

## Watch out! Biden wants to save the planet

Technology choices will decisively impact whether climate-pivoted economic policy brings benefit or disaster

By **JONATHAN TENNENBAUM**

MARCH 1, 2021

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Then-President-elect Joe Biden is pictured announcing members of his climate and energy appointments at the Queen theater in Wilmington, Delaware, on December 19, 2020. Photo: AFP / Joshua Roberts / Getty Images

*This is Part 1 of the series Watch Out! Biden wants to save the planet.*

*This is the first article in a series.*

President Joe Biden's climate plan is a grandiose vision, combining deliberate echoes of Franklin Roosevelt's New Deal with the crash-program approach to development of technology, exemplified by the Apollo program of the 1960s. If it works, planet Earth and the US economy will be saved at the same time.

Biden has vowed to establish US leadership in saving the planet from an impending climate apocalypse. His appointments of establishment climate activists to high positions in his administration, along with his opening salvos of executive orders, confirm his intention to make climate the central topic in all spheres of US government activity.

He calls it the "Whole of Government Approach to the Climate Crisis."

Among other things Biden ordered a National Intelligence Estimate (NIE) of the threat that climate change poses for US national security. He made climate officially the priority focus of US foreign policy.



US President Joe Biden speaks on climate change, creating jobs, and restoring scientific integrity before signing executive orders in the State Dining Room of the White House on January 27. Photo: AFP / Mandel Ngan

One has the distinct impression that the Biden Administration intends to use the climate crisis as an occasion for reasserting the primacy of US power in international affairs. Far beyond rejoining the Paris Agreement on his first day in office, Biden has made clear that the United States will act as global enforcer of CO<sub>2</sub> reduction measures – and he intends to focus especially on China.

At the same time, Biden has committed himself to making climate the center of US domestic economic policy. The recent executive orders already contain elements of his campaign promise to channel \$2 trillion into building a “clean” national infrastructure – thereby creating millions of new jobs and driving innovation and economic growth.

If all goes according to plan, by 2035 the US should have 100% CO<sub>2</sub>-free electricity generation – and by 2050 total net emissions should reach zero.

Among the first concrete steps is to initiate planning for replacing the entire fleet of over 600,000 vehicles used by federal government and the US Postal Service to zero-emission vehicles.

A key move, which has so far attracted little attention in the news media, is to implement the so-called “social cost system” as a guiding criterion for daily government decision-making. The social cost system is based on attaching a numerical value to the “global damage” attributed to emission of a given amount of carbon dioxide – in the production of a given commodity, for example.

This will have a big economic impact through the choice of products and vendors for government purchases, on which Washington spends about \$600 billion a year.

The \$2 trillion climate plan – whose funding must, of course, be approved by Congress – would follow on the heels of a \$1.9 trillion American Rescue Plan to help the US economy and population recover from the effects of Covid-19.

All in all, the degree of concentration of a US government on a single theme is practically unprecedented in peacetime. Were it not for the Covid-19 pandemic there would doubtless be much more discussion about this radical course. People who believe that global warming is the greatest crisis of our time might easily overlook problematic, even ominous implications of declared policies.

While making some polemical remarks, I wish to emphasize that I am not motivated by political opposition to the Biden Administration. Nor, of course, do I oppose rational measures to reduce and eventually eliminate the world’s one-sided dependence on fossil fuels.

One should also keep an open mind in respect to any new administration, which carries contradictory interests and impulses with it into office and may adjust its course as it confronts reality.

But there are reasons to take Biden’s declarations very seriously.

Firstly, to all appearances Biden and his close advisors truly believe that the world is headed toward an unprecedented catastrophe through global warming, that the clock is ticking and that urgent action is necessary to reduce [CO<sub>2</sub>](#) emissions world wide. Not only the US but other nations as well must do so, especially the [largest CO<sub>2</sub>](#) emitters, with China in first place.



Then-President-elect Joe Biden departs after speaking at an event to introduce key Cabinet nominees and members of his climate team at the Queen Theater in Wilmington, Delaware, on December 19, 2020.

Photo: AFP / Alex Edelman

Countries that refuse to reduce their emissions by the necessary amounts voluntarily must be forced to do so. The logic is inescapable.

Secondly, as Biden has emphasized for the United States, replacing the world's entire fossil fuel infrastructure with "clean technology" over the next 30-40 years creates a new market of colossal dimensions – assuming that the nations and populations are able to pay for it.

Thirdly, immense amounts of financial capital have already been committed to the expectation of radical climate policies. CO<sub>2</sub> emissions are being monetized and a vast financial machinery created, tying asset valuations to parameters such as “carbon intensity” and “sustainability indices.”

Climate projections are being built into long-term risk strategies and the premium structures of insurance companies. The volume of carbon trade is growing exponentially and, with it, the market for climate-linked financial instruments such as green bonds (already at \$500 billion) and other so-called green assets.

Thereby, climate policy becomes a powerful instrument for shaping global investment patterns and financial flows. In his 2020 “Open Letter to CEOs” Larry Fink, the Chairman of the world’s largest asset management company, BlackRock, declared: “I believe we are on the edge of a fundamental reshaping of finance.”

In the meantime BlackRock, several of whose executives have been named to high positions in the Biden Administration, announced that it is making climate change central to its investment strategy for 2021.



People hold signs calling for Biden to support a Green New Deal, in St. Paul, Minnesota on January 29.

Photo: AFP / Tim Evans / NurPhoto

Thus, in all probability the Biden Administration will indeed pursue the radical course announced during his campaign and signaled by initial executive orders.

What will that mean?

From the positive side, I have reason to expect that areas of science and technology that are critically important for the future – nuclear fission and fusion, new materials, hydrogen technologies, high-density energy storage, applications of high temperature superconductivity and much more – will receive greater support under the new administration, than has been the case under preceding ones.

This is a crucial point. Leaving many other factors aside, the [choice of technologies](#) employed in the promised rebuilding of US infrastructure – assuming it actually occurs – will have a decisive impact on whether Biden’s climate-pivoted economic policy will benefit the nation or lead to disaster.

Following this introductory article no. 1, further installments in the series will take up the following concerns:

- Green imperialism: Is the Biden Administration turning the climate issue into a vehicle for great-power geopolitics?
- Will Biden’s climate policy serve, defacto, as a vehicle for financial interests that are positioning themselves to profit from the tectonic shifts in global financial flows, arising from a forced move away from fossil fuels? Is this a “BlackRock Administration”?
- Will overheated climate measures set the stage for a financial crisis? Major bets are being placed on the future of the world energy system, and market stability faces the dual menaces of a “green bubble” of climate-linked financial assets and a “carbon bubble” of potentially worthless fossil fuel assets.
- Consider the risk of a California-like horror scenario: economically ruinous over-

expansion of so-called renewable energy sources and ideologically-driven environmentalist measures, leading to exploding energy prices, blackouts, economic austerity, productivity losses and growing poverty. Will ill-conceived climate measures generate a political backlash and a resurgence of the Republicans, at latest by the 2024 Presidential elections?

- Will the United States descend into economic and social crisis when the temporary, government money injections-induced “high” begins to wear off?
- What’s the danger that ill-conceived measures by the Biden Administration, in the name of saving the planet, will undermine the capability of the United States and other nations to cope with climate changes in the future?
- At the end I shall make some remarks concerning what a rational approach to the climate issue would look like.



UNITED STATES

## Biden eyes new era of green imperialism

US-led 'planet saving' could become new source of military conflict as oil and gas have so frequently in the past

By **JONATHAN TENNENBAUM**

MARCH 2, 2021



US President Joe Biden says he will put fighting climate change at the center of his foreign policy. Image: Facebook

*This is Part 2 of the series Watch Out! Biden wants to save the planet..*

In his January 27 [“Executive Order on Tackling the Climate Crisis at Home and](#)

[Abroad](#),” US President Joseph Biden declares that his administration aims at “putting the climate crisis at the center of United States foreign policy and National Security.”

Taken literally, this statement – as I think any sober observer of today’s situation in the US and internationally will agree – is a piece of insanity. Joe, please tell us you don’t mean it.

Whatever one might believe about an oncoming climate apocalypse, the urgent domestic and international problems the Biden administration will face in the immediate months ahead have little or nothing to do with the temperature of the Earth’s atmosphere. They include the likelihood of crises that might decide between war and peace on a short time-horizon.

There may be a method in the madness, however. By implication, Biden’s executive orders make the release of CO<sub>2</sub> in any corner of the world into a US national security issue. The forthcoming National Intelligence Estimate would provide the basis for using the resources of the US intelligence community and national security apparatus to enforce administration climate policies on a global scale.

That has ominous implications. The construction of a new highway, pipeline, factory or power plant in a developing country, which might lead to increased CO<sub>2</sub> emissions, could in principle be classified as a threat to US national security.

Depending on the case, the US administration would thereby feel justified or even compelled to stop such projects. Green imperialism thus becomes a duty of the US government. One should consider the magnitude of the interventions and conflicts which may result.

