Special Report

Green Nightmare for Americans

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Introduction

The President of the united States and radical environmentalists have said the United States must be carbon neutral, i.e., net zero carbon emissions, by 2050.

The essence of their plan is summarized here:

1. Close all coal-fired power plants.
2. Build wind and solar plants with required storage.
3. Eliminate the use of natural gas for home heating and water heating.
4. Eliminate natural gas for power generation.
5. Mandate that all new light vehicles be battery powered.
6. Promote zero emissions for large vehicles.
7. Use negative carbon strategies.

This report will establish that there is sufficient geographic area in the United States to construct all the wind and PV solar facilities needed to meet the administration's goal, but that it is absurd to try to do so.

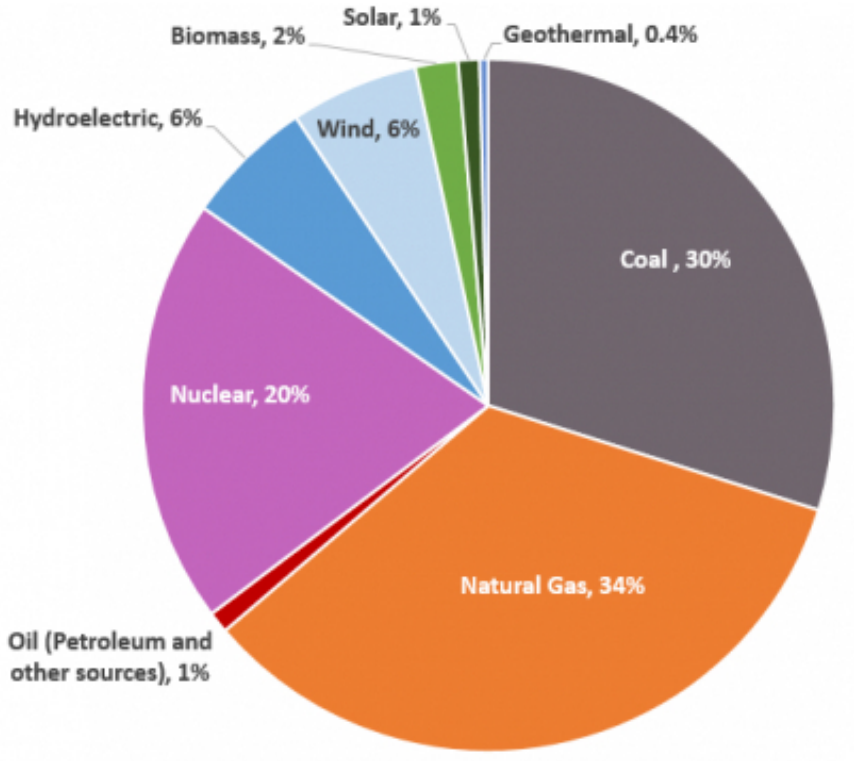
The report is divided into examining four problems associated with what will be required to achieve the administration's goal for becoming carbon neutral by 2050. The first problem is whether nuclear power will be able to contribute to this need.

Problems 2 and 3 describes the necessary steps for eliminating coal-fired and natural gas combined cycle power plants.

Problem 4 addresses how to achieve a doubling of electricity output in 2050.

