SUPREME COURT OF THE STATE OF NEW YORK
COUNTY OF ALBANY

In the Matter of

HUDSON RIVER SLOOP CLEARWATER, INC., GOSHEN GREEN FARMS, LLC, NUCLEAR INFORMATION AND RESOURCE SERVICE, INDIAN POINT SAFE ENERGY COALITION, and PROMOTING HEALTH AND SUSTAINABLE ENERGY, INC.

Petitioners-Plaintiffs,

For a Judgment pursuant to Article 78 of the CPLR,

-against-

NEW YORK STATE PUBLIC SERVICE COMMISSION, along with KATHLEEN BURGESS in her official capacity as Secretary, AUDREY ZIBELMAN, in her official capacity as Chair, PATRICIA L. ACAMPORA, GREGG C. SAYRE, and DIANE X. BURMAN, in their official capacities as Commissioners,

Respondents-Defendants,

and

CONSTELLATION ENERGY NUCLEAR GROUP, LLC, With subsidiaries and affiliates EXELON GENERATION COMPANY, LLC, R.E. GINNA NUCLEAR POWER PLANT, LLC, NINE MILE POINT NUCLEAR STATION, LLC,

Nominal Respondents-Defendants.

Index No. 07242-16

AFFIDAVIT OF MARK COOPER

STATE OF MARYLAND)
) ss:
COUNTY OF MONTGOMERY)

MARK COOPER, being duly sworn, hereby deposes and, under penalties of perjury, states as follows:

1. My name is Dr. Mark Cooper. I am a Senior Fellow for Economic Analysis at the Institute for Energy and the Environment at Vermont Law School. I hold a Ph.D. from Yale University. I was Director of Energy and Director of Research at the Consumer Federation of America for 35 years. I have testified over 400 times on energy and telecommunications issues at federal and state regulatory and legislative bodies in over forty jurisdictions in the U.S. and Canada.
2. Although I have been analyzing the electricity sector in general and nuclear power, in particular, for over 35 years, in the past decade I have focused on the challenge of building a low cost, low carbon sector.[1] In the first five years I focused on the construction of new nuclear reactors because the "nuclear renaissance" aspired to build dozens of huge, expensive reactors that, it was claimed were extremely low carbon emitters that would anchor the electricity system for decades. I showed that new nuclear reactors were far from the least cost option around which to center a low carbon electricity sector by analyzing the economics of alternatives, efficiency and non-hydro renewable resources.
3. The "nuclear renaissance" evaporated, with billions of dollars wasted on abandoned plans and projects and is now reduced to a mere two reactors under construction and likely to be the most expensive source of electricity. For the past five years I have added a much more intensive analysis of how a 21st century low carbon electricity sector would be built and operated and examined the role of aging reactors in the transition to that sector.
4. Attachment MNC-1 shows academic publications, testimony, and research reports I have authored in the past decade dealing only with the electricity sector and the role of nuclear power in it.

[1] Appendix A shows my testimony, publications and research reports for the past decade, dealing only with the electricity sector and the role of nuclear power in it.

5. I submit this Affidavit in further support of Petitioners' effort, pursuant to Article 78 of the New York State Civil Practice Law and Rules to annul, vacate, and set aside Tier 3 of the Public Service Commission's August, 1 2016 Order (the "Order').

Overview of Findings

6. I have been asked by parties who are challenging the Zero Emission Credit (ZEC) program to review its impact on ratepayers, the environment, and the state's goals for the sector (e.g. the transition to an electricity sector that relies on low carbon resources for 50% of its output, including efficiency- based reductions in demand). The task I have been given fits squarely in the center of my ongoing analysis.

7. My research leads me to conclude that the analysis prepared by the New York State Public Service Commission ("PSC") staff to defend the large subsidy for existing reactors, and the ZEC program is fundamentally flawed.[2] It misunderstands and misrepresents the current economics of the resources available in New York to meet the need for clean, low carbon electricity. As a result, the ZEC program is not only contrary to the public interest, it is contradictory to and will frustrate the accomplishment of the stated goals for the Clean Energy Standard (CES).

8. I base this conclusion on six analytic conclusions:

I. Nuclear power is uneconomic in every time frame (short-, mid-, and long-term) and across the most important vintages (aging and new).

[2] This affidavit shows that I agree with all of the major criticism that AGREE/NIRS have offered of the ZEC proposal.

a. From an economic point of view. there is no future for new nuclear power in a low carbon, American electricity sector.

b. From an economic point of view, there is no present for aging nuclear reactors in a low carbon, American electricity sector.

