Why Letter by Hansen et al Misses the Mark on Nuclear Power and Renewables

On November 3, four climate and atmospheric scientists issued a letter to prominent US environmental organizations urging them to support extensive build-out of nuclear power to combat global warming.

The scientists[i] made a number of assertions in their letter that get to the heart of the nuclear power debate and the scalability of renewable power.

With respect to nuclear power, their letter claims or implies the following:

Economics of Nuclear power:
- "Innovation and economies of scale can make new power plants even cheaper than existing plants;"

"Advanced" Nuclear Designs:
- "Advanced" nuclear designs can "reduce proliferation risk, solve the waste disposal issue, use fuel more efficiently;"

Renewables, Energy Efficiency, and Distributed Power:
- Renewables "cannot scale up fast enough to deliver cheap...power."

Reliability and Climate
- Renewables "cannot scale up fast enough to deliver… reliable power."
- "…[O]pposition to nuclear power threatens humanity's ability to avoid dangerous climate change;"
- Nuclear power is "essential to any credible effort" to address climate change;
- Nuclear power can "displace a large fraction of our carbon emissions;"

Safety
- Nuclear power can be safe; [ii]

As bold as these statements are, they are misplaced. Rather than reflections of immutable truths, they affirm ignorance of nuclear power developments past and present. They affirm a fundamental misunderstanding of the potential for renewables and energy efficiency, the realities of nuclear economics, and electric grid operation.

Indeed, the letter fell on deaf ears. No environmental organization took the bait. Instead, NRDC, Greenpeace, Friends of the Earth (FOE), and Sierra Club decry nuclear power as too slow to build, costly, and dangerous. The response was similar across the spectrum of national environmental organizations, from mainstream NRDC to those like FOE and Greenpeace that are considered more "lefty". The reason behind this is that these organizations understand the history and legacy of nuclear power. They also understand that a revolutionary change is underway in the electric power sector that will be dominated by renewables, efficiency, storage, and, distributed power. They understand that the central station paradigm for delivering electric power is no longer viable and, along with that, nuclear power.[iii]

The authors of the letter say that things have changed since the 1970s in their effort to convince their target audience to drop their opposition to nuclear power. What's changed is that renewables, energy efficiency, and distributed power have ushered in an era of technological revolution in the energy sector. What haven't changed are the disastrous financial failures and severe safety risks that have plagued nuclear power since its inception.

Commercialized Nuclear Power Reactors: Economics and Trends

Nuclear power is the electric power generation technology of false promises. Although a cadre of scientists, environmentalists, and industry pundits and hopefuls resonate the tired, repetitive clichés of the past, decade upon decade of analysis comes to one conclusion: Nuclear power is a financial albatross. No amount of taxpayer or ratepayer subsidy over the last 60 years has been able to reduce its costs. On the contrary, they continue to balloon. The only conclusion to reach is that nuclear power makes no economic sense.

Review of Nuclear Power

This month, Morningstar, an investment research firm, referred to the so-called nuclear renaissance in the West as a "fiction" and a "fantasy." Among the problems for new nuclear construction raised by Morningstar was "enormous cost." But for a few units in the US and France currently under construction, the firm declared new nuclear construction in the West "dead."[iv]

In China, where nuclear plants are being built at a feverish pace, Morningstar cautioned enthusiasts, stating that the quick build-out should raise concerns for safety and construction quality.[v] True to form, construction in China on a so-called "third generation" AP 1000 reactor has run into construction delays and pumps designed to cool the reactor during operation had to be sent back to the US for repair and testing.[vi]

This is neither the end nor the beginning for nuclear power's financial troubles. GE declared in 1954 that "within ten" years, nuclear power plants would be "built without government subsidy."[vii] But the history of nuclear power is one characterized by extreme subsidization and numerous boondoggles.

