CONSTRAINING RENEWABLES IS A NATIONAL NEED

BY DAVID WOJICK

CFACT

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EXECUTIVE SUMMARY

Renewables cannot be made reliable with storage so their penetration must be constrained and managed. The North American Reliability Corporation (NERC) must develop Reliability Standards to ensure that the reckless growth of renewables does not destabilize the grid.

Grid scale storage at the scale needed to replace fossil fuels with wind and solar is impossibly expensive. Even assuming fantastic price reductions, analysis shows the cost of the required battery storage still nearly equals the $23 trillion annual American GDP. The likely cost would be many times GDP. Clearly this is economically impossible. Despite this impossibility, present government policies and utility practices are driving toward massive grid penetration by renewables. This reckless drive must be properly constrained and managed, in order to protect reliability. American grid reliability must be maintained.

National grid reliability is the responsibility of NERC, under the direction of the Federal Energy Regulatory Commission (FERC). NERC develops and maintains Reliability Standards, which are approved by FERC. In order to constrain the reckless growth of renewables, NERC must now develop Standards that govern their penetration of the grid.

We now know that the battery storage for the entire American grid is impossibly expensive, thanks to a breakthrough study by engineer Ken Gregory. Looking at several recent years he analyzed, on an hour-by-hour basis, the electricity

produced with fossil fuels. He then calculated what it would have taken in the way of storage to produce the same energy using wind and solar power. He did this by scaling up those years' actual wind and solar production.

Based on his work, which only covered 48 states, our working estimate of the required storage is an amazing 250 million MWh. America today has less than 20 thousand MWh of grid scale battery storage, which is next to nothing. Grid scale batteries today cost around $700,000 a MWh. For 250 million MWh we get an astronomical total cost of $175 trillion dollars just to replace today's fossil fuel generated electricity needs with wind and solar. Even the fantastically low-cost estimates that some people are proposing puts the cost around the total GDP of America. Even worse, if we get the electric cars the Biden Administration is calling for, these astronomical numbers could easily double.

None of this impossibility is being considered in today's reliability assessments. Not by the States, the utilities, NERC, or FERC. Instead, throughout the country fossil fuel power plants are being replaced by wind and solar, without the required storage. The reason is obvious, namely the necessary storage is impossibly expensive.

As a result, America's grid is steadily becoming more and more unreliable. The grid is sick and getting sicker. The obvious solution is for NERC to issue Reliability Standards to constrain the growth of renewables. So far NERC has simply ignored this progressive loss of reliability. NERC needs to be redirected, either by FERC or Congress. In fact, FERC is developing an order to NERC on the topic of renewables and reliability. But that order does not address the storage issue at all. It only looks at things like momentary loss of power.

Congress and FERC must act to restore America's grid reliability.

SECTION 1: BATTERY BASED RELIABILITY IS IMPOSSIBLY EXPENSIVE

A. THE BREAKTHROUGH GREGORY HOUR BY HOUR STORAGE STUDY

We now have a powerful new analysis of the long-term storage requirements for making solar and wind reliable. As expected the numbers are enormous. They are also precise.

The study is "The Cost of Net Zero Electrification of the U.S.A." by engineer Ken Gregory.

As the title says, Gregory's study focuses on net zero electrification, which is not my focus here. His very first step is to analyze what storage would be required to simply meet today's electric power needs using solar and wind instead of fossil fuels. This simple analysis is a big breakthrough.

The scale is one year of solar and wind replacing American fossil fueled generation in the lower 48 states. The approach is elegant in its powerful simplicity. Here is how it works.

Fossil fuels power roughly a conveniently round 3 billion MWh a year. Gregory starts with the hour by hour solar and wind generation for 2019 and 2020. Hourly total generation captures the continual intermittency at the hourly scale. There is a lot of generation up and down at that scale. Wind and daytime clouds both come and go a lot.