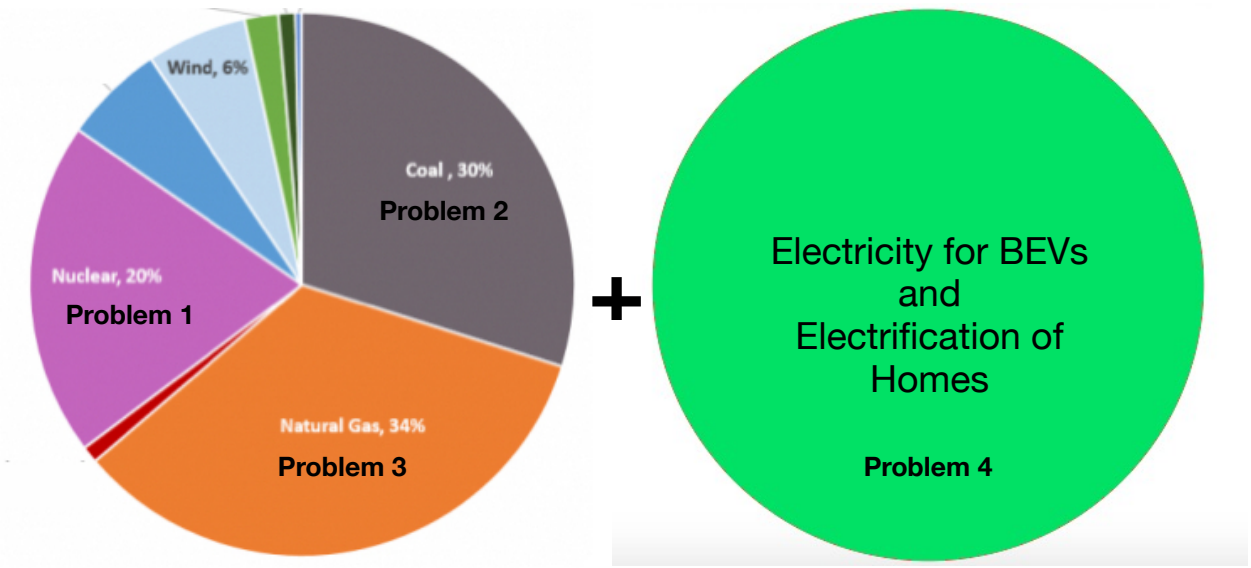
The sources of electricity in the United States is as shown in this graphic from the EPA[1].

Total generation in 2020 was 4,009 billion kWh[2]



How much electricity is needed to meet these goals?

The 2021, *Electrification Futures Study*[3], by the national renewable energy laboratory (NREL), has established that accomplishing goals 3 and 5, as proposed by the administration, will require doubling the power generation capacity of the United States.



Where will the electricity come from in 2050, to meet the doubling of America's usage of electricity?

Problem # 1: Nuclear Power

As things stand today, there will only be 6 nuclear power plants in operation in 2050, assuming that the two units under construction in Georgia are completed. **But, 4 of these 6 would be closed by 2054**[4]**.**

As things stand today, it will be necessary to replace over 90% of all existing nuclear power plants by 2050, **or renew the operating licenses of 86 nuclear power plants for 20 years. In other words:**

- Replace 86 existing nuclear power plants with some other type of generation, OR
- Renew the operating licenses of 86 existing nuclear power plants by 2050.

Here are the facts.

In 2012 there were 104 nuclear power plants in operation.

Since then, 10 plants have been closed.

Another 8 plants are scheduled to close by 2025, leaving only 86 nuclear power plants in operation.

There is every reason to believe more nuclear power plants will be closed beyond the 8 that have already been announced.

The plants that have been closed are being closed for political reasons or because the rigged auctions being used by the RTO/ISOs are making nuclear plants uneconomic.

These closures are in spite of the fact that existing nuclear power plants generate electricity that is far less costly than that produced by wind or solar, and that they provide baseload power by producing electricity 24/7, 365 days per year.

The closure of eighteen fully operational, safe and reliable power plants is tragic, and a huge cost to all Americans.

Two steps are necessary for these 86 plants to receive their second renewal. The plant owner must request the renewal, and then the Nuclear Regulatory Commission (NRC) must approve the renewal.[5]

As of this writing, 4 plants have already received their second renewal, and the owners of 11 other plants have either submitted their application to the NRC or have said they intend to ask for the second renewal.

This leaves 71 plants where the owners have not yet indicated whether they will request the NRC to grant a second renewal.

The only conclusion that can be reached relative to nuclear power is: (1) nuclear will supply less electricity in 2050 than it does today, and (2) nuclear will not be able to provide any of the additional electricity required to meet the administration's climate goals, which, in turn, according to the NREL study, require a doubling of electricity generation.

Where will the additional electricity come from?

Possibly from new nuclear power designs, such as small modular reactors.

However, these new designs have three hurdles to overcome. The first is to get NRC approval. The second is to be able to build these plants at a cost that is much lower than $6,000 per KW. And, of course, thirdly, to overcome the environmentalists who oppose nuclear power.

Since it is unknown whether the NRC will approve additional license renewals, or whether new nuclear designs can be built by 2050, this report assume that electricity output from nuclear power will remain as it is today, but that nuclear power will not contribute to providing the additional electricity needed in 2050 and beyond.

It's important to recognize that this may be overly optimistic as we reach conclusions concerning the required capacity additions in 2050.