The Union of Concerned Scientists reviewed the history and its impacts on taxpayers and ratepayers in 2011. The subsidies that underwrote nuclear construction into the 1980s, USC estimates, are "equal to about 140% of the average wholesale price of power from 1960 to 2008, making subsidies more valuable than the power produced over that period." Its fuel and operating and maintenance (O&M) costs are "offset" by subsidies "to the costs of uranium, insurance and liability, plant security, cooling water, waste disposal, and plant decommissioning"… and "represent 35%" of those costs.[viii]

The results of the initial nuclear build-out reveal a devastating failure of wrong-headed public policy. Analysts have estimated the cost of cancellations to ratepayers and taxpayers of nuclear power plants from 1972 to 1984 to range between $40 to $50 billion.[ix] Cost overruns, an inevitable feature of nuclear power construction, reached a staggering $150 billion for the first wave of plant construction.[x]

Of the first wave of construction, "about half of all reactors approved were cancelled…, 15 percent retired early, 23 percent had extended outages of one to three years, and 6 percent had outages of more than three years."[xi]

Despite these disasters, the nuclear power industry received yet another infusion of public dollars when states began to deregulate their retail electric markets in the mid- to late-1990s. Arguing that they couldn't compete under market conditions, the nuclear industry convinced policymakers to see to it that the public covered its stranded costs – the mortgage that wasn't yet paid. The sum total of this bailout reached an estimated $110 billion.[xii]

As early as 1985, an article in Forbes declared "[t]he failure of the US nuclear power program ranks as the largest managerial disaster in business history… only the blind or biased can now think that most of the money has been spent well."[xiii]

This trend continued when in 2001 the Economist quipped, "Once considered to be too cheap to meter, nuclear power is now too expensive to matter."[xiv]

Wall Street weighed in at the end of the last decade. Moody's view on nuclear power is particularly cogent: "We view nuclear generation plants as a 'bet the farm' endeavor for most companies, due to the size of the investment and the length of time needed to build a nuclear power facility."[xv]

Government largesse for nuclear power doesn't stop with the past. UCS also analyzed the subsidies for new reactors and found that they range from "70 to 200% of the projected value of the power."[xvi]

New Construction

In keeping with its history, the US nuclear industry has ignited visions of the past with its recent attempts to construct new plants. By 2003 the nuclear industry announced a "Nuclear Renaissance" peppered with the promises that jumpstarted the first wave of construction. But costs remain high and construction timeframes 8 to 10 years.[xvii]

Of 31 reactors proposed for construction in the US by 2009, only four are now under construction[xviii], two of which (at the Vogtle nuclear plant in Georgia) have progressed enough to rack up nearly $1 billion in cost overruns.[xix] Additionally, the federal government has postponed issuing an $8.3 billion loan guarantee five times due to the financial risk of construction.[xx]

The other two began construction this year in South Carolina but are already delayed, with the current estimate for cost overruns at $200 million. Moreover, one utility partner in the venture, with a 45% stake, is squirming to back out of the deal. [xxi]

Duke Energy suspended construction at its Levy units where costs escalated from a projected $3 - $6 billion in 2006 to nearly $25 billion today. But customers have had to pay nearly $1.5 billion for nothing due to passage of the financial, risk-shifting mechanism CWIP (construction work in progress) by the Florida legislature. [xxii]

Utility company Luminant suspended licensing for new nuclear units in early November (2013) in Texas until a later date citing, among other things, "market conditions."[xxiii]

TVA continues construction of its Watts Bar nuclear unit. Construction was initially suspended in the 1990s. But, like its cousins in the past and now, TVA announced delays by two years and an estimated doubling in cost in April 2012. The unit is now scheduled for completion by the end of 2015.[xxiv]

Existing Plants

As new construction continues to experience cancellations, delays, cost overruns and credit rating problems for nuclear utilities, financial pressures are building at existing plants. A recent report by the Vermont Law School "Renaissance in Reverse" makes a compelling argument for the unviable nature of nuclear power.

Vermont Law School sums up the difficulty for the nuclear industry this way:

- "In the near-term old reactors are uneconomic because lower cost alternatives have squeezed their cash margins to the point where they no longer cover the cost of nuclear operation.
- "In the mid-term, things get worse because the older reactors get, the less viable they become.
- "In the long term new reactors are uneconomic because there are numerous low-carbon alternatives that are less costly and less risk."[xxv]

2013 has seen historic retirements in US nuclear history, the report says. One was due to poor economics. Three were due to repair costs. Additionally, five uprates (increasing the output of units) were cancelled, adding to the parade of shutdowns.[xxvi]

