## NRR-DMPSPEm Resource

**From:** Andrene Dabaghi <Adabaghi@elpc.org>
**Sent:** Monday, June 18, 2018 11:06 AM
**To:** Vaidya, Bhalchandra
**Cc:** Margrethe Kearney
**Subject:** [External_Sender] RE: RE: Citizen Complaint and Request for Enforcement Action Regarding FirstEnergy Nuclear Facility Operations in Ohio and Pennsylvania
**Attachments:** 1. Peter A. Bradford Declaration.pdf; 2. Callan Institute 2017 NDT Survey.pdf

Dear Mr. Vaidya,

As discussed, attached please find the following supplemental material in advance of our meeting with the PRB tomorrow:

(1) Declaration of Peter A. Bradford
(2) Callan Institute 2017 Nuclear Decommissioning Funding Study

Best,
Andrene

Andrene Dabaghi
Associate Attorney
Environmental Law & Policy Center
35 E Wacker Drive, Suite 1600
Chicago, IL 60601
(312) 795-3702

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**From:** Andrene Dabaghi
**Sent:** Friday, June 15, 2018 1:13 PM
**To:** Vaidya, Bhalchandra
**Cc:** Margrethe Kearney
**Subject:** RE: RE: Citizen Complaint and Request for Enforcement Action Regarding FirstEnergy Nuclear Facility Operations in Ohio and Pennsylvania

Dear Mr. Vaidya,

As discussed on our call, the names of the attendees for our June 19 meeting with the PRB are as follows:

(1) Margrethe Kearney
(2) Andrene Dabaghi
(3) Peter Bradford

We will also plan to send you supplemental information on Monday.

Thank you,
Andrene

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**From:** Vaidya, Bhalchandra [Bhalchandra.Vaidya@nrc.gov]
**Sent:** Friday, June 15, 2018 7:34 AM
**To:** Andrene Dabaghi
**Cc:** Margrethe Kearney
**Subject:** RE: RE: Citizen Complaint and Request for Enforcement Action Regarding FirstEnergy Nuclear Facility Operations in Ohio and Pennsylvania

Ms. Dabaghi,

Thank you for the update. I am available anytime today until 3 pm eastern time to discuss the logistics of the meeting on June 19, 2018.
Please let me know what time you will be calling or whether I should call you.

Bhalchandra K. Vaidya
Licensing Project Manager
NRC/NRR/DORL/LPL3
(301)-415-3308 (O)
bhalchandra.vaidya@nrc.gov

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**From:** Andrene Dabaghi [mailto:Adabaghi@elpc.org]
**Sent:** Thursday, June 14, 2018 6:42 PM
**To:** Vaidya, Bhalchandra <Bhalchandra.Vaidya@nrc.gov>
**Cc:** Margrethe Kearney <MKearney@elpc.org>
**Subject:** [External_Sender] RE: Citizen Complaint and Request for Enforcement Action Regarding FirstEnergy Nuclear Facility Operations in Ohio and Pennsylvania

Dear Mr. Vaidya,

Per our conversation on Tuesday, I wanted to update you on our motion for relief from the automatic stay before the bankruptcy court. The court entered the attached stipulation today regarding ELPC's participation in the PRB meeting on June 19.

Are you available for a call tomorrow (Friday) afternoon to discuss? Please let us know what time works best for you.

Best,
Andrene

Andrene Dabaghi
Associate Attorney
Environmental Law & Policy Center
35 E Wacker Drive, Suite 1600
Chicago, IL 60601
(312) 795-3702

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**From:** Margrethe Kearney
**Sent:** Monday, June 04, 2018 4:06 PM
**To:** Vaidya, Bhalchandra; Andrene Dabaghi
**Subject:** RE: Citizen Complaint and Request for Enforcement Action Regarding FirstEnergy Nuclear Facility Operations in Ohio and Pennsylvania

Mr. Vaidya –

Thanks for your response. We are working with the Debtors in the bankruptcy case to reach a resolution on our motion for relief from the automatic stay. As of now, the stay has not been lifted and it is unclear whether the motion will be resolved at the June 8 hearing. If we are able to confirm either that the stay does not apply or is lifted for purposes of this proceeding, we will attend in person on June 19. I will provide the additional details requested below as they are available.

Thank you for your patience during this process. I will keep you updated on the proceedings in front of the bankruptcy court.

Margrethe

**Margrethe K. Kearney**
Senior Attorney
Environmental Law & Policy Center
1514 Wealthy St. SE, Suite 256
Grand Rapids, MI 49506
(773) 726-8701 (mobile)
MKearney@elpc.org

**From:** Vaidya, Bhalchandra [mailto:Bhalchandra.Vaidya@nrc.gov]
**Sent:** Thursday, May 31, 2018 9:29 AM
**To:** Andrene Dabaghi; Margrethe Kearney
**Subject:** Citizen Complaint and Request for Enforcement Action Regarding FirstEnergy Nuclear Facility Operations in Ohio and Pennsylvania

Margrethe Kearney
Andrene Dabaghi
Environmental Law & Policy Center
35 E. Wacker Drive, Ste. 1600
Chicago, IL 60601
(312) 673-6500

Dear Margrethe Kearney and Andrene Dabaghi,

Thank you for your email dated May 25, 2018.

The Petition Review Board (PRB) will be available on Tuesday, June 19, 2018, for you to address the PRB in person or by telephone, from 12:30PM to 1:30 PM. This time period includes time for the PRB's introductory comments, "Introductions," and "Questions & Answers," including those from the PRB, and Public, leaving about 20-30 minutes for you to present additional and/or supplemental information.

Please confirm that this date and time is acceptable to you, including whether you will addressing the PRB in person, or by telephone.

Also, to make further arrangements, please provide some additional details such as follows:

(1) Number of People attending
(2) Names of the Presenters
(3) Presentation Material, such as Handouts
(4) Additional and Supplemental Information

Please feel free to contact me, if you have any questions.

Thanks.

Bhalchandra K. Vaidya
Licensing Project Manager
NRC/NRR/DORL/LPL3
(301)-415-3308 (O)
bhalchandra.vaidya@nrc.gov

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**From:** Andrene Dabaghi [mailto:Adabaghi@elpc.org]
**Sent:** Friday, May 25, 2018 10:58 AM
**To:** Vaidya, Bhalchandra <Bhalchandra.Vaidya@nrc.gov>; Margrethe Kearney <MKearney@elpc.org>
**Cc:** Buckberg, Perry <Perry.Buckberg@nrc.gov>
**Subject:** [External_Sender] RE: Citizen Complaint and Request for Enforcement Action Regarding FirstEnergy Nuclear Facility Operations in Ohio and Pennsylvania

Dear Mr. Vaidya,

Thank you for your email. The following dates after June 8 work best for us to address the PRB in-person:

**Tuesday, June 19**
**Wednesday, June 27**

Thank you,

Andrene Dabaghi
Associate Attorney
Environmental Law & Policy Center
35 E Wacker Drive, Suite 1600
Chicago, IL 60601
(312) 795-3702

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**From:** Vaidya, Bhalchandra [mailto:Bhalchandra.Vaidya@nrc.gov]
**Sent:** Thursday, May 24, 2018 10:23 AM
**To:** Andrene Dabaghi; Margrethe Kearney
**Cc:** Buckberg, Perry
**Subject:** Citizen Complaint and Request for Enforcement Action Regarding FirstEnergy Nuclear Facility Operations in Ohio and Pennsylvania

Margrethe Kearney
Andrene Dabaghi
Environmental Law & Policy Center
35 E. Wacker Drive, Ste. 1600
Chicago, IL 60601
(312) 673-6500

Dear Margrethe Kearney and Andrene Dabaghi,

Thank you for your email dated May 18, 2018.

In consideration of your request to address the Petition Review Board (PRB) after June 8, 2018, please note that the PRB would wait to make any decisions regarding "initial recommendations" until after you have had the opportunity to address the PRB.

However, consistent with MD 8.11, in order to provide timely response to your petition, please provide a few possible dates soon after June 8, 2018, when you would like to address the PRB, in person or by telephone.

Please do not hesitate to contact me if you have any questions on the above or the petition process.

Thank you,

Bhalchandra K. Vaidya
Licensing Project Manager
NRC/NRR/DORL/LPL3
(301)-415-3308 (O)
bhalchandra.vaidya@nrc.gov

**Hearing Identifier:** NRR_DMPS
**Email Number:** 431

**Mail Envelope Properties** (B73BB64525149F42989D6BD5C7BCAED101ED145B)

**Subject:** [External_Sender] RE: RE: Citizen Complaint and Request for Enforcement Action Regarding FirstEnergy Nuclear Facility Operations in Ohio and Pennsylvania
**Sent Date:** 6/18/2018 11:06:04 AM
**Received Date:** 6/18/2018 11:07:43 AM
**From:** Andrene Dabaghi

**Created By:** Adabaghi@elpc.org

**Recipients:**
"Margrethe Kearney" <MKearney@elpc.org>
Tracking Status: None
"Vaidya, Bhalchandra" <Bhalchandra.Vaidya@nrc.gov>
Tracking Status: None

**Post Office:** elpc03

| **Files** | **Size** | **Date & Time** |
|---|---|---|
| MESSAGE | 7915 | 6/18/2018 11:07:43 AM |
| 1. Peter A. Bradford Declaration.pdf | 291039 | |
| 2. Callan Institute 2017 NDT Survey.pdf | 5322293 | |

**Options**
**Priority:** Standard
**Return Notification:** No
**Reply Requested:** No
**Sensitivity:** Normal
**Expiration Date:**
**Recipients Received:**

# DECLARATION OF PETER A. BRADFORD

I, Peter A. Bradford, pursuant to the provisions of 28 U.S.C. § 1746 do hereby declare as follows:

1. My name is Peter Amory Bradford. I live in Peru, Vermont. My resume is attached to this declaration as Attachment 1.

2. I am President of Bradford Brook Associates, a firm advising on utility regulation and energy policy.

3. I have served as an expert witness on aspects of nuclear power plant regulation and nuclear plant economics in state legislative and regulatory proceedings as well as in court proceedings and before the U.S. Nuclear Regulatory Commission. I have written and advised on nuclear power costs including decommissioning in many U.S. states and abroad.

4. I am a commissioner on the Texas/Vermont Low Level Radioactive Waste Compact Commission, whose responsibilities include the receipt of the eventual decommissioning waste from the closed Vermont Yankee nuclear power plant as well as other present and future decommissioning sites in the U.S.

5. I have taught a course entitled "Nuclear Power and Public Policy" at Vermont Law School. I have been a member of the Keystone Center "Nuclear Power Joint Fact Finding" (June 2007) and the National Research Council of the National Academy of Science's Committee on "Alternatives to the Indian Point Energy Center for Meeting New York Electric Power Needs" (June 2006). I was also a member of the International Expert Panel advising the European Bank for Reconstruction and Development assessing the economic case for completing Khmelnitsky 2 and Rovno 4 (K2/R4) – two partly built, Russian designed 1,000 MW VVER nuclear units in Ukraine – to replace the two operational 1,000 MW units at Chernobyl (February 1997).

6. I chaired the New York Public Service Commission (1987-95). During that time, the NYPSC set rates to cover the costs, including decommissioning, of eight nuclear power units, including the now decommissioned Shoreham plant.

7. I served on the Maine Public Utilities Commission (1971-1977 and 1982-1987) and was Chairman in 1974-1975 and 1982-87. During my 1982-87 term, Maine electric rates included payments into the now decommissioned Maine Yankee plant decommissioning trust fund.

8. Between 1968 and 1977, I lived within 10 miles of the Maine Yankee nuclear power plant in Wiscasset Maine. Maine Yankee began operating in 1972. I have firsthand familiarity with the awareness and expectations of a host community in that era as to issues that would confront it when the plant closed.

9. I served as a commissioner on the U.S. Nuclear Regulatory Commission (1977-82). During my term, the NRC commenced work on the rulemaking that led to its first comprehensive decommissioning rule.

10. I was a member and sometime chair of Vermont's Public Oversight Panel on the reliability of the Vermont Yankee nuclear power plant. I advised the Vermont Legislature and the Town of Wiscasset, Maine on issues related to spent nuclear fuel storage. I am also affiliated with the Regulatory Assistance Project, which provides assistance to state and federal energy regulatory commissions regarding economic regulatory policy and environmental protection.

11. I make this declaration based on my own personal knowledge in support of the petition by the Environmental Law & Policy Center ("ELPC") submitted to the NRC on March 27, 2018 under 10 C.F.R. § 2.206 pertaining to decommissioning funding for the Beaver Valley, Davis-Besse, and Perry nuclear plants. These plants are owned by FirstEnergy Nuclear Generation and operated by FirstEnergy Nuclear Operating Company.