To borrow an expression from former president Barack Obama, the US has a variety of “tools” at its disposal to enforce its climate goals on the world. Biden already speaks of the use of carbon tariffs, fees or quotas on carbon-intensive goods from countries that are “failing to meet their climate and environmental obligations.”

Climate would thus provide the Biden administration with an argument to pursue Donald Trump’s protectionist aims with other means. As Biden put it during his campaign: “Countries that fail to meet their climate responsibilities won’t be allowed to erode global progress with cheap, carbon-dirty goods.” A hard line against “carbon-dirty goods” would thus be a way to “protect American jobs.”



Smoke is discharged from chimneys at a coal-fired power plant in Changchun city om northeast China’s Jilin province, December 24, 2018. Photo: AFP

But there is much more in the toolbox. Climate goals provide ample justification for strong interventions into the domestic politics of nations, including support for selected parties, social movements and NGOs.

Naturally, everything will be done with 100% political correctness. Moreover, Biden evidently regards it as his prerogative, in the name of saving the planet, to dictate to other nations which projects they may or may not finance and build.

The executive order directs the departmental secretaries at State, Treasury and Energy as well as leaders of other government agencies, in consultation with the assistant to the president for national security affairs, “to identify steps through which the United States can promote ending international financing of carbon-intensive fossil fuel-based energy.”

Biden has made it clear that China is the number one target of his climate-leveraged foreign policy. China has over 250 gigawatts (GW) of coal-fired power now in development, with 97 GW already under construction. The 250 GW total is roughly equivalent to the entire coal power capacity of the US, which Biden has pledged to shut down.

During the electoral campaign, Biden declared: “I will lead a diplomatic initiative to get every nation to go beyond their initial commitment” to reducing CO<sub>2</sub> emissions. “This is especially true for China, by far the world’s largest emitter of carbon. We will not only hold their leaders accountable for reducing carbon output at home, in their country but make sure they stop financing billions of dollars of dirty fossil fuel projects all across Asia.”

It is true that many of the projects sponsored by China in the context of its Belt and Road Initiative involve the construction of fossil fuel power plants and fossil fuel infrastructure.

Chinese banks are presently the main source of financing for coal power plants worldwide, with Chinese financing and Chinese companies involved in at least 240 coal projects, including in Vietnam, Bangladesh, Pakistan, Kenya, Ghana, Malawi, Zimbabwe, Egypt, Tanzania, and Zambia.



Chinese and Pakistani technicians at the Chinese-financed Qasim Power Plant near Karachi. Image: Facebook

The simple fact is that developing countries need energy and they are expanding their fossil fuel infrastructure accordingly. This can be seen clearly from the construction of oil and gas pipelines.

India has over 21,000 kilometers of pipelines in planning or construction, African countries have over 33,000 kilometers and Latin America over 13,000 kilometers. The pipelines now in pre-construction or under construction in the Asia-Pacific region (including China) have a total length equal to twice the equator of the Earth.

Will the US under Biden attempt to stop these projects in the name of saving the climate?

Note that pipeline projects have long played a role in tensions between the US and Russia (and earlier the Soviet Union). Most prominent, of course, is the North Stream 2 project linking Russia and Germany, which Trump and now Biden have

pledged to stop.

But there is more. Russia would be one of the biggest losers from CO<sub>2</sub> reductions by its oil and gas customers. Fossil fuels make up 60% of Russia's export earnings and about 30% of its GDP.



An oil pump-jack at the Abino-Ukrainian oil and gas field in the Krasnodar region, Russia. Vitaly Timkiv / Sputnik

Taking on the role of a climate policy “enforcer” will bring the Biden administration into conflict with the interests of many countries.

Nearly all Middle East nations live on exports of oil. Among the other countries that depend on fossil fuels for more than 50% of their export earnings are Algeria, Angola, Azerbaijan, Brunei, Columbia, Republic of the Congo, Gabon, Nigeria, Sudan, Turkmenistan and Venezuela.

Scores of other developing countries earn significant amounts from fossil fuel

exports, and many have fossil fuel reserves that are counted on as part of their national wealth. The International Monetary Fund report “[Unburnable Wealth of Nations](#)” explores this issue.

More broadly, will the Biden administration effectively attempt to force the world’s nations to write off trillions of dollars of still-functioning, non-depreciated fossil fuel infrastructure, and at the same time pay for a whole new infrastructure?

Needless to say, there are also military implications. What about Russian activities in the Arctic region, in which oil and gas play a major role?



Servicemen of a separate motor rifle brigade of Russia’s Northern Fleet attend tactical training drills last month for an Arctic expedition near the village of Pechenga, in the Murmansk region, Russia. Photo: AFP / Pavel Lvov / Sputnik

What about the immense oil and gas deposits in the areas claimed by China in the South China Sea?

What if Russia or China or other nations refuse to terminate activities that “threaten the global climate”?

Will “saving the planet” become a new source of military conflicts, as oil and gas have so frequently been in the past?



UNITED STATES

## Biden, BlackRock and climate bubble trouble

It's not too early to start asking who will lose and who will win if the market is compelled to decide fossil fuels are toast

By **JONATHAN TENNENBAUM**

MARCH 3, 2021

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Biden's climate policies threaten to burst fast-inflating fossil fuel and green market bubbles. Image: Facebook

*This is Part 3 of the series Watch Out! Biden wants to save the planet*

BlackRock Inc, the world's largest investment management company with about 8 trillion dollars of managed assets, plays a singular role in US President Joe Biden's climate policy. Indeed, it looks like BlackRock and the Biden administration are married to each other.

The marriage was consummated, one might say, with the appointments and nominations of prominent BlackRock executives to high posts in the administration. All of them are typical of the "revolving door" phenomenon of leading personnel shifting back and forth between government and big finance.

Brian Deese, appointed by Biden to be director of the National Economic Council, served as a senior advisor to President Barack Obama for climate and energy policy. He played a key role in negotiating the Paris Climate Agreement. Afterward, his BlackRock biography says, he became "global head of sustainable investing" at BlackRock "identifying drivers of long-term return associated with environmental, social and governance issues."

Wally Adeyemo, nominated as deputy secretary at the Treasury Department, was an advisor to and interim chief of staff for BlackRock chairman Larry Fink. Before joining BlackRock, Adeyemo served in various capacities in the Obama administration, including deputy national security advisor for international economics and deputy director of the National Economic Council.

Thomas Donilon, appointed as senior advisor to Biden, was chairman of the BlackRock Investment Institute. He served as national security advisor to then-president Barack Obama and was reportedly considered by Biden as a potential nominee to head the CIA.

Mike Pyle, appointed as chief economic advisor to Vice President Kamala Harris, was the chief investment strategist at the BlackRock Investment Institute.

Looking beyond these up-front appointments, a number of commentators have remarked that BlackRock seems to be taking the place of Goldman Sachs in Wall Street's symbiotic relationship with the US government.

In fact, BlackRock has had a close relationship to the US government since the 2007-2009 financial crash, when the New York Federal Reserve Bank hired it to manage and liquidate the assets of the bankrupt Bear Stearns Co.

Last year, BlackRock was contracted again by the Federal Reserve to serve as executor of the Fed's \$750 billion corporate bond purchasing program. The New York Times refers to BlackRock as the "Mr Fix-it" of Wall Street.

What does this have to do with climate policy?

BlackRock is disliked by many climate activists, among other things because of its heavy investment in fossil fuels and other “dirty” things. They accuse Fink of trying to “greenwash” the company.



BlackRock chairman and CEO Laurence Fink at the World Economic Forum annual meeting in Davos, Switzerland, January 23, 2020. Photo: AFP/Fabrice Coferini

Political correctness has indeed become a very big business, which by its very nature has more to do with image than substance. But [Fink's 2020 conversion to climate activism signifies much more.](#)

BlackRock is evidently positioning itself, as the world's largest asset manager, to profit from the tectonic shifts in global financial flows that Biden's climate policies are set to unleash. Other major players in Wall Street, London and elsewhere are following suit.

Will BlackRock, moreover, be called upon by the government to manage and liquidate stricken fossil fuel-based assets, as it did with Bear Stearns's assets in the

2007-2009 financial crisis?

This time around, the sums could be a hundred times larger.

### **Climate meltdown?**

This brings us to the question: How might actions by the Biden administration, in the name of preventing a climate apocalypse, affect the stability of the financial system?

One can easily imagine scenarios for crises or even a meltdown of financial markets.

The most obvious would be a collapse of the “carbon bubble”: the mass of fossil fuel-based assets, many of which would become virtually worthless in the event the Biden government forced through a rapid transition to a “CO<sub>2</sub>-free” economy.

The second obvious risk is the collapse of the “[green bubble](#)” resulting from:

- Overbuying and speculation in climate-based financial assets;
- Overvaluations based on misjudgment of the sustainability and profitability of various renewable energy and low-carbon investments;
- Overestimation of the willingness and ability of governments to subsidize these technologies – especially in the event of an economic downturn.