The issues facing nuclear units in states with deregulated markets are declining wholesale rates and increasing operational costs. The end results are negative profit margins. Low natural gas prices, wind energy (that has no fuel costs), and energy efficiency driving declining electric demand are lowering wholesale rates. Meanwhile the aging plants are becoming more expensive to maintain. The NRC safety investigation in the wake of Fukushima will probably add to that. These older units must also change out fuel every 18 months instead of the usual 24 for new plants, which increases cost of operation and time offline. Nuclear units are feeling economic stress in regulated states, as well. Of the 38 plants that the report finds are on the bubble, Vermont Law School estimates that about "two dozen regulated reactors" face "challenging economics."[xxvii]

Similar to new construction, major lifecycle extension and uprate projects at existing plants also experience cost overruns, which undermines their economics. Indeed, over half of the almost 36 uprates approved since 2009 have been cancelled or suspended for the time being. The kilowatt cost of the cost overruns for those projects that proceeded exceed the kilowatt cost of a combined cycle natural gas plant.[xxviii]

Moreover, the 90% average capacity factors for existing plants experienced in the last decade has been short lived. The average capacity factor over the lives of the plants has been under 75%.[xxix]

Conclusions

The lesson here is obvious. The massive government and state-level subsidies in R&D and construction that ushered in the forced construction of nuclear power plants did not, have not, and will not drive down costs for new or existing nuclear power. As nuclear plants age, nuclear utilities are confronted with the same set of construction risks for lifecycle extensions and uprates as new plants. Repair and safety costs will add to their economic difficulties. Alternatives (low natural gas prices, energy efficiency, renewables) are also squeezing nuclear power out of the market.

"Advanced" Nuclear Designs

The letter drafted by the climate and atmospheric scientists claims that "innovation and economies of scale can make new power plants even cheaper than existing plants." They also assert that new designs would address proliferation risks and the high-level nuclear waste problems. They refer to technologies that can "burn current waste," i.e. the breeder reactor.

As the history of nuclear power shows us, no one, no amount of subsidies, and no manipulation of policy or markets have solved these problems. The economies of scale argument, that is building larger units, proved false long ago. The new argument for small, modular nuclear plants is that construction risks are reduced. But this turns the economies of scale assertion on its head, the smaller the unit the higher the kilowatt cost.

Fast Breeder Reactors

The basis for "solving" many of the issues raised in the November letter, although not directly stated, is the breeder reactor. The fast breeder or integrated fast reactor is not a new concept. The idea, raised just after World War II, is to create a reaction that makes more fuel, in this case plutonium, than it uses. It would require reprocessing of high-level nuclear waste and the creation of weapons grade material – plutonium.

In 2010, the Bulletin of the Atomic Scientists published "It's Time to Give Up on Breeder Reactors," noting: "Since the dawn of the nuclear age, nuclear energy advocates have dreamed of a reactor that could produce more fuel than it used. More than 60 years and $100 billion later, that vision remains as far from reality as ever."[xxx]

Seven countries, including the United States and the Soviet Union, poured $100 billion into developing and commercializing the technology, which proved unsuccessful. The US abandoned it in the mid-1990s due to cost and proliferation risks. France shuttered its breeder reactor in 2009. Advocates predicted 1,000s of operating reactors by now. Their new prediction for commercialization is 2050.[xxxi]

The Monju breeder reactor in Japan serves as an example of the safety issues in running these plants. An enormous safety concern expressed about fast breeder reactors is the cooling medium for the reactor. These reactors can't use water. They are normally designed to use liquid sodium. Liquid sodium burns when exposed to air and explodes when exposed to water. The plant suffered a liquid sodium leak not long after startup and the resulting fire caused a shutdown that has remained in effect since 1994.[xxxii]

The performance of breeder reactors also leaves a lot to be desired. France's Superphenix breeder reactor began operation in 1986 and was shut down much of time until decommissioned in 1998. The plant suffered a dismal lifetime capacity factor of 7%. [xxxiii]

The proliferation risks posed by breeder reactors are extreme. Plutonium would be readily available in large quantities if the technology took hold. As an example India used the first plutonium separated for its breeder reactor program to conduct a nuclear bomb test.[xxxiv]

Passive Cooling

The technology that employs passive cooling with an approved design is the AP 1000 reactor. It is the design abandoned by Duke Energy in Levy County, Florida at an estimated cost of $24.7 billion, and the design of the new Vogtle nuclear units in Georgia at around $700 million in cost overruns and counting. The Chinese are building 4 units. As noted, they had problems with the water pumps, which had to be sent back to the US for repair and testing.