Since nuclear is unlikely to play a role in providing the electricity needed to meet our nation's additional needs, it's necessary to first establish how many wind turbines must be installed to eliminate CO2 emissions from existing coal-fired and natural gas power plants, and then to determine how much PV solar must be installed to double the supply of electricity by 2050.

The approach of isolating wind and PV solar to specific problem areas will be explained later.

Problem # 2: Closing coal-fired power plants

Coal-fired power plants currently supply approximately 30% of our electricity.[6]

US total electricity usage was 4,009 billion kWh in 2020, of which coal was 774 billion kWh, or 19%.[7]

It will require 32,725 off-shore wind turbines, rated 6 MW each, with a capacity factor of 45%, to replace the lost generation from closed coal-fired power plants.

Off-shore wind turbines of this size require 3,150 feet between turbines (seven rotor lengths). There is a total of 9,659 miles of shoreline along the continental United States, so the off-shore wind turbines would be stacked two deep in the oceans and Great Lakes around the United States.

These 32,725 wind turbines will cost $1.2 trillion at $6,000 per KW. ($6,000 is the average of the costs projected by the EIA[8] and IER[9] for offshore wind turbines.)

While GE is testing a 12 MW offshore wind turbine, details as to cost and capacity factor have not yet been confirmed. Such a unit could reduce the number of offshore wind turbines by more than half, but may not reduce costs.

Problem 3: Eliminating natural gas combined cycle power plants.

Natural gas power plants generated 1, 617 billion kWh in 2020.[10]

It would require 176,000 on-shore wind turbines, rated 3 MW, with a capacity factor of 35%, and an area of at least 52,000 square miles, to replace all natural gas combined cycle (NGCC) power plants.

The cost of building these wind installations, at $1,300 per KW, is $686 billion.

Virtually the entire available area in Montana and Wyoming, where the best winds are located, would be required to replace the NGCC power plants with wind turbines.

Problem 4: Doubling electricity generation by 2050

US total electricity usage was 4,009 billion kWh in 2020. This is the amount of additional electricity that will be needed, according to NREL's, *Electrification Futures Study,*[11] to implement the administration's climate proposal.

Solar hasn't been addressed in discussing problems 1, 2, and 3, primarily because it only provides electricity during the daytime and automatically raises the issue of storage.

It would require 22,000 square miles, (3.5 square miles per GWh from NREL[12]) to install sufficient PV solar panels to generate the required 4,009 billion kWh.

Area is not an issue. There is sufficient land area in the Southwestern United States to easily accommodate 22,000 square miles of PV solar.

While PV solar installations in the Southwest could use federal land, it would require huge investments in transcontinental transmission lines to distribute the power.

The 22,000 square miles of PV solar power could be spread around multiple states, though this has some drawbacks, e.g., cost of private land, lower insolation levels, and increased effects from bad weather.

The initial cost of 22,000 square miles of PV solar panels would be $4.9 trillion assuming a cost of $1.10 per watt.[13] (Current costs are approximately $1.40 per watt.[14])

Storage is an important issue. It can affect both wind and PV solar.

Sufficient storage must be provided to supply electricity for at least twelve days, otherwise there will come a time when the nation, or large regions of the nation, would experience blackouts. For example, former Secretary of Energy, Moniz said, Texas had, in the past, experienced nine consecutive days where winds were unavailable.[15] ISO-NE reported a period of twelve days where insignificant amounts of PV solar were generated.[16]

It's obvious that solar requires storage when the sun sets if we are to rely on solar to provide reliable electricity without fossil fuels.

According to former Secretary of Energy, Moniz, "batteries will never be the solution" for long term storage.[17]

At this writing, there is no known battery that can store large quantities of electricity for several days.

It is, therefore, not possible, at this time, to meet the administration's climate goal.

Problem 5: Unaddressed Issues

Transmission lines:

An important area that has not been addressed, is the need for new transmission and distribution lines.

These costs are not trivial. (See, *Battery Powered Vehicles: Their effect on the electric grid,* March 2021.)

- A minimum of $135 billion is required to install transformers of greater capacity in the distribution system.

NREL estimates that the size of the transmission system will have to be increased by 50% to 75%. The current transmission system is 120,000 miles long. At $5 million per mile, (500KV, double circuit, MISO, cost estimating guide[18]) the cost for increasing the transmission system by 50% would be $300 billion.