This is a huge advance over the typical one-year analysis, which uses annual averages. It also goes way beyond the kind of short-term storage study that I and others have done. In fact, it turns out that seasonal storage is the big driver.

The key step is that Gregory scales up each of the two sample years' hourly generation profiles to generate as much power as fossil fuels did that year. He uses a simple multiplier to do this. Each year is a bit different, but the multiplier is about seven. That is, fossil fuels generated about seven times as much juice as solar and wind, so we up the solar and wind profile that much, as though it were doing the job. Non-fossil sources like hydro and nuclear are left as is.

He then compares the scaled up solar and wind generation with the hour-by-hour usage of electricity (technically called demand, as though we could demand electricity). Gregory analyzes the hour by hour solar and wind generation, versus the usage, to see how much storage is required to make solar and wind work. He does not count up storage that is replenished, then used again, rather he is just looking for the maximum required capacity. (These two different things -- amount stored and storage capacity -- are often confused because both are measured in MWh.)

How storage is computed -- the basic math.

There are three variables - D, G, and S.

There are two independent oscillators -- hourly demand (D) and hourly S+W generation (G). Each goes up and down independent of the other.

Total energy storage at each hour (S) is then dependent on D and G, as follows.

If G is greater than D for a given hour then S is increased by the difference. If G is less than D then S is decreased by that difference. If G equals D then S is unchanged. Thus S will also be an oscillator.

Total G for the year is set to equal total D. Thus S is zero at the year's beginning and end (or equal to some preset initial value to allow for D to exceed G in the beginning).

There are two cases - 2019 and 2020. In each case hourly D is the demand met during the year using fossil fuel generation. Hourly S+W generation for that year is then scaled up to create G, such that total G = total D.

The central question is what is the maximum value of S during the year? (Or the maximum increase over the initial nonzero value, if there is one?) There are many other interesting questions. For example what the variation of S over the year looks like, how much energy passes through S, etc.

B. OUR WORKING ESTIMATE: REQUIRED STORAGE IS AN AMAZING 250 MILLION MWH

The two sample years are slightly different, but in round numbers Gregory finds that something like an enormous 230 million MWh of storage are required for this case. The reality is likely to be higher for reasons explained below, also somewhat uncertain, so we round this up to an even 250 million MWh for purposes of analysis. This is our working estimate.

Mind you this is just an eighth or 12.5% of the total amount of electricity needed from solar and wind, so relatively speaking it is not a lot. The storage cost, however, is astronomical because it is still a huge amount of juice. Americans use an enormous amount of electricity.

Note that these two sample years are not the worst case for which we need to plan. With solar and wind, low generation is as dangerous as peak demand, if not more so. Many prior years should be analyzed to establish the lowest solar and wind planning case. Different mixes of solar and wind should also be considered. This all needs to be done at least regionally, more likely on a State by State or Utility basis.

This is just the sort of reliability analysis the utilities should be doing, especially before shutting down thermal generation like coal, gas, and nuclear power. NERC should have a Reliability Standard requiring this kind of analysis, including reasonably likely lowest solar and wind scenarios. FERC should order them to create and enforce such a standard, as quickly as possible. We must restore reliability to America's grid -- with thermal energy, not storage.

The only technologically feasible way to make renewables reliable in the foreseeable future is with massive amounts of grid scale batteries. Whether this is even remotely possible depends on the cost -- and here things get truly strange.

C. ESTIMATING THE IMPOSSIBLE COST OF BATTERY STORAGE

On the one hand we have real utility reports of the capital cost of these big battery arrays --battery systems that have actually been built. On the other hand we have projected capital costs, which are being used to defend the growth of unreliable renewables.

The real costs and the projected costs are wildly different. So different that the projected costs have the aspect of fantasy.

Let's start with the reality. The EIA has collected annual utility data on the cost of grid scale battery arrays. A recent report is "Battery Storage in the United States: An Update on Market Trends -- August 2021."