Among other things, the [real, longer-term cost of wind energy](#) will almost certainly turn out to be far higher than investors believe.

Needless to say, the carbon and green bubble scenarios do not exclude each other.

It is difficult to estimate the size and risk of the green bubble. It currently enjoys widespread support from governments and [will no doubt grow many times](#) over under the Biden administration.

For the moment, the carbon bubble is vastly larger and poses more fundamental risks.

## Trillions in stranded assets

Proponents of green policies have long warned that the failure of investors to take global warming seriously has led to a huge overvaluation of fossil fuel-linked assets – based on investors’ assumptions that growth in worldwide consumption of these fuels will continue unabated and governments will take no serious action to halt it.

Conversely, a rapid transition to CO<sub>2</sub>-free energy sources would leave behind a gigantic mountain of “stranded fossil fuel assets,” which will have to be written off because their underlying real value has evaporated. There’s already an abbreviation being bandied about in the jargon-loving financial industry: SFFAs.



Oil prices have recovered after collapsing due to the double whammy of the Covid-19 pandemic and a massive supply overhang. Photo: Facebook

Starting before the November 2016 US presidential election, there was considerable discussion in financial circles concerning “transition risk,” or financial risk associated with a transition away from fossil fuels.

A particularly prominent voice was the then-governor of the Bank of England, Mark

Carney. In a now-famous September 29, 2015, [speech at Lloyds of London](#), Carney stated::

Changes in policy, technology and physical risks could prompt a reassessment of the value of a large range of assets as costs and opportunities become apparent. The speed at which such re-pricing occurs is uncertain and could be decisive for financial stability.... While a given physical manifestation of climate change – a flood or storm – may not directly affect a corporate bond’s value, policy action to promote the transition towards a low-carbon economy could spark a fundamental reassessment... [A] wholesale reassessment of prospects, especially if it were to occur suddenly, could potentially destabilize markets, spark a pro-cyclical crystallization of losses and a persistent tightening of financial conditions.

Carney has been in the middle of the process of creating an international framework of agreements and financial arrangements in the direction of a “fundamental reshaping of financial markets” by climate policy.

In 2019, while still Bank of England governor, Carney practically called upon investors to drop their financial exposure to fossil fuel-connected assets. [In a BBC interview](#) on January 30 that year, he highlighted the threat to pension funds, warning that:

Up to 80% of global coal assets and up to half the world’s proven oil reserves could become stranded assets as the world moves to curb carbon emissions and [as] supplies of clean, renewable energy continue to replace fossil fuels.

What is the size of the carbon bubble?

Start with the most obvious component, state and private ownership of or extraction rights to proven reserves of oil, gas and coal. [It is very roughly estimated](#) that a 2% decline in demand for fossil fuels every year, required by the Paris Agreement on

climate change would cause a loss of \$25 trillion in future income from coal, oil and gas at present prices.



Sunset for the oil and gas extraction industry? The oil drilling ship Tungsten Explorer is seen docked at the block 4 area off the coast of the Lebanese coastal town of Safra, February 25, 2020, as the sun sets. Photo: AFP/Joseph Eid

Not just investors but, especially, developing countries would be hard hit. A 2017 bulletin of the International Monetary fund, “[Unburnable Wealth of Nations](#)” states:

[I]f there are successful global actions to address climate change, poorer countries that are rich in fossil fuels will likely face a precipitous fall in the value of their coal, gas, and oil deposits. If the world makes a permanent move away from using fossil fuels, the likely result will be a huge reduction in the value of [those countries’] national and natural wealth.

That is just part of the story, however.



To get a vivid sense of the magnitude of the assets that will become stranded, one must take into account not only the fossil fuels themselves but also:

- coal mines,
- the oil and gas extraction industry,
- land values in regions of extraction,
- pipelines and pipeline construction companies,
- oil and LNG tanker fleets and tanker construction,
- harbor and storage facilities,
- refineries,
- fueling stations,
- coal yards,
- fossil fuel power and heating plants,
- coal-based steel plants,
- significant parts of the auto industry supply chains tied to production of internal combustion engines,
- and much, much more.

Some credible estimates say that 20-30% of the total market capitalization of the world's stock exchanges is tied to fossil fuels. Whatever the actual figure, we can be sure that it will be more than sufficient to cause a financial meltdown if significant numbers of investors were suddenly to drop these asset categories.

Whether or not this will happen depends to a significant extent on perceptions of how fast and how far the Biden administration is willing to go.

So far Big Oil has shown no signs of panic. One could argue that the economic interests tied with fossil fuels are so deeply embedded in the political structure of the US, and of the world, that even the power of the US government would not be enough to defeat them.



Biden has a controversial green energy vision. Image: Getty via AFP/Frederic Brown

According to that view, Biden is basically bluffing, that it's just political talk and the promised end of the era of fossil fuels is not going to happen.

But how much are you ready to bet on that? Powerful forces within the financial community appear to be readying for a collapse of the carbon bubble – and intend to profit from it.

In fact, some voices argue in favor of deliberately provoking the collapse as soon as possible, before the carbon bubble grows even larger with massive amounts of investment continuing to flow into fossil fuel infrastructure worldwide. The collapse is inevitable, they argue, so better for it to happen sooner than later.

Financial losses from climate change are certain to be larger, is the key argument. Ever more frequent floods, fires, drought, extreme storms will be bad for many investments and especially bad for insurance companies.

How will investors place their bets in the coming period?

In reality, a transition away from fossil fuels – which are still the foundation of the world economy – can only occur gradually over decades. But market expectations can shift within minutes.

In his first weeks in office, Biden has sent strong signals that he means business about getting the world off fossil fuels, starting with the US itself. The signals include America's return to the Paris climate agreement, termination of the Keystone XL pipeline project, a moratorium on new oil and gas leases on public lands, an instruction to federal agencies to purchase large numbers of electric cars and a declaration of intent to end fossil fuel subsidies.

The day after Biden's January 27 [Executive Order on Tackling the Climate Crisis at Home and Abroad](#) was issued, Fortune Magazine wrote, "Oil and gas companies knew they would face a fight with President Joe Biden, who had campaigned on tackling climate change. Nobody expected fossil fuel to come under such an immediate attack."

UNITED STATES

## Biden's climate plan has a nuclear solution

Biden has few, if any, options apart from nuclear to achieve his goal of 100% carbon-free power by 2035

By **JONATHAN TENNENBAUM**

MARCH 5, 2021



The Biden administration has intimated support for nuclear energy but will face resistance from within his Democratic Party. Image: Getty/AFP Forum

*This is Part 4 of the series Watch Out! Biden wants to save the planet.*

President Joe Biden has set goals of achieving 100% carbon-free electricity production by 2035 and reducing net CO2 emissions to zero by no later than 2050 in the United States.

From a technical standpoint, it is certainly possible to reduce the net emission of carbon dioxide by human activity to zero while boosting the productivity and prosperity of the world economy at the same time.

This goal can be achieved entirely, or nearly entirely, using technologies that either already exist or are within reach. We can combine:

- nuclear power, fission and/or fusion (see my fission articles [here](#) and [here](#); fusion articles [here](#) and [here](#)) and my other Asia Times fission and fusion [articles](#);
- at most a moderate proportion (no more than 35%) of so-called renewable power sources, including hydroelectric power;
- fuel cells using hydrogen produced by nuclear and/or renewable power sources;
- nuclear ship propulsion;
- complete electrification of land transportation using batteries and hydrogen fuel cells;
- conversion of industrial processes that presently use fossil heat sources to electricity and/or hydrogen;
- transition to electricity and “clean fuels” in domestic heating and cooking; and
- large-scale (re)forestation with related measures to increase photosynthetic carbon-binding, possibly large-scale [industrial removal of carbon dioxide from the atmosphere](#), as well as utilization of carbon – extracted from the atmosphere – in building materials such as carbon fibers and other products.

Air transport is one of the more challenging areas, but hydrogen-burning aircraft, battery-powered electric aircraft and [hydrogen fuel cell-powered electric aircraft](#) have already flown and multiple [projects are under way to commercialize them](#).