II. **Nuclear power is not the most environmentally benign way to achieve a clean, low carbon sector. It is neither clean, nor the lowest source of carbon emissions available.**

a. From an environmental point of view, new nuclear reactors take so long to build that a substantial part of their low carbon claim is dissipated. While aging reactors emit less carbon than coal or gas, they emit more carbon than the alternatives – efficiency, wind and solar (non-hydro renewables).

b. With respect to non-carbon pollution, the alternatives impose much less harm and pose much less of a threat than nuclear power.

III. **There is nothing to be gained from subsidizing aging nuclear reactors, but much to be lost because such subsidies undermine the working of the market and crowd out alternatives, contrary to New York policy.**

a. Nuclear power crowds out alternatives. Historically, nuclear power has been dependent on subsidies and failed to deliver its promised benefits.

b. In the case of New York, however, it also will "crowd out" two important institutions, the market and the creation of a 21st century grid. The ZEC will continue the subsidy tradition in both respects. Rather than preventing "backsliding," it will slow the transition to a clean, low carbon sector and likely extend the dependence on nuclear power.

IV. **Aging nuclear reactors are not needed to meet the clean energy goals for the electricity sector of New York State.**

a. The combination of efficiency, onshore wind, utility PV, and demand response with intensive management and integration of supply and demand, can readily meet the mid-term need. Given the steadily progressive goals, prospects are also excellent for the short-term measures to lay the basis for mid- and long-term success.

b. Given the dramatically declining cost of alternatives and the concomitantly expanding resource base that can be economically exploited, there is no doubt that they can fulfill mid- and long-term needs.

V. **Efficiency plays a key role in facilitating the transition to a clean, low carbon electricity sector.**

a. Efficiency is the least cost, lowest carbon, cleanest resource for the 21st century.

b. Efficiency brings a vitally important resource to the table for the transition to a 21st century sector – it buys time for the transition to develop.

VI. **Subsidizing aging reactors is a very poor approach to a jobs program.**

a. Subsidizing aging reactors is far more likely to produce an overall decrease in jobs in the state than an increase.

b. Subsidizing aging reactors fails to provide a solution to the shift in employment that will inevitably result from the transformation of the electricity sector.

9. In sum, nuclear power has no positive role to play in the present or the future and is likely to have a negative impact on both the present and the future by delaying and distorting the transition to a dynamic 21st electricity system.

10. The remainder of this affidavit briefly presents the empirical evidence upon which I rely to reach each of these findings. The question before the court is whether the ZEC proposal complies with the State's policy and whether the process in which it was adopted complies with the administrative procedures of state law. I show in this affidavit that, if sound economic and environmental reasoning are part of that determination, the ZEC program makes no sense whatsoever.

NUCLEAR POWER IS UNECONOMIC[3]

11. The analysis presented by the Staff is fundamentally flawed. Compared to independent analysis, it overestimates the cost of wind, fails to adjust the going forward contribution of new renewables, underestimates the potential contribution of efficiency, and ignores the contribution of important resources that are certain to play a major role in the long-term development of a clean, low carbon electricity sector. The reasons that independent analysts project a continuing trend of declining costs for the alternatives include experience (a learning curve) and "economies

[3] It is a consumer rip-off to force New York's consumers to buy nuclear power at such costly rates when real clean energy options are available for lower cost, and those costs are falling. Given the environmental, health, and public safety threats imposed by nuclear reactors are considered, staff's "responsive proposal" is even more one-sided. Responsive Comments by Alliance For A Green Economy and Nuclear Information and Resource Service, Proceeding on Motion of the Commission to Implement a Large-Scale Renewable Program and a Clean Energy Standard, Case 15-E-0302, April 22, 2016; RE: Case 15-E-0302- In the Matter of the Implementation of a Large-Scale Renewable Program and a Clean Energy Standard Re: Case 16-E-0270: Petition of Constellation Energy Nuclear Group, LLC; R.E. Ginna Nuclear Power Plant, LLC; and Nine Mile Point Nuclear Station, LLC to Initiate a Proceeding to Establish the Facility Costs for the R.E. Ginna and Nine Mile Point Nuclear Power Plants, July 22, 2016; CASE 15-E-0302: Proceeding on Motion of the Commission to Implement a Large-Scale Renewable Program and a Clean Energy Standard Petition for Rehearing, August 31, 2016. P. 5 (hereafter Responsive Comments)

of scale in permitting, planning, supply chain contracts, etc."[4] As a result of its erroneous assumptions, the staff raises the near-term costs the alternatives, limits their contribution, and "backloads" the real transformation of the sector, further increasing the cost.

(a) The long-term cost of resources: nuclear power has no future in a low carbon electricity sector

12. The proximate cause of the demand for subsidies for aging reactors is the declining level of market clearing prices in New York and elsewhere across the country. This short-term fight must be placed in long-term context, however, to appreciate the real causes and consequence of the ongoing battle over the ZEC.