From 2013 to 2018 the average reported cost was around $1,500,000 per MWh. The range was pretty large, from under $500,000 to around $3,000,000 per MWh.

It is worth noting that in 2020 EIA excitedly reported a big drop in cost. This was from an average of $2,100,000 in 2015 way down to a low of $600,000 in 2019. I am rather skeptical that this 70% cost drop was real. There was no technological breakthrough to cause it. I suspect it was either a case of price cutting or of utilities manipulating their cost reports. Tesla has been bidding very low, at around $500,000 for some time. These are likely loss leader bids.

It is certainly the case that the cost must be going way up these days, not down, given the huge price spike in lithium and other essential constituent materials, as well as in the energy needed for making these monster battery arrays.

So it seems fair to say that the cost is at least $600,000 a MWh, quite possibly a lot more. A million dollars a MWh is not an unreasonable estimate. Keep in mind that a MWh is what an average American home uses in just a month, so it is not a lot of juice storage for a lot of money.

Now comes the fantasy. There are several recent mainstream estimates of the future capital cost of grid scale battery arrays. These estimates are often used in assessments of the economic feasibility of a transition from coal and gas fired generation to wind and solar. The battery cost estimates are crucial because it will take an enormous amount of batteries to try to make intermittent wind and solar reliable.

For example, DOE's National Renewable Energy Laboratory has published battery cost projections through 2050 in their report "Cost Projections for Utility Scale Battery Storage: 2021 Update." NREL is gung ho on renewables, so also on the batteries needed to try to make wind and solar reliable.

Each NREL projection is for a narrow range of costs. The low end of that range is a mere $143,000 per MWh in 2030 and $87,000 in 2050. That’s right -- just $87,000 for something that today costs $600,000 to $1,000,000, with costs going up.

Clearly this projection is extremely rosy, to the point of fantasy.

In a recent report -- "The Future of Energy Storage" -- MIT goes even lower. Their 2050 battery cost estimate is a tiny $70,000 per MWh -- for something that costs upwards of a million dollars today! Surely this is pure fantasy.

Mind you, given the Biden goal of zero electric power emissions by 2035, the 2050 fantasy figure may be irrelevant since what counts is the cost between now and 2035. But even NREL's 2030 estimate of $143,000 is unbelievable. Given the way prices are rising, $1,000,000 is a better bet. Plus Biden's goal is itself pure fantasy.

In short, energy policy needs to be based on sound engineering estimates, not wishful fantasies. But in this case even the fantastically low unit costs yield impossibly high total costs. This shows how truly impossible the renewables plus storage policy really is.

Listed below are the total storage costs for our 250,000,000 MWh, for each of the possible unit costs discussed above.

$1,500,000 per MWh = $375 trillion

$1,000,000 = $250 trillion

$600,000 = $150 trillion

Gregory's $347,000 = $87 trillion

NREL $143,000 = $36 trillion

NREL $87,000 = $22 trillion

MIT $70,000 = $18 trillion

US annual GDP is about $23 trillion, so even the fantastically low MIT number gives a storage cost roughly equal to that enormous number. More reasonable costs quickly get into the hundred trillion dollar range or more.

Clearly these astronomical cost figures show that storage is simply impossible.

SECTION 2: FACTORS THAT MAKE OUR COST ESTIMATES VERY LOW

Gregory's analysis is relatively simple, so there are several factors that could greatly increase our cost estimates. Let us briefly consider a few.

A. TRANSMISSION COST

The huge amount of storage required to make renewables reliable would likely require its own transmission system. This is a major design issue that I have yet to see addressed.

By their nature, utility scale renewables have to be put in low population density places. Offshore wind is the extreme case. But load is mostly concentrated in high density places, so the two by their very nature must be far apart.