An electric Airbus helicopter pictured during a presentation at the Airbus helicopters production site in Donauwoerth, southern Germany, on July 20, 2020. Photo: AFP/Christof Stache

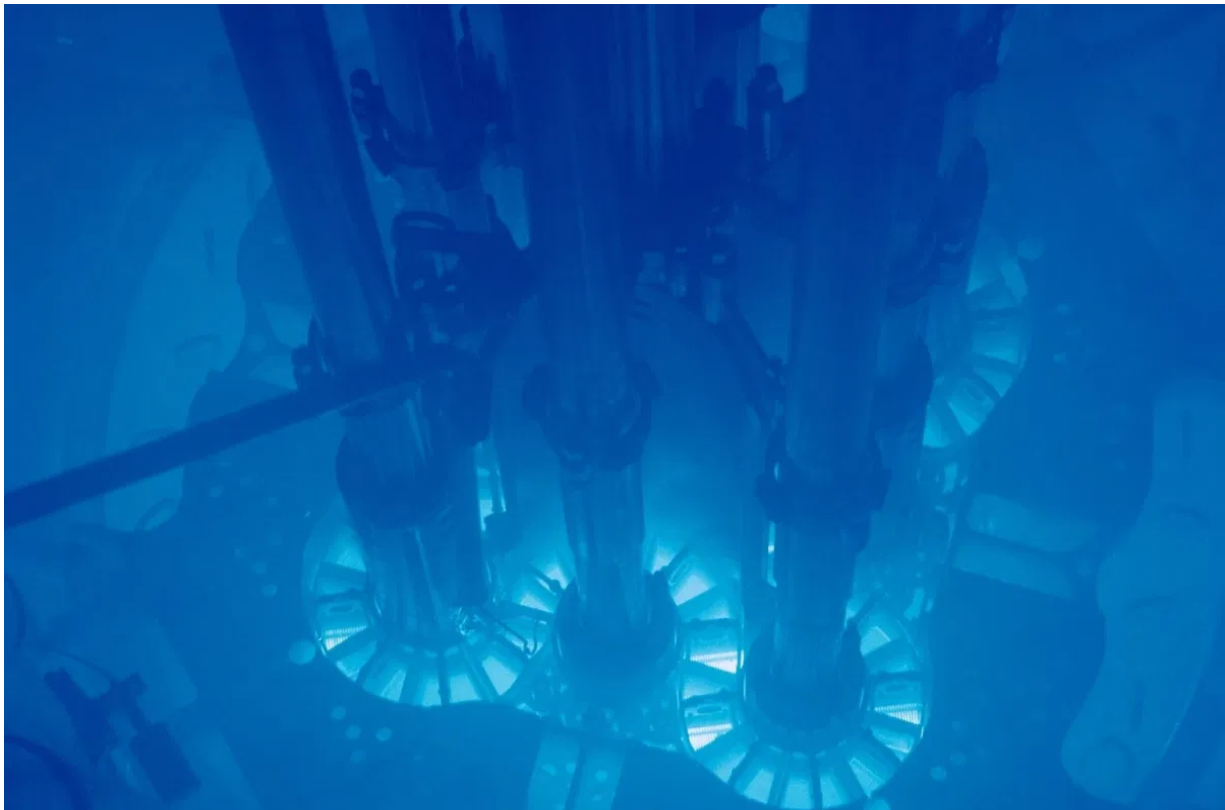
Breakthroughs in high-temperature superconductors could enhance this zero-emission scenario – among other ways by permitting a drastic increase in power-to-weight and power-to-size ratios of electric motors and generators. Electric aircraft engines could become much smaller, lighter and more powerful.

There are many other considerations, but I shall pass over them here.

Most importantly: Given sufficient support for research and development in the context of large-scale infrastructure investment worldwide, ending the era of dependence on fossil fuels could be accomplished without austerity and with a minimum of coercive measures by governments. The major drivers would be higher efficiency, lower costs, competitive advantages.

This would be a natural process if guided by rationality rather than quasi-religious belief in a coming “climate apocalypse.”

While climate changes can have serious effects, this is no time to commit economic suicide. Strong economies are better equipped than weak ones to deal with climatic changes and natural catastrophes. And stronger economies can better afford to invest in advanced technology, as well as measures to enhance their resilience.



The Advanced Test Reactor at Idaho National Laboratory uses plate type fuel in a clover leaf arrangement. The blue glow around the core is known as Cherenkov radiation. Photo: Courtesy of Idaho National Laboratory

The Chinese leadership is correct in adopting a pragmatic approach. Alongside its investment in so-called renewable energy and in nuclear power – both by far the largest of any country – China presently has no reasonable choice but to continue its massive buildup of the fossil fuel sector.

The same holds for all rapidly-developing nations. They will gradually move out of fossil fuels, as this becomes economically advantageous, but probably not in a rush. Meanwhile, Biden has set the goal to eliminate all use of fossil fuels for electricity generation in the US by 2035.

At present, about 60% of electric power in the US is generated by combustion of coal, gas and petroleum. Fifteen years from now all of that should be gone, replaced by “100% clean” sources of electric power.

Many regard this goal as completely unrealistic. There is a relevant precedent, however: [France’s mobilization to expand its nuclear power plant capacity](#) in response to the oil crisis of 1973.

Within 15 years the percentage of electricity generated from nuclear plants rose from 7% percent in 1975 to over 75% in 1990. France currently has the lowest electricity prices in Western Europe – about 40% lower than those of Germany and Denmark, the leaders in wind and solar energy.





An inspection by the French Nuclear Safety Authority last month paved the way for the continued life of the country's oldest reactors, 40 to 50 years old, including this one, Chinon, at Avoine. Photo: AFP/Guillaume Souvant

Given the will, and by reviving what is left of its nuclear industry, the US could accomplish the same thing, or better, today. Advanced-generation nuclear fission reactors promise to be far safer and cheaper than the aging French and American plants designed 40 years ago.

Fusion could be much better, insofar as it avoids many of the drawbacks of fission. It might possibly be brought on line inside a 15-year horizon if the US were to launch a crash program like the Apollo moon-landing program of the 1960s.

During his electoral campaign, Biden himself likened his mobilization for “clean energy” to the Apollo program. With some luck, we may even get cheap, compact [hydrogen-boron fusion reactors](#) or [dense plasma focus reactors](#), which [produce virtually zero radioactivity](#)

To their credit, President Biden and, to a lesser extent, Vice President Kamala Harris have declared their support for nuclear energy. Nuclear fission power already accounts for 20% of US electricity production.

In his official campaign program, Biden pledged to create a new Advanced Research Projects Agency on Climate (ARPA-C) “to target affordable, game-changing technologies to help America achieve our 100% clean energy target.”

The specific targets for the agency were to include, among others, “advanced nuclear reactors that are smaller, safer, and more efficient at half the construction cost of today’s reactors.” In fact, already under Trump the Nuclear Regulatory Commission and other US agencies began taking steps to facilitate the [introduction of small modular reactors](#).



Democratic presidential candidate Joe Biden speaks at a ‘Build Back Better’ clean energy event in July in Wilmington, Delaware. Photo: AFP / Olivier Douliery

At this point, it looks like the Biden administration may actually invest significant resources into nuclear energy, including fusion. If this happens it will assuredly

produce results, including the potential for the US to once again be a leading exporter of nuclear power technology.

Particularly encouraging is the role of private companies and private investors in developing innovative reactors. Practically all of these possess built-in “passive safety” features that rule out serious accidents, such as the one that occurred in Fukushima.

However, there is considerable ideological opposition to nuclear energy in the left-wing of the Democratic Party and presumably in the Biden administration itself. Add a powerful lobby of interests connected with so-called renewable energy sources, which stand to lose from an expansion of nuclear power.

Mounting an all-out effort to expand nuclear power within the 15-year horizon of Biden’s announced “100% clean electricity” goal, along the lines of what was done in France, would not be easy politically. The Biden administration would have to fight for it. On the other hand, it could gain nonpartisan support given that 70% of the American population is favorable to nuclear energy.

There is also a good chance that private-led efforts, supported by government, can come up with fission or fusion systems able to produce electricity so cheaply that they would be commercially unstoppable.

Failing that, and without a forced buildout of nuclear power, Biden’s alternative will be either to abandon the 2035 target, or subject the country to the kind of horror scenario we have been witnessing in California.

**ENERGY**

# Wind and solar reliance would black out the US

If Biden goes to undependable renewables without nuclear, expect exploding power costs, rationing and blackouts

By **JONATHAN TENNENBAUM**

MARCH 8, 2021

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A doctrinaire green energy program risks blacking out the US. Image: Facebook

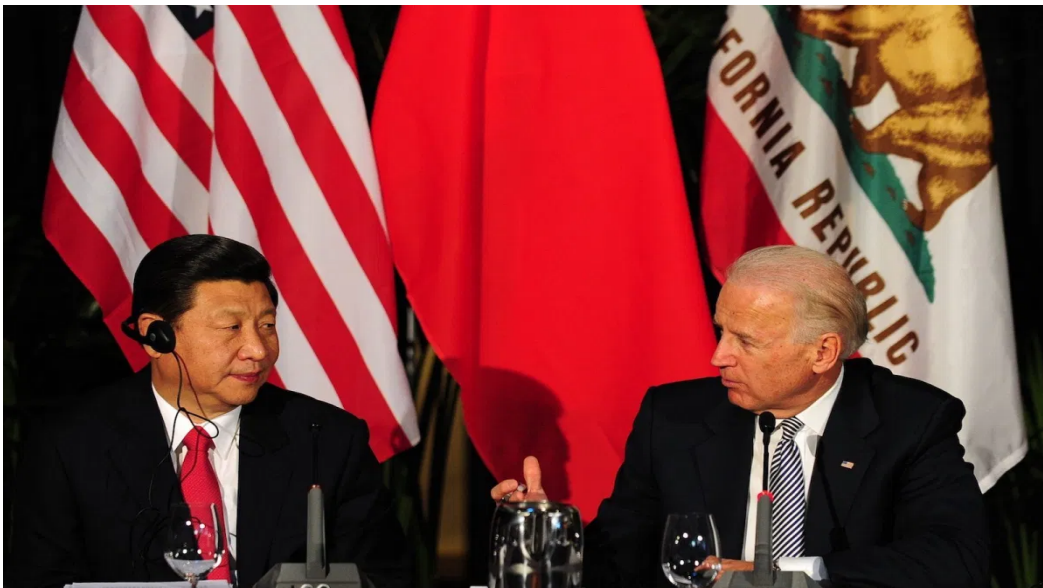
*This is Part 5 of the series Watch Out!*

US President Joe Biden has made fighting global warming a top priority in all spheres of government activity and vows to make the US electric power system 100% carbon dioxide-free by 2035. He has not, however, spelled out how the administration intends to achieve this goal. The choice of technology plays a key role.