13. To put this observation in simple terms, we must know where our ultimate destination is located to plot a course to it. With the end-point in sight, we can then see which immediate actions will get us headed in the right direction. In this case, nuclear power is not part of the end-point and keeping uneconomic reactors on line points us in the wrong direction. Indeed, it puts a large obstacle in the way of achieving the ultimate goal.

14. The supply curves I have used to illuminate the underlying issue are presented in Attachment MNC-2. The fact that a technological revolution has made an economically viable response to carbon emissions possible in the electricity sector means that nuclear power has no economic future in the low carbon, 21st century electricity sector, not if economics is an important consideration. Every nuclear reactor must be replaced over the course of the 21st century and nuclear power simply cannot compete.

---

[4] Comments by Alliance For A Green Economy and Nuclear Information and Resource Service, Proceeding on Motion of the Commission to Implement a Large-Scale Renewable Program and a Clean Energy Standard, Case 15-E-0302, April 22, 2016; RE: Case 15-E-0302- In the Matter of the Implementation of a Large-Scale Renewable Program and a Clean Energy Standard Re: Case 16-E-0270: Petition of Constellation Energy Nuclear Group, LLC; R.E. Ginna Nuclear Power Plant, LLC; and Nine Mile Point Nuclear Station, LLC to Initiate a Proceeding to Establish the Facility Costs for the R.E. Ginna and Nine Mile Point Nuclear Power Plants, July 22, 2016, p. 8 (hereafter Comment).

15. "A technological revolution in generation dramatically lowered the cost of some low-carbon technologies.[5] It was built on a combination of public policies and support for research and development that set the direction of socially responsible economic growth and created markets.[6] Policies went well beyond basic research to support deployment and market formation... The private sector responded with investment in innovation. Clean energy patents proliferated, followed by rapid deployment as costs fell.[7]

16. "While the cost of nuclear power continued to rise, the cost of wind and other low-carbon alternatives plummeted. [A]nother technology that has exhibited sharply declining costs—a trend that is expected to continue—is storage. The central station approach used expensive, dirty, fossil-fueled peakers to meet demand surges on a daily basis. Since the raw materials were inexpensive and the externalities of pollution were ignored, it did not make economic sense to invest in storage technologies. Today storage receives a great deal of attention... In the 2025–2030 timeframe—and perhaps sooner—battery power will be the least-cost source of peaking power.[8] Battery power can interact dynamically with renewables to increase their load factor and/or make their output more attractive to grid operators. In fact, some argue that when all of their potential values to the operation of the grid are taken into account, batteries are beneficial at today's costs and will be very attractive at future costs. In any case, storage represents a potential

---

[5] Paragraphs 12-15, are drawn from, Mark Cooper, *The Political Economy of Electricity: Progressive Capitalism and the Struggle to Build a Sustainable Power Sector* (Santa Barbara, Praeger, 2017), pp. 14-17 (hereafter, Cooper, *Political Economy of Electricity).*

[6] The recognition of the technological revolution came first in the academic literature, then in the popular press. See, for example, Ryan Avent, "Creating the Clean Economy," *The Economist*, June 11, 2011; David Leonhardt, "There's Still Hope for the Planet," *New York Times*, July 21, 2012. Cooper, *The Political Economy of Electricity,* Chapter 4.

[7] Marshall Goldberg, *Federal Energy Subsidies: Not All Technologies Are Created Equal* (Washington, DC: Renewable Energy Policy Project, 2000); Nancy Pfund and Ben Healey, *What Would Jefferson Do? The Historical Role of Federal Subsidies in Shaping America's Energy Future* (San Francisco, CA: DBL Investors, 2011); Luis M. A. Bettencourt, Jessika E. Trancik, and Jasleen Kaur, "Determinants of the Pace of Global Innovation in Energy Technologies," *PLOS ONE* 8 (2013): 10, doi: 10.1371/journal.pone.0067894.

[8] Brian Eckhouse, "Batteries Gaining Favor over Gas Peaker Plants in California," *Bloomberg*, December 22, 2015.

resource that could reduce the cost of the 100 percent renewable scenario and make it easier/less costly to ensure its viability.

17. "The potential for storage to transform the electricity system goes hand in hand with another technological revolution that is taking place, powered by information, communications, and advanced control technologies (ICT). It is transforming the ability to manage a dynamic electricity system that integrates decentralized, variable clean renewable supply with demand. It also brings supply into closer coordination with demand, so the size of the system needed to meet demand can be substantially reduced as a result.[9] The ICT revolution is already playing this role in the electricity system, and it could play a large role in meeting the need for low-carbon electricity at affordable costs. Its contribution to the system could be substantial.