The passive cooling aspect of the reactor comes into play after some event knocks out the water pumps to cool the reactor. In the event of coolant system failure, the reactor would shut down and gravity would take over. A large amount of water sits atop the reactor and flows when a shutdown occurs. Of course, the valves have to work and, depending on the length of the shutdown, the water would have to be replaced somehow.

Analysts have also raised issue with the containment structure. They claim that it is too flimsy and actually allows radioactivity from a core breach to be released in the atmosphere. There is essentially a hole in the roof that design engineers left without a filter to scrub escaping radioactive contamination.[xxxv]

But, as is the experience with all other nuclear designs, financial risk would appear to be a significant deterrent in expanding use of the technology.

Modular Nuclear Reactors

The prospects for small nuclear reactors are not any better than for the larger units. The industry never seems to run out of ideas, no matter how far afield, to save itself. To become financially viable, these units would require enormous subsidies and the public would have to be exposed to greater safety and security risks.

This technological approach is based on reactors that power nuclear submarines. The industry's logic is that these smaller units will be easier to deploy thus the onsite construction risks are greatly diminished. They would be mass-produced and shipped for installation. A utility company, for instance, could build a few small units and then add on as needed thus avoiding the complexities of constructing large units. They would be installed below ground, as well, making them safer, proponents say.

But analysts raise some concerns. The industry will still need tens of billions of dollars in subsidies to support the supply chain until orders reach a sustainable level for modular nuclear manufacturers. In fact, the industry has suggested to DOE that it purchase 2,000 megawatts of installations at a cost to the US taxpayer of $20 billion. Industry also wants loan guarantees, tax credits, and state-level CWIP, arguing, as in the past, that costs will eventually come down.[xxxvi]

But modular nuclear manufacturers also want to reduce the number of operating personnel, to shrink the 10-mile emergency planning zone, and allow units to share cooling systems, which will increase risks of accident and attack. Underground construction may improve safety in some respects but exposes the reactor to flooding.[xxxvii]

There is also no contingency for factory manufacturing flaws. How would they be repaired? How do you recall such units once in operation? Moreover, how do you properly plan for unit additions? Do you build one control room, hoping for future expansion or one control room for each unit, which would increase the costs?[xxxviii]

Contrary to what the industry is now saying, the suspicion is that the modular nuclear industry would expand first in China, not in the US where advocates promise jobs. China has a much more mature nuclear supply chain. The US would have to create one over time. Westinghouse apparently recognizes this problem. It has signed an MOU with China's State Nuclear Power Technology Corporation to develop and commercialize its design in China.[xxxix]

Another issue that may be raised with modular nuclear units is their base load quality. The vision is that these units could be daisy-chained over time, with the potential of a site with multiple modular nuclear units eventually accruing the output of a large nuclear reactor. However, if that is not the case or the build-out is slow (which would probably be the case) and a site houses only 300 to 400 megawatts, why would you want such a small plant, essentially a peaking unit, running 24/7? It seems like a very inefficient unit on an otherwise increasingly flexible electric grid.

What is certain is that modular nuclear units would not be built in states with retail deregulation. Rather, these units would be built, if at all, in states with traditional regulatory regimes for integrated, monopoly utility companies. It is the only opportunity for shifting production risk to ratepayers with CWIP in order for utilities and modular nuclear manufacturers to recover capital costs and to attain sufficient profit margins.

Thorium Fuel

Thorium-based fuel and using it in light water reactors or in a breeder context has gone the way of breeder reactors. The Institute for Energy and Environmental Research and PSR (Physicians for Social Responsibility) report, "Research and development of thorium fuel has been undertaken in Germany, India, Japan, Russia, the UK, and the US for more than half a century… Compared to uranium, the thorium fuel cycle is likely to be even more costly." Just like its breeder reactor counterpart, the thorium fuel cycle has yet to be commercialized, despite many attempts over many decades to do so.[xl]

Reprocessing

Any hope of commercializing breeder reactors, as delusional as that may seem, requires reprocessing to separate out plutonium for fuel. The US abandoned reprocessing 40 years ago. The shuttered reprocessing facility near Buffalo, New York continues to be a cleanup nightmare.