Many climate activists – but by no means all – are pushing for a plan based exclusively on so-called renewable energy sources, particularly wind and solar power, without any use of nuclear energy. But without nuclear energy, Biden’s green effort will be doomed to disaster.

The only available alternative to large-scale nuclear power would be to scale up wind and solar energy to cover 80% or more of total electricity generation. Other sources, such as hydroelectric power, geothermal, biomass (with replanting), could hardly be expected to cover more than about 20% of total US consumption.

A vast infrastructure would be needed to support such a heavy reliance upon wind and solar, which are intermittent, land- and resource-intensive energy sources. That includes restructuring the whole US electricity grid and creating gigantic amounts of electricity storage capacity.



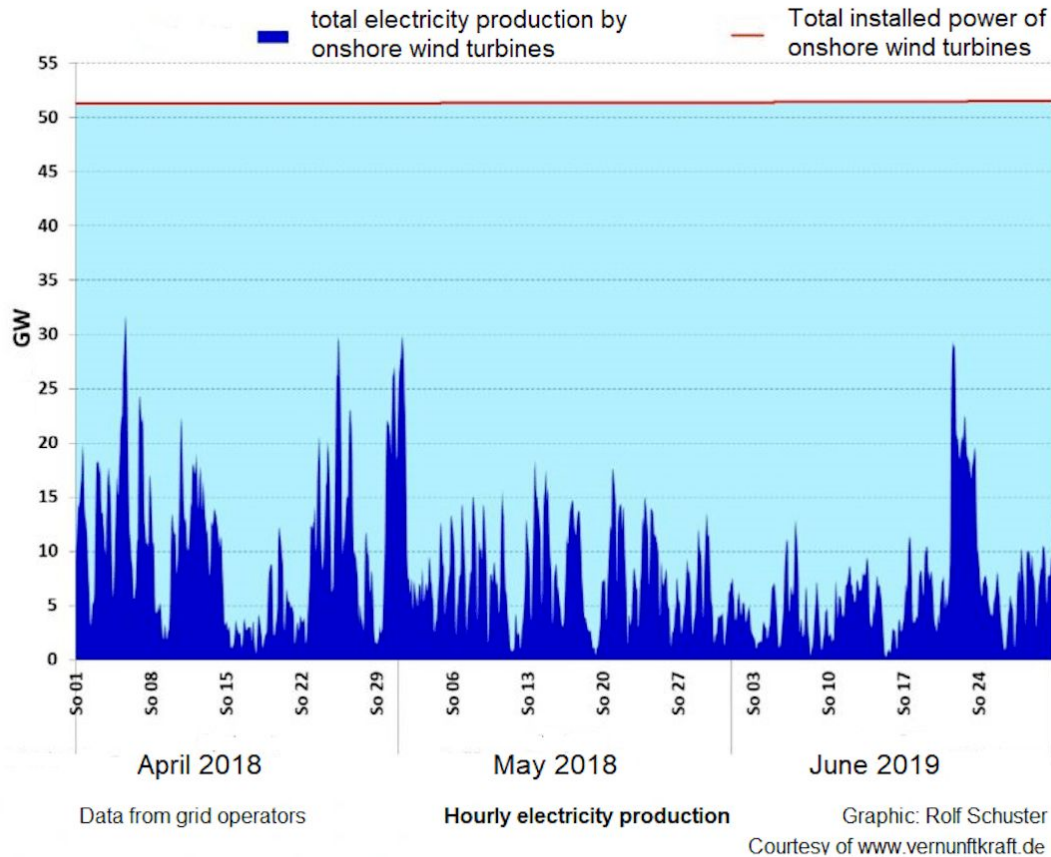
If the magnitude of financial and physical resources that would need to be invested are taken into account, it is clear that this scenario will never be carried through to the end.

Instead of the promised nirvana of 100% renewable energy, the overhaul would inevitably end in chaos with exploding electricity costs, frequent blackouts, rationing of electricity consumption and repressive measures to cut energy consumption. Many power plants would most likely still be burning fossil fuels, as the country would not be able to get along without them.

Long before that, a powerful political backlash would likely have swept the Democratic Party out of power – along with anyone else identified with the plan. So what is so problematic about the “100% renewable” scenario?

First: the output of wind turbines and solar cells fluctuates over a wide range on time-scales of minutes, depending on weather conditions. Solar cell output varies depending on cloud cover and time of day, being zero at night.

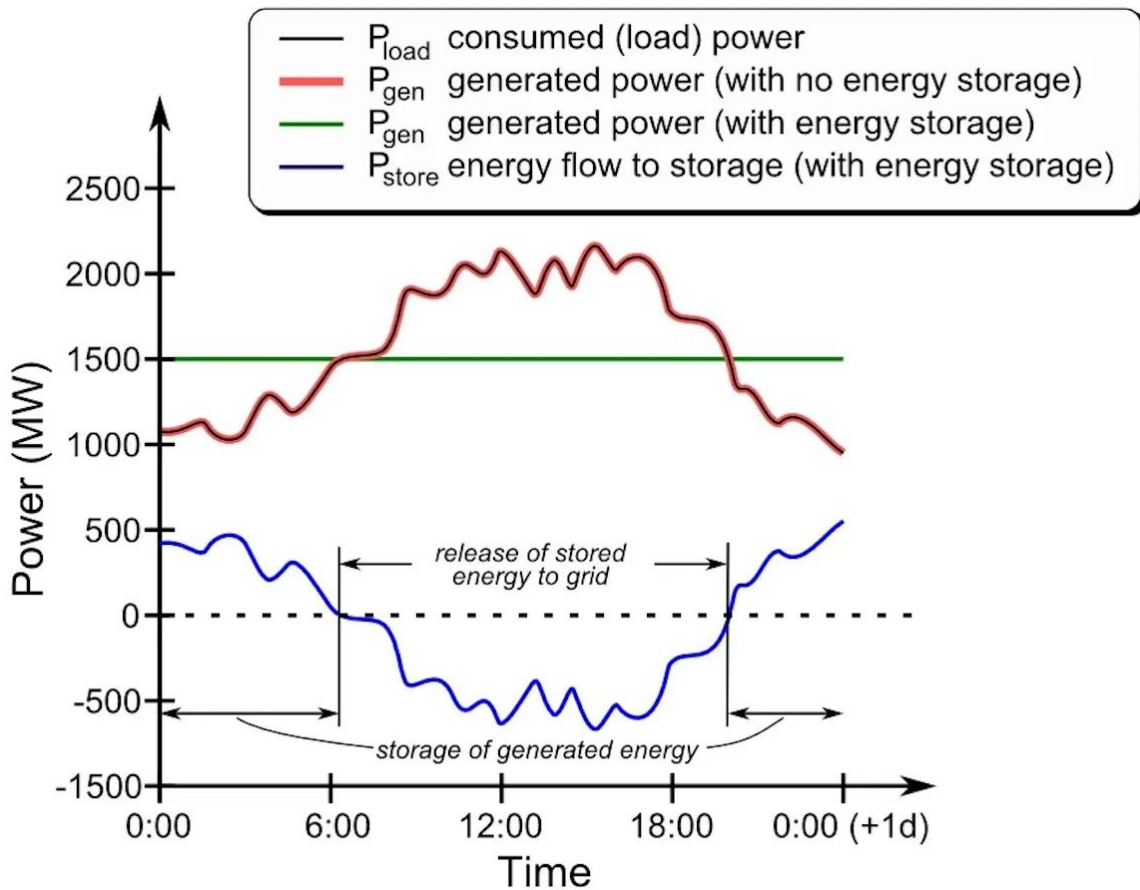
Due to the erratic variations in wind strength, the average output of an onshore wind turbine is generally only about a third of its maximum rated capacity (the figure is about 38% for an offshore turbine). About 2000 typical-size 1.5 megawatt wind turbines are needed to generate as much average electric power as a standard one-gigawatt nuclear power plant. Unlike wind turbines, nuclear plants generate a constant, controllable flow of electricity.