18. "A final technological revolution is also taking place on the demand side… [N]ew, more energy-efficient technologies in capital equipment and consumer durables first weakened, then severed the tie between energy consumption and economic growth.[10]

(b) Market clearing in the short-term: uneconomic, aging reactors have no place in a low carbon sector[11]

19. The ZEC program is a blanket subsidy for a collection of reactors, some of which are and would be profitable without a subsidy. In some cases, the subsidy is likely to be too little to meet the revenue goal of the utility. In other cases, it is too much. But, in all cases it is unnecessary

[9] I have analyzed the changes in system size in Jim Lazar, *Teaching the "Duck" to Fly*, Regulatory Assistance Project, January 2014, Regulatory Analysis Project, and concludes that a "dividend" of 10–20 percent in reduced load is achievable, in addition to the benefits of reduced peak and system reliability. Mark Cooper, *The Political Economy of Electricity,* Chapter 6.

[10] U.S. Energy Information Administration, *Monthly Energy Review*, various; Department of Commerce "US Real GDP by Year," *multipl.com*, 2016 http://www.multpl.com/us-gdp-inflation-adjusted/table.

[11] All of the upstate nuclear reactors become eligible for long-term out-of-market contract through 2029. despite one of the proposed eligibility criteria requiring an assessment of "the costs and benefits of such a subsidy for zero-emissions attributes for the facility in relation to other clean energy alternatives for the benefit of the electric system, its customers and the environment," no such analysis has been produced or even implied to support the staff's recommendation that certain nuclear facilities receive the 12-year indication of public necessity. (Responsive Comments, p. 4).

and a huge burden on ratepayers. The nuclear subsidy offered by the ZEC, as calculated by the staff, is over three times as large as the subsidy for renewables.[12]

20. Of equal, if not greater importance is the fact that the cost of keeping aging reactors online is above the full levelized cost of the alternatives and the economic superiority of these alternatives is likely to grow as their costs decline and the cost of aging reactors grows. Attachment MNC-3 shows my recent estimates of the cost of keeping aging reactors online compared to some other recent estimates and the full cost of efficiency, wind and solar. Projecting the trend out a decade would put the cost of high-quality wind and utility PV well below $40/MWh. This is consistent with the more recent analyses by Lazard and NREL of the cost of renewables. Lazard shows the cost of wind and utility PV to be well below the cost of aging reactors even in the near term, as depicted in the Attachment MNC-3.

21. If efficiency and renewables could compete for the subsidy dedicated to nuclear, the total consumer savings could be much larger because the total cost of the low carbon resources could be much lower. The harm of ZECs to the transition is more profound than simply increasing consumer cost, however. It also will slow, distort or undermine the broader transition because cordoning off so much of the market will stunt its development.

22. After counting hydro, the need for low carbon resources to meet the short term goal is just under 40 GWh.[13] The aging reactors that are the target of the ZEC subsidy and removed

[12] For example, a policy to replace closing nuclear reactors with energy efficiency or increased renewable energy was not considered, yet analysis by the Department of Public Service indicates such alternatives would be cost effective and viable. The direct costs of the nuclear subsidies ($7.6 billion through March 31, 2029) are estimated to be more than triple the total direct costs of new renewables supported through the Clean Energy Standard ($2.44 billion through 2030),4 though the total annual generation to be provided by new renewables in 2030 (~34 TWh per year) is more than 25% greater than the amount of nuclear to be subsidized through March 2029 (~27 TWh per year).5 This suggests that incentives spent on new renewable generation sources would be nearly four times more effective in providing zero-carbon generation than subsidies to nuclear generation. (Rehearing Comment, pp. 5-6)

from competition provide over half the nuclear power in the state, at 27 GWh.[14] Since the estimate already includes a modest amount of efficiency gains, the resulting market for new, non-hydro renewables is extremely small, only 12 GWH, or 8% of projected load.

23. The dramatic impact of the inclusion of this huge block of "must run" nuclear power in the short-term supply function can be seen in Attachment MNC-4, which shows the very small market for renewables that results from forcing "must run" nuclear reactors into the stack. This severely restricted market will strangle the ability of non-hydro renewables to expand and is likely to drive the market clearing price down, as resources compete for a smaller market.

NUCLEAR POWER IS NOT THE MOST ENVIRONMENTALLY BENIGN WAY TO ACHIEVE A LOW CARBON SECTOR.[15]

(a) Carbon footprint

24. As shown in Attachment MNC-5, while it is certainly true that aging reactors have fewer greenhouse gas emissions than coal or gas, it is just clear that they have higher levels of emissions than the alternatives. Thus, if decisions are made on "marginal values," aging reactors would be chosen after the alternatives. Moreover, as shown in Attachment MNC-6, new reactors have an even larger deficit compared to the alternatives because they cannot save on carbon emissions during their long construction period, while the alternative, which are much quicker to market, can.