To force the issue in the US, the nuclear industry recently turned again to reprocessing high-level nuclear waste in the wake of Obama Administration opposition to Yucca Mountain as a repository for the waste. Many reprocessing advocates point to France where they claim reprocessing has been done successfully. They have made wild claims that France recycles 90% or more of its waste.[xli]

As it happens, France is not a good example for reprocessing advocates. Only 4.7% of the fuel in a nuclear plant produces energy. In France, reprocessing increases that by 1%. Moreover, the French public pays an additional $1.4 billion per year for reprocessing, which adds an average 2.3 cents per kilowatt-hour to their electric bills. The government actually admitted it was a money loser in 1989 but the commitment had been made and the jobs created. Beyond the economic drawbacks, Reprocessing is not a pristine activity in the least. The French dump an estimated 4 million gallons of contaminated liquid waste from their reprocessing facility into the English Channel every year.[xlii]

As for the US, the President's Blue Ribbon Commission on America's Nuclear Future said in its final report that there is no available technology that could alter the challenges posed by high-level nuclear waste in the foreseeable future.[xliii]
Given its history, problems, and excessive costs, reprocessing of nuclear waste has been revealed as yet another false promise in a long line of false promises spun by the nuclear industry.

Conclusions
The so-called new, advanced technologies described in the Hansen et al letter are neither. Decades have been spent attempting to commercialize the technologies they allude to. Fast breeder reactors, despite ongoing attempts being made in some countries, were largely abandoned because they are costly, unreliable, prone to accident given the cooling system, and pose a significant proliferation risk. The backbone of this plutonium-based energy system would be reprocessing that, contrary to belief, is costly and inefficient, highly polluting, and poses a significant proliferation risk. The AP 1000 is a light water reactor like currently operating units with a giant tub of water above the reactor core in case of a core breach or loss of coolant event in an otherwise active cooling system.

Trends in Renewables, Efficiency, Storage, and Distributed Power
In their letter, Hansen et al essentially dismiss renewables as a means of providing enough power and in addressing climate change. The charge against renewables is that they are uneconomic, unreliable, and not scalable. These assertions couldn't be farther from the truth. Moreover, the letter completely skirts the potential for energy efficiency and distributed combined-heat-and-power (CHP).

Ironically, what Hansen et al contend to be the case for wind and solar PV actually applies to nuclear power. As it happens, renewables do not require the enormous planning and construction timeframes that plague nuclear units and are not prone to cost overruns, are cheaper than nuclear power, and are less costly to run. As such, they represent the least cost and risk investment opportunities. Energy efficiency and distributed power belong in the same least cost/risk category. And all of these technologies are scalable.

Cost Comparisons

In August of 2013 Lazard, a leading financial advisory and asset management firm, published an update of cost comparisons between conventional and alternative forms of electric generation. In terms of upfront capital costs, Lazard's analysis is revealing. Whereas new nuclear construction stands at an average of nearly $7,600 per kilowatt, new onshore wind and solar PV (whether rooftop or utility scale) is much lower. Wind ranges, according to Lazard, between $1,500 to $2,000 per kilowatt and the high price for solar PV (rooftop) is assessed at $3,500 per kilowatt. Even offshore wind (which receives little to no subsidies from the US government) is competitive with new nuclear power units at an estimated $4,050 per kilowatt.[xliv]

Although the levelized cost of solar PV (the average cost over its lifetime) is estimated to be larger than Lazard's estimated nuclear levelized cost , no one actually knows the final cost of a new nuclear plant in the US, and, given constant construction delays, if any can be built.

Onshore wind and solar PV reached the cost threshold depicted by Lazard essentially over the last decade or less. And their costs continue to decline. In fact, in the last four years estimates are that onshore wind and solar PV's average lifetime costs have dropped 50%.[xlv]

The trend is well recognized by Wall Street analysts. For instance, Citi Research declared in the fall of 2012 that solar was already cheaper than retail electric rates "in many parts of the world…" Citi analysts wrote, "The perception of renewables as an expensive source of electricity is largely obsolete…"[xlvi]

The firm made the point that "[r]enewable technologies (wind and solar PV) can already compete against CCGTs (combined cycle natural gas-fired plants) in higher-priced regions (of the world), and rapidly falling cost curves imply parity even vs. cheap 'shale-electricity' in windy and sunny regions before 2020."[xlvii]

This fall Deutsche Bank published a report wherein it predicted grid parity (at or below the retail or wholesale rate) for solar PV in 75% of the world market within 18 months. It predicted annual solar installations in the US to reach 16,000 megawatts per year by 2016.[xlviii] This means that solar PV can soon be installed with little to no subsidies.