## Wind power in Germany

To obtain a dependable supply based on wind and solar, supplementary electricity sources are needed to step in when their output drops. That costs money. In most present-day practice – where fossil fuels have not yet been banned – this is done mainly with the help of auxiliary gas turbines, diesel generators or – when nuclear plants are available – by “load-following” that constantly adjusts nuclear plant outputs. Load-following can work as long as the ratio of nuclear to wind-plus-solar is large enough.

Otherwise, the only alternative is to import electricity from somewhere else, assuming it is available when you need it, or to store part of the output of wind and solar sources and inject stored electricity back into the grid when their output falls. The most-cited option is to use batteries – a lot of them.



Source: Wikimedia

The second basic problem is the low power density of wind and solar energy. Aside from hurricanes and tornadoes, wind is a diffuse form of energy that requires large areas to “harvest” it. The same applies to sunlight on the surface of the Earth.

Compared to nuclear plants or state-of-the-art fossil fuel plants, wind and solar require hundreds of times as many individual units, hundreds of times more land area and tens of times larger amounts of steel, concrete and other materials to produce a given average power output.

The figure below illustrates what low power density means: a 260-meter tall 12 MW GE Haliade X offshore wind turbine, compared with the size of a nuclear power plant – in this case an advanced-generation reactor being developed by the [ThorCon](#) company for Indonesia.



**GE Haliade X**  
**12 MW intermittent**

Rotor diameter  
**220m**



**12MW turbine**  
**260m high**

**ThorCon liquid fission**  
**500 MW full time**  
**length 165 m**



Source: Thorcon

GE's Haliade X is two-thirds the height of the Empire State Building, or half the height of the former World Trade Center! But for a nominal rating of 12 megawatts, we will be lucky to get 5 MW average output – a hundredth of the output of the “tiny” nuclear power plant at the right.

That's similar for land use. Michael Shellenberger, a staunch environmentalist who has become an outspoken advocate of nuclear energy, [compared the land area required](#) for a given level of power production by typical nuclear plants, wind farms and solar parks in various countries.

For example, the nuclear plant in Borsella, Netherlands, occupies about .16 square kilometers of land and produces 3.46 billion kilowatt-hours of electricity per year, while Holland's Gemini Offshore Wind Farm occupies 68 square kilometers and produces 2.6 billion kilowatt-hours. The nuclear plant produces 570 times more

power per unit area than the wind farm – and 370 times more than the solar park Sunport Delfzijl.

In South Korea the factor was 625 times for nuclear versus onshore wind and 468 times for nuclear versus solar. Figures in the nine other countries examined are analogous.

Note also that wind turbines degrade the quality of life of people unfortunate enough to live in the vicinity. Ironically, irrational environmentalism has caused an unprecedented scale of destruction of the natural landscape.

This has given a new meaning to the term blowback. In Germany, the resistance of local populations has brought the expansion of wind energy to a standstill. Large solar parks are not popular, either.



Wind turbines in southern California. Photo: Wikimedia

There is no question that wind and solar power are mature technologies, that have an important role to play as complementary energy sources in specific contexts. But as far as the economics of large-scale use is concerned, the lobby of commercial interests linked to wind and solar energy – which is now much larger than the nuclear lobby ever was – has done everything possible to pull the wool over the eyes of the public.

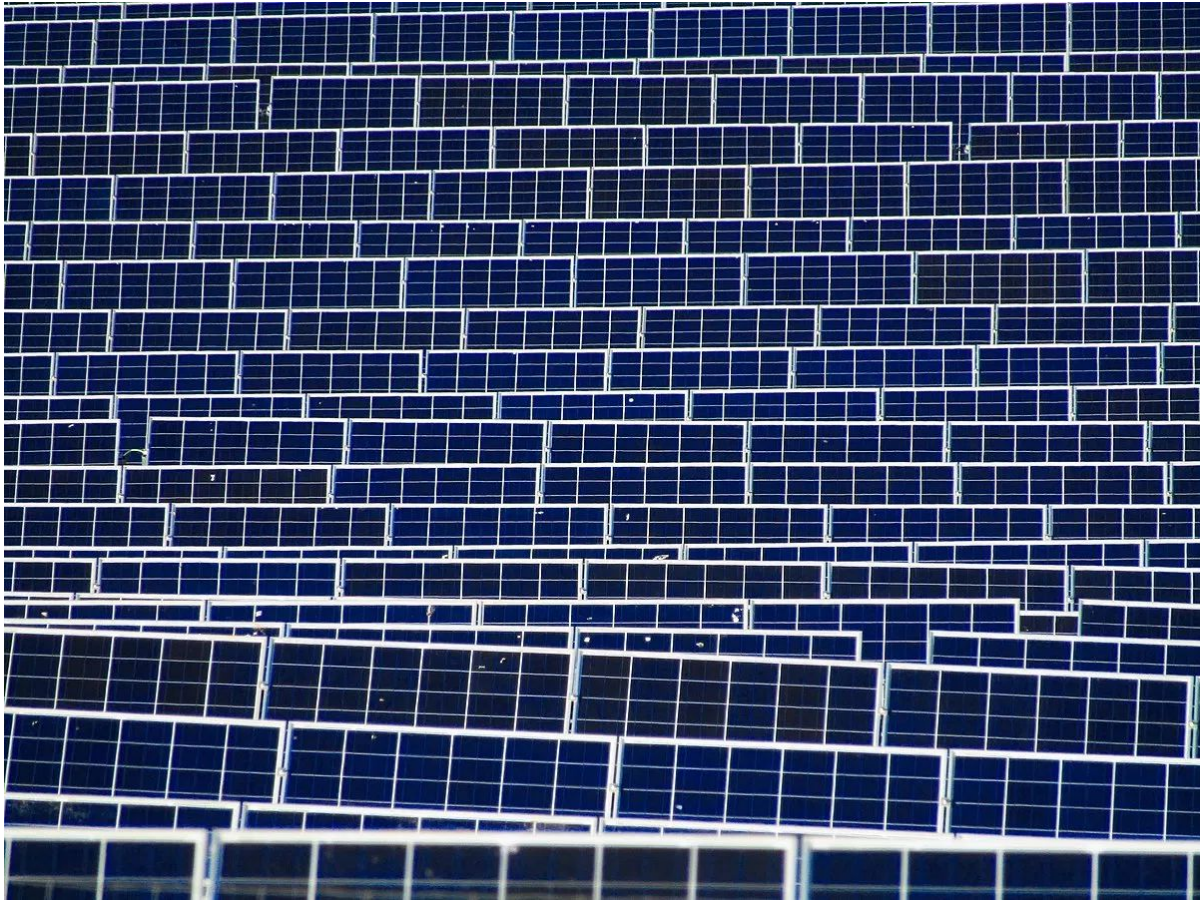
We are constantly told that the cost of wind and solar energy has dropped dramatically and that they are already the cheapest power sources.

Common sense, and the electricity prices in California, Germany, and Denmark – which have all gone big on renewable energy – tell a different story, as do many independent studies. See for example the detailed study by Gordon Hughes of the University of Edinburgh, “[Wind Power Economics – Rhetoric & Reality.](#)”

The [real costs of wind and solar are obscured](#) by subsidized prices, renewable energy credits, production tax credits, green bond discounts, accelerated depreciation, property tax exemptions and tax credits.

Competing fossil fuel sources are “punished” by imposing carbon taxes and by giving first preference to renewables in the purchase of electricity by network providers. (See Chapter 3 of the excellent book [Electrifying Our World](#), by ThorCon co-founder Robert Hargraves.)

The real costs of wind and solar energy also include the investments needed to integrate them into a national power system that must reliably meet demand. A 100% renewable energy scenario means transforming a vast electrical system that was designed to operate on the basis of stable fossil fuel and (later) nuclear energy sources.



A field of solar panels in Devon, England, UK. Photo: wiki.jpg

During the Windpower 2019 conference, [Dan Shreve, head of global analysis at Wood Mackenzie Power and Renewables](#), [stated](#) that achieving 100% renewable energy would require doubling the length of the high-voltage electric transmission lines in the US.

That means putting up over 320,000 kilometers of new transmission lines. In addition, the US would need huge amounts of additional electricity storage capacity. How much electricity would have to be stored in batteries and other storage systems to make sure the lights don't go out when it gets dark and the wind drops off ?