(b) Non-carbon footprint

---

[13] Comment, pp. 5-6, points out that White paper Staff White Paper on Clean Energy Standard, Case 15-E-0302 (Department of Public Service, January 25, 2016 (hereafter, White Paper) projects demand at 150GWH) (Appendix B, p. 2), which requires 75 GWh to meet the 50% goal. With hydro at 36 GWh (Appendix B, p. 3), the need for low carbon resources is 39GWh.

[14] White paper (p. 3).

[15] Though nuclear energy is often seen as a carbon-free energy source, it remains one of the most dirty (and dangerous) ways to generate electricity. The nuclear fuel cycle is rife with environmental racism against Native American, indigenous, and other environmental justice communities, elevated cancer rates for miners, energy intensive and greenhouse gas emitting processes, radioactive leaks and emissions, thermal pollution of rivers and lakes, intractable and costly nuclear waste issues, and environmental catastrophes. (Comment, p. 5)

25. Although carbon emissions are the central concern in this proceeding, no discussion of nuclear subsidies for aging reactors established under a Clear Energy Mandate which is embedded in a policy of "Reforming the Energy Vision," could be complete without recognition of the non-carbon impacts of resources.

26. Attachment MNC-7 compares the three primary non-hydro renewables (efficiency, wind and solar) to the two primary low carbon central station resources (nuclear and gas with carbon capture). It presents evidence on the traditional non-carbon environmental concerns, pollutants and accidents. Central station resources are a much greater concern. Nuclear is not clean by any stretch of the imagination. This ranking was in evidence in the literature on resources long before climate change and carbon emissions were the focal point of concern.[16] Attachment MNC-7 also includes two other factors that enter into the contemporary debate – water and land use. Here there is a mixed message. Central station facilities have much higher water us, but lower land use.

27. While nuclear advocates frequently try to claim the land use question "disqualifies" non-hydro renewables, that argument is a distraction at best. The potential for rural utility PV is one possible response to the land use issue. It is also important to recognize that these two resources use land in different areas in different ways and some applications (commercial, residential and even utility scale PV) represent a secondary use of land that is already occupied. The challenge

[16]Older Rankings can be found in Wilson B. Goddard, *A Comparative Study of the Total Environmental Costs Associated with Electrical Generation Systems* (G&GE Applied Research, 1997); *U.S* Congressional Office of Technology Assessment, *Studies of the Environmental Costs of Electricity* (Washington, D.C. September 1994), evaluating Richard Ottinger, et al., Pace University Center for Environmental Legal Studies, *Environmental Costs of Electricity* (New York,: Oceana, 1990), Paul Chernik and Emily Caverhill, "The Valuation of Externalities from Energy Production, Delivery and Use" (Fall 1989); Olave Hohmeyer, *Social Costs of Energy Consumption: External Effects of Electricity Generation in the Federal Republic of Germany* (Berlin: Springer-Verlag, 1988); Michael Shuman and Ralph Cavanagh, *A Model of Conservation and Electric Power Plan for the Pacific Northwest: Appendix 2: Environmental Costs* (Seattle, WA: Northwest Conservation Act Coalition, November 1982).

of locating the core facilities of the 21st century electricity system appears to be much smaller than the challenge of permanently locating the huge quantities of radioactive waste created by the operation of nuclear reactors.

28. The accident category deserves a comment. The reality is that nuclear reactors suffer a series of smaller incidents that raise safety concerns and also put pressure on the system. Since the electricity system must be design to withstand an outage of its largest generators, the presence of nuclear reactors tends to drive up reserve margins and because they are so large, those margins will have to be met with natural gas. Consequently, both the carbon and non-carbon impacts of nuclear power can be larger than the simple arithmetic of generation units.

SUBSIDIZING UNECONOMIC REACTORS CROWDS OUT RENEWABLES[17]

(a) The Extent and Harm of Crowding out

29. New York State policy seeks to achieve a clean, low carbon electricity sector driven primarily by the market, recognizing that specific standards and subsidies will be necessary to jump start the transition. The ZEC will frustrate, slow and perhaps undermine this objective. [18]

[17] Under this plan, no other company or resource would be allowed to compete for these subsidies, even if they can offer comparative emissions reductions for lower costs and without the dangers and environmental harm caused by nuclear plants. (Responsive Comment, p. 4). The uncompetitive nature of the nuclear subsidies proposed flies in the face of the rest of the Clean Energy Standard proposal, under which renewable energy providers will have to compete for either power purchase agreements or renewable energy credits (or both). It contradicts the entire framework of the Reforming the Energy Vision, under which utilities are asked to provide competitive opportunities to find the most efficient and affordable ways to avoid large consumer investments in big infrastructure and centralized power plants. And it distorts New York's long-standing competitive wholesale marketplace at a moment that it is finally bringing down costs for consumers. (Responsive Comments, p. 6)