Even the utility industry in the US admits that solar PV has attained grid parity in 16% of the country.[xlix]

The same goes for energy efficiency and distributed power. Wall Street's Fitch Ratings says that "[t]he economics of energy efficiency are compelling." Its analysis shows that the cost of energy efficiency "is substantially less than all forms of conventional or renewable power generation." It asserts that efficiency is "an effective tool in displacing new power generation, produces peak load shaving, and avoids or at least reduces the highest cost sources of electricity generation (i.e.

nuclear power)." (*emphasis added)* It expects "large customer" interest to continue in "distributed generation" including solar PV.[l]

Ease of Deployment and Scalability
Over the last decade, renewables and combined-heat-and-power (cogeneration or distributed power) overtook nuclear power generation. The former, by 2010, represented 18% of the world's electric generation while nuclear represented 13%.[li]

Since 2000, the annual growth rate for global wind power has been 27%; for solar PV 42%.[lii]

From 2002 to 2012 in the US, nearly 50,000 megawatts of wind were installed. Currently, the US installs a solar system every 4 minutes. That's expected to decline to every one minute by 2015. And the numbers are accelerating. Two-thirds of all distributed solar systems have been installed over the last 2 ½ years. By 2016, the GTM research projects the US will have one million residential solar PV installations.[liii]

Worldwide solar is expanding at a feverish pace. In four decades, 50,000 megawatts of solar PV were installed globally. But an additional 50,000 were added just over the last 2 ½ years while panel prices have fallen 62%. By 2015, another 100,000 megawatts are projected to be installed. [liv]

In 2012 in the US, almost half of all generation capacity additions were renewable. In January of this year, all capacity additions were renewable. Most of that was wind and solar PV.[lv] From January through September this year in the US, over 5,000 megawatts of wind and over 1,000 megawatts of solar PV have been installed. No nuclear additions occurred.[lvi]

In terms of energy efficiency, a recent NRDC analysis yields impressive results. Due to energy efficiency investments over the last 40 years, which the organization characterizes as "huge" and "inexpensive," the productivity of the US economy has doubled saving the economy hundreds of billions of dollars per year. "US energy use peaked in 2007," the report says, "and has trended downward since…" This despite a growing population and a GDP increase of 25% between 1999 and 2012.[lvii]

More energy efficiency investment, the report implies, means more benefits to the economy. NRDC asserts, "Additional investments in efficiency could cut US energy consumption by 23 percent by 2020, saving customers nearly $700 billion, and create up to 900,000 direct jobs…"[lviii]

Technologies that drive grid flexibility, important for responding to the variability of increasing amounts of wind and solar PV penetration on the grid, are also taking hold in the market. As ACEEE explains, information and communication technologies that comprise intelligent efficiency "communicate and receive communications, and… respond to the external stimuli. [They] have the ability to "respond, adapt, and predict." What ACEEE is describing is the "smart" building or manufacturing facility. The organization, in a recent report, predicts that "the building automation industry will reach $43 billion in sales by 2018."[lix]

These technologies enable commercial building owners and manufacturers to bid into the wholesale market by reducing electric demand of their facilities in the short term. They are also critical to responding to variable but predictable wind and solar resources. These technologies are an important part of the flexible grid design.

In the eastern portion of the country where PJM (a regional transmission organization (RTO)) runs the transmission system, demand response programs (where commercial and industrial facilities can bid their power reductions in the market and get paid for it) "have displaced the need for and estimated 80 power plants that provide peak power."[lx] Peaking units are generally natural gas plants.

Nuclear power hasn't seen the same success. Its percentage of global energy generation dropped 7% from a peak of 17% in 1993 to 10% in 2012. Currently, 14 countries are building 66 nuclear reactors worldwide. Forty-four of them are being constructed in China, India, or Russia. Nine of the 66 have been listed as "under construction" for 20 years; four for 10 years. Forty-five of them have no start-up date and 23 have experienced construction delays.[lxi]

It's also important to note that none of the reactors being built overseas have received private financing.[lxii] As in the US, nuclear power is and always will be essentially a public works project because the market will not take the risk, which means, when a nuclear plant is built, the public (taxpayers and ratepayers) assumes the vast majority of the financial risk. In the US, the risk of accident is largely borne by the public through the Price Anderson Act, which limits accident liability for nuclear plant operators. Renewables, efficiency, and distributed power are not plagued by these kinds of risks. Private capital flows much more easily to them, indicating their least risk nature, and demand far less in subsidies to leverage investment.