This much is well known but where to put huge amounts of storage in this highly distributed system is far from clear. Putting huge numbers of small storage facilities at every renewable generation site is inefficient and might well be uncontrollable. But putting huge facilities near load centers might be highly redundant, hence also inefficient. Perhaps a storage hub and spoke transmission system is best?

The point is that the massive storage required might well add significant transmission cost. The scale of this design is also unclear. It well might have to be at the multi-state or regional level. If so then it is an issue for FERC and NERC.

B. DROUGHT OF GENERATION

Gregory just uses the generation profiles of two recent years. It is extremely unlikely that these are the worst-case scenarios necessary to properly design the grid scale storage system. Wind and solar droughts will give much lower generation.

Just as we design generation for peak demand, storage must be designed for peak drought.

This clearly requires regional analysis, maybe even local scale.

In fact, the local nature of wind and solar generation makes Gregory's huge estimate very low. He found the storage required to balance national generation with national load. These national averages mask the extreme regional and local variability that calls for a lot more storage.

Here is a simple example. One hour's storage need may be due to wind and solar drought in Iowa, while Virginia has lots of power. Another hour's need, of the same size, might be due to drought in Virginia with good power in Iowa. The sum of these two storage requirements, one in Iowa and the other in Virginia, will be much greater than the single requirement derived twice from the national averages.

In effect Gregory's analysis assumes that all storage serves the whole country, which is far from true. This is not a criticism of Gregory. The point is that his method has to be applied at the scale at which storage serves load. This probably means that every State and NERC region has to do it, perhaps even every utility.

C. COST OF BATTERIES

We earlier noted the fantastic cost reductions being predicted for grid scale batteries. The reality is that the cost could as easily go up as down. It is basically mass production versus scarce materials.

There is already a large literature on the enormous demand on metals and minerals that a switch to EVs would create. In some cases the quantities required for the batteries greatly exceed total present production.

What has not been factored in is the huge amount of grid scale batteries that would be needed at the same time, in order to make renewables reliable. In fact, the material requirements for these grid batteries may well exceed what is needed for EVs. So if the EV requirements are impossible, the grid needs are doubly so.

Clearly the rush to quickly transition to EVs powered by renewables has the potential to create a seller's market for batteries and their materials. In that case we would see the cost of batteries rise sharply, not fall. Given the long time it takes to find and open mines, then build the needed transportation and processing infrastructure, often in remote locations, this seller's market could last a very long time.

D. BATTERY EFFICIENCY

Gregory uses 80% but something like 60% may be more likely. It is standard practice in many cases to only drain batteries to 20% of capacity and only charge them to 80%. In that case the usable storage is only 60% of nameplate capacity. In this 60% case, Gregory's huge estimate needs to be increased significantly.

Or the efficiency might be a complex combination of values, depending on how long the storage was for. Many MWh would be for overnight while others are seasonal. A significant fraction would be for rare low supply, only being used in a decade or more. Or if this sort of very long storage is not feasible, some sort of rotation might be set up. All of these complex factors tend to increase the total storage capacity required for reliability. This is a design feature with which NERC should be heavily involved.

E. OVERBUILDING GENERATION

Overbuilding means building more renewable capacity than needed to just meet consumption. It does reduce the huge battery requirements, but with rapidly diminishing effect. Overbuilding does not make the sun shine at night or the wind blow stronger. It only helps with moderately cloudy days and moderately windy conditions. For example, two wind turbines generating half power equals one at full power.

Gregory calculates that for his 2019 and 2020 cases the maximum benefit to huge overbuilding reduces his 250 million MWh of batteries to 185 million. The battery cost is still economically impossible, especially as Gregory's estimates might be very low, as discussed here.

So there is no way to avoid an enormous battery cost. Moreover, significant overbuilding greatly reduces the capacity factors of the generators, as a lot is seldom needed. This in turn increases the cost of the electricity produced.

