

# The Impossible Dream: Using batteries to store electricity from wind and solar sources

(material heavily borrowed from Bernie McCune and Mark Mills)



Bob Endlich

[bendlich@msn.com](mailto:bendlich@msn.com)

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COMMENTARY

# Inconvenient Energy Realities

Mark P. Mills

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*The math behind “The New Energy Economy: An Exercise in Magical Thinking”*

A week doesn't pass without a mayor, governor, policymaker or pundit joining the rush to demand, or predict, an energy future that is entirely based on wind/solar and batteries, freed from the “burden” of the hydrocarbons that have fueled societies for centuries. Regardless of one's opinion about whether, or why, an energy



REPORT

# The "New Energy Economy": An Exercise in Magical Thinking

Mark P. Mills

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## EXECUTIVE SUMMARY

A movement has been growing for decades to replace hydrocarbons, which collectively supply 84% of the world's energy. It began with the fear that we were running out of oil. That fear has since migrated to the belief that, because of climate change and other environmental concerns, society can no longer tolerate burning oil, natural gas, and coal—all of which have turned out to be abundant.



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## Not Possible in the foreseeable future:

- Scientists discover and entrepreneurs invent anything as remarkable as hydrocarbons in terms of low-cost, high energy density, safety and portability
- to see 10-fold gains in photovoltaic cells due to the Shockley-Queisser Limit
- to see 10-fold gains in wind power technology due to the Betz Limit
- **to find ways for batteries to power the grid for more than a few hours and have power densities coming anywhere near hydrocarbons**

# The Two Flaws

- Realities of physics don't allow energy systems to undergo revolutionary change seen in the digital domains
- No fundamentally new energy technology has been discovered or invented in nearly a century
  - nothing like the transistor or the internet

# Today's Reality

- Oil, natural gas and coal supply 84% of global energy while 2 decades ago these fossil fuels supplied 87%
- Over those 2 decades total world energy use rose by 50% (an amount equal to adding two entire US's worth of demand)
- The 3% drop in fossil fuel use, required over \$2 trillion in cumulative global spending on alternatives over that period
- Fossil fuels supply 93 billion-barrel equivalent for the world; **for the alternates to replace and supply growing energy needs requires alternates to increase 90-fold from today**

# The Fantasy of Gearing Up in the US

- It took 50 years for global oil and gas production to expand by 10-fold
- Cost aside, it is just a dream that a new form of energy infrastructure could now expand *nine times in half that time* (much less in the next ten years as some politicians propose)
- **For electricity and the grid to support, it would require an industrial effort greater than a World War II level of mobilization for the former and grid construction 14-fold bigger than the grid build-out rate that's taken place during the past 50 years for the latter**



# The Physics-Driven Cost for Alternate Energy

- The technologies and hardware involve windmills, solar panels and batteries - with batteries being key due to the intermittent nature of the alternates
- Windmills and solar power are actually 50-year old technology with most of the innovations and increases in efficiencies in the past
- Lithium battery technology is also 50 years old
- We still expect that these technologies will continue to get better within limits

# Low vs. High costs

- It costs less than \$1 a barrel to store oil or a natural gas equivalent for a couple of months and, coal is even cheaper
- US on average has about one to two months' worth of national demand in storage for each kind of fossil fuel at any given time
- **With batteries, it costs roughly \$200 to store the energy equivalent to one barrel of oil, which leads to the fact that only two hours of national electric demand is found (and not readily available) in grid scale batteries plus all the batteries in the 1 million US electric cars**

# Wind/Solar Grid Sizes

- Alternate grids would need to be sized to meet peak demand and have enough extra capacity to store enough extra capacity in battery banks for when the wind does not blow, and the sun does not shine
- This would require that a pure wind/solar system would have to have 3 times the capacity of a hydrocarbon grid
- **Even this significant capacity would not be sufficient since meteorological and operating data indicate that output can drop as much as two-fold during their respective “low” seasons**