Reliability and Climate

There's no question that large amounts of variable renewables can be integrated into the electric grid without threatening reliability. The National Renewable Energy Lab (NREL) published a report in 2012 demonstrating through a number of scenarios that renewables could generate 80% of electric power while keeping the lights on every hour of every day of the year.[lxiii] Similarly, Synapse Energy Economics analyzed grid reliability of increasing renewables, on average, 50% in the country while eliminating coal plants entirely and 25% of the nuclear fleet and found that reliability would be maintained in every region throughout the year.[lxiv]

Recently, GE conducted a study of the eastern portion of the country. It found that wind and solar PV penetrations of 30% could be easily integrated into the electric grid without disturbing reliability. It also found that such levels of penetration would cut costs and require only a small amount of reserves to backup the renewables, 4,000 megawatts to back up 100,000 megawatts of wind and solar PV.[lxv] The State of Michigan found similar results in a report released in November 2013[lxvi]

Unlike solar PV and wind energy, however, nuclear power plants will become increasingly unreliable as climate change causes more frequent heat waves and droughts, and as water resources dwindle from overuse and climate change.

Heat and drought have impacted the operation of numerous plants. They include in 2012 the Perry 1 and Braidwood III reactors; in 2011, the Browns Ferry plant; in 2006, the DC Cook and Prairie Island reactors; in 2008, TVA lost a third of its nuclear capacity due to drought.[lxvii]

In the summer of 2013, UCS released its "Water-Smart Power" report. It found the best way to reduce carbon emissions and relieve stress on water resources was its renewables and energy efficiency scenario "where energy efficiency could more than meet growth in demand for electricity, and renewable energy could supply 80 percent of the remaining demand."[lxviii]

In fact, investment in efficiency and renewables is far superior to cutting carbon emissions than build-out of nuclear power. First of all, an additional 1,000 to 1,500 large nuclear would have to be built to cut just 25% of carbon emissions.[lxix] Given the current state of affairs globally with nuclear power, the fact that it has taken 60 years to build the currently running 440 reactors, and the escalating costs of nuclear power, this is impossible to achieve at all let alone in a reasonable timeframe to combat climate change. But it is also much more cost-effective to go the alternative route. As energy analyst Amory Lovins calculates, "Each dollar spent on a new nuclear reactor buys about 2-10 times less carbon savings, 20 – 40 times slower, than spending that dollar on the cheaper, faster, solutions that make nuclear power unnecessary and uneconomic: efficient use of electricity… and renewable energy."[lxx]

Conflicting Strategies

A policy to simultaneously build out nuclear and increase renewables and energy efficiency investments are incompatible strategies. For one, higher penetrations of renewables require a much more flexible electric grid system. Nuclear plants are inflexible technologies. They cannot readily ramp up and down to accommodate the variability of wind and solar PV resources.

Secondly, nuclear power requires a substantial private and public resource commitment. A 2010 study illustrates this problem. It found that countries that had not committed to nuclear power had higher renewable penetrations in their energy mix, that they had higher renewable targets, and spent much more on energy efficiency. These countries were compared to the US and France, which lagged behind in investment in efficiency and renewables due to their commitment to nuclear power, the report found. [lxxi]

What the report demonstrates is that the all-of-the-above energy policy supported by the Obama Administration and many in Congress won't work. It is unaffordable and works at cross-purposes, undermining the very resources that can address both our cost and climate challenges.

Conclusions
The flaws the authors of the nuclear letter attribute to renewables actually apply to nuclear power. Documentation clearly shows that renewables and efficiency are less costly, less risky, can be deployed quickly, are scalable, variable but predictable therefore reliable, are experiencing cost reductions that have been sustained and will continue, can address climate change effectively, and will most likely not need subsidies by the end of the decade.