F. ELECTRIFICATION

Electrification means replacing the myriad uses of fossil fuels, other than to generate electricity, with methods that use electricity. One prominent case that has been widely analyzed is transportation, especially electric cars and trucks, or EVs. Another is replacing gas fired heat with electric heat.

The power presently consumed for each of these two cases is on the same scale as today's electric power generation. Thus the electricity needed might be several times what is produced today. Obviously this vastly increases the amount of storage required to make a solar and wind system reliable.

Electrification also potentially changes the load profile a lot, including increasing peak consumption compared to the average. Gas heat is a huge winter peaker, with relatively little needed in warmer weather. EV charging could shift daily peak to late night.

Note that solar power is not good for either change. There is less solar in winter and none at night. Depending on the mix of wind and solar these changes could significantly increase the need for storage.

Electrification is well underway.

We are already seeing the spread of major policies aimed at reducing the use of gas heat and pushing EVs. Utility projections of the need for more electricity are not keeping up so grid reliability is increasingly threatened. Typical projections of slow growth of 1% per year are clearly incompatible with rapid electrification.

Planning for reliable electrification needs to include constraining and managing renewables. Adding solar and wind cannot meet increasing need. NERC must take the lead here.

SECTION 3: NEW ENGLAND ISO STUDY SHOWS THE BIG GAP IN TODAY'S RELIABILITY ASSESSMENTS

A recent study by the New England Independent System Operator (ISO) shows what is being done on reliability analysis and what still needs to be done. The missing piece is hour by hour analysis.

Standard grid reliability modeling uses fixed hourly averages for wind and solar generation, which completely misses huge hourly intermittency. The resulting assessment gap yields storage estimates that are very low, compared to what hourly variability finds.

The NE ISO study is titled "2021 Economic Study: Future Grid Reliability Study Phase 1."

A summary story from Utility Dive is here.

The NE ISO describes the gap, but just in passing, saying this:

"Wind and solar have traditionally made up a small part of overall production, and thus a simplified modeling approach using fixed hourly averages was acceptable practice. As these power sources become predominant, modeling approaches must better reflect the variability of these resources to produce representative results." (Page 2)

They use fixed hourly averages, not hour by hour analysis. As Gregory discovered, this is a huge gap in the analysis. Estimating this gap confirms our conclusion that infeasible amounts of battery storage would be needed to make wind and solar reliable without major fossil fueled backup. (Note too that the NE ISO scenario includes overbuilding of wind and solar by 300%. As discussed above, overbuilding cannot make storage feasible.)

STORAGE GAP ANALYSIS

The NE ISO study, using fixed hourly generation, found that with significant electrification of transport and gas heating, plus no fossil fuel backup, New England would require about 2,300,000 MWh of storage. The ISO's region uses about 3% of total US consumption, so scaling this usage up gives around 77,000,000 MWh for the country as a whole.

This is already a huge number, but it is about a third lower than the 250,000,000 MWh that we find using Gregory's study on lower 48 US storage without electrification.

Thus, in this case hour by hour analysis gives a storage requirement that is at least three times higher than what fixed hourly analysis gives. Given the enormous potential power requirements of electrification, hour by hour analysis might give results 5 to 10 times what fixed hourly averages find. Thus, the gap in analysis is as much as an order of magnitude.

These New England ISO findings strongly confirm our conclusion that it is impossible to make wind and solar reliable using battery storage. Nor is any other presently existing storage technology even remotely feasible.

But hour by hour analysis is clearly essential for proper planning and control of grid penetration by wind and solar generation. Today's reliability assessments, using fixed hourly average wind and solar generation, are completely inadequate. We must close this gap.

SECTION 4: NERC MUST ISSUE RELIABILITY STANDARDS TO CONSTRAIN RENEWABLES

We must constrain and manage the penetration of renewables to maintain reliability. Given that battery costs are impossibly large, even assuming fantastic cost reductions, powering the grid with wind and solar is itself impossible. Reliability requires sufficient backup generation.