# Issues of increased scale of Alternate power production

- South Australia, with 40% of their power produced by wind turbines, has had a couple of episodic events where the wind died unexpectedly with complete blackouts lasting for days in some areas
- **After a total outage in South Australia in 2018, Tesla built the largest lithium battery “farm” on their grid that serves just 2.5 million people**
- **However, to keep South Australia lit for 1/2 a day without any wind, requires 80 of these, the world’s biggest battery systems**

# Reliability in the Alternate Grid

- In a few words, the answer to reliability problem is to use old-fashioned giant diesel-engine generators as backup (actually running on natural gas)
- These are the same engines used in modern cruise ships. In the US without much fanfare the utilities are installing these units at a furious pace (presently over \$4 billion worth of generators enough to for about 100 ships)
- This hidden cost, paid by electric rate payers, is like US auto drivers paying for highway wear and tear by trucks while subsidizing the fuel costs of those trucks
- On a national scale Alternate power generation is impractical and not cost effective, much like the helicopter, useful for special cases but not for flying the Atlantic

# Batteries Cannot Save the Grid or the Planet

- At this point in the Alternate technology development curve, batteries are key to optimum functioning of the system
- Storage that is equivalent to oil in a barrel or even natural gas in a pipe or LNG form is, for now, very far over the horizon
- **Batteries are a 200-fold more costly method of storage**
- **Equivalence of one barrel of oil (300 pounds) requires 20,000 pounds of batteries**
- And yet, American and European policy makers continue to embrace programs and subsidies to expand battery use

# Short List of more Battery Issues

- Tesla's \$5 billion "Gigafactory" in Nevada is currently the world's biggest battery manufacturing facility
- **It's total annual production could store 3 minutes' worth of US electricity demand**
- **Two days of storage for the US would require 1000 years of Gigafactory production**
- **Wind/Solar advocates minimize battery usage** by saying that there are always windy or sunny days somewhere
- The huge transmission line length and cost as well as security challenges for parts of that line make this idea a huge challenge (transport by wire is 2X as expensive as by pipe)

# Batteries and Mining

- Alternates are supposed to be environmentally friendly
- **Truth is that 50-100 pounds of various materials are mined, moved and processed for one pound of battery**
- Lots of minerals including lithium, copper, nickel, graphite, rare earths and cobalt must be extracted to build batteries for grids and cars
- **That's gigatons of material for batteries but also for wind turbines and many acres of solar arrays**
- This all-alternate global power idea would expand mining of copper by 200% and 500% for lithium, graphite and rare earths and much more for cobalt



# Energy Revolutions are still beyond the Horizon

- Most of the present energy systems will get us into the future in a fairly graceful way
- And in a way if “it ain’t broken” why are we trying so hard to fix it?
- There might be new ways to deal with consumption and usage patterns that will spread the benefits of electricity and autos without running the cost up or harm people or the environment
- **This should come from basic research not developmental research which is what most of energy research is these days**

# Google's RE<C

- Bob discussed this idea of Renewable Energy < Coal recently
- About 10 years ago Google engineers worked on this until about 2014 when it was canceled
- The lead engineers on the project wrote: “Incremental improvements to existing [energy] technologies aren’t enough; we need something truly disruptive. . . .We don’t have the answers”.
- Mills’ comment: “Those engineers rediscovered the kinds of physics and scale realities highlighted in this paper”.
- That’s a pretty good conclusion. No need for anything further

# Subsidies

Subsidies have given us the situation where we have ethanol required to be included in refined gasoline even though we no longer need worry about running out of crude oil supplies.

We now produce too much ethanol, because fuel mileage increased dramatically. One “solution” is to increase required amount of ethanol in gasoline to 15% (its now 10%) making gas mileage worse and converting food for humans into auto fuel. This is parasitic of fossil fuels, because it requires fossil fuels to produce the ethanol.

Subsidies have resulted in the proliferation of wind and solar as alternative energy sources when construction of highly dispatchable electricity from nuclear power would have solved the non-problem of Carbon Dioxide emissions from electricity production.