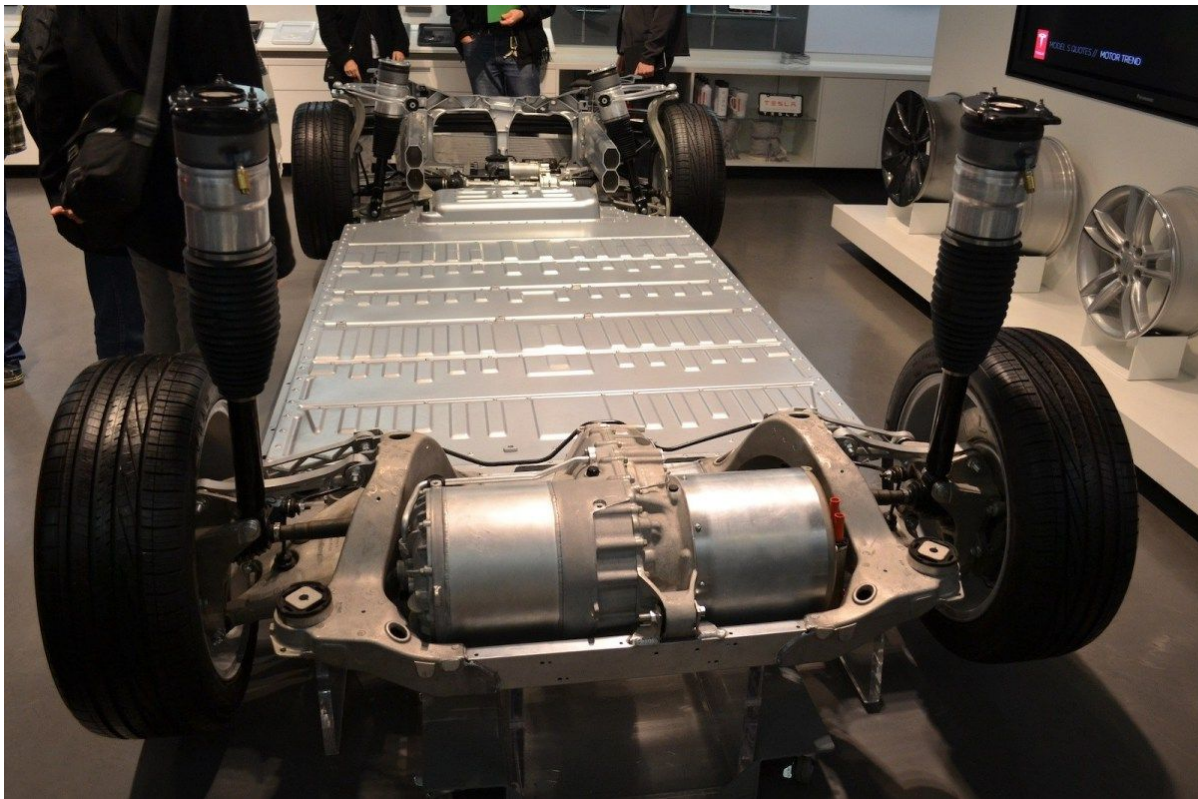
This is a complicated question, but it is worth citing a couple of crude estimates.

Willem Post, a former engineer and frequent writer on energy issues, [addresses this issue](#): “According to weather data, the US has multi-day, wind/solar lulls covering at

least 25% of the land area. They occur at random times throughout the year. A lull is defined at 15% of normal electricity output for that time of year.”

Estimating how much electricity would have to be supplied by storage systems in order to make up for missing wind and solar output during such a one-day lull, he comes up with 67 billion kilowatt-hours.

For comparison, the battery of a Tesla model S electric car can store about 85 kilowatt-hours. Dividing that into his estimate, we get the equivalent of 788 million fully-charged Tesla S batteries.



A Tesla Model S battery – long, thin and flat – occupies the base of the chassis. Photo: Wikimedia Commons

Tesla founder Elon Musk has promised that battery storage costs will come down to \$100 per kilowatt-hour – a 30% improvement from today. The price-tag would then be \$6.7 trillion for the first full set of batteries. Let’s hope they will not have to be replaced too often.

Results of [a much more elaborate study](#) were reported last year in the engineering magazine Bridge. The authors utilized data for the hourly electricity load and weather conditions in the seven New England states of the US during 2018, scaling up wind and solar capacities to match the annual energy consumption. The study takes into account the entire regime of operation of the system of sources and storage, which shows strong seasonal variations.

The authors come up with an estimate of 14 billion kilowatt-hours for the amount of electricity storage capacity that would be needed to ensure a reliable supply for New England in a “100% wind and solar” scenario. If we scale this estimate up to the whole US – whose electricity consumption is 35 times larger – we get the terrifying figure of 490 billion kilowatt-hours.

Assuming all-battery storage at the optimistic price of \$100 per kWh, the price-tag would be \$49 trillion!

The actual amount of storage capacity required would presumably be much less than this extrapolation suggests. Among other things, climate and weather conditions differ greatly among US regions.

In addition, building 320,000 kilometers of new transmission lines, as mentioned above, would allow electricity to be constantly shipped back and forth all across the country, according to the weather and time of day.

But whatever the millions or billions of batteries will cost, the very prospect of a nation basing its entire energy security on intermittent, weather- and climate-dependent power sources ought to frighten any sane person.

Meanwhile, some climate activists such [David McDermott Hughes](#) have come up with a much cheaper and quicker solution: Abandon the traditional goal of providing a reliable energy supply to meet the demands of society. Instead, require the population to adapt its consumption to the available supply.

Under this prescription the US population should simply come to accept rationing and power interruptions, of the sort that are unfortunately still common in underdeveloped

countries. That would be the necessary price for averting the climate apocalypse.

Caution: read this before the lights go out.

**ENERGY**

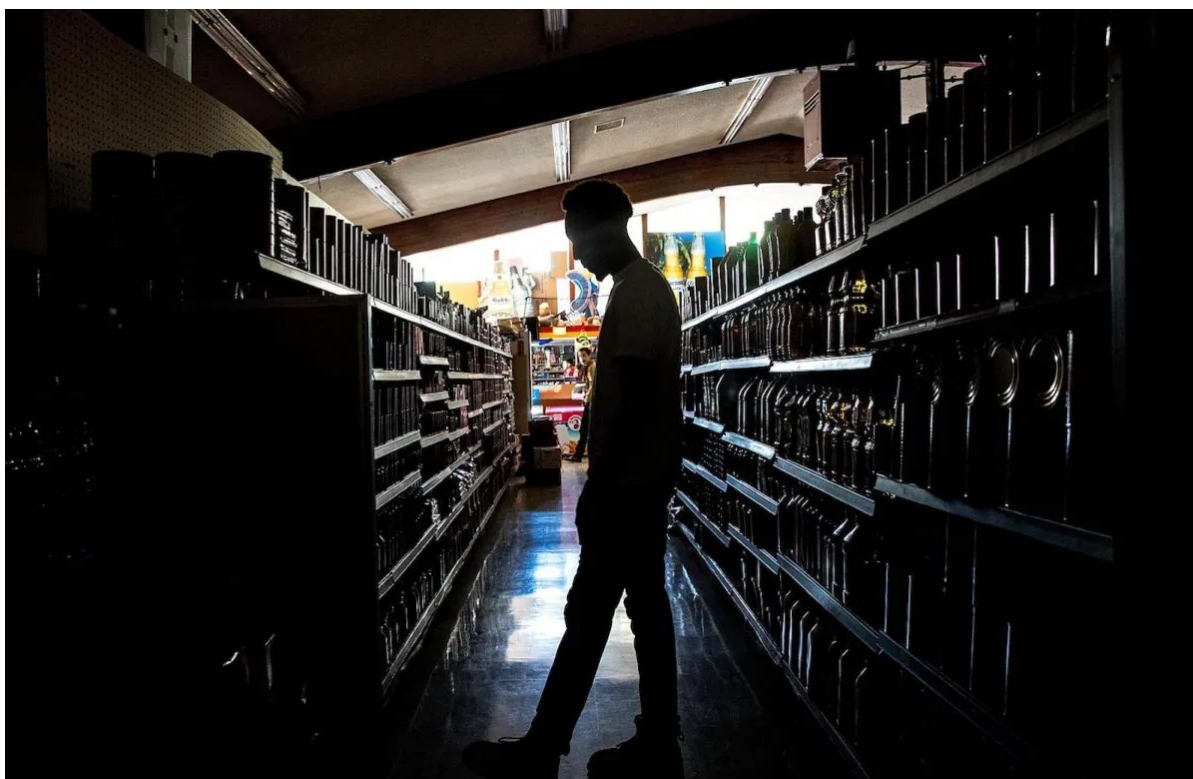
## California horror scenario could sink Biden

What will Biden's 'clean energy future' look like? California's sky-high energy prices and poverty rates sound a warning

By **JONATHAN TENNENBAUM**

MARCH 9, 2021

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A power blackout at a convenience store in California. Image: Facebook

*This is Part 6 of Watch Out! Biden wants to save the planet.*



Climate fundamentalists tend to believe in sacrifice and regimentation as the only way to avert a climate apocalypse and atone for man's crimes against the Earth.

In his campaign, Joe Biden set a very different tone: his climate plan would make building a new zero-emission infrastructure for the US into a vehicle for restoring prosperity and high-wage employment.

That sounds great, but what will President Biden's "clean energy future" look like? And will it be economically sustainable?

