re: Docket No. AD17-11-000
25 April 2017

Hon. Cheryl A. LaFleur, Acting Chairman
Federal Energy Regulatory Commission, Washington DC 20426

Dear Acting Chairman LaFleur:

Unfortunately I can't attend the important and thoughtfully designed 1–2 May 2017 Technical Conference, but I hope you and Staff might find these comments useful to consider in advance.

Around-market nuclear subsidies

The Agenda focuses on some state policymakers' efforts to select or advantage specific resources that can't compete in resource-neutral wholesale markets: specifically, new state-level subsidies to distressed nuclear plants, as recently adopted in Illinois and New York (totaling perhaps $10b) and proposed in Ohio, New Jersey, Pennsylvania, and Connecticut. These subsidies are influenced by such local political considerations as jobs and tax revenues, and are sometimes exacted from states under threat of abrupt shutdown disruptive to grid operations, but their main rationale is the climate benefit of prolonging a carbon-free (in operation) resource for as long as safely possible. I believe this argument is fundamentally mistaken and the claimed climate benefits are illusory, because of climate opportunity cost: avoiding and properly reinvesting nuclear operating cost (opex) can save even more carbon. Using 2013 $ throughout, the argument is:

1. Distressed nuclear plants' high opex makes them uncompetitive in wholesale markets.
2. Individual nuclear plants' and units' opex is generally secret, but aggregated data from the Electric Utility Cost Group, published by the Nuclear Energy Institute, show the latest busbar opex, for 2010–12, averaged 6.2¢/kWh for the top quartile and ~4¢ for the third quartile.[1] Opex for the average 2014–15 nuclear plant was ~3.5¢/kWh.[2]
3. Closure would avoid that opex with immaterial effect on NPV decommissioning cost.
4. Utilities pay an average of 2–3¢/kWh, with wide ranges, to buy end-use efficiency.[3]
5. Closing an average top-quartile nuclear plant and buying equivalent efficiency instead, as state regulators could require, would therefore procure (at the average price) 2–3 kWh of efficiency for each nuclear kWh not generated. One of those kWh could serve the nuclear output's function while the other 1–2 kWh could displace fossil-fueled generation.
6. This swap of nuclear operations for a greater quantity of efficiency could save at least as much carbon, plausibly twice as much, as if a fossil-fueled plant had been closed instead.
7. This ability to close a nuclear plant *and* cut CO_2 underlies PG&E's multi-stakeholder agreement to close the Diablo Canyon two-unit nuclear plant—well-running but redundant and with a forward levelized operating cost ~7¢/kWh—and buy cheaper efficiency, renewables, or other carbon-free resources instead (the best renewables undercut *average* U.S. nuclear operating costs).[4] The mix will be determined by California's IRP process so market competition finds the cheapest carbon abatements subject to reliability and other constraints. PG&E agreed that closing Diablo—cheaper to close than to run, by ≥$1 billion NPV, says NRDC—will make the grid more flexible and emit no more carbon.

8. Thus the argument that reducing CO_2 emissions requires new subsidies for uncompetitive-to-run nuclear plants is generally wrong. (Even for lower-opex plants, around <2–4¢/kWh, it may not be true if cheaper-than-average efficiency is substituted.)
9. These comparisons are conservative because efficiency is already delivered to the retail meter, so it defers or avoids any marginal components (operating costs and losses, modernization, upgrades, expansions) of the embedded average ~4.1¢/kWh cost[5] of delivery.

In summary, closing a nuclear unit in at least the top quartile of operating costs (>6¢/kWh) does not directly save CO_2, but can indirectly save *more* CO_2 than closing a coal-fired power plant *if* the nuclear plant's *larger saved operating costs* are reinvested in efficiency that in turn displaces more fossil output. Exact values will depend on specific details. Broadly, such reinvestment enables closing either an average coal plant *or* a high-operating-cost nuclear plant to avoid similar releases of fossil carbon—and the latter plausibly even twice as large—so neither kind of closure should be discouraged. But buying a carbon abatement that does not save the most carbon per dollar results in emitting more carbon than necessary. Nuclear *new*-build is clearly many times costlier than almost any alternative[6], so it makes climate change worse than with best buys first.

Proponents of added nuclear subsidies argue that they're justified by market failure. Before approving any around-market subsidy that distorts pool-wide prices, crowds out competitors, and destroys competitive price discovery, ISO/RTOs and states should require a high standard of proof that the market is unable to provide a cost-effective solution to a real problem, for reasons that cannot be fixed within market principles. The burden of proof should be on proponents of the around-market subsidy. Absent definitive proof, the market should be allowed to work.