The legal responsibility for maintaining reliability is with FERC, assisted by NERC. The actual design of the necessary Reliability Standards is NERC's job. But to date NERC has done nothing in this regard.

SILENCE OF THE POWER ENGINEERS: NERC DOES NOTHING.

In 2022 NERC released a major report warning of likely blackouts across much of America, and for the foreseeable future thereafter.

The report got lots of publicity, including this piece titled "Report: Deadly Summer Blackouts Inevitable As Renewables Struggle To Replace Reliable Energy."

My question is, instead of reporting this pending calamity, why is NERC not preventing it? What is not reported, and seems to be little known, is that NERC is a quasi-regulatory federal agency whose mission is to maintain reliability.

NERC issues standards which the electric power industry is supposed to follow. These federal standards are supposed to be enforced by NERC's regional subsidiaries. Clearly this process has not worked or we would not be facing widespread blackouts. Why not?

By way of background, NERC was originally a Council, not a Corporation. It was formed in 1968 as a voluntary industry body after the massive 1960's Eastern blackout. It became a corporation when it was "federalized" around 2006. It answers to the Federal Energy Regulatory Commission in the US, but also includes Canada. NERC creates and files Reliability Standards with both countries.

Here is NERC's mission statement: "*The vision for the Electric Reliability Organization Enterprise, which is comprised of NERC and the six Regional Entities, is a highly reliable and secure North American bulk power system. Our mission is to assure the effective and efficient reduction of risks to the reliability and security of the grid*."

This vision is clearly inconsistent with NERC's warning that widespread blackouts loom large for America.

Here is what NERC says about its Reliability Standards: "*NERC's Standards program ensures the reliability of the bulk power system by developing quality reliability standards in a timely manner that are effective, clear, consistent and technically sound*."

If the NERC standard program supposedly "*ensures the reliability*" of the grid then either the standards are inadequate or they are not being followed. The NERC report simply does not address this massive issue.

Unreliability is reported to already be getting pretty bad. Sustained outages in the U.S. went from less than 12 in 2000 to over 180 in 2020. The average utility customer went from 8 hours of power failure per year in 2013 to 16 in 2020.

Looking ahead it gets much worse. The Biden Administration's stated goal is for the electric power system to produce zero carbon dioxide emissions by 2035, a mere 13 years away. That means shutting down all fossil fueled generation, which presently provides more than half of America's electricity.

Meeting the incredible Biden Federal Plan target is clearly a great threat to reliability. Given that this goal was announced over a year ago, NERC should already have developed standards to protect reliability during this called-for transition. Either that or NERC should say that eliminating fossil fuels in 13 years simply cannot be done reliably.

I find no indication that NERC or any of its Regional Entities is even looking at this staggering scenario. The studies I have seen are limited to around 50% renewables and even these are not leading to standards. They do a huge amount of modeling but apparently nothing on the Federal Plan.

Moreover, many utilities are posting generation plans that are clearly unreliable, swapping fossil fueled and nuclear plants for wind and solar with very little of the required storage. For an example see my report: "Dominion's VCEA Compliance Plan is Disastrously Unreliable."

NERC should be blowing the whistle on these massively unreliable plans.

Biden himself tasked every Federal Agency with focusing on the Federal Climate Plan. NERC's role in this is to issue those Reliability Standards needed to protect reliability. NERC is simply ducking this vital responsibility.

NERC is clearly failing to meet its mission.

I have now done some digging into this mess and the news is not good. As NERC itself says, the blackout threat is at least partly due to utilities rapidly replacing coal fired power plants with wind and solar generators that are intrinsically unreliable. So I looked to see how their rules, which are called Reliability Standards, address this recklessness, if at all. Turns out the problems are deep.