[18] Pursuant to Section 3.7 of the New York State Public Service Commission's Rules of Practice and Procedure, Alliance for Green Energy ("AGREE") and Nuclear Information and Resource Service ("NIRS") petition the Public Service Commission for rehearing of certain parts of the Commission's Order issued on August 1, 2016 in the Clean Energy Standard proceeding (Case 16-E-0302). CASE 15-E-0302, p. 5 progress in both carbon emissions reduction and in adoption of renewables appears to be inversely related to the strength of continuing nuclear commitments." (hereafter Rehearing Comment). The closure of unprofitable nuclear reactors is "a true bridge to the renewable energy economy. Freed from wasting ratepayer money on these old plants, New York's consumers could invest in clean technologies and a grid that supports them. This path would provide more durable and long-term investments in the state's decarbonization efforts. (Comment, p. 5) This suggests that

30. As shown in Attachment MNC-8, nuclear power has a tendency to crowd out alternatives. Utilities that do not have any nuclear reactors in their generation mix have almost three times as much non-hydro renewables in their mix as utilities that have nuclear. New York is very close to the regression line, high on nuclear and low on alternatives. If New York behaved like states without nuclear, it would increase its renewables by almost 20%.

31. Suggesting that nuclear must play a central role in the future decarbonization of the electricity sector is simply wrong as a matter of fundamental economics and totally irrelevant to policy making. The existence of nuclear power is a very old sunk cost and its deployment had nothing to do with decarbonization. Backward-looking analysis that nuclear advocates use to make the obvious point that nuclear power has made up a large part of current and total low-carbon generation are an exercise in misdirection. Forward-looking analysis shows that it is not needed to meet the goals of carbon reduction.

- The existing nuclear reactors cannot grow their contribution to decarbonization (except at a huge cost of minor uprating and increased level of high burn up fuel waste). It is the future that matters.
- In the past twenty years, 95% of the low carbon resources deployed have been non-hydro renewables. The recent past is much more likely to be relevant to the future.
- Backward looking analysis can only inform forward looking analysis if it has relevance to the future. Sunk costs should not be considered unless they actually influence important future variables or prices, which the existing nuclear reactors do not (except perhaps in the fact that their operating costs are rising dramatically as they age).
- In the mid- to long-term, none of the existing nuclear reactors will make any contribution to decarbonization. They will all have to be replaced and their future costs, compared to the available alternatives, are all that matters.

---

incentives spent on new renewable generation sources would be nearly four times more effective in providing zero-carbon generation than subsidies to nuclear generation. (Rehearing Comment, pp. 6)

32. With low costs and high potential for non-hydro renewables, the fear of inadequate resources is misplaced. The barrier is not technological or economic, but policy and effort, primarily institutional and, to a lesser extent, physical. New York needs to build the institutional and physical infrastructure to support the 21st century alternative. To do so, policy must overcome three sources of resistance. First, the central station paradigm must be uprooted. It cannot even be part of the solution due to its fundamental conflict with the institutional framework needed by renewable/distributed/demand-based alternatives. Second, this institutional and physical infrastructure will have to be built in any event as the demand ramps up. The primary challenge is now to build the physical and institutional infrastructure that will support a greatly expanded electricity sector that uses only renewable and distributed resources. Third, delaying or slowing the process serves no purpose, but that is precisely what subsidizing aging reactors does.

33. The emerging 21st century system is so totally different from the 20th century system that it not only supplants the old approach, but the old approach gets in the way because central station generation resources are incapable of engaging in the behaviors, above all, responsive flexibility, that are central to the operation of the new system. Nuclear power is the worst offender from the antiquated, central station approach.[19]

---

[19] Lovins, Amory B., and Rocky Mountain Institute. Reinventing Fire: Bold Business Solutions for the New Energy Era. Boulder, CO: Rocky Mountain Institute, 2011, p. 216) had earlier elaborated on the deep-seated sources of conflict between nuclear power and the alternatives, making it clear that a truce that tries to accommodate both sides is neither very likely, nor good policy. "All of the above" scenarios are... undesirable for several reasons.... First, central thermal plants are too inflexible to play well with variable renewables, and their market prices and profits drop as renewables gain market share. Second, if resources can compete fairly at all scales, some and perhaps much, of the transmission built for a centralized vision of the future grid could quickly become superfluous. Third, big, slow, lumpy costly investments can erode utilities' and other provider's financial stability, while small, fast granular investments can enhance it. Competition between those two kinds of

(b) The Benefit of Rapidly Phasing Out Nuclear Energy Stimulates Investment in Renewable Technologies, Renewable Technologies are More Likely Payoff of Investment

34. The baseload-dominated electricity system of the 20th century was created by policy support and subsidies for physical and institutional infrastructure that favored a specific type of technology.[20] The dominant incumbents will seek to slow or stop the spread of alternatives to defend these trillion-dollar investments and assets sunk into central station facilities.[21] Recent climate-change analysis highlights how the inertia of a century of domination by central-station, focused institutions has created a unique challenge.