For example, states wanting to buy carbon-free resources without harming existing market mechanisms could run a laddered series of auctions open to all demand- and supply-side options. This free-market approach would value the carbon-free attribute without substituting policymakers' guesses for prices discovered in the market.[7] Historically, such guesses have almost always been wrong, and that risk is rising because prices are in rapid flux. In 2016 alone, global prices fell by 17% for solar PV, 18% for onshore windpower, and ≥16% for lithium-battery storage. Regional prices can be even more volatile, falling in about eight months of 2016 by 37% for Mexican solar PV and 43% for European offshore windpower. No informed policymaker can be confident of guessing 2027 relative prices. It's foolish to substitute long guesses for market outcomes constantly calibrated to reality. Illinois' new nuclear subsidies were rationalized on the grounds that renewables could not compete without the accompanying higher RPS, but some local renewable providers dispute that and deny they were given a fair chance to disprove it in the market.

Continued nuclear operations might win such an auction initially, until cheaper new efficiency and renewables ramped up and won on cost per unit of time-integrated carbon avoided; but markets, not regulators or legislators, should determine that outcome. Nuclear operators' insistence on locking in long-term subsidies is especially harmful to market flexibility, innovation, and competition. It rejects and defeats the whole purpose of having wholesale power markets. In my view, operators that insisted on restructuring so they could benefit from wholesale markets should live with the consequences —especially when they've already been compensated first for building their assets (with heavy subsidies[8]), then for transition costs of the restructuring they later demanded (notably "stranded-asset" allowances), sometimes yet again by some ISO/RTOs' additional capacity payments favoring large thermal units, and they hope now for a fourth time via new state payments and competitive boosts for alleged unrecognized virtues. Once is enough.

Attributes of central thermal plants that their owners would like to be paid [more] for

Carbon pricing. I agree with NEI that pricing carbon emissions is desirable and would help nuclear plants compete with gas-fired plants. However, it would equally advantage carbon-free renewables—a cheaper, stable-and-declining-price, more resilient, more popular, and more potent and ubiquitous competitor than gas. If avoided carbon emissions are to be valued, they should be valued equally for all resources. Rather than acknowledging this and its adverse consequences for their offering, nuclear advocates claim nuclear power has *other* important attributes not recognized in its wholesale-market power prices, causing further "market failures" that regulators or ISO/RTOs must intervene and somehow change market structure to correct, notably these nine:

"Baseload." Energy Secretary Perry claims[9] that "baseload" plants are "critical" resources "necessary to a well-functioning electric grid," reflecting a common confusion about what "baseload" means.[10] It's simply a description of how an inflexible big thermal generator functions and of the role such plants have historically played on the grid. It is not a grid need, as former FERC Chairman Jon Wellinghoff[11], National Grid CEO Steve Holliday[12], and GE (which says[13] inverters can provide frequency response and other ancillary services even better than synchronous generators), among others, have clearly said. Indeed, inflexible baseload generators are becoming an impediment to further grid integration.[14] The weight of expert opinion clearly concurs.[15,16,17] Confirming the feasibility of reliable largely-renewable supply without a "storage miracle," four EU countries with modest or no hydropower met 46–64% of their 2014 electricity needs with renewables (Spain 46%, Scotland 50%, Denmark 59%, Portugal 64%), with no added bulk storage yet superior reliability. In 2015, the former East German utility 50Hertz was 49% powered by renewables, three-fourths of which were wind and PV—~9× what was thought possible 10–15 years ago, says its CEO—yet its last high-voltage outage was many decades ago, and he says 60–70% variable renewables would not require more bulk storage.[18] What has changed, he explains, is the evolution of mindset and of adaptive market mechanisms. The modern view is that supposed storage and backup needs are less a need of variable renewables than a consequence of central thermal plants' relative *in*flexibility. That's not the renewables' fault.

Subsidies. Secretary Perry is correct that "federal subsidies that boost one form of energy at the expense of others" can distort markets and may weaken the grid, but such subsidies appear in fact to be generally larger and more durable for fossil-fueled and nuclear plants than for modern renewables.[19,20] I hope the Secretary will seek a comprehensive and unbiased assessment of *all* federal energy subsidies (unlike studies that Congressional sponsors in recent years have biased to produce desired conclusions[21]). The last such effort I know of was conducted by my organization for FY1984[22], and found 1–2-order-of-magnitude distortions favoring incumbents. Bringing such work up to date, as Doug Koplow has valiantly attempted without official help,[23] would be a vital tool for crafting fair policies to desubsidize, I fervently hope, the entire energy sector.[24]

Dispatchability. RTO bidders must satisfy uniform, pool-wide reliability criteria. Variable renewables' grid balancing costs are generally borne by bidders and are usually <$5/MWh, nearly always <$10. The corresponding balancing costs (at least outside ERCOT) for managing the intermittence (forced outages) of central thermal plants—reserve margin, spinning reserve, part-load penalties—are traditionally socialized and unanalyzed. But emerging evidence suggests that a well-designed and -run portfolio of PV and wind resources may well have balancing costs several times *lower* than those of central thermal plants. That is, variable renewables may need *less* backup (or storage) than utilities have already bought to manage the intermittence of their legacy thermal plants. (Utilities have found that high wind fractions can be firmed by fueled generators ≤5% of wind capacity—severalfold below classical ~15–20% reserve margins for thermal-dominated systems.[25] Unbundled ERCOT ancillary-services market price data confirm that wind's reserve costs per MWh are about half those of thermal generation[26,27]. NREL's models confirm for the western US that central thermal plants cost more to integrate than variable renewables.[28]) FERC should explore this issue and ensure that grid balancing costs are analyzed symmetrically for *all* resources—big and small, renewable and nonrenewable, supply- and demand-side.