The most difficult problem, with respect to building new transmission lines, is obtaining the necessary permits and authorizations from multiple political jurisdictions with opposition from both Nimby's and environmental groups.

It will require massive use of takings, using eminent domain, where constitutional issues will have to be addressed.

Negative Carbon Strateggies:

The administration's goal includes the term "net zero" which infers removal of CO2 from the atmosphere.

This is actually a distraction because it is a hypothetical that lacks substance or validation.

Theoretically, there are five ways to effect removal of CO2 from the atmosphere, or for preventing it to reach the atmosphere.

- Capturing CO2 from where it is produced, i.e., carbon capture
- Using CO2 in a process, such as in the making of steel
- Sequestering CO2 underground
- Sequestering CO2 in plant growth
- Geo-engineering, such as fertilizing the oceans to increase plankton growth to absorb CO2 from the atmosphere

These concepts are either unproven, or have serious limitations or drawbacks.

The concept is a distraction because the breadth of the proposal is unlimited and leads to conjecture rather than facts.

A few examples are cited here to provide some context to the issue.

Capturing CO2 from NGCC power plants will result in a derating of the plant by around 30%, requiring the building of additional generating capacity to replace the power lost in capturing, compressing and transporting the liquid CO2 to where it can be sequestered underground.

There can be no assurance that CO2 sequestered underground will remain there for thousands of years. Only two, Class VI wells have been approved for sequestering CO2 underground in the United States, primarily because of the risks involved.

Quoting the Competitive Enterprise Institute[19],

> "The EPA bases the regulation of CO2 injection as a separate class of wells on several unique risk factors:
>
> - the large volumes of CO2 expected to be injected through wells;
> - the relative buoyancy of CO2 in underground geologic formations;
> - the mobility of CO2 within subsurface formations;
> - the corrosive properties of CO2 in the presence of water that can effect well materials; and
> - the potential presence of impurities in the injected CO2 stream."

As for sequestering CO2 in plants, such as trees, there is the question of what happens when the trees or plants are cut down? Or die? Can sequestration, such as planting trees in Mongolia or the Amazon, be honestly certified? For how long? And by whom?

The issues surrounding negative carbon strategies are never ending, which is why it is a distraction rather than a serious component of any proposal.

Summary

The purpose of this report is not to prove it is impossible to replace fossil fuels. Obviously, there is ample area in the United States, and the rest of the world, to install required quantities of wind and PV solar.

Rather, this report demonstrate the absurdity of trying.

Pernicious penalty of wind and PV solar

Wind and PV solar power plants have an expected life of 20 years, which means that wind and PV solar installations built prior to 2021, and in the 2020 decade, will have to be replaced before 2050.

This is the pernicious penalty of wind and PV solar. Wind and PV solar installations need to be replaced every 20 years.

Meanwhile:

- Nuclear power plants are lasting for at least 60 years.
- NGCC power plants last for at least 60 years.
- Coal-fired power plants can also last for at least 60 years.

Explorations are underway to see whether nuclear power plants can last for 100 years.

Wind

The amount of wind capacity that needs to be added between now and 2050, to replace coal-fired and natural gas combined cycle (NGCC) power plants is 723,744 MW.

Table 1 shows the amount of wind capacity that will have to be added by 2050, including replacements.

TABLE 1 - TOTAL WIND ADDED BETWEEN 2020 and 2050		
723,744	MW	Wind added between 2020 and 2050 to eliminate coal-fired and NGCC power plants
30	years	Number years from 2020 to 2050
24,125	MW/yr	MW needed to be added annually between 2020 and 2050 before replacements
10	years	number of years 2020 to 2029
241,248	MW	MW added during 2020 decade that must be replaced during 2040 decade
140,447	MW	MW to replace wind built during 2000 - 2009 and between 2010 and 2019
1,105,439	MW	Total MW wind that must be added between 2020 and 2050
36,848	MW	MW needed to be added annually between 2020 and 2050

The most wind capacity added during any single year in the United States was 16,913 MW in 2020.

To replace coal-fired and NGCC power plants, we must, beginning this year, and for every year until 2050, add more than twice as much wind capacity than has ever been added in a single year.

Much of this wind capacity will have to be imported.