12. The Atomic Energy Act, 42 U.S.C.A. § 2201(x)(1), and NRC regulations, 10 CFR § 50.75, contain provisions outlining nuclear plant licensees' responsibilities with respect to assurances that funds will be available to decommission their nuclear facilities.

13. Future decommissioning costs are subject to many large uncertainties, including the pace and nonradiological standards of decommissioning that may be required by the host states and localities, the pace at which the federal government is able to carry out its obligation to remove the spent fuel from the reactor sites and the costs of transporting and disposing of radioactive waste other than spent fuel.[1] Neither the licensees nor the Nuclear Regulatory Commission control these costs.

14. Decommissioning cost estimates have increased at a compound annual rate of about 6% in recent years, rising from a low of $49.2 billion in 2008 for investor owned

[1] One example of these uncertainties with which I am quite familiar is the financial peril which caused the nation's only licensed repository for class B and class C nuclear waste, an unavoidable product of nuclear plant decommissioning, to describe itself as a "failing company" in court filings in 2015 and 2016. Though the facility has since changed hands, its long-term economic viability is not assured.

utilities to $76.0 billion in 2016.[2] This rate of escalation is higher than that assumed in NRC regulations. Furthermore, calculations and critiques by credible independent entities indicate that there may be decommissioning-related costs beyond those calculated according to NRC regulations and that NRC formulae may omit some significant cost elements.[3]

15. The institutional framework within which decommissioning funds have accumulated has changed dramatically in the last half century.

16. When I was on the Nuclear Regulatory Commission, only a handful of very small power reactors had been decommissioned, and there were no requirements for separated decommissioning trust funds that I recall.

17. As recently as 25 years ago, all of the reactors that are the subject of this petition were owned by vertically integrated utilities. The same company that owned the reactors sold electricity to retail customers, who had no choice of suppliers. The NRC by then required that adequate decommissioning trust funds be established and maintained for every power reactor. As to investor-owned reactors, the relevant state or federal utility regulators approved rates that included annual contributions to these decommissioning funds. A goal of the regulatory commission rate decisions with which I am familiar was to assign the costs of accumulating decommissioning trust funds as nearly as possible to the customers who were using the electricity from the nuclear power plants, considering growth in the value of the decommissioning trust funds. Future electric customers who do not use the electricity from today's nuclear plants should not, to the extent possible, have any of the costs of these nuclear plants reflected in their electric bills. Assigning costs to customers who do not cause them is both unfair and contrary to fundamental principles of economically efficient utility pricing.

18. With the coming of electric industry restructuring and competition in the generation of electricity in the 1980s and 1990s, many power reactors, including those subject to the ELPC petition, were conveyed to nonutility owners who sold the energy and capacity from their plants into power markets rather than to end-use customers. With the ending of the protection of regulated monopoly markets, many of these reactors lost the ability to pass decommissioning fund contributions on to monopoly customers through regulated rates. They often ceased making contributions to the

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[2] *See* CALLAN INSTITUTE, 2017 Nuclear Decommissioning Study 9 (2017), https://www.callan.com/wp-content/uploads/2017/09/Callan-2017-NDT-Survey.pdf.

[3] U.S. Gov't Accountability Off., GAO-12-258, Nuclear Regulation: NRC's Oversight of Nuclear Power Reactors Could be Further Strengthened 13–15 (2012), https://www.gao.gov/assets/590/589923.pdf.

decommissioning funds and represented to the NRC that growth in the value of the funds coupled with guarantees from parent companies would assure that decommissioning costs would be fully covered.

19. On March 31, 2018, FirstEnergy Solutions ("FES") and its subsidiaries FirstEnergy Nuclear Generation ("NG") and FirstEnergy Nuclear Operating Company ("FENOC") filed for bankruptcy.

20. FES has announced plans to retire its nuclear plants soon: 2020 for Davis-Besse and 2021 for Beaver Valley and Perry. The most recent Decommissioning Funding Status Report ("DFS Report") dated March 2017 for these nuclear plants, *see* ML17083B221, does not reflect this accelerated decommissioning timeline. This new timeline severely cuts the time available for the funds to grow[4] and eliminates any chance that the plants themselves will make contributions based on earnings. The early retirement of these plants means that the time before major expenditures deplete the funds and before complete decommissioning will be shortened by many years.

21. Despite the funding shortfalls occasioned by the aforementioned events, the NRC issued a Preliminary Notification on April 4, 2018 stating "Decommissioning funding for each site continues to be sufficiently funded under NRC regulations," *see* ML18094A834.

22. The basis for the NRC's finding of reasonable assurance of adequate decommissioning funding for Beaver Valley, Davis-Besse, and Perry is not clear from either the 2017 DFS Report or the April 4, 2018 NRC letter. The accelerated decommissioning timelines make it imperative for FENOC and NG to provide updated DFS Reports for Beaver Valley, Davis-Besse and Perry to provide some basis for their belief in adequate assurance of decommissioning funding.

23. Guarantees from parent company FirstEnergy Corporation ("FE") have in past been used to make up for decommissioning fund shortfalls. However, FE has acknowledged in Ohio regulatory proceedings that its own credit position has weakened, resulting in rating agency downgrades.

24. In addition to nuclear units owned by bankrupt debtors, FE is also among the creditors of troubled coal plants. If these debts are not paid, FE will be less able than

[4] Beaver Valley 1 would close in 2021 rather than 2036. Its decommissioning fund would contain $310 million instead of $417 million. If the same decommissioning assumptions are made, large withdrawals will occur 15 years sooner than planned. Decommissioning expenditures will conclude in 2082 instead of 2097. (DFS Report for Beaver Valley 1, March 24, 2017). Beaver Valley 2 will close in 2021 rather than 2047. Davis-Besse would close in 2020 rather than 2037. Perry would close in 2021 rather than 2026.

had been assumed to make up shortfalls in decommissioning funding. In particular, FE is now trying to reduce or even escape its exposure as a parent company guarantor.[5] Indeed, FE now lists only TMI-2 as a nuclear facility for whose decommissioning costs it may be liable[6], though it has in past acknowledged a potential liability for the decommissioning costs of Davis-Besse, Perry and Beaver Valley. FE CEO Chuck Jones has been described as saying that FE, "expects to wash its hands of the troubled generation subsidiary" in the FES bankruptcy filing.[7]

25. The FES and FENOC bankruptcies raise serious concerns that the company's nuclear plants will be kept in SAFSTOR much longer than will be in the economic and land use interests of the host states and localities.

26. The use of SAFSTOR to defer the need for decommissioning expenditures (as well as to allow for decay of radioactivity) is a gamble that most units not adjacent to operating plants have preferred to avoid. Prematurely closed plants such as Maine Yankee, Connecticut Yankee and Massachusetts Yankee as well as the Zion units in Illinois preferred the certainty of prompt decommissioning under today's known rules and funding sources. They did not need to roll the dice in hopes that financial markets would provide the assurance that their past management had not.

27. In addition, the state and local governments with which I am familiar have strongly preferred that closed nuclear power plants be decommissioned as quickly as possible, primarily for economic development reasons, to make the land available for other purposes. Few communities hosting nuclear plants (and none where the plants were sited before the 1980s) were told that decommissioning might last for many decades after the plants were closed. The SAFSTOR option, legal though it may be, is a breach of the faith of any state or locality that expected to be able to devote the entire nuclear plant site to other uses within a decade or two of the plant closing.

28. As far as I know, the NRC has no experience with assuring the adequacy of decommissioning funds in the context of a bankrupt licensee backstopped by ostensible guarantees from a financially stressed parent company. Licensees FENOC

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[5] FirstEnergy Corp., Form 10Q for the period ending March 31, 2018 at 3.

[6] *Id.* at 37. TMI 2 will be a unique decommissioning project. Experience elsewhere will be of limited assistance in trying to predict the costs. This is the site of the 1979 Three Mile Island accident. The plant only operated for one year before the accident and has not operated since. The used fuel has been removed from the site. However, the accident released far more radioactivity than will be encountered at other sites, and much of it remains in the containment and elsewhere.

[7] Anya Litvak, "FirstEnergy's Bruce Mansfield and Beaver Valley likely headed for bankruptcy next month", PITTSBURGH POST-GAZETTE (Feb. 21, 2018), http://www.post-gazette.com/powersource/companies/2018/02/21/FirstEnergy-s-Bruce-Mansfield-and-Beaver-Valley-likely-to-be-plunged-into-bankruptcy-next-month-coal-nuclear/stories/201802220050.

and NG have not provided any updated DFS reports for Beaver Valley, Davis-Besse and Perry since March 2017, and therefore have not accounted for early plant retirement in their calculations. It is essential for the NRC to require updated financial information from FES regarding the decommissioning of these plants, so that the agency may properly analyze the availability of decommissioning funds.

29. If FES and FE fail to assure fully adequate funding for all decommissioning contingencies, future customers and taxpayers may be called on to make up shortfalls in the hundreds of millions of dollars. Otherwise, the consequences of inadequate funding will fall upon the neighbors of the nuclear power plants through delayed decommissioning. These are precisely the results that decommissioning legislation and regulation has long sought to avoid.

30. For these reasons, I support the Demands for Information made by ELPC in its 2.206 petition and strongly urge the NRC promptly to request from FES an updated DFS Report for the Beaver Valley, Davis-Besse, and Perry nuclear plants. Because of the bankruptcy of FES and FENOC as well as the financial stress on FE, the NRC should be sure that it takes the full range of potential decommissioning costs into account and that the payment of these costs can be assured through fully protected access to assured funding from a financially reliable source. Any necessary guarantees from FE should be in forms that cannot be undermined by the current bankruptcy proceedings or by the financial stress under which FE finds itself.

I declare under penalty of perjury that the foregoing is true and correct.

Executed on this _15th__ day of _June__, 2018.

Peter A. Bradford

**ATTACHMENT 1**

**PETER A. BRADFORD**
P.O. BOX 497
PERU, VERMONT 05152
(802) 824-4296

**PROFESSIONAL EXPERIENCE:**

Peter Bradford was until 2018 an adjunct professor at Vermont Law School, where he taught "Nuclear Power and Public Policy" and "The Law of Electric Utility Restructuring". He also advises and teaches on utility regulation, restructuring, nuclear power and energy policy in the U.S. and abroad. He was a member and chair of the Public Oversight Panel for the Comprehensive Vertical Assessment of Vermont Yankee Nuclear Power Plant and has served as an expert witness on investment in new nuclear power plants in several states. He is one of Vermont's two representatives on the Texas/Vermont Low Level Radioactive Waste Disposal Compact Commission and served on the advisory panel for the Bipartisan Policy Center project on nuclear waste. He has been a visiting lecturer in energy policy and environmental protection at Yale University and served on New York State's 2012-13 Moreland Commission on Utility Storm Response

He served on the U.S. Nuclear Regulatory Commission from 1977 until 1982. During his term, the NRC undertook major upgrading of its regulatory and enforcement processes in the wake of the Three Mile Island accident.

He chaired the New York State Public Service Commission from 1987 until 1995 and the Maine Public Utilities Commission from 1982 until 1987. During these years, New York resolved its stalemate over the Shoreham nuclear power plant and Maine resolved its involvement in Seabrook, both on favorable economic terms. He was Maine's Public Advocate in 1982 and was President of the National Association of Regulatory Utility Commissioners during 1987.

Prior to becoming a member of the NRC, he had served on the Maine Public Utilities Commission (1971-1977) and was Chairman in 1974-1975.

He served on the 2007 Keystone Center fact finding collaboration on nuclear power and the 2006 National Academy of Sciences panel evaluating the alternatives to continued operation of the Indian Point Nuclear Power Plants in New York. He is also affiliated with the Regulatory Assistance Project, which provides assistance to state and federal energy regulatory commissions regarding economic regulatory policy and environmental protection.

He served on a panel advising the European Bank for Reconstruction and Development on how best to replace the remaining Chernobyl nuclear plants in Ukraine and also on an expert panel advising the Austrian Institute for Risk Reduction on regulatory agency issues associated with

the opening of the Mochovce nuclear power plant in Slovakia. He advised the Vermont Legislature on issues relating to spent fuel storage at Vermont Yankee and the Town of Wiscasset, Maine, on issues related to the storage of spent nuclear fuel at the site of the former Maine Yankee nuclear power plant.

He has advised on electric restructuring issues and has testified on aspects of nuclear power, electricity and telecommunications restructuring in many U.S. states.

He has also advised on energy, telecommunications and water utility restructuring issues in China, Armenia, Azerbaijan, Canada, Georgia, India, Indonesia, Kazakhstan, Kyrgyzstan, Mongolia, Russia, Samoa, South Africa and Trinidad and Tobago. He is a member of the Policy Advisory Committee of the China Sustainable Energy Program, a joint project of the David and Lucille Packard Foundation and the Energy Foundation.