Resilience. Power plants with "fuel on hand" have lately been claimed to be more "resilient" than those relying on renewable energy flows, especially variable ones. This is an odd argument, since renewables need no fuel, and historical experience suggests that fuel delivery is a worrisome weakness. Coal plants have proven vulnerable to fuel-logistics problems (rail and bridge failures, frozen barges and onsite coal piles, etc.); gas plants suffer the inherent physical and cybervulnerabilities of pipeline systems[29]; and nuclear plants in various countries have suffered mass shutdowns caused by accidents, safety concerns, heat waves, and grid failures. For example, in the 14 Aug 2003 Northeast Blackout, nine U.S. nuclear plants SCRAMmed from 100% to 0% output as designed, then took nearly two weeks to restore (<3% in three days, 41% in 7), due largely to xenon and samarium poisoning and core-flux inhomogeneities.[30] This physics attribute makes reactors an "anti-peaker" resource, guaranteed unavailable when most needed. Of course PV and windpower are variable, averaging respective 2016 U.S. capacity factors of 27.2% and (net of several points' curtailment) 34.7%[31]; yet they're generally more predictable than demand, and they have far lower forced outage rates than big thermal stations. Distributed resources are especially resilient, especially with islandable microgrid architecture, because they can largely or wholly bypass grid failures, which EPRI found trigger ~98–99% of outages.[32]

Loadshape effects. ISO/RTOs should and do consider match to load; most compete load flexibility resources against supply. RMI recently found that thorough demand response could more than eliminate California's "duck curve," halving daily load variation with a ~5-month payback.

Price deflation (where high renewable fractions depress wholesale prices, making it progressively harder to elicit further investment) is an artifact of models that artificially constrain or exclude ways to mitigate this problem (if lower prices are a problem).[33] Also, nonrenewables, especially nuclear, would suffer even worse from the same phenomenon if identically modeled.

Accounting vs. economics. The prior employer of the recently appointed head of Secretary Perry's grid study claimed[34] (along with exorbitant supposed storage needs) that revenues lost by incumbent thermal plants are an "imposed cost" of the renewables that outcompeted them—a novel theory that would have had Netflix compensate cable TV providers and Henry Ford compensate horse-stable owners. This proposed barrier to competition and innovation confuses economics (sunk costs) with accountancy (unamortized assets), and when called the "utilization effect," was rejected by two EU workshops advised by this theory's originator. The workshops found that society bears transformation costs and needn't ascribe them to particular technologies, new or old, nor to particular parts of the power system.[35] Of course, renewables with virtually zero dispatch cost do push higher-opex thermal plants up the load-duration curve so they run less. Customers then benefit from lower market-clearing prices. Owners suffer from lower revenues and would love to be made whole, but they were already compensated for all the risks of their investments, including competition and innovation, and should not be paid twice.

Financial economics of volatile prices. To compare volatile-price resources, like CCGTs, fairly against fixed-price resources, like efficiency and renewables, requires risk-equalization by adding to volatile costs the market value of their price volatility. This makes modern renewables robustly cheaper than CCGTs.[36] FERC and ISO/RTOs that don't risk-equalize create a market failure. Nearly all market players commit that failure, in blatant violation of financial economics.

Local expenditures and jobs. Big thermal plants employ people and pay taxes. State and local governments will properly consider this, but such production costs are hardly a basis for raising the prices RTOs pay for the resource. All reasonable costs of generation are costs not benefits, are reimbursed by ratepayers, and should not be paid again via added subsidies. At least for employment, such local benefits are also inferior to those of equivalent efficiency and renewables.[37]

I hope these comments will help Commissioners and Staff in considering this important topic.

Respectfully,

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[9] Perry, R., Study Examining Electricity Markets and Reliability, Memorandum to the Chief of Staff, DOE, 14 Apr 2017.

[10] "Baseload" may mean: to utility load analysts, the apparently steady-in-aggregate portion of demand below the shoulder of the load-duration curve; to utility resource buyers, the resource of least levelized long-run marginal cost; to grid dispatchers, the resource of least short-run marginal (dispatch) cost; to laypeople, the big thermal power plants that traditionally satisfied the second and third roles (but no longer can because renewables undercut their dispatch costs); and to nuclear advocates, a mythical 23/7/365 power plant. I suggest Staff guiding the Technical Conference clarify which of these five sense(s) speakers are using.

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