On the other hand, nuclear power is cumbersome, expensive and difficult to build, is experiencing and has experienced excessive planning and construction time horizons, is experiencing increases in costs, cannot be built without heavy public subsidies and will always need them, cannot operate without heavy public subsidies and will always need them, is becoming more unreliable as climate conditions change, and, as a result of the foregoing, will have little impact on climate change.

Moreover, nuclear build-out is incompatible with a policy and investment emphasis on renewables and energy efficiency. Investments in nuclear power tend to displace these more economic and environmentally benign resources.

In reviewing their respective histories, the 20-year stint it took nuclear power to prove itself an abject failure is roughly the same period of time it took for renewables to become a resounding success.

Nuclear Safety
An assumption made in the Hansen et al letter is that nuclear power plants can be operated safely. However, mounting evidence suggests that nuclear safety and the US Nuclear Regulatory Commission (NRC) are near contradictions in terms. The captive nature of the NRC brings into question the ability for the United States to ensure safe operation of existing or new nuclear power plants.

In 2011, AP issued a highly critical report documenting the cozy relationship between the US NRC and the nuclear industry. AP found that safety standards were purposely weakened to allow aging reactors to continue operation. The report asserts that "examples abound" of this behavior. [lxxii]

During the course of its investigation, AP investigators found that "several nuclear engineers and former regulators used nearly identical terminology to describe how industry and government research has frequently justified loosening safety standards to keep aging reactors within operating rules. They call the approach 'sharpening the pencil' or 'pencil engineering – the fudging of calculations and assumptions to yield answers that enable plants with deteriorating conditions to remain in compliance."[lxxiii]

The AP report's assertion that the institutional bias within the NRC is to protect rather than regulate the nuclear industry is reinforced by the Union of Concerned Scientists 2012 report about nuclear power plant safety. The 2012 report is one in a series that documents "near misses" at nuclear power plants. UCS defines a near miss as "an event that increases the chance of a core meltdown by at least a factor of 10…"[lxxiv]

The report found that NRC "has repeatedly failed to enforce essential safety regulations." In its reports from 2010 to 2011, UCS documented 56 near-misses at 40 reactors, which means some operators are chronic violators of the law. [lxxv]

One of the recurrent problems highlighted in the UCS report is NRC's "blind spot" when it comes to storage of high-level nuclear waste in spent fuel pools. Federal appeals courts have "twice found the agency failed to comply with NEPA (the National Environmental Protection Act) with its decisions on safe storage of spent fuel at nuclear plant sites." NRC has had to suspend licensing and relicensing of nuclear plants until it resolves this issue.[lxxvi]

Spent fuel pools in the US house the greatest concentration of radioactivity in the world. Since fuel replacement has been extended from 12 to 18 months, the spent fuel entering the pools is more radioactive and hotter, which strains the cooling systems in the already over-crowded pools. 75% of all high-level nuclear waste is stored in spent fuel pools.[lxxvii]

"Between 1981 and 1996, the NRC reported… 56 events that resulted in the loss of spent fuel coolant (water)." Since then, 10 such events have been reported. Once exposed to air and steam, the spent fuel could catch fire. A 1997 report conducted on behalf of the NRC found that "a severe fire could render 188 square miles around the nuclear reactor uninhabitable, cause as many as 28,000 cancer deaths, and spur $59 billion in damages."[lxxviii]

A report comparing the Fukushima and Three Mile Island accidents documented striking similarities. Post-accident reports found in both cases: "Failure of voluntary, self-regulation, denial of the reality of risk, lack of safety culture, lack of a comprehensive, consistent regulatory framework, failure to require existing reactors to add safety measures because of cost,"etc.[lxxix]

A recent example of the failure to require existing reactors to add safety measures because of cost are charges leveled at the NRC for backing off an investigation of the adequacy of Entergy's revenue stream to maintain safety at its nuclear plants. The claim by US Senators Ed Markey and Bernie Sanders is that NRC backed off the investigation after Entergy raised objections about the information the agency sought. [lxxx]

Conclusions

The bottom line is that the United States has been extremely lucky in avoiding a catastrophic nuclear accident on the scale of Fukushima or Chernobyl. The NRC has simply failed to do its job, which could have dire consequences for the country at any time. Nuclear power plants appear to be proverbial ticking time bombs, according to the documentation presented here. The history and behavior at the NRC raises doubt that nuclear power plants, old or new, can be operated safely in the US, which is a central theme of nuclear advocates.

Endnotes

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