As of 2019, the reported total wind turbine manufacturing capacity in the United States was 9,136 MW.[20] GE was the largest, with a capacity of 4,146 MW. However, GE's largest new unit, the 12 MW Haliade is currently manufactured in France.

PV Solar

The expected life of PV solar installations is also 20 years.

PV solar is subject to the same pernicious economic penalty as wind, with installations having to be replaced every 20 years.

Here is the current relevant data concerning PV solar.

- Total PV solar installed as of 2020 = 97,700 MW[21]
- PV solar installed in 2020 (largest annual amount on record) = 19,200 MW[22]
- Total USA kWh generated in 2020 by all methods = 4,009 billion kWh[23]
- Total electricity generated by PV solar in 2020 = 88 billion kWh[24]

To accommodate a doubling of electricity output in 2050, as projected by NREL:

- PV solar in 2050 must generate 46 times more electricity than in 2020.

This will require an installed PV solar capacity of 4,450,901 MW.

It will require installing 148,363 MW of PV solar every year between now and 2050, which is 7.7 times the amount installed in 2020.

Actually, it will require more because all PV solar installed between 2020 and 2029, will have to be replaced in the 2040 decade.

A majority of the PV solar panels will probably be from China.[25]

For a different perspective, it would take 232 years to install the required amount of PV solar based on the amount installed in 2020.

(While some of this capacity could be provided by on-shore wind turbines in areas not already used for wind installations, it merely shifts the problem from PV solar to wind, where wind has the same inability to construct the necessary additional capacity.)

Costs

(As determined previously in above sections on wind and PV solar, including replacements.)

The cost of adding wind capacity to replace coal and natural gas plants = $2.6 trillion.

The cost of adding PV solar capacity for the needed additional capacity in 2050 = $4.9 trillion.

The cost of required storage is unknown, but will likely be trillions of dollars.

Conclusions

There may be enough area in the united States to install sufficient quantities of wind and solar to replace fossil fuels, but only if battery storage technologies can be developed that are capable of storing large quantities of electricity for twelve or more days.

It is, however, absurd to attempt to replace fossil fuels with wind and PV solar by 2050.

The quantities of wind and PV solar that must be installed between now and 2050 are enormous, requiring far greater installation capacities than we have yet demonstrated to be possible.

The pernicious nature of wind and solar, of having to be replaced every twenty years, results in a never ending cycle of installing, and replacing of wind and PV solar facilities.

The costs are also unbelievably huge, and amount to roughly $7.5 trillion, which is over 25% of the nation's debt in 2020. **And, because of the pernicious nature of wind and solar, this investment would be repeated every twenty years after 2050.**

Bear in mind that these Herculean efforts don't address other important sources of CO2 emissions, such as the making of steel and cement, so these are not the full costs.

Attempting to replace fossil fuels with wind and PV solar is irrational, and a grotesque nightmare for the people of America.

Notes

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Author

Donn Dears is a retired GE Company engineer and senior executive who worked for Jack Welch.

Donn began his career at General Electric testing large steam turbines and generators used by utilities to generate electricity; followed, by manufacturing and marketing assignments at the Transformer Division. Later he led an organization servicing these and other GE products in the United States. He then established GE subsidiaries in nine countries, and was responsible for service operations around the world, servicing power generation, transmission and other electric equipment. Donn was involved with the work done at customer locations; steel mills, electric utilities, refineries, oil drilling and production facilities and open pit and underground mining operations. At every opportunity he learned of the needs of these industries.

Donn was involved in Saudi Arabia, including activities in the eastern province with its oil producing and shipping facilities. He has investigated many of the other oil producing countries in the Mideast and Northern Europe, as well as examining iron-ore mining locations and major shipping centers in Europe and Asia.

All told, Donn has visited over 60 countries and has knowledge of their need for the technologies that can improve their well being and their use of equipment manufactured in the United States.

Following his retirement he continued to study and write about energy issues. Before retiring as president of TSAugust, a 501 (C) 3 think tank comprised entirely of volunteers, he wrote for www.tsaugust.org. He currently writes for Power For USA.

He has written several books as well as various papers and articles. He also speaks about energy issues at professional meetings, at conferences, and on cruise ships.

Donn has been active in the community, serving two terms on the board of the Reston Association, one of the largest such association with over 60,000 residents.

Donn is a graduate of the U.S. Merchant Marine Academy and served on active duty in the U.S. Navy during the Korean War.