Mr. Bradford was an advisor to Maine Governor Kenneth Curtis from 1968 to 1971, with responsibilities for oil, power and environmental matters. He assisted in preparing landmark Maine laws relating to oil pollution and industrial site selection and was Staff Director of the Governor's Task Force on Energy, Heavy Industry and the Coast of Maine.

Mr. Bradford is the author of Fragile Structures: A Story of Oil Refineries, National Security and the Coast of Maine, a book published by Harper's Magazine Press in 1975. His articles on utility regulation and nuclear power have appeared in many publications, including The New York Times, The Washington Post, The Los Angeles Times, The Boston Globe, The Atlanta Journal Constitution, The Bulletin of the Atomic Scientists, and The Electricity Journal.

He is a 1964 graduate of Yale University and received his law degree from the Yale Law School in 1968.

He is married, has three children and lives in Peru, Vermont.

**PROFESSIONAL AFFILIATIONS:**

2011-present – Commissioner, Texas/Vermont Low Level Radioactive Waste Compact Commission

2013-2015 – Member Bipartisan Policy Center panel on disposal of high level nuclear waste.

1999-2015 - Member, Policy Advisory Committee, China Sustainable Energy Project (funded by the David and Lucille Packard Foundation and the Energy Foundation).

2012-13 – Commissioner, New York State Moreland Commission on Utility Storm Response

2007 – Member, Keystone Center project on the future of nuclear power

2006 – Member of the National Research Council Center on Alternatives to the Continued Operation of the Indian Point Nuclear Power Plants

1998-2002 - Member, Advisory Council, New England Independent System Operator

Nov. 1986-Nov. 1987 President, National Association of Regulatory Utility Commissioners

1977-1995 NARUC positions**,** Member, Executive Committee; Member, Electricity Committee (1977-1989); Member, Gas Committee (1989-1993); Member, Communications Committee (1975-1977); Board of Directors, National Regulatory Research Institute (1985-1987).

1975-1977, 1982-1986. Advisory Council, Electric Power Research Institute

1987-1995, Member of New York State Energy Planning Board

1987-1995, Member, Board of Directors, New York State Energy Research and Development Administration

!987-1995, Member, New York State Environmental Board;

1987-1995, Chair, New York State Energy Facilities Siting Board

1992-1994, State co-chair, New York State Task Force on Telecommunications Policy

Vice-chair, Board of Directors, Union of Concerned Scientists

Board of Directors, Nuclear Control Institute

**EDUCATION:**

1964 *B.A*. History, Yale University, New Haven, CT
1968 *L.L.B.,* Yale University School of Law, New Haven, CT

**AWARDS:**

Honorary Degree, Unity College, 1981.
Environmental Award, Natural Resources Council of Maine, 1979.

**PUBLICATIONS**

**Books**

*Fragile Structures: A Story of Oil Refineries, National Security and the Coast of Maine,* 1975, Harpers Magazine Press.

**Law Review**

*Maine's Oil Spill Legislation*, Texas International Law Journal, Vol.7, No.1, Summer 1971, pp.29-43.

**Articles**

"Wasting Time: Subsidies, Operating Reactors and Melting Ice", Bulletin of the Atomic Scientists, January, 2017, http://www.tandfonline.com/doi/full/10.1080/00963402.2016.1264207?scroll=top&needAccess=true

"Compete or Suckle: Should Troubled Nuclear Power Plants Be Subsidized?". The Conversation, August 17. 2016; https://theconversation.com/compete-or-suckle-should-troubled-nuclear-reactors-be-subsidized-62069

"Delivering the Nuclear Promise: TVA's Sale of the Bellefonte Nuclear Power Plant Site", Bulletin of the Atomic Scientists, June 1, 2016, http://thebulletin.org/delivering-nuclear-promise-tvas-sale-bellefonte-nuclear-power-plant-site9524

"When the Unthinkable is Deemed Impossible: Reflections on Fukushima", Bulletin of the Atomic Scientists, March 20, 2016, http://thebulletin.org/commentary/when-unthinkable-deemed-impossible-reflecting-fukushima9268

"What the EPA's Clean Power Plan Means for Nuclear Energy", Bulletin of the Atomic Scientists, September, 2015

"Why GOP Support for Subsidized Nuclear Energy is Confounding", Bangor Daily News, July 11, 2015;

"Playing Chicken with Illinois Electric Rates Won't Improve the Climate", Crain's Chicago Business, January 7, 2015;

"Foreword, World Nuclear Industry Status Report", July 2013, WNISR, pp. 4-5, http://www.worldnuclearreport.org/IMG/pdf/20130716msc-worldnuclearreport2013-lr-v4.pdf;

"How to Close the U.S. Nuclear Industry: Do Nothing", Bulletin of the Atomic Scientists, March, 2013, pp. 12-21;

"Transparency and Nuclear Regulation: A U.S. Perspective", prepared for International Right to Know Day, Tokyo, September 2012;

"The Nuclear Landscape", Nature, March 8, 2012, p. 151, http://www.nature.com/nature/journal/v483/n7388/full/483151a.html;

"Taxpayer Funding for Nuclear Power: Issues and Consequences", Chapter 5 of Nuclear Power's Global Expansion: Weighing Its Risks, Henry Sokolski, ed. http://www.npolicy.org/userfiles/image/Taxpayer%20Financing%20for%20Nuclear%20Power,%20Precedents%20and%20Consequences_pdf.pdf;

Book review, *The End of Energy,* The Wall Street Journal, May, 2011, http://online.wsj.com/news/articles/SB10001424052748703421204576327370005700428;

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Study

# 2017 Nuclear Decommissioning Funding Study

NDT Fund Balances, Annual Contributions, and Decommissioning Cost Estimates as of Dec. 31, 2016

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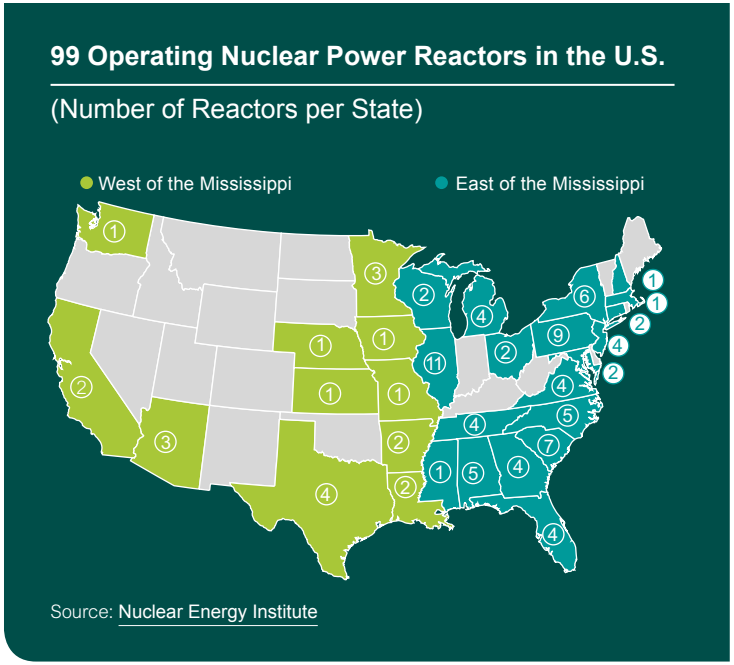
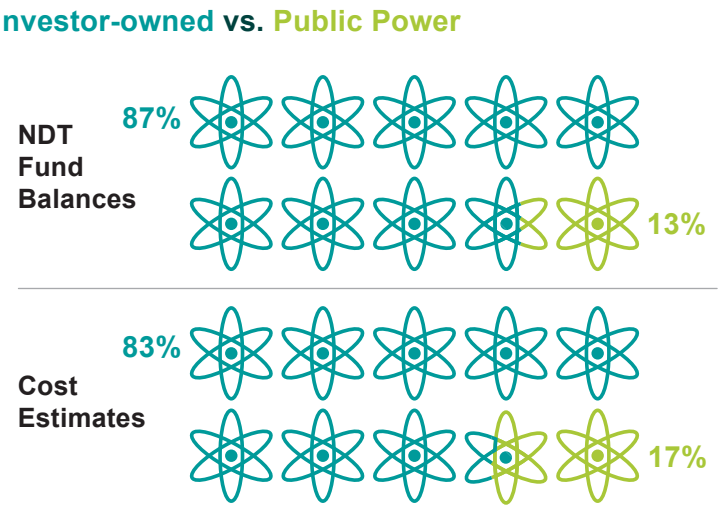
# Executive Summary

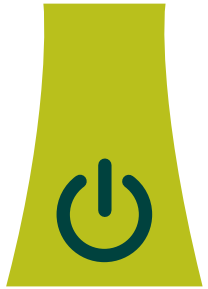



Callan's annual *Nuclear Decommissioning Funding Study* offers key insights into the status of nuclear decommissioning funding in the U.S. to make peer comparisons more accurate and relevant. The 2017 study covers 27 investor-owned and 27 public power utilities (excluding public power owners with small shares)[1] with an ownership interest in the 99 operating nuclear reactors and 11 of the non-operating reactors in the U.S. The number of utilities with an ownership interest declined steadily in the early- to mid-2000s, due primarily to mergers/acquisitions and the sale of nuclear-generating facilities. However, in recent years the number of these utilities has remained fairly steady.

## What Is Nuclear Decommissioning?

After a nuclear power plant is closed, the facility must be decommissioned by safely removing it from service and reducing residual radioactivity to a level that permits release of the property and termination of the operating license. Decommissioning involves removing spent fuel from the reactor vessel, dismantling and disposing of radioactive components and materials such as the reactor and piping, and cleaning up any radioactive or hazardous contamination that remains on site.



## Decommissioning Funding and Reporting

The U.S. Nuclear Regulatory Commission (NRC) oversees the decommissioning of nuclear facilities and requires owners to set aside funds for the work. Approximately 70% of licensees are authorized to accumulate decommissioning funds over the operating life of their plants. These owners—generally traditional, rate-regulated utilities—gradually build up money for decommissioning over the plant's operating life by collecting money from customers through rates that are then placed in a nuclear decommissioning trust (NDT). The remaining licensees (approximately 30%) must provide financial assurance through other methods, such as prepaid decommissioning funds and/or a surety method or guarantee.

1 Public power owners excluded: Dalton Utilities (Edwin Hatch 1 & 2 and Vogtle 1 & 2), Hudson Light and Power Department (Seabrook 1), Seminole Electric Cooperative (Crystal River 3), Taunton Municipal Lighting Plant (Seabrook 1), and seven municipalities in Florida (Crystal River 3).

# Executive Summary

**Decommissioning Costs Include:**

- **Labor**
- **Energy**
- **Waste material transportation & disposal**

Each year, owners must review the decommissioning cost requirements and the status of their decommissioning funding for each reactor or share of a reactor they own. The findings must be reported to the NRC every two years, or annually within five years of shutdown or once the plant ceases operation.

Labor, energy, and waste material transportation and disposal are the primary components of decommissioning costs. Costs can be based on either the NRC minimum cost formula or a site-specific cost estimate calculated by an engineering firm—as long as that amount is greater than the NRC cost figure. Site-specific engineering studies provide the most reliable decommissioning cost estimates. These studies often include costs beyond the NRC's scope of decommissioning, such as spent fuel management and site restoration (also known as "green fielding"), which together can run into the hundreds of millions of dollars.

## Key Findings

**The shrinking gap between assets and liabilities in 2016 resulted in an increase in the funding level from 67% in 2015 to 70% in 2016**

See pages 7, 9, and 11 for details.

**$64 billion**

**in total NDT funds**

See page 7 for details.

**In 2016 NDT contributions fell**

**$64 million**

See page 8 for details.

**Cost Estimates of Decommissioning**
(2008 v. 2016)

= $10 billion

See page 9 for details.

# Methodology

| Lic Exp | [Avg Yrs] | |
|---|---|---|
| 2044 | [28] | |
| 2034-2037 | [19] | 2, |
| 2029-2046 | [20] | 4, |
| 2032-2045 | [17] | 6,7 |
| 2045 | [28] | 1, |
| 2030-2046 | [19] | |
| 2045-2047 | [30] | |

| | Cost Est | A |
|---|---|---|
| 236 | $865 | $ |
| 2,285 | $1,961 | $85 |
| 4,117 | $2,491 | $605 |
| 6,726 | $4,345 | $646 |
| 1,217 | $1,700 | $1,39 |
| 155 | $8,150 | $8 |
| 5 | $433 | |
| | $1,798 | |

| Balance ($mm) | Pro Forma Fund Shortfall ($mm) | Annu Curren Amount |
|---|---|---|
| $557 | $489 | $7 |
| $1,803 | $158 | $9 |
| $2,185 | $1,301 | $0 |
| $4,484 | $1,211 | $2 |
| $1,291 | $409 | $0 |
| 207 | $2,391 | |
| | $315 | |

| Annual Contribution ($mm) | |
|---|---|
| Current Amount | Pro Forma Amount Shortfall/Avg Yrs |
| $7 | $18 |
| $9 | $8 |
| $0 | $66 |
| $2 | $70 |

This *Nuclear Decommissioning Funding Study* covers two types of utilities:

1. Investor-owned utilities, which are publicly traded companies that provide for-profit electric service, and
2. Public power utilities, which are operated by local governments to provide not-for-profit electric service.