I find it a questionable policy that the American grid is regulated by a nonprofit corporation, not a Federal agency. This means the normal rules of federal regulation do not apply. It is true that the rules have to be approved by the Federal Energy Regulatory Commission, but FERC is not directly involved in either rulemaking or enforcement. Much follows from this.

To begin with, there is very little visibility. In fact, NERC's basic financial and strategic documents are password protected! They have a membership, which presumably mostly includes the electric power utilities they regulate. Looks like only members can see the core documents.

This black box includes how much money they and their regional corporations make, which could be a lot. By way of scale, the PJM independent system operator for the Mid-Atlantic, rakes in about a third of a billion dollars a year, which all comes out of our electric bills. Mind you there is no apparent connection between PJM and NERC, whose Mid-Atlantic regional entity is ReliabilityFirst Corporation.

It appears that NERC is funded by a tax on utility electric power sales. Thus it is paid by the very entities it regulates, which sounds like a very bad plan. Its rulemaking is also largely done by committees, which are dominated by the regulated utilities.

This *de facto* dependence on the utilities may well explain why NERC has never exposed the recklessly unreliable utility behavior that led to the present precarious grid. One might say that not only is the utility fox in the reliability chicken house, but that the fox is also running and funding it.

There are 93 NERC Reliability Standards that have been approved by FERC. It looks like none has anything to do with controlling the adverse impact, of the increasing grid penetration of renewables, upon reliability. The list of approved Reliability Standards is here. Note that this is a dot com address, not dot gov.

There is one Standard that actually mentions the issue of renewables and reliability, but it basically says nothing. The title of this Reliability Standard is promising: "Planning Resource Adequacy Analysis, Assessment and Documentation."

Unfortunately this Standard merely requires that the resource adequacy analysis includes "modeling assumptions of intermittent and energy limited resource such as wind and cogeneration"

There is nothing about what those assumptions should be, or how to assess them, in order to properly analyze the adverse impact of intermittency on reliability. Something like the Gregory hour by hour analysis should be used to find the likely worst solar and wind droughts.

NERC also has a short list of Reliability Standards under development, but here too there is nothing about renewables and reliability.

These results confirm that, other than announcing the growing unreliability of America's electric power system, NERC is doing nothing about it. That NERC is both funded and dominated by the utilities it regulates may well be the fundamental problem. These utilities are making a fortune building unreliable wind and solar generation.

SECTION 5: NERC NEEDS TO BE REDIRECTED, EITHER INTERNALLY OR BY FERC OR CONGRESS

Reliability must be restored and maintained. NERC has the authority to develop proposed Reliability Standards to constrain and manage the reliable growth of renewables.

If NERC will not act then FERC has in the past ordered NERC to draft specific Reliability Standards. A while back they ordered an entire set of Standards for cyber security. The Order itself went through the proposal notice and comment process, before being finalized and sent to NERC for action.

This sort of Order may be just what is needed to constrain the presently reckless transition from dispatchable fossil fueled generation to intermittent, weather dependent wind and solar power.

Alternatively, if NERC and FERC fail to act then Congress should mandate that they do so. NERC's reliability regulatory authority was created by law and that law can be amended to require them to create regulations making renewables reliable. The law in question was the Energy Policy Act of 2005. Bills have been introduced in the past directing FERC and NERC to develop specific standards, so thus would not be unprecedented.

At a minimum these new Reliability Standards should cover the following topics:

1. WIND AND SOLAR SUPPLY DROUGHT PREDICTION (HOURLY OR FINER)

2. DISPATCHABLE BACKUP REQUIREMENTS AND PLANNING

3. STORAGE REQUIREMENTS AND PLANNING

4. MAINTAINING STABILITY WITH INCREASED PENETRATION OF INTERMITTENT SOURCES

5. IMPACT OF INVERTERS ON STABILITY (RENEWABLES AND BATTERY STORAGE BOTH USES INVERTERS)

6. CONTROLLING AND MANAGING INTERCONNECTION WITH INTERMITTENT SOURCES