35. One of the obvious ways to overcome inertia, fill the "innovation gap" and speed the transition is to shift subsidies away from incumbents to the renewable alternatives.[22] In fact, some have argued that the benefits of stimulating innovation are so large that they can offset the apparent "cost" of phasing out nuclear power altogether.[23] Our results show that phasing out nuclear power would stimulate investment in R&D and deployment of infant technologies with

---

investments can turn people trying to recover the former investments into foes of the latter – and threaten big-plant owners' financial stability. Fourth, renewable, and especially distributed renewable, futures require very different regulatory structures and business models. Finally, supply costs aren't independent of the scale of deployment, so PV systems installed in Germany in 2010 cost about 56–67% less than comparable U.S. systems, despite access to the same modules and other technologies at the same global prices.

[20] Gross, Robert, Jonathan Stern, Chris Charles, Jack Nicholls, Chiara Candelise, Phil Heptonstall, and Philip Greenacre. *On Picking Winners: The Need for Targeted Support for Renewable Energy.* London: Imperial College London, 2012, p.18.

[21] Cooper, *Political Economy of Electricity,* Chapter 9; Bianconi, Marcelo, and Joe A. Yoshino. "Risk Factors and Value at Risk in Publicly Traded Companies of the Nonrenewable Energy Sector." *Energy Economics* 45 (2014): 19–32, refer to this as the escalation of commitment. See also Arbuthnott, Katherine D., and Brett Dolter. "Escalation of Commitment to Fossil Fuels." *Ecological Economics* 89 (2013): 7–13; Bloomberg New Energy Finance, *Fossil Fuel Divestment: a $5 Trillion Challenge*, White Paper, August 2014; Farrar-Rivas, Patricia, and Anders Ferguson. *Emerging Research on Climate Change Risk and Fossil-Fuel Divestment.* Veris, July 2014.

[22] Cooper, *Political Economy of Electricity*, Chapter 9

[23] Zelenika-Zovko, I., and J. M. Pearce. "Diverting Indirect Subsidies from the Nuclear Industry to the Photovoltaic Industry: Energy and Financial Returns." *Energy Policy* 39 (2011): 2626–2632.

large learning potentials. This could bring about economic benefits, given the under provision of innovation due to market failures related to both intertemporal and international externalities."[24]

36. Because the potential external costs are so large and the need to overcome inertia is so great, climate change puts a spotlight on technological innovation. Targeted approaches that speed and smooth the transition to low carbon resources can have many benefits.[25] The growing concern over adjustment leads to concern over an "innovation gap."[26] Beyond inertia, many of the benefits of alternative generation technology resources or the processes by which their costs would be reduced – e.g., learning by doing, network effects – are externalities themselves, which means the private sector will underinvest in them.[27] Returns to R&D can be high.[28] Accelerating innovation and adoption can speed the transition, saving a decade or two[29] while reducing economic disruption.[30]

37. The evolution of the renewables costs in the coming years will not be independent of the future of nuclear power, as well as of energy and climate policies. In this context of uncertainty,

---

[24] De Cian, Enrica, Samuel Carrara, and Massimo Tavoni. *Innovation Benefits from Nuclear Phase-Out: Can They Compensate the Cost?* Fondazione Eni Enrico Mattei, 2012., p. 14.

[25] Acemoglu, Daron, Philippe Aghion, Leonardo Bursztyn, and David Hemous. "The Environment and Dedicated Technical Change." *American Economic Review,* 102 (2012), p. 132; Acemoglu, Daron, Ufuk Akcigit, Douglas Hanley, and William Kerr. *Transition to Clean Technology.* Working Paper, Harvard Business School, December 3, 2014.

[26] Gross, et al., 2012.

[27] Gross, et al., 2012, p. 18; Massetti, Emanuele, and Lea Nicita. *The Optimal Climate Policy Portfolio.* CESifo Working Paper no. 2988, Energy and Climate Economics, 2010, p. 1

[28] Qui, Yeuming, and Laura D. Anadon. "The Price of Wind in China During its Expansion: Technology Adoption, Learning-by-Doing, Economies of Scale, and Manufacturing Localization." *Energy Economics* 34 (2012); Massetti and Nicita, 2010.

[29] Dechezleperte, Antoine et al. *Climate Change & Directed Innovation: Evidence from the Auto Industry.* London: London School of Economics and Political Science, 2011.