We list these companies in alphabetical order in two separate tables (pages 5 and 6). For each table, the first column provides the range of the years of license expiration (Lic Exp) for each unit owned along with the average years to expiration in brackets.[1] We collected the decommissioning cost estimates, NDT fund balances, and annual contributions from sources including (but not limited to): company 10-K filings with the Securities and Exchange Commission (SEC), company decommissioning report filings with the NRC in accordance with 10 CFR 50.75, and company annual reports. The NRC and Nuclear Energy Institute's websites were also valuable resources in collecting and verifying information in this report.

Unless otherwise noted, cost estimates are in 2016 dollars and based on site-specific studies representing the total cost (license termination, spent fuel management, and site restoration) to decommission the facility. In order to make the data comparable, we have calculated a "pro forma" decommissioning cost estimate, which is the higher of either the company cost estimate of decommissioning or $847/kilowatt (KW). We arrived at $847/KW by taking the average cost per KW reported for all investor-owned utilities. Trust fund balances represent liquidation values and include any internal reserves dedicated to decommissioning unless otherwise noted. Contributions include those to both external trust funds and any internal reserves dedicated to decommissioning.

Pro forma fund shortfall is the difference between the "pro forma" cost estimate of decommissioning and the fund balance. Pro forma contribution is the pro forma fund shortfall divided by the average years until license expiration as represented in brackets under the license expiration column. The average years until license expiration weights each unit's license by its percent of the total megawatts owned by that particular utility, and takes into account license extensions granted by the NRC as of Dec. 31, 2016.

1 Non-operating units are included in all figures except the range of license expiration years.

# Investor-Owned Utilities

| | Company | Lic Exp | [Avg Yrs] | MW Nuclear Capacity | Decommissioning Cost Estimate ($mm) Cost Est | Amt/KW | Cost or $847/KW | Fund Balance ($mm) | Pro Forma Fund Shortfall ($mm) | Annual Contribution ($mm) Current Amount | Pro Forma Amount Shortfall/Avg Yrs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Ameren Corporation [1, 2] | 2044 | [28] | 1,236 | $865 | $700 | $1,047 | $557 | $489 | $7 | $18 |
| 2 | American Electric Power Company [3] | 2034-2037 | [19] | 2,285 | $1,961 | $858 | $1,961 | $1,803 | $158 | $9 | $8 |
| 3 | Constellation Energy Nuclear Group [4, 5] | 2029-2046 | [20] | 4,117 | $2,491 | $605 | $3,486 | $2,185 | $1,301 | $0 | $66 |
| 4 | Dominion Resources [6, 7] | 2032-2045 | [17] | 6,726 | $4,345 | $646 | $5,695 | $4,484 | $1,211 | $2 | $70 |
| 5 | DTE Energy Company [1, 7] | 2045 | [28] | 1,217 | $1,700 | $1,397 | $1,700 | $1,291 | $409 | $0 | $14 |
| 6 | Duke Energy Corporation [8] | 2030-2046 | [19] | 10,155 | $8,150 | $803 | $8,598 | $6,207 | $2,391 | $14 | $124 |
| 7 | El Paso Electric Company | 2045-2047 | [30] | 665 | $433 | $651 | $563 | $248 | $315 | $5 | $11 |
| 8 | Energy Future Holdings Corporation [3] | 2030-2033 | [15] | 2,430 | $1,798 | $740 | $2,057 | $938 | $1,119 | $17 | $77 |
| 9 | Entergy Corporation [9] | 2013-2044 | [12] | 8,779 | $9,241 | $1,053 | $9,241 | $4,910 | $4,331 | $49 | $351 |
| 10 | Exelon Corporation [5, 10] | 2026-2049 | [22] | 18,351 | $10,738 | $585 | $15,538 | $8,809 | $6,728 | $23 | $305 |
| 11 | FirstEnergy Corporation [1, 11] | 2026-2047 | [15] | 4,989 | $5,260 | $1,054 | $5,260 | $2,511 | $2,749 | $2 | $179 |
| 12 | Great Plains Energy [1] | 2045 | [28] | 596 | $360 | $603 | $505 | $223 | $282 | $3 | $10 |
| 13 | Green Mountain Power Corporation [7, 12] | 2045 | [29] | 22 | $13 | $575 | $19 | $10 | $8 | $0 | $0 |
| 14 | MidAmerican Energy Company [4, 7] | 2032 | [16] | 505 | $316 | $625 | $428 | $460 | -$32 | $2 | -$2 |
| 15 | NextEra Energy [7, 13] | 2030-2043 | [17] | 6,494 | $5,539 | $853 | $5,539 | $5,410 | $129 | $0 | $7 |
| 16 | NRG Energy [2, 7, 14] | 2027-2028 | [11] | 1,192 | $986 | $827 | $1,009 | $610 | $399 | $1 | $35 |
| 17 | Pacific Gas and Electric Company [15] | 2024-2025 | [8] | 2,388 | $4,423 | $1,852 | $4,423 | $2,606 | $1,817 | $96 | $226 |
| 18 | Pinnacle West Capital Corporation | 2045-2047 | [30] | 1,225 | $696 | $568 | $1,037 | $726 | $311 | $2 | $11 |
| 19 | Public Service Company of New Mexico [7] | 2045-2047 | [30] | 429 | $244 | $569 | $363 | $254 | $109 | $4 | $4 |
| 20 | Public Service Enterprise Group [7] | 2033-2046 | [23] | 3,945 | $3,645 | $924 | $3,645 | $1,862 | $1,783 | $0 | $79 |
| 21 | San Diego Gas and Electric Company [1, 16] | | [0] | 430 | $717 | $1,666 | $717 | $751 | -$35 | $0 | N.A. |
| 22 | SCANA Corporation [7] | 2042 | [26] | 687 | $739 | $1,076 | $739 | $123 | $616 | $3 | $24 |
| 23 | Southern California Edison [16, 17] | 2045-2047 | [8] | 2,347 | $3,322 | $1,415 | $3,322 | $3,622 | -$300 | $0 | -$36 |
| 24 | Southern Company [18] | 2034-2049 | [24] | 3,699 | $3,148 | $851 | $3,148 | $1,604 | $1,544 | $6 | $64 |
| 25 | Talen Energy Corporation [4, 7] | 2042-2044 | [26] | 2,336 | $1,200 | $514 | $1,978 | $1,033 | $945 | $0 | $36 |
| 26 | Westar Energy [1] | 2045 | [28] | 596 | $360 | $603 | $505 | $200 | $305 | $5 | $11 |
| 27 | Xcel Energy [7] | 2030-2034 | [16] | 1,871 | $3,271 | $1,748 | $3,271 | $1,861 | $1,410 | $20 | $89 |
| | **Investor-Owned Utilities Totals** | | | **89,712** | **$75,959** | **$847** | **$85,793** | **$55,298** | **$30,495** | **$271** | **$1,780** |

See page 20 for endnotes.

# Public Power Utilities

| | Company | Lic Exp | [Avg Yrs] | MW Nuclear Capacity | Decommissioning Cost Estimate ($mm) Cost Est | Amt/KW | Cost or $847/KW | Fund Balance ($mm) | Pro Forma Fund Shortfall ($mm) | Annual Contribution ($mm) Current Amount | Pro Forma Amount Shortfall/Avg Yrs |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | Allegheny Electric Cooperative [1] | 2042-2044 | [26] | 260 | $133 | $513 | $220 | $124 | $96 | $0 | $4 |
| 2 | Austin Energy (City of Austin, TX) [2, 3] | 2027-2028 | [11] | 433 | $359 | $828 | $367 | $212 | $155 | $0 | $14 |
| 3 | Central Iowa Power Cooperative | 2034 | [17] | 136 | $208 | $1,533 | $208 | $113 | $96 | $0 | $6 |
| 4 | Corn Belt Power Cooperative [4] | 2034 | [17] | 68 | $76 | $1,120 | $76 | $46 | $30 | $0 | $2 |
| 5 | CPS Energy (City of San Antonio, TX) [2, 5] | 2027-2028 | [11] | 1,083 | $897 | $828 | $917 | $546 | $371 | $1 | $33 |
| 6 | Energy Northwest [6, 7, 8] | 2043 | [27] | 1,200 | $584 | $486 | $1,016 | $283 | $733 | $1 | $27 |
| 7 | Florida Municipal Power Agency [9] | 2043 | [26] | 95 | $65 | $684 | $80 | $74 | $7 | $0 | $0 |
| 8 | Kansas Electric Power Cooperative [10] | 2045 | [28] | 76 | $46 | $604 | $64 | $22 | $43 | $0 | $2 |
| 9 | Long Island Power Authority [11] | 2046 | [30] | 227 | $177 | $779 | $192 | $116 | $76 | $0 | $3 |
| 10 | Los Angeles Dept of Water and Power [12] | 2045-2047 | [30] | 240 | $136 | $568 | $203 | $133 | $70 | $0 | $2 |
| 11 | Massachusetts Muni Wholesale Elec Co [13] | 2030-2045 | [18] | 204 | $143 | $702 | $173 | $107 | $65 | $2 | $4 |
| 12 | Municipal Electric Authority of Georgia [14] | 2034-2049 | [27] | 831 | $718 | $864 | $718 | $440 | $278 | $0 | $10 |
| 13 | Nebraska Public Power District [15] | 2034 | [17] | 801 | $608 | $759 | $678 | $582 | $96 | $0 | $6 |
| 14 | New York Power Authority [16] | 2015-2034 | [8] | 1,894 | $2,126 | $1,122 | $2,126 | $1,504 | $622 | $0 | $80 |
| 15 | N Carolina Electric Membership Corp [8, 17] | 2043 | [27] | 741 | $434 | $585 | $627 | $201 | $427 | $3 | $16 |
| 16 | N Carolina Muni Power Agency No 1 [17] | 2043 | [27] | 904 | $529 | $585 | $765 | $326 | $440 | $6 | $16 |
| 17 | Oglethorpe Power Corporation [14] | 2034-2049 | [26] | 1,213 | $1,068 | $880 | $1,068 | $458 | $610 | $5 | $23 |
| 18 | Old Dominion Electric Cooperative [18] | 2038-2040 | [22] | 227 | $125 | $550 | $192 | $159 | $33 | $0 | $1 |
| 19 | Omaha Public Power District [19] | | [0] | 484 | $1,383 | $2,858 | $1,383 | $382 | $1,001 | $0 | N.A. |
| 20 | Orlando Utilities Commission [14] | 2043 | [26] | 66 | $53 | $802 | $56 | $42 | $14 | $0 | $1 |
| 21 | Piedmont Municipal Power Agency [17] | 2043 | [27] | 301 | $176 | $586 | $255 | $69 | $186 | $1 | $7 |
| 22 | Riverside Public Utilities [10, 20] | | [0] | 38 | $64 | $1,688 | $64 | $72 | -$8 | $2 | N.A. |
| 23 | Salt River Project | 2045-2047 | [30] | 736 | $419 | $569 | $623 | $370 | $253 | $0 | $9 |
| 24 | South Carolina Public Service Authority | 2042 | [26] | 343 | $415 | $1,210 | $415 | $218 | $197 | $3 | $8 |
| 25 | South Mississippi Electric Power Assoc [21] | 2044 | [28] | 144 | $123 | $855 | $123 | $64 | $59 | $3 | $2 |
| 26 | Southern Calif. Public Power Authority [12] | 2045-2047 | [30] | 249 | $141 | $568 | $211 | $175 | $36 | $0 | $1 |
| 27 | Tennessee Valley Authority [15] | 2033-2055 | [23] | 8,476 | $3,863 | $456 | $7,177 | $1,673 | $5,503 | $0 | $239 |
| | **Public Power Utilities Totals** | | | **21,470** | **$15,070** | **$702** | **$20,000** | **$8,509** | **$11,490** | **$27** | **$514** |

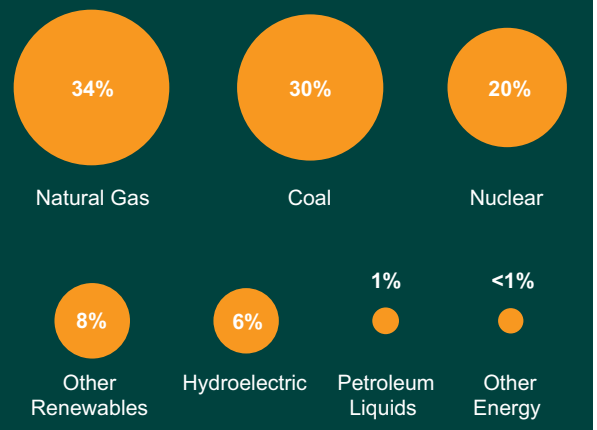
See page 21 for endnotes.