As I argued in the last installment, a policy of attempting to achieve "100% clean electricity" without massive expansion of nuclear energy will inevitably mean subjecting the population to economic austerity – among other things, through exorbitantly high energy prices and taxes resulting in a loss in buying power and, most likely, rationing and regimentation in the use of electricity. Plus blackouts.

To get a bitter taste of that future we have only to look at California – the state that has taken the lead in "clean energy." California also leads with the highest energy prices outside of the Northeast – more than 50% higher than the national average – and the highest real poverty rate in the US.



Then-California Governor Jerry Brown (R) and US Secretary of the Interior Ryan Zinke tour a school burned by the Camp Fire on November 14, 2018, in Paradise, California. Fueled by high winds and low humidity, the Camp Fire ripped through the town of Paradise, charring over 135,000 acres, killing at least 48 people and destroying over 8,000 homes and businesses. Photo: AFP / Justin Sullivan / Getty Images

California is supposed to be showcase of the Democratic Party's environmental policies. The state has been solidly in Democratic hands since the election of environmentalist Governor Jerry Brown in 2011. Vice President Kamala Harris and powerful House Speaker Nancy Pelosi are leading California Democrats. California also has vast financial and economic resources. If California were a country, it would be one of the six richest nations in the world, with a nominal GDP of \$2.6 trillion.

SO why is this state not able to provide its citizens with reliable and affordable electric power? Throughout October last year, millions of Californians suffered from a constant series of "rolling blackouts" in which electricity supply was cut off to various regions of the state on a rotating basis.

The rolling blackouts were provoked by a severe heat and dry spell, but were made possible by the desolate state of the state's ancient electric power grid. Sparking from

its overland power lines had long been a main trigger of California's frequent forest fires.

To avert this danger during the heatwave, California's main supplier company, Pacific Gas and Electricity (PG&E), simply cut off electricity to entire areas, calling these events "public safety power shutoffs."

PG&E, the largest power company in the US and greatly concerned to cultivate its image as a pioneer in "clean" energy, had evidently given more priority to investing in solar and wind than maintaining the power grid.

The crisis was also caused by insufficient reserves of generation capacity, including the environmentally-motivated reduction in natural-gas-based power generation and closing of the next-to-last nuclear plant, as well as phasing out of fossil fuel plants in neighboring states, which reduced the amount of electricity that could be imported. (With net imports amounting to 25% of its supplies, California is the largest importer of electricity in the US.)

Then there were the large fluctuations in supply from wind turbines, with swings of up to 1,000 megawatts, and the unavailability of solar power at night. At a certain point, the situation got out of hand.



Traffic signals non-operative due to a rolling blackout. An elementary school crossing guard pitches in to help drivers navigate an intersection on 19th Avenue, a busy San Francisco thoroughfare. Photo: AFP / Monica M. Davey

The latest crisis was no surprise for those familiar with California’s energy system. California already led the country in the number of power outages per year, and the system had already come near collapse in the preceding months.

More important than mere blackouts, California gives a foretaste of the economic austerity that ideologically-driven climate measures threaten to bring to the whole country.

Two years ago, a coalition of civil-rights leaders calling themselves “The Two Hundred” brought [a legal suit](#) against the California Air Resources Board (CARB) – the main agency of the California government responsible for implementing climate policies.

These policies, the suit alleged, were systematically violating the rights of minority citizens in the state, particularly those living in poverty. By the US Census Bureau's "functional poverty" criteria, 18% of Californians are considered "poor."

California's environmental measures have been hitting the living standards of the poorer population in multiple ways:

- Rapidly increasing cost of electricity (+ 30% since 2011, compared with a 4% average increase in the rest of the US);
- Growth in the costs of housing arising from obligatory "energy-efficiency" measures in old and new buildings and other environmental regulations;
- Moves toward banning the use of natural gas for heating and cooking, forcing people to turn instead to the use of electricity, which is nearly four times more expensive;
- Increased transportation costs due to environmental taxes on motor fuels and a new "[Vehicle Miles Travelled](#)" fee, designed to reduce emissions from car driving but defacto punishing people who move to outer-lying areas in the search of affordable housing.

The list goes on and on. In their lawsuit, The Two Hundred [argued](#):

"California's climate change policies – and specifically those policies that increase the cost, and delay or reduce the availability, of housing; that increase the cost of transportation fuels, and intentionally worsen highway congestion, to lengthen commute times and further increase electricity costs – have caused and will cause unconstitutional and unlawful disparate impacts to California's minority populations, which now comprise a plurality of the state's population."



Homeless people try to protect themselves from being displaced by street cleaning and power washing from the Los Angeles Sanitation service on February 8, 2021 in Hollywood, California. Photo: AFP / Valerie Macon

They added, in bitter irony:

“With climate change repeatedly described as a ‘catastrophe’ that could destroy civilizations, perhaps it is necessary for CARB to plunge more of California’s minority residents into poverty and homelessness. If so — if climate change requires that the state ignore civil rights, federal and state clean air, fair housing, transportation and consumer protection mandates, and ignore the administrative law checks and balances that require a thorough environmental and economic assessment of regulatory proposals — then this is a conclusion that may only be implemented by the Legislature, to the extent it can do so consistent with the California and federal Constitutions.”

The last sentence hints at a totalitarian tendency lurking behind the climate measures: the “climate apocalypse” provides a blank check for government to do whatever it wants.

Despite golden promises, Biden and his team are well aware of the link between climate policy and austerity. It has been a major issue at the base of the Democratic Party, with an ideologically-driven leftist constituency on one side and traditional Democratic constituencies such as trade unions on the other.

The latter, from experience and common sense, fear they will end up paying for the “clean energy” policies with lower living standards and increased unemployment. For example: what will happen to the millions of persons whose livelihood depends, directly or indirectly, on coal mining, natural gas and oil extraction activities?

One should bear in mind the colossal size of the fossil fuel sector in the US economy.

The US is currently the largest oil producer in the world, the largest natural gas producer and the third-largest hard coal producer. A radical reduction in fossil fuel production would hit not only the 1.1 million people directly employed in these activities but also the economies of entire regions in states such as Wyoming, West Virginia, Pennsylvania, Ohio, Texas, North Dakota, New Mexico and Oklahoma.



Workers dig near a part of a natural gas liquids pipeline, in West Chester, Pennsylvania, on March 13,

Needless to say, most of those regions voted overwhelmingly for Donald Trump in the last election.

Biden knows this, of course. In executive orders he promises that 40% of the “benefits” of the \$2 trillion climate plan will go to “disadvantaged communities.”

Biden proposes that large numbers of people in these communities will find employment in the process of shutting down the fossil fuel sector, such as:

- Closing down mines
- Sealing off oil wells;
- Dismantling pipelines;
- Restoring the surrounding, often severely damaged environment;
- Decommissioning fossil fuel plants.

This may be partly true, although the jobs involved have only a marginal effect on the productivity of the US economy. What happens later?

The experiences of the “rust belt” resulting from the deindustrialization of the US Midwest and parts of the Northeast in the 1980s, are not particularly encouraging.

Greater hopes can be placed in a buildup of new, “clean infrastructure” as a locomotive for increased employment. No doubt this will work, if enough money is provided.

Mere number of jobs is not a sufficient criterion, however.

The expansion of solar and wind energy in the US has already generated a very significant amount of employment. Currently, more people are employed in the renewable energy sector than in fossil energy.





Workers unload solar panels during an installation in Washington, DC. Photo: AFP/Alex Wong/Getty Images

This looks good at first glance but it reflects the fact that solar and wind energy are extremely labor-intensive, and have intrinsically low productivity. This is due among other things to the huge numbers of units that must be installed and maintained in order to reach a given output level.

California, for example, has 6,575 wind turbines, with a total nominal power of 5,842 megawatts and – taking account of intermittency – a realistic average power output of about 2,000 gigawatts. That is less than the constant output of the Diablo Canyon nuclear power station, which PG&E now plans to shut down.



Renewable energy development in the California desert. Photo: Wikimedia Commons

The critical question is whether the US economy, after having spent all the money and resources to reach “100% clean energy,” will be more or less productive. The answer depends crucially on the choices of technology.

Biden emphasized in his campaign: “A key plank of our Build Back Better Recovery Plan is building a modern, resilient climate infrastructure and clean energy future that will create millions of good-paying union jobs — not 7, 8, 10, 12 dollars an hour, but prevailing wage and benefits.”

However, if irrational environmentalist policies collapse the real productivity of the economy, then real wages and real living standards will inevitably collapse, too, at least for the majority of the working population.

Large injections of money might create the opposite impression but, as in the case of every anesthetic, the effect eventually wears off.

*Jonathan Tennenbaum received his PhD in mathematics from the University of California in 1973 at age 22. Also a physicist, linguist and pianist, he is a former editor of FUSION magazine. He lives in Berlin and travels frequently to Asia and elsewhere, consulting on economics, science and technology.*

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