[30] Grubb, Michael, Thierry Chapuis, and Minh Ha Duong. "The Economics of Changing Course: Implications of Adaptability and Inertia for Optimal Climate Policy." *Energy Policy* 23 (1995): 417–431, p. 428.

policymakers need to understand the economic consequences of nuclear power scenarios when accounting for its interplay with innovation and cost reduction in renewables.[31]

38. Analyzing past subsidies strongly supports the proposition that shifting subsidies from nuclear to other resources will lower the cost and accelerate the speed of transition.[32] It strongly rejects the notion that new subsidies should be showered on mature old technologies like aging reactors. While the nuclear industry complains about the subsidies that are bringing renewables into the market today and resists programs to promote energy efficiency, analysis of the historical pattern demonstrates that the cumulative value of federal subsidies for nuclear power dwarfs the value of subsidies for renewables and efficiency.[33] Renewables are in the early stage of development, as shown in Attachment MNC-9. Nuclear received much larger subsidies in its developmental stage and enjoyed truly massive subsidies compared to other resources as it grew.

39. The graph calculates the rate of growth in subsidies that would be necessary to bring renewables into parity with the early rate of growth in subsidies enjoyed by central station resources. Renewables are more than a dozen years behind the central station resources, but given the importance of inertia, parity may not be enough to overcome the advantages of incumbency. There can be debate about the current level of subsidies, particularly given the difficulty of valuing the nuclear insurance and waste subsidies which are existential rather than

---

[31] De Cian, Enrica, Samuel Carrara, and Massimo Tavoni. "Nuclear Expansion or Phase Out? Costs and Opportunities." *Review of Environment, Energy and Economics*, January 9 2014, p. 1-2.

[32] Cooper, *The Political Economy of Electricity,* pp. 80-85, 220-234, discusses the vastly superior effectiveness of comparatively small subsidies for renewables versus the much larger and less effective subsidies for nuclear.

[33] Goldberg, Marshall. *Federal Energy Subsidies: Not All Technologies Are Created Equal.* Washington, DC: Renewable Energy Policy Project, 2000; Slavin, Matthew. "The Federal Energy Subsidy Scorecard: How Renewables Stack Up." *Renewable Energy World.com*, November 3, 2009.; Branker, Kadra, Michael Pathak, and Joshua M. Pearce. "A Review of Solar Photovoltaic Levelized Cost of Electricity." *Renewable and Sustainable Energy Reviews* 15 (2011): 4470–4482; Badcock, Jeremy, and Manfred Lenzen. "Subsidies for Electricity-Generating Technologies: A Review." *Energy Policy* 38 (2010): 5038–5047; Pfund, Nancy, and Ben Healey, 2011, *What Would Jefferson Do? The Historical Role of Federal Subsidies in Shaping America's Energy Future*. San Francisco, CA: DBL Investors, 2011.

material (i.e., without the socialization of liability and waste disposal the industry would not exist). However, there is no doubt that the long-term subsidization of nuclear power vastly exceeds the subsidization of renewables and efficiency by an order of magnitude of 10 to 1.[34]

40. A decision to shift subsidies to the alternatives should have nothing to do with fairness, however, it should be based on the likely payoff of the investment. Analyses of past subsidies globally and in the United States make it clear that renewables are a much better bet[35] even though the estimates do not include the very large implicit subsidies nuclear enjoys from the socialization of the cost of risk and waste management.[36] It is clear that with a much smaller level of subsidy to drive innovation and economies of scale, the renewables have achieved dramatically declining costs in a little over a decade, which is exactly the economic process that has eluded the nuclear industry for half a century. Attachment MNC-10 captures the essence of the subsidy issue by juxtaposing the magnitude and timing of subsidies and the extent of innovation, as measured by patents issued. The ultimate irony is that despite much smaller subsidies to drive innovation and economies of scale, renewables have achieved dramatically declining costs in just over half a decade.

41. The dramatic increase in innovative activity despite relatively low levels of R&D subsidy and much lower cumulative subsidization reflects the decentralized nature of innovation in the renewable space. It leads to the dramatic payoff in terms of declining price. As we have seen,

---

[34] BWE, German Wind Energy Association. The Full Costs of Power Generation: A Comparison of Subsidies and Societal Cost of Renewable and Conventional Energy Sources. BWE, Berlin, August 2012.; Kitson, Wooders, and Moerenhout, 2011; Berwick, Ann G. Comparing Federal Subsidies for Renewables and Other Sources of Electric Generation. Massachusetts Department of Public Utilities Massachusetts Solar Summit, June 13, 2012; U.S. GAO. Federal Electricity Subsidies: Information on Research Funding, Tax Expenditures, and Other Activities That Support Electricity Production, GAO-08-102. Washington, DC: U.S. Government Printing Office, 2007.; Goldberg, 2000; Pfund and Healey, 2011.

[35] Badcock, and Lenzen, 2010.

[36] Zelenika-Zovk and Pearce, 2011, p. 2626,