# Fund Balances

NDT fund balances have risen substantially since a sharp decline in 2008. The NDT funds covered in this study totaled nearly $64 billion in 2016. The $3.6 billion (6.1%) increase from a year earlier can be attributed largely to capital market performance in 2016, which saw the U.S. stock and bond markets up roughly 10% and 3%, respectively. Investor-owned funds have accounted for approximately 87% of total NDT fund balances over the past decade, with public power funds accounting for the remainder.

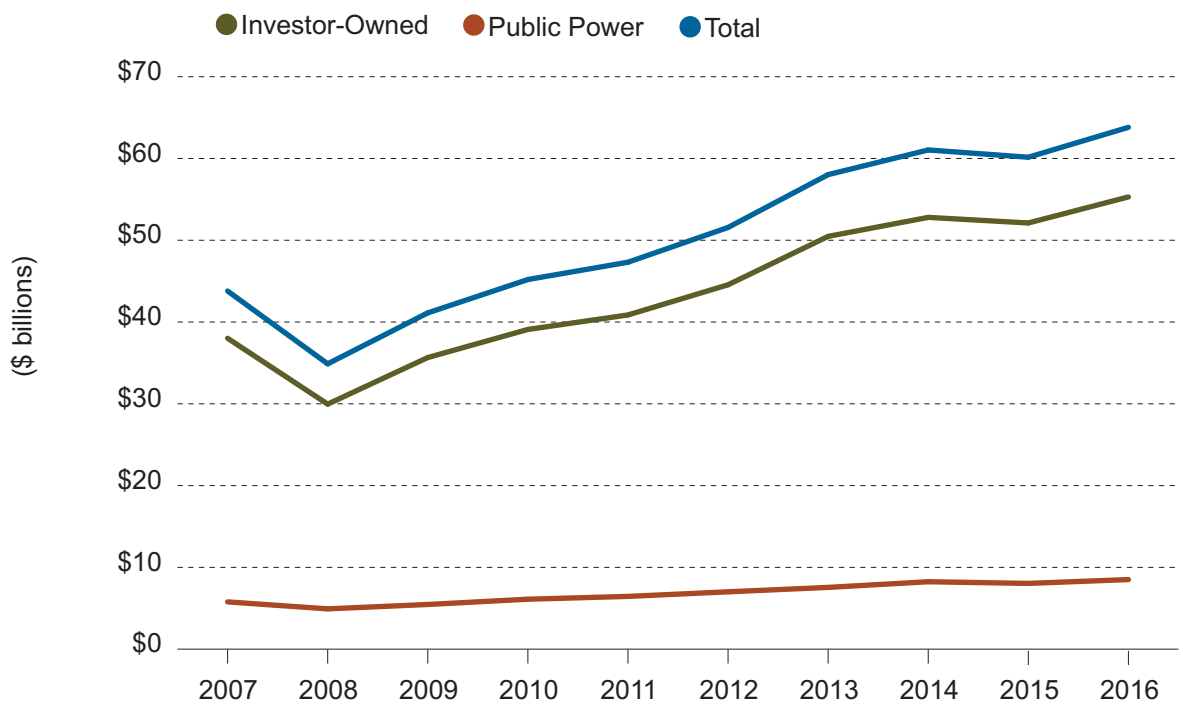
*Did You Know?*

**2016 U.S. Electricity Generation by Source**




Source: U.S. Energy Information Administration

## NDT Fund Balances

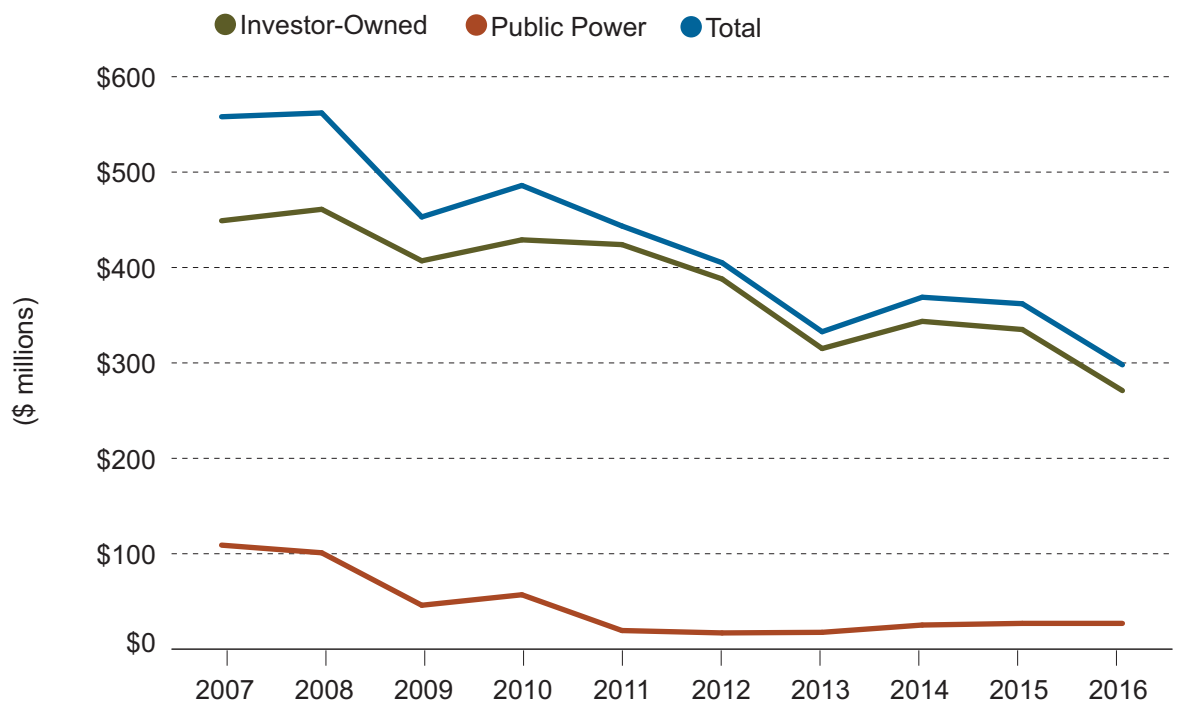



| | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|
| Investor-Owned ($bn) | 38.0 | 30.0 | 35.7 | 39.1 | 40.9 | 44.6 | 50.5 | 52.8 | 52.1 | 55.3 |
| Public Power ($bn) | 5.8 | 4.9 | 5.5 | 6.1 | 6.4 | 7.0 | 7.6 | 8.2 | 8.0 | 8.5 |
| **Total ($bn)** | **43.8** | **34.9** | **41.1** | **45.2** | **47.3** | **51.6** | **58.0** | **61.0** | **60.2** | **63.8** |

# Contributions

Total contributions fell for the second straight year, declining almost $64 million in 2016 to below $300 million for the first time. In 2016, investor-owned contributions were 60% of their 2007 level while public power contributions were just 25% of their 2007 level.

## Annual Contributions to NDT Funds




| | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|
| Investor-Owned ($mm) | 449 | 461 | 407 | 429 | 424 | 388 | 315 | 344 | 335 | 271 |
| Public Power ($mm) | 109 | 101 | 46 | 57 | 20 | 18 | 18 | 25 | 27 | 27 |
| **Total ($mm)** | **558** | **562** | **453** | **486** | **444** | **406** | **333** | **369** | **362** | **298** |

***Did You Know?***

**The top five U.S. states in terms of number of operating nuclear power reactors:**

1. **Illinois** (11)
2. **Pennsylvania** (9)
3. **South Carolina** (7)
4. **New York** (6)
5. **Alabama and North Carolina** (tie 5 each)

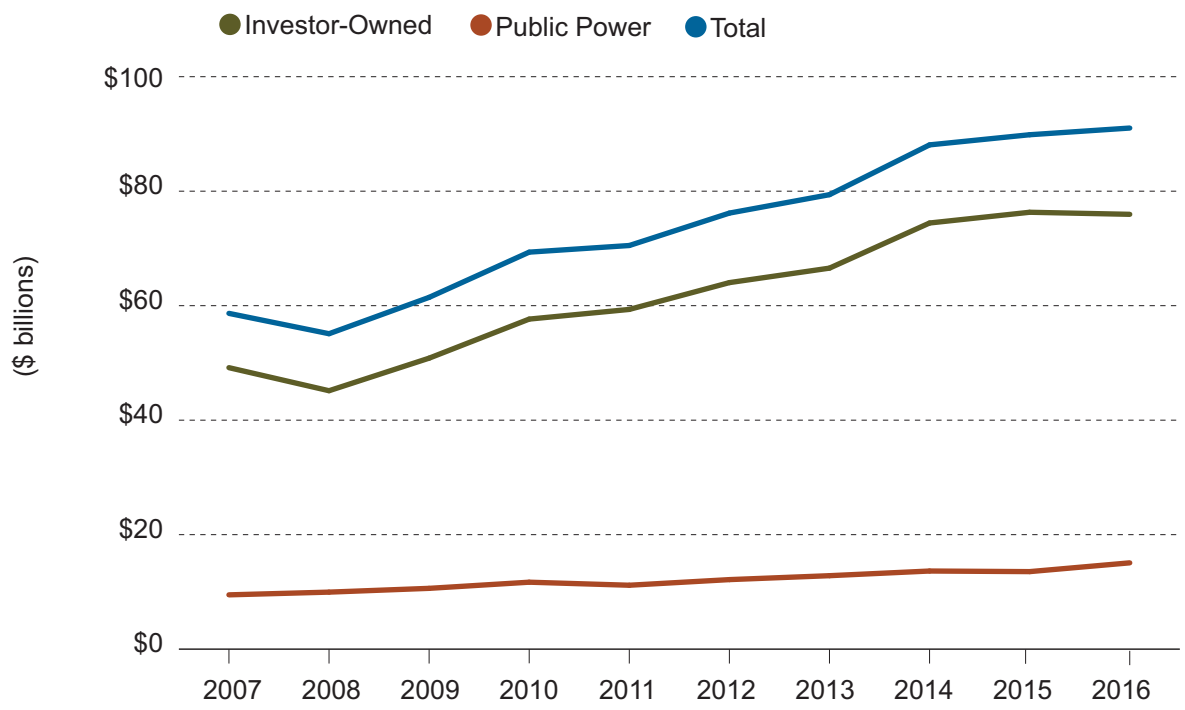
Source: Nuclear Energy Institute

# Cost Estimates

Total decommissioning cost estimates have risen from a low of $55 billion in 2008, reaching $91 billion in 2016. The modest $1.1 billion (1.3%) increase from the $90 billion in 2015 is likely due to a combination of updated site-specific cost studies by several owners and NRC minimum amounts that fell from their 2014 estimates.

As with NDT fund balances, investor-owned costs have accounted for more than four-fifths of total costs over the past decade, with public power costs accounting for the rest.

## Cost Estimates of Decommissioning in Current Dollars




| | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|
| Investor-Owned ($bn) | 49.2 | 45.1 | 50.8 | 57.7 | 59.3 | 64.0 | 66.6 | 74.4 | 76.3 | 76.0 |
| Public Power ($bn) | 9.5 | 10.0 | 10.6 | 11.7 | 11.2 | 12.1 | 12.8 | 13.6 | 13.5 | 15.1 |
| **Total ($bn)** | **58.7** | **55.1** | **61.5** | **69.4** | **70.5** | **76.2** | **79.4** | **88.1** | **89.9** | **91.0** |

***Did You Know?***

**Of the U.S. operating nuclear power plants:**

**Largest:** Palo Verde in Arizona

**Smallest and Oldest:** Oyster Creek in New Jersey

**Newest:** Watts Bar in Tennessee

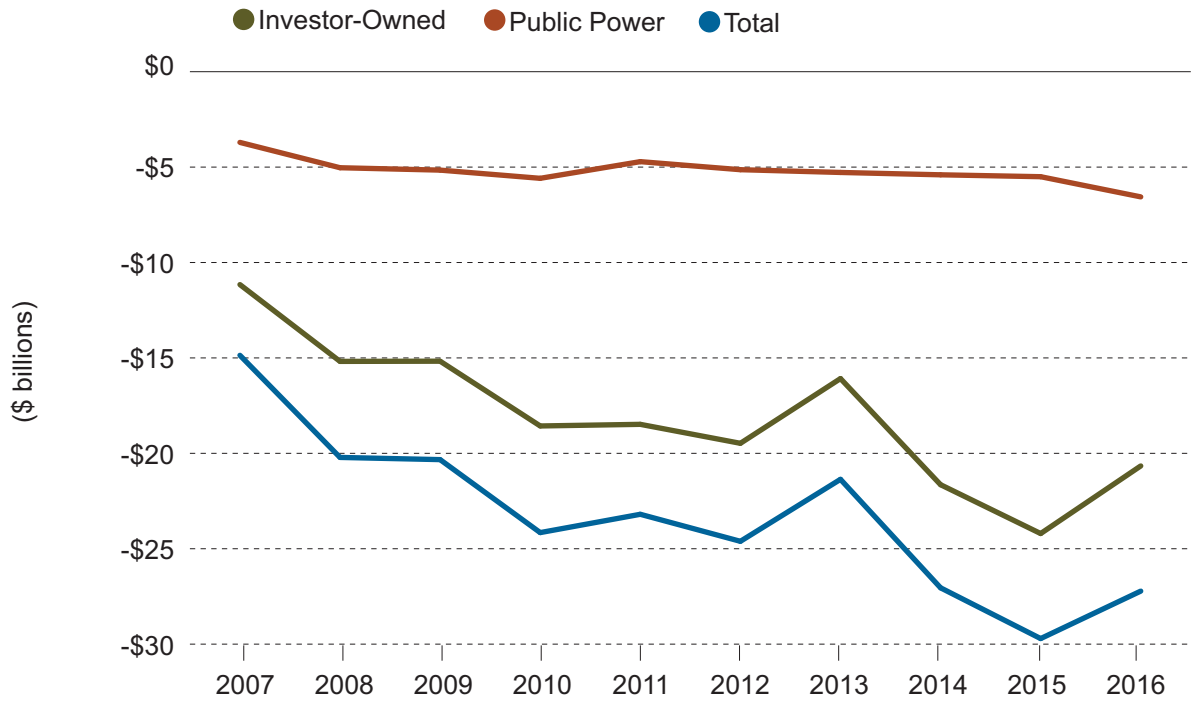
Source: Nuclear Energy Institute

# Funding Status

Investor-owned assets have lagged behind costs by approximately $11 billion to $24 billion over the past decade. Public power assets have lagged behind costs by approximately $3 billion to $7 billion over the same period.

The total deficit declined from a 10-year high of almost $30 billion in 2015 to $27 billion in 2016. The improvement is due to strong market performance as well as modest growth in costs in 2016.

## **Decommissioning Funding Status** (Assets Less Costs)

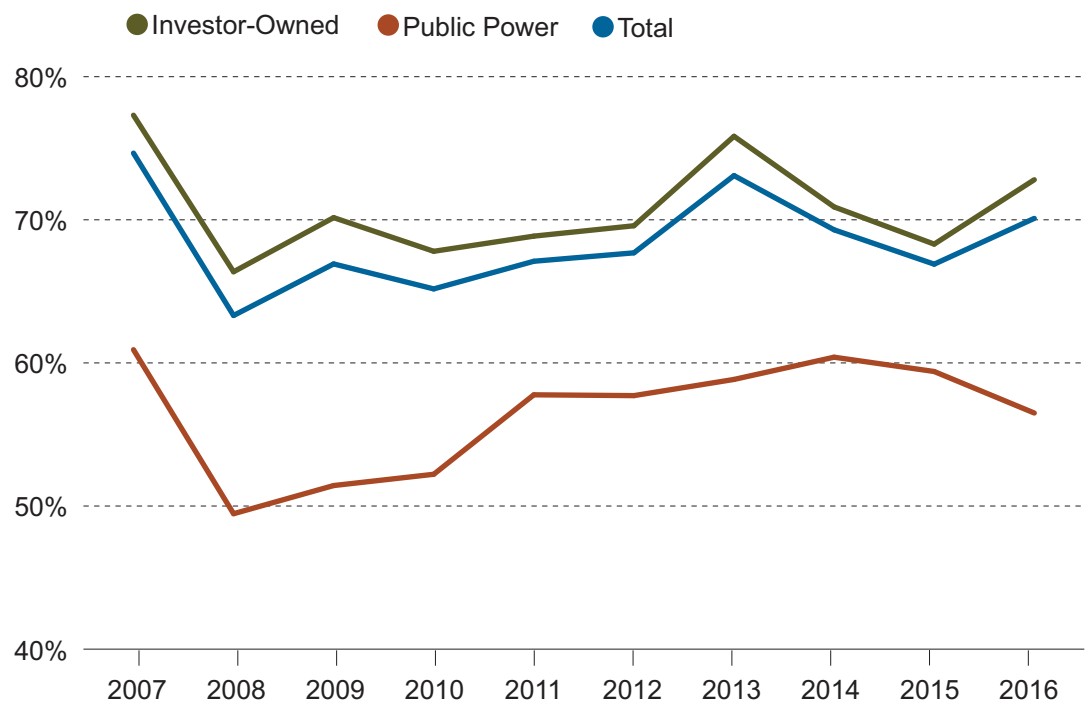



| | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|
| Investor-Owned ($bn) | -11.2 | -15.2 | -15.2 | -18.6 | -18.5 | -19.5 | -16.1 | -21.6 | -24.2 | -20.7 |
| Public Power ($bn) | -3.7 | -5.0 | -5.2 | -5.6 | -4.7 | -5.1 | -5.3 | -5.4 | -5.5 | -6.6 |
| **Total ($bn)** | **-14.9** | **-20.2** | **-20.3** | **-24.2** | **-23.2** | **-24.6** | **-21.4** | **-27.0** | **-29.7** | **-27.2** |

# Funding Status

Assets as a percentage of costs averaged approximately 71% for investor-owned utilities over the past decade versus just 56% for public power utilities. Total funding stood at approximately 70% in 2016, an improvement from the previous year (67%). The improved funding status is largely due to the strong market performance of 2016.

## **Decommissioning Funding Status** (Assets as Percentage of Costs)




| | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|---|---|---|---|---|---|---|---|---|---|---|
| Investor-Owned | 77.3% | 66.4% | 70.2% | 67.8% | 68.9% | 69.6% | 75.8% | 70.9% | 68.3% | 72.8% |
| Public Power | 60.9% | 49.5% | 51.4% | 52.2% | 57.8% | 57.7% | 58.8% | 60.4% | 59.4% | 56.5% |
| **Total** | **74.7%** | **63.3%** | **66.9%** | **65.2%** | **67.1%** | **67.7%** | **73.1%** | **69.3%** | **66.9%** | **70.1%** |

***Did You Know?***

**There are 99 nuclear power reactors operating in the U.S. in 30 states.**

Watts Bar 2 began commercial operation in 2016, the first nuclear power plant to come online in the U.S. since Watts Bar 1 in 1996.

2016 also saw the closure of Fort Calhoun in Nebraska, keeping the number of operating reactors in the U.S. at 99.

65 are pressurized water reactors

34 are boiling water reactors

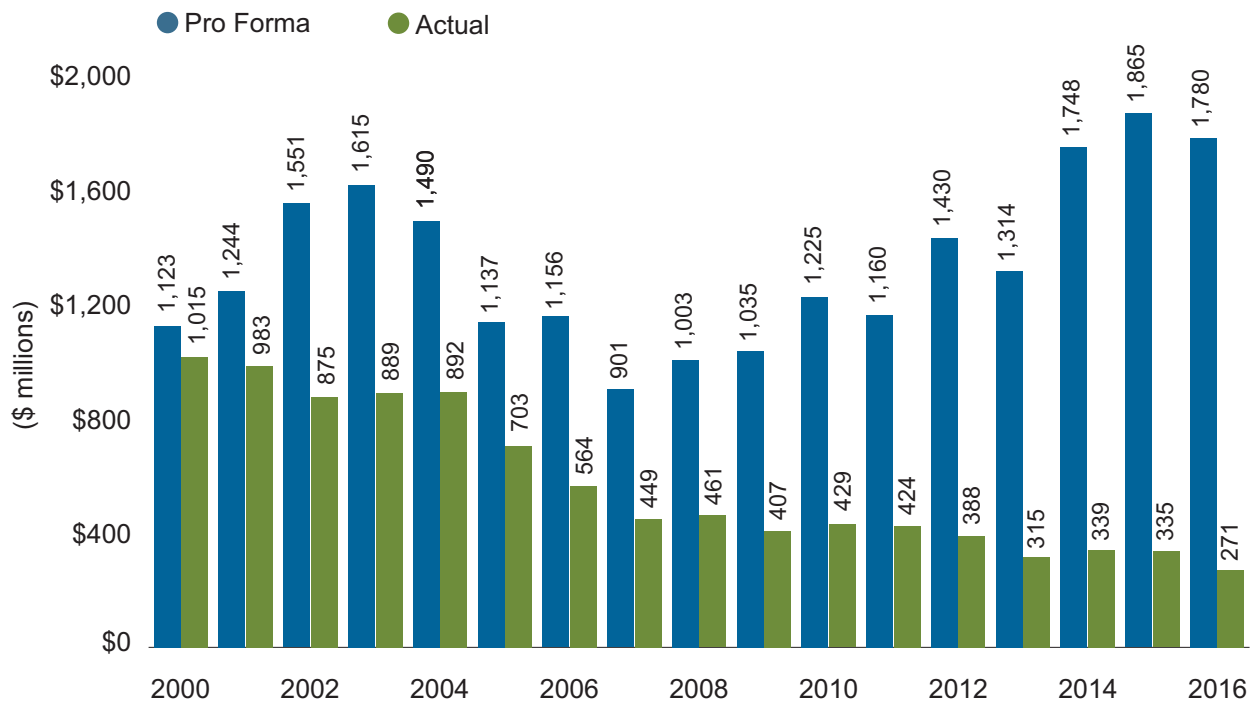
While 4 reactors are under construction (Virgil C. Summer 2 & 3 in South Carolina and Vogtle 3 & 4 in Georgia), a handful of owners say they plan to close a number of plants in the coming years.

Source: Nuclear Energy Institute

# Investor-Owned Pro Forma Contributions vs. Actual Contributions

Actual investor-owned contributions outpaced the pro forma estimate in the late 1990s before falling behind in 2000. In 2016, actual contributions were $1.5 billion lower than the pro forma estimate. Actual contributions were just 15% of the pro forma estimate in 2016, the lowest percentage in the 16-year period.

## Investor-Owned Utilities

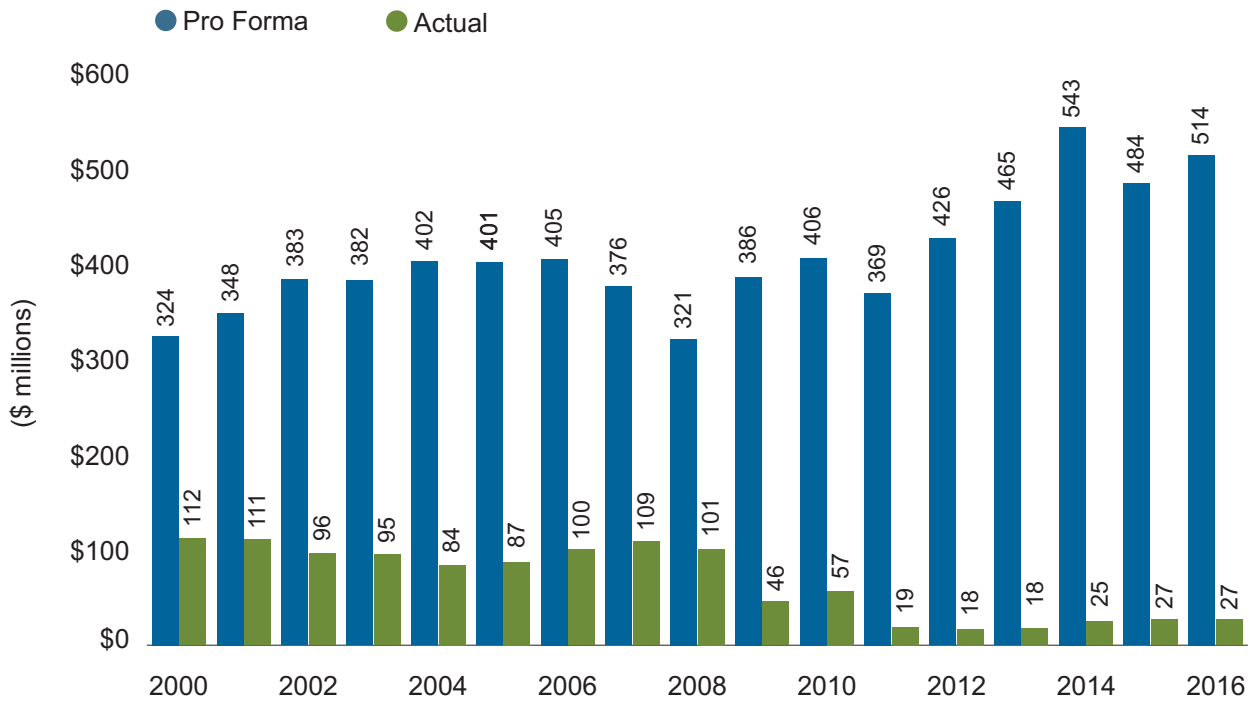



In order to make the data among companies more comparable, we have calculated a "pro forma" decommissioning cost estimate, which is the higher of either the company cost estimate of decommissioning or the product of the company KW times the average cost per KW reported for all investor-owned utilities. In 2016, this average cost was $847/KW. Pro forma contribution is the pro forma fund shortfall (the difference between the "pro forma" cost estimate of decommissioning and the fund balance) divided by the average years until license expiration. The average years until license expiration weights each unit's license by its percent of the total megawatts owned by that particular utility and takes into account license extensions granted by the NRC as of the end of each year listed.

# Public Power Pro Forma Contributions vs. Actual Contributions

Actual public power contributions have lagged well behind the pro forma estimate from 2000 to 2016. While pro forma contributions grew from $324 million in 2000 to $514 million in 2016, actual contributions fell from $112 million to just $27 million. Actual contributions as a percentage of the pro forma estimate were at 35% in 2000, but have fallen to just 5% in 2016.

## Public Power Utilities

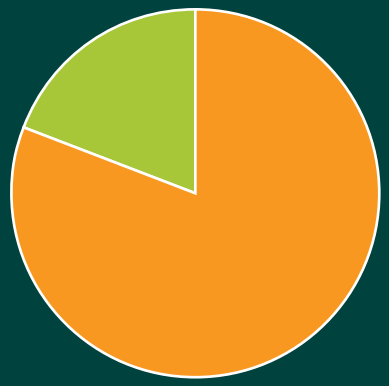



In order to make the data among companies more comparable, we have calculated a "pro forma" decommissioning cost estimate, which is the higher of either the company cost estimate of decommissioning or the product of the company KW times the average cost per KW reported for all investor-owned utilities. In 2016, this average cost was $847/KW. Pro forma contribution is the pro forma fund shortfall (the difference between the "pro forma" cost estimate of decommissioning and the fund balance) divided by the average years until license expiration. The average years until license expiration weights each unit's license by its percent of the total megawatts owned by that particular utility and takes into account license extensions granted by the NRC as of the end of each year listed.

***Did You Know?***

**Public vs. Investor-Owned Generation Capacity**

**Public power 19%** **Investor-owned 81%**



Source: Data from tables on pages 5-6.

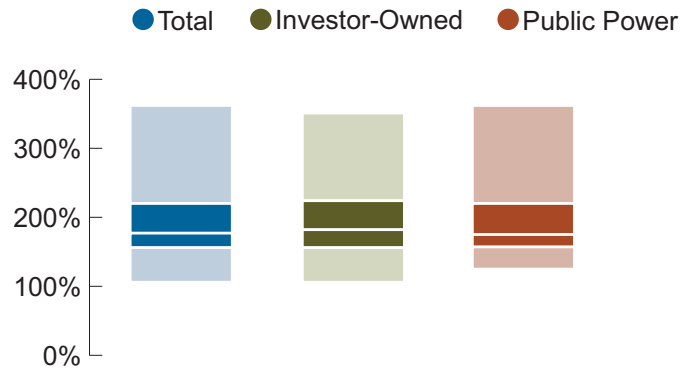
# Cost Comparisons

We gather both NRC and site-specific total cost estimates where possible in order to capture the relative magnitude of the two figures. This page is updated biennially to coincide with the NRC's filing schedule.

Site-specific cost estimates totaled approximately $73 billion versus $39 billion under the NRC minimum formula in 2016, a difference of $34 billion. The median site-specific total cost estimate was approximately 1.75 times the NRC minimum formula amount for all plants regardless of ownership. Assuming license termination costs (the NRC portion of decommissioning) represent approximately 60% of total site-specific costs, the NRC formula amounts are roughly in line with the site-specific estimates for license termination. Taking the assumption one step further, if the license termination portions of the site-specific estimates are roughly in line with the NRC formula amounts, then spent fuel management and site restoration costs are what account for most of the additional $34 billion in decommissioning costs.

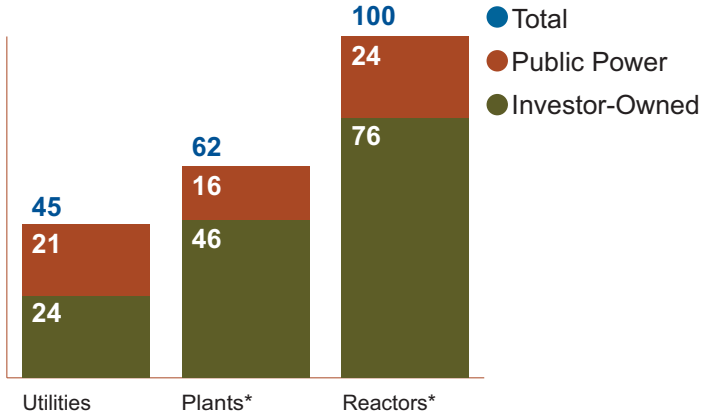
The distributions are positively skewed, which results in average cost comparison figures that are approximately 5%–15% greater in absolute terms than the medians.

## Decommissioning Cost Comparisons (Site-Specific Total/NRC Minimum)




| | All | Investor-Owned | Public Power |
|---|---|---|---|
| 75th Percentile | 220% | 224% | 220% |
| Median | 177% | 182% | 175% |
| 25th Percentile | 156% | 156% | 157% |
| Average | 190% | 189% | 204% |

### Dataset Breakdown




*Not necessarily distinct or wholly owned plants/reactors.

**Notes**

***This page is updated biennially to coincide with the NRC's filing schedule.***

Bars depict the full range of cost comparisons (site-specific total/NRC minimum) while the darker shading represents the 25th to 75th percentiles. The percentages to the left show site-specific cost estimates as a percentage of the NRC minimum formula amounts. The data set includes 2016 cost estimates for 62 plants—not necessarily distinct or wholly-owned—owned by 45 utilities.

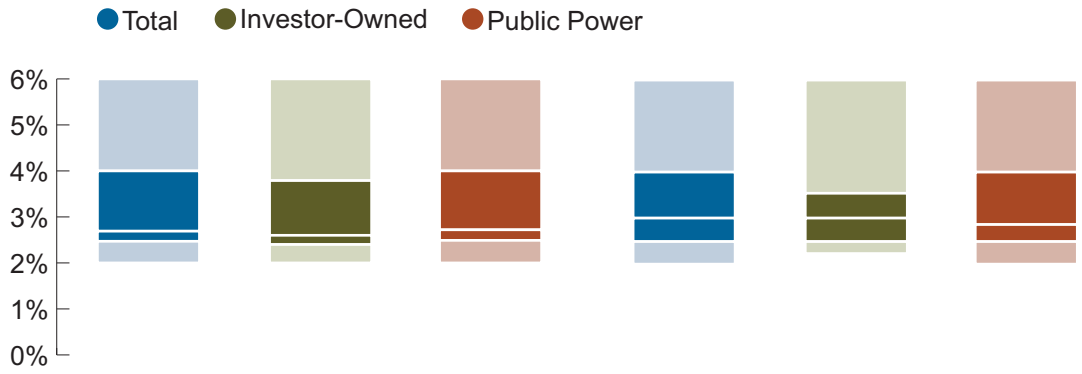
# Escalation Rates

Utilities employ escalation rates to forecast future decommissioning expenditures given current dollar cost estimates. The escalation rates shown to the right are a blend of escalation rates specific to the different cost categories such as labor, energy, and burial. The data set includes escalation rates for 68 plants—not necessarily distinct or wholly-owned—owned by 39 utilities.

The median escalation rate for all plants is 2.69% with an average of 3.15%. Public power plant escalation rates tend to be approximately 10–20 basis points above those of investor-owned plants. The median public power plant rate is 2.72% and average is 3.26%, contrasted with the median investor-owned plant escalation rate of 2.60% and average of 3.09%.

From an owner perspective, the median public power utility rate is 2.86% and the average is 3.32%, versus a median investor-owned utility escalation rate of 3.00% and average of 3.20%. The median escalation rate for all owners is 3.00% with an average of 3.26%.

## Decommissioning Escalation Rates




### Escalation Rates by Plant*

| | All | Investor-Owned | Public Power |
|---|---|---|---|
| 75th Percentile | 4.00% | 3.79% | 4.00% |
| Median | 2.69% | 2.60% | 2.72% |
| 25th Percentile | 2.47% | 2.40% | 2.49% |
| Average | 3.15% | 3.09% | 3.26% |
| Count | 68 | 43 | 25 |

### Escalation Rates by Owner

| All | Investor-Owned | Public Power |
|---|---|---|
| 4.00% | 3.54% | 4.00% |
| 3.00% | 3.00% | 2.86% |
| 2.49% | 2.49% | 2.49% |
| 3.26% | 3.20% | 3.32% |
| 39 | 19 | 20 |

*Not necessarily distinct or wholly owned plants.

Note: Bars depict the full range of escalation rates while the darker shading represents the 25th to 75th percentiles.

# Asset Allocations

Asset allocation information is gathered each year for all NDT owners. Unfortunately, the public power data set is too limited to be meaningful so only investor-owned utility asset allocation data is displayed here; 25 of the 27 investor-owned utilities are represented in the data set.

All 25 NDTs are invested in equity and fixed income securities with a median allocation of 56% equity and 39% fixed income.

Approximately two-thirds of the owners reported a cash equivalent allocation that tended to range in the low single digits.

Four of the utilities reported allocations to real estate, private equity, and/or hedge funds with one-fifth indicating an "other" allocation. In most instances the other allocation could represent cash, alternatives, or other securities.

## **Investor-Owned Utilities' Asset Allocations** (as of 12/31/2016)

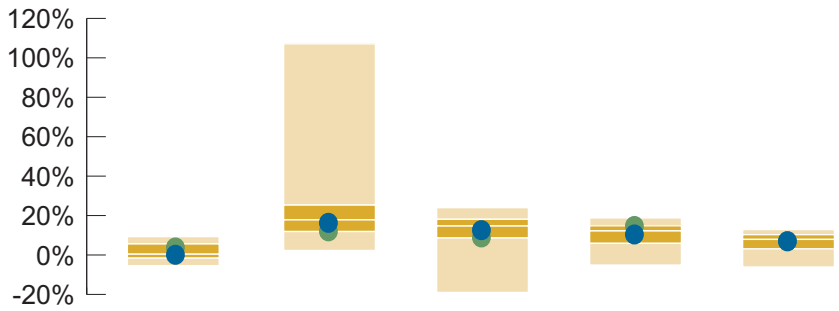
| | Equity | Fixed | Cash | Alternatives | Other |
|---|---|---|---|---|---|
| 75th Percentile | 66% | 43% | 2% | 17% | 3% |
| Median | 56% | 39% | 1% | 12% | 2% |
| 25th Percentile | 51% | 32% | 1% | 7% | 2% |
| Percent Invested | 100% | 100% | 64% | 16% | 20% |
| Count | 25 | 25 | 16 | 4 | 5 |

Note: Bars depict the full range of asset allocations while the darker shading represents the 25th to 75th percentiles.

# Investment Returns of Investor-Owned Utilities

We show the range of returns for 23 of the 27 investor-owned utilities for periods ended Dec. 31, 2016. Investor-owned utilities with nuclear power reactors outperformed the S&P 500 Utilities Index over all periods with mixed results compared to the broad market S&P 500 Index.

## **Investor-Owned Utilities' Returns** (Periods ended 12/31/2016)




| | Last Quarter | Last Year | Last 3 Years | Last 5 Years | Last 10 Years |
|---|---|---|---|---|---|
| 75th Percentile | 5.6 | 25.3 | 18.1 | 14.8 | 10.3 |
| Median | 0.4 | 17.8 | 14.7 | 12.2 | 7.9 |
| 25th Percentile | -1.6 | 11.9 | 8.6 | 5.9 | 3.1 |
| S&P 500 ● | 3.8 | 12.0 | 8.9 | 14.7 | 6.9 |
| S&P 500 Utilities ● | 0.1 | 16.3 | 12.6 | 10.4 | 7.0 |
| Count | 23 | 23 | 23 | 23 | 23 |

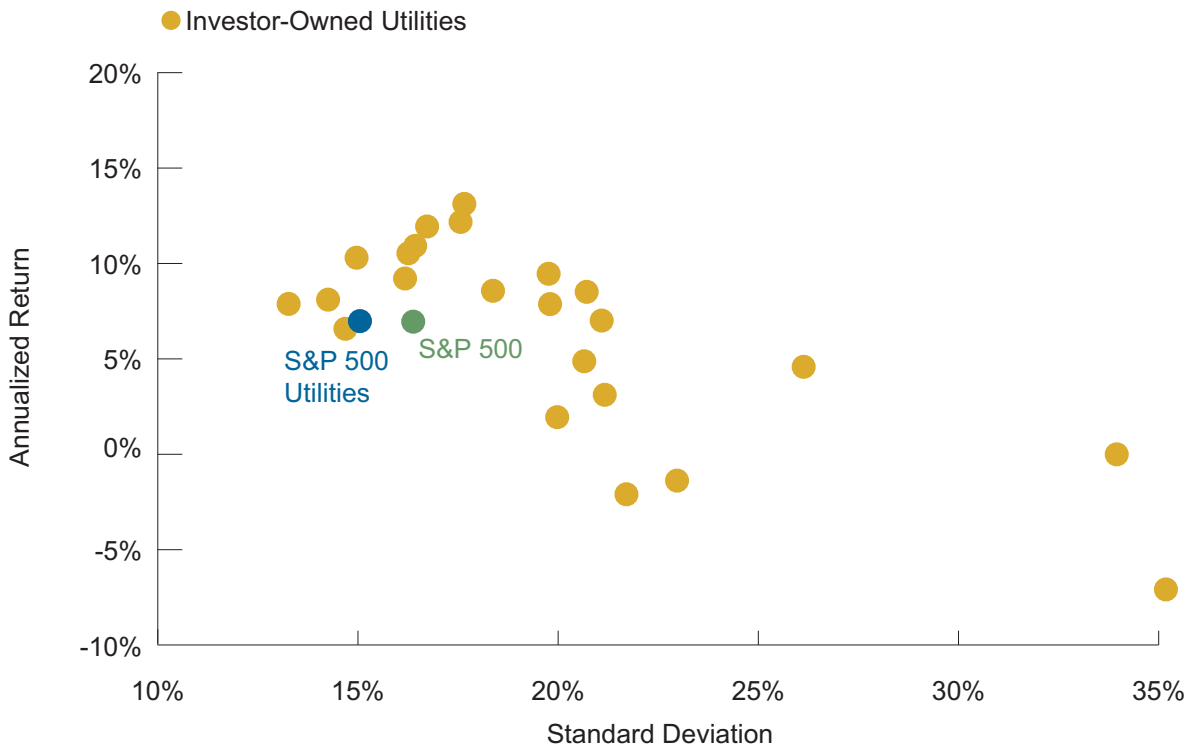
Note: Bars depict the range of returns from the 5th to 95th percentile while the darker shading represents the 25th to 75th percentiles. Last year return figures include a 125% return for Talen Energy.

# Investment Returns of Investor-Owned Utilities (Continued)

This chart shows the 10-year return and standard deviation ended Dec. 31, 2016, for the 23 investor-owned utilities along with the S&P 500 Utilities and S&P 500 Indices. A majority of investor-owned utilities had a more volatile (greater standard deviation) return pattern than both the indices over the past 10 years.

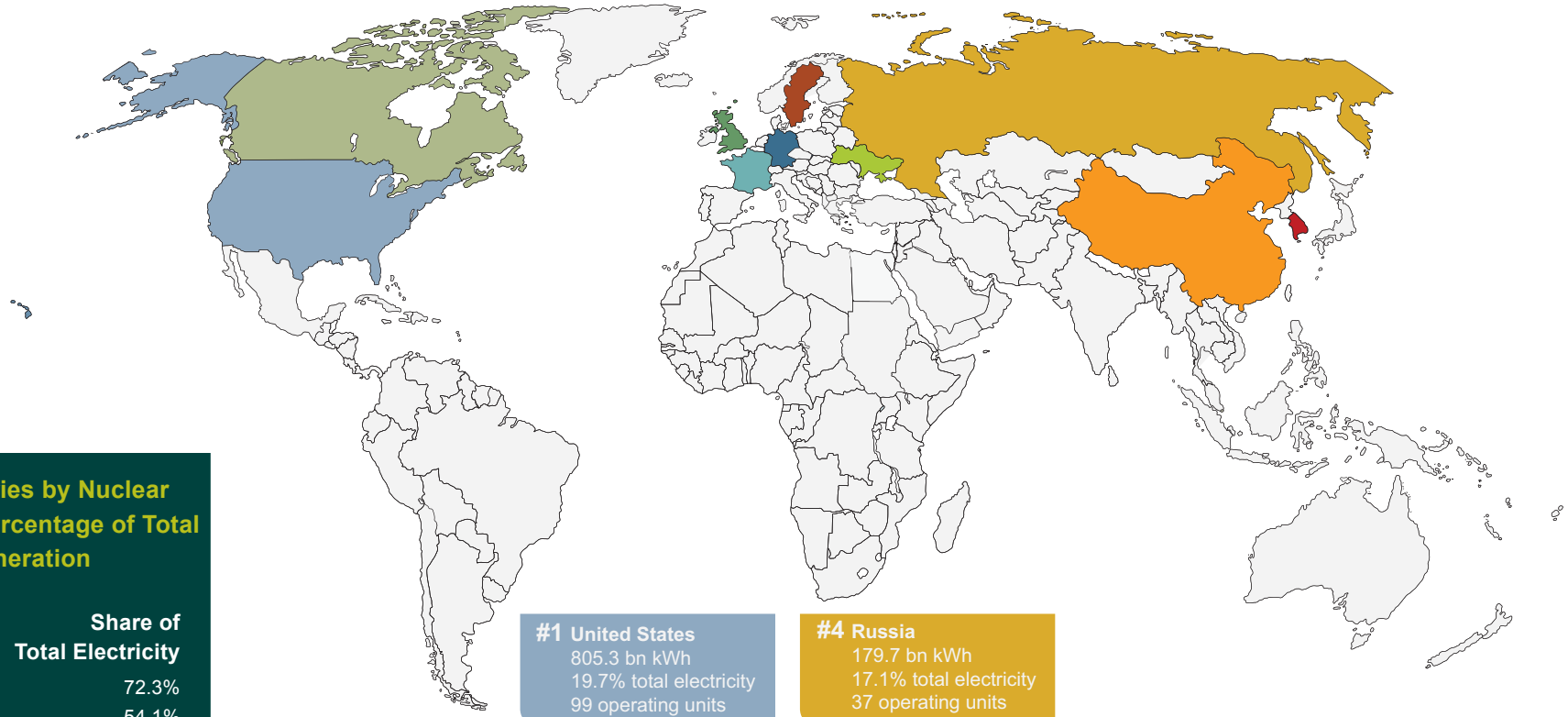
It is important to note that nuclear power generation accounts for varying degrees of the utilities' overall businesses.

## Annualized Return vs. Standard Deviation (10 years ended 12/31/2016)



# Global Nuclear Power Generation

## Top 10 Nuclear Generating Countries in 2016



**Top 10 Countries by Nuclear Power as a Percentage of Total Electricity Generation**

| Country | Share of Total Electricity |
|---|---|
| France | 72.3% |
| Slovakia | 54.1% |
| Ukraine | 52.3% |
| Belgium | 51.7% |
| Hungary | 51.3% |
| Sweden | 40.0% |
| Slovenia | 35.2% |
| Bulgaria | 35.0% |
| Switzerland | 34.4% |
| Finland | 33.7% |

**#1 United States**
805.3 bn kWh
19.7% total electricity
99 operating units

**#2 France**
384.0 bn kWh
72.3% total electricity
58 operating units

**#3 China**
210.5 bn kWh
3.6% total electricity
36 operating units

**#4 Russia**
179.7 bn kWh
17.1% total electricity
37 operating units

**#5 South Korea**
154.3 bn kWh
30.3% total electricity
25 operating units

**#6 Canada**
97.4 bn kWh
15.6% total electricity
19 operating units

**#7 Ukraine**
81.0 bn kWh
52.3% total electricity
15 operating units

**#8 Germany**
80.1 bn kWh
13.1% total electricity
8 operating units

**#9 United Kingdom**
65.1 bn kWh
20.4% total electricity
15 operating units

**#10 Sweden**
60.6 bn kWh
40.0% total electricity
10 operating units

Source: Nuclear Energy Institute

## Endnotes from page 5:

1 Cost estimate in 2014 dollars
2 2014 contribution
3 Cost estimate in 2015 dollars
4 NRC mininum cost estimate
5 Fair market value; license termination funds only
6 Includes 660 MW Millstone Unit 1 and 566 MW Kewaunee, which have been shut down permanently. Total cost less certain spent fuel costs expected to be recovered from the Department of Energy.
7 Fair market value
8 Includes 860 MW Crystal River Unit 3, which has been shut down permanently. Cost estimate in 2013 and 2014 dollars.
9 Includes 620 MW Vermont Yankee, which has been shut down permanently. Excludes Indian Point Unit 3 and James A. Fitzpatrick (trust funds retained by New York Power Authority). Cost estimates in 2012 and 2014–2017 dollars.
10 Includes 210 MW Dresden Unit 1 and 115 MW Peach Bottom Unit 1, which have been shut down permanently. Combination of site-specific license termination cost estimates and NRC minimums.
11 Includes 906 MW Three Mile Island Unit 2, which has been shut down permanently
12 Total cost less certain spent fuel costs expected to be recovered from the Department of Energy
13 Combination of site-specific total cost estimates in 2015 dollars and NRC minimums
14 Cost estimate in 2012 dollars
15 Includes 65 MW Humboldt Bay Unit 3, which has been shut down permanently
16 Includes 1,070 MW San Onofre Unit 2 and 1,080 MW San Onofre Unit 3, which have shut down permanently
17 Cost estimate in 2014 and 2016 dollars
18 Cost estimate in 2013 and 2015 dollars

## Endnotes from page 6:

1 NRC mininum cost estimate in 2010 dollars
2 Cost estimate in 2012 dollars
3 Fund balance as of Sept. 30, 2016
4 Cost estimate in 2008 dollars
5 2015 contribution
6 Cost estimate in 2015 dollars
7 Fund balance as of June 30, 2016, and Dec. 31, 2016
8 2014 contribution
9 2015 cost estimate less certain spent fuel costs expected to be recovered from the Department of Energy
10 Cost estimate in 2014 dollars
11 Cost estimate in 2012 dollars and represents license termination costs only
12 Fund balance as of June 30, 2016
13 Cost estimate in 2015 and 2016 dollars
14 Cost estimate in 2015 dollars
15 NRC mininum cost estimate
16 Cost estimate in 2007 and 2012 dollars
17 Cost estimate in 2013 dollars
18 2016 cost estimate less certain spent fuel costs expected to be recovered from the Department of Energy
19 Includes 484 MW Fort Calhoun Unit 1, which shut down permanently in 2016
20 Includes 1,070 MW San Onofre Unit 2 and 1,080 MW San Onofre Unit 3, which shut down permanently in 2013 and are decommissioning
21 Cost estimate in 2017 dollars

# About the Author

**Julia A. Moriarty, CFA**, is a Senior Vice President and Co-Manager of Callan's Capital Markets Research group. The Capital Markets group helps Callan's fund sponsor clients with their strategic planning, conducting asset/liability studies, developing optimal investment manager structures, and providing custom research on a variety of investment topics. The group consults to a wide range of clients, including defined benefit and defined contribution employee-benefit plans (corporate, public, and Taft-Hartley), endowments, foundations, insurance, hospitals, health-care systems, and nuclear decommissioning trusts. Julia also conducts target date and diversified real return manager research and publishes Callan's annual *Nuclear Decommissioning Funding Study*. Julia is a shareholder of the firm and is a member of Callan's Management Committee.

Julia earned an MBA from the University of California at Berkeley's Haas School of Business and a BS in Finance from California Polytechnic State University at San Luis Obispo. She earned the right to use the Chartered Financial Analyst designation and is a member of the CFA Society of San Francisco and CFA Institute.

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Callan was founded as an employee-owned investment consulting firm in 1973. Ever since, we have empowered institutional clients with creative, customized investment solutions that are backed by proprietary research, exclusive data, and ongoing education. Today, Callan advises on more than $2 trillion in total fund sponsor assets, which makes it among the largest independently owned investment consulting firms in the U.S. Callan uses a client-focused consulting model to serve pension and defined contribution plan sponsors, endowments, foundations, independent investment advisers, investment managers, and other asset owners. Callan has five offices throughout the U.S. For more information, please visit www.callan.com.

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