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The Economics Of U.S. Nuclear Power: Natural Gas Prices And Loan Guarantees Are Key To Viability

Primary Credit Analysts:
Swami Venkataraman, CFA, San Francisco (1) 415-371-5071; swami_venkataraman@standardandpoors.com
Aneesh Prabhu, New York (1) 212-438-1285; aneesh_prabhu@standardandpoors.com

Secondary Credit Analyst:
Richard W Cortright, Jr., New York (1) 212-438-7665; richard_cortright@standardandpoors.com

Table Of Contents

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Fourteen years ago, the last nuclear power plant in the U.S. started commercial operations. Safety and cost concerns had long since discouraged the construction of new nuclear facilities in this country. However, the appeal of nuclear power as clean energy without harmful emissions has grown due to climate change concerns, the nuclear sector's record of strong operating performance over a sustained period, and a changing political environment. Following the U.S. Dept. of Energy's (DOE) conditional approval for a new nuclear reactor at Georgia Power Co.'s Vogtle plant earlier this year, Congress and the Obama Administration is likely to secure more funding to cover loan guarantees for additional nuclear projects.

Yet, risks confronting the development, construction, and operation of any type of nuclear plant remain. Foremost among these are safety and cost issues, a lack of experience in building nuclear facilities, and federal and state regulatory environment. Given the significant capital costs, even modest overruns or schedule delays can impair the balance sheets of even the largest U.S. utility companies engaged in nuclear power plant construction. Furthermore, the recent decline of natural gas prices also raises the question of the longer-term competitive viability of nuclear power as a base-load energy source.

The nuclear renaissance that seemed imminent in 2007 has slowed due to moderate natural gas prices and the credit crisis that followed the economic downturn, which limited funding options. We expect unregulated companies, which are sponsoring new nuclear projects and which do not receive loan guarantees, will defer or abandon them altogether because it's too expensive, or uneconomic, to build them without such guarantees. Other than the two frontrunners under the DOE's Loan Guarantee Program (see note 1), we believe nuclear facility sponsors have slowed plans until there is greater certainty about Congressional appropriations available for construction guarantees (see note 2).

Under any conditions, especially amid uncertainty over the climate change bill and in the aftermath of the credit crisis, the financing of large capital projects is difficult. This is particularly a challenