Growth** – World Bank – https://data.worldbank.org – Accessed: January 2023

[754] **A World of 8 Billion** – United Nations – Policy Brief – October 2022

[755] **Half of the global population lives on less than US$6.85 per person per day** – Marta Schoch, Samuel Kofi Tetteh Baah, Christoph Lakner and Jed Friedman – World Bank – 8 December 2022

[756] **The State of the World's Forests 2018** – Food and Agricultural Organization of the United Nations – 2018

[757] **The State of Food Security and Nutrition in the World 2022** – Food and Agriculture Organization of the United Nations – 2022

[758] **For the first time in decades, the number of people without access to electricity is set to increase in 2022** – Laura Cozzi, Daniel Wetzel, Gianluca Tonolo, Sub-Saharan, Jacob Hyppolite II – International Energy Agency – 3 November 2022

relates to addressing the need to improve the quality of life for the billions of people living in the developing world.

The Energy Transition

From the year 1900 to present the global cost of energy (all primary sources of energy) has averaged 4% of the value of the world's economic output.[759] Coincident with the advancement of the Energy Transition, the cost of energy relative to the scale of the economy is expected to rise to 13% in the near-term.[760]

That would imply that relative to historical norms the deadweight burden of the cost of energy is expected to rise by an amount equal to 9% of global economic output.[1]

Wind power and solar power combined provide 2.0% of global energy, as seen in Table 1.[761]

Critically, the energy provided by wind power and solar power is in the form of electricity – not intense heat – and it is intermittent.

The trajectory of energy costs relative to the growth in the market share of wind power and solar power is unsustainable: The Energy Transition is unsustainable.

The economic effects of the Energy Transition are two-fold. Firstly, the Energy Transition transfers wealth away from other possible uses. Secondly, wealth channeled into the Energy Transition impoverishes our societies through the low returns it generates.

The US has the world's largest and most prosperous economy globally, yet 65% of America's middle class is experiencing economic hardship to the extent that financially they are "gasping for air".[762] Globally, the number of people suffering from hunger is rising at an

[759] **An Industrial Waste Land?** – Robert West – Thunder Said Energy – https://thundersaidenergy.com/ – Accessed: January 2023
[760] **An Industrial Waste Land?** – Robert West – Thunder Said Energy – https://thundersaidenergy.com/ – Accessed: January 2023
[761] **Key World Energy Statistics 2021 (Data for 2019)** – International Energy Agency – September 2021
[762] **New National Poll: Economic Hardships of Millions of Middle-Class Americans Go Unseen** – National True Cost of Living Coalition – 4 June 2024

alarming rate for the first time in half a century.[763]

It is imperative to appreciate that the success of the agenda to divert more wealth year after year into the Energy Transition would necessarily have the results that we are now seeing in terms of the middle class "gasping for air" and the rise in global hunger. The probability of the Energy Transition having these results was 100% - this was foreseeable with absolute certainty.

Biofuels

Biofuels represent the best conceptual basis to advance the Energy Transition. They represent a return to the combustion of pre-industrial fuels, namely, wood, alcohol and vegetable oil. The supply of biofuels is limited by the availability of the forests and farmland.

Wind Power and Solar Power

Conceptually, wind power and solar power are capable of providing electricity intermittently into a grid-based system supported by reliable forms of energy. There can be conceptual merit in wind power and solar power in that context; however, it is important to appreciate that the law of diminishing returns applies to unreliable sources of energy.

In an absolute sense, there is nothing wrong with wind power and solar power; however, it has been wrong and ultimately futile to promote green energy and the Energy Transition based on false premises, such as the misrepresentation that wind power and solar power are capable of replacing fossil fuels without decimating the human population.

[763] **Undernourishment around the world, Counting the hungry: trends in the developing world and countries in transition; The State of Food Insecurity in the World 2006** – Food and Agriculture Organisation of the United Nations – 2006; **The State of Food Security and Nutrition in the World 2019** – Food and Agriculture Organization of the United Nations, International Fund for Agricultural Development, UNICEF, World Food Programme and World Health Organization – 2019; and
The Neglected Crisis of Undernutrition: Evidence for action – UKAID, UK Department of International Development – 2009

Electrical batteries are transforming the energy landscape; however, they are not a source of energy, but rather a means of storing electrical energy.

Over the decades ahead we can expect to see electricity continue to gain market share.

Fossil fuels and nuclear power will be prerequisites for increased electrification.

Electrical vehicles represent a technological means for low-cost fossil fuels to gain market share from oil, a relatively high-cost fossil fuel.

China's dominance of the electrical battery sector and the electrical vehicle industry is preponderant. China itself is overwhelmingly the most important market for electric vehicles globally. Although it is true that China is investing in wind power and solar power to provide energy at the periphery of its electrical grid, there is no scope or intention for those investments to eliminate the use of coal. That is made abundantly clear by the reality that China is investing in new coal mines to produce an additional 1.28 billion metric tons of coal per year[764] – a prerequisite to grow the market share of electric vehicles in China.

It is critical to appreciate that fossil fuels and the reliable, low-cost energy provided by fossil fuels underpin the expansion of electric vehicles in China and elsewhere.

The Energy Transition is Intellectually Incoherent

The Energy Transition's goals are irreconcilable with the strategies applied to advance the Energy Transition.

The materials required for wind power and solar power require fossil fuels; therefore, it is incoherent to suggest that the Energy Transition is a sustainable transition able to achieve the goal of eradicating the use of fossil fuels. Moreover, the use of fossil fuels are a prerequisite

[764] **China has more than 1 billion tons/year of new coal mines in pipeline, report says** – Reuters – 10 September 2024

to create the wealth that is being channeled into advancing the Energy Transition through governmental controls.

Strategies to advance the Energy Transition on the basis that it will reduce carbon dioxide emissions often have the opposite effect.

Strategies to advance the Energy Transition on the basis that doing so will protect the environment are causing significant environmental harm, deforestation, habitat loss and significant unresolved end of life waste challenges.

Reliable forms of energy provide the backbone of the on-grid system chosen to grow the market share of wind power and solar power: There was never a chance that the grid-based system chosen to grow the market share of wind power and solar power could grow the market share of wind power and solar power to the point of eradicating the use of fossil fuels. The only conceptual means of sourcing electrical energy 100% from wind power and solar power would involve simple off-grid electrical battery energy storage systems, which are conceptually feasible but uneconomic and environmentally unsustainable. The point is that the goal of the Energy Transition – to eradicate the use of fossil fuels – is not consistent with choices made by our governments to advance the Energy Transition.

End Game

The economic landscape that allowed wealth to flood into the Energy Transition – in flows greater than a trillion dollars per annum – has ended.

The flows of wealth into the Energy Transition supported by ESG finance and governmental controls were unsustainable as they required the lowest interest rates ever experienced by humanity, unprecedented creation of money from central banks and unprecedented increases in indebtedness.

The inherently unsustainable backdrop supporting the Energy Transition between the period of 2008 to 2022 has ended, with high inflation, reduced confidence in Western currencies and highly precarious levels of governmental indebtedness.

At its core, the Energy Transition fundamentally consists of allocating as much wealth as possible into green energy. After several decades,

that strategy has run its course: Socially, politically and economically, the limits of the Energy Transition have been reached.

The Origins of the Energy Transition

The economic origins of the Energy Transition are instructive to ascertain its character.

In 1977, well before the United Nations' determined that the carbon dioxide emissions from fossil fuels were creating climate risks, the US Government under the Presidency of Jimmy Carter advanced the first government-led energy program in the US.[765] In 1978, an ancillary part of that program was devised to transfer wealth to US farmers: Alcohol (ethanol) derived from corn and intended to be blended into gasoline was supported by a subsidy amounting to 40 cents a gallon (10.6 cents per liter) of alcohol.[766]

In the context of the Cold War, the free market ethos of the US at that time were in opposition to the statist economic ethos of the Soviet communist empire; however, the Carter Administration's departure from the free market principles of the US through the introduction of statist intervention in energy markets was considered to be only slight. However, that slight deviation from free market principles would grow within energy markets in ways that were not necessarily expected or intended.

The elements of that statist intervention, revolved around creating public support for governmental interventions to i) transfer wealth to targeted beneficiaries, and ii) actively manage the market shares of various forms of energy – the template of the Energy Transition.

For reference, the official accounting methodologies to quantify the carbon dioxide emissions from the use of corn-derived alcohol assume that bio-fuels do not emit any carbon dioxide.[767] In contradiction to that assumption, the use of corn-derived alcohol emits more carbon

[765] **President Jimmy Carter Report to the Nation on Energy, Fireside Chat** – 4 August 1977
[766] **The US Ethanol and Biofuels Boom: Its Origins, Current Status, and Future Prospects** – Wallace E. Tyner – Bioscience – 7 July 2008
[767] **Biofuels explained** – US Energy Information Administration – https://www.eia.gov – Accessed February 2023

dioxide into the atmosphere than naturally produced gasoline, while its environmental impacts are significant and harmful.[768]

The Real Issue

The real issue is not whether green energy is better or worse than fossil fuels: The only issue that matters is whether free markets or statist controls are applied to determine which forms of energy gain or lose market share.

There are No Long-Term Winners in the Energy Transition

With $1.4 trillion being diverted into green energy per annum[769] it is natural to assume that the Energy Transition has created tremendous wealth for its beneficiaries. While it is true that tremendous wealth has been transferred into an ecosystem that benefits from the Energy Transition, that ecosystem is as unsustainable as the Energy Transition itself. As a result, the financial beneficiaries of the Energy Transition do not have an interest in a long-term, sustainable project, but rather in an unsustainable project that has largely run its course.

Fossil Fuels

Fossil fuels provide abundant, reliable, affordable and useful energy in the form of heat.

In contradiction to many narratives, fossil fuels have tremendous benefits, inclusive of supporting the substantial entirety of our material well-being.

Without fossil fuels most humans would precipitously perish, mostly through starvation. With fossil fuels, humanity is able to progress its goals, achieve its full potential and have optimism for the future.

[768] **Why corn ethanol is worse for the climate than petrol** – Jeremy Plester – The Guardian – 26 September 2024
[769] **World Energy Investment 2022** – International Energy Agency – June 2022

Habitat Matters

The global warming agenda has distracted conservationists from what matters, namely, protecting wildlife habitats.[770]

Farming Matters

Agricultural yields have been the principal determinant for human prosperity for millennia. It has been unwise and costly, in terms of human suffering, to have ignored that in the promotion of the Energy Transition.

Higher agricultural yields reduce the amount of land required for farming, which increases the amount of land available for wildlife habitat.

Efficient farming requires the abundant provision of fossil fuels for fertilizers, steel and energy.

Humanity's Dependence on Combustion

The human species is the only species on Earth that is genetically adapted to an external source of energy. Our minds, our teeth and our digestive systems are genetically adapted to our use of heat to cook food.[771] From prehistoric times to the present day, the materials created by humanity have required energy in the form of intense heat provided by combustion. Industrial progress was inhibited by the limited availability of wood; however, fossil fuels freed humanity from the limitations of wood, which has underpinned the tenfold increase in the human population from pre-industrial levels (1750) to present.[772]

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[770] **Nature's Dangerous Decline 'Unprecedented' Species Extinction Rates 'Accelerating'** – United Nations, Intergovernmental Science-Policy on Biodiversity and Ecosystem Services – 6 May 2019

[771] **Catching Fire: How Cooking Made Us Human** – Richard Wrangham – Profile Books – September 2009;
Control of Fire in the Palaeolithic, Evaluating the Cooking Hypothesis – Richard Wrangham – Current Anthropology – 16 August 2017 and
Food for Thought: Was Cooking a Pivotal Step in Human Evolution? The dietary practice coincided with increases in brain size, evidence suggests – Alexandra Rosati – Scientific America – 26 February 2018

[772] **A World of 8 Billion** – United Nations – Policy Brief – October 2022; and

To understand energy requires an appreciation of our deep human dependence on upon it.

Miscalculating humanity's readiness to replace fossil fuels with alternatives and restricting humanity's freedoms to benefit from combustion in a context where our species is genetically dependent on combustion can only have very profound implications.

The Trojan Horse

Western societies have willingly given up their freedoms and welcomed governmental controls on our economies and lifestyles on the basis that carbon dioxide, according to our governments, is more dangerous than nuclear war,[773] opening the gates of hell[774] and the world's most fearsome weapon of mass destruction.[775]

Limits of PR and Politics

Humanity's dependence on combustion is comparable to our dependence on oxygen for breathing.

It is possible to conceal our dependence on both oxygen for breathing and combustion for energy for a time; however, it is not possible to do so for long before the consequences of doing so become extremely painful and obvious. The reality of our dependence on fossil fuels supersedes politics and the messaging of public relations campaigns. Politics and public relations are futile tools to upend our relationship to what from a physical perspective fundamentally makes us human, namely, combustion.

A Key Point of Reflection

There is a 0% chance that the Energy Transition will be successful. There is a 100% probability that countries that reject the Energy

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Historical Estimates of World Population – United States Census Bureau – https://www.census.gov – Accessed: January 2023

[773] **Biden Says Climate Change Poses Greater Threat Than Nuclear War** – Jordan Fabian and Akayla Gardner – Bloomberg – 10 September 2023

[774] "**Humanity has opened the gates to hell" warns Guterres as climate coalition demands action** – United Nations – Press Release – 20 September 2023

[775] **John Kerry's Phony Climate War** – Rich Lowry – Politico Magazine – 19 February 2014

Transition will dominate the future. There is a 100% probability that this will become very obvious – no matter the efforts of powerful public relations campaigns suggesting that the Energy Transition is working.

There is very little benefit in reflecting upon the Energy Transition in terms of how far it will get – as a means of eradicating the use of fossil fuels, it has not even begun.

A point of reflection that is more likely to yield benefit is the contemplation of how Western Civilization became enmeshed in a government-controlled venture as costly and futile as the goal of eliminating our use of fossil fuels.

What Adam Smith Didn't Know

Adam Smith elaborated in 1776 that free-markets create the greatest good for all. As a pragmatic observation there is overwhelming evidence that free markets and the freedom to use fossil fuels are also beneficial to the environment to the extent that they encourage higher agricultural yields and reduced land use to procure the energy and materials required by humanity – freeing land for wilderness.

The Manipulation of Compassion and Kindness

The Energy Transition has been advanced by pleas to humanity's goodwill. A lesson to be learned from the harm caused by the Energy Transition is that humanity's goodness can be manipulated if the scope of our considerations is limited, manipulated or influenced by emotions, particularly fear. If we consider the consequences of our actions wholistically, calmly and with a positive mindset, it is certain that actions arising from humanity's goodwill will result in better outcomes.

Positive Goals

Without diminishing the reality of humanity's current challenges, from a broader perspective humanity's march forwards and upwards has been a constant over the millennia. Fear and anxiety have distracted Western Civilization from the achievement of its positive goals. The goals of reducing hunger, creating prosperity, fostering

peace and protecting wilderness are all imminently achievable. In fact, these goals are most likely to be achieved together.

Energy Shocks

Energy Shocks was written to provide a straightforward understanding of how energy and carbon dioxide work and to provide context to appreciate how they relate to other key issues that affect our world.

Energy Shocks was also written to provide an understanding of the potential for energy to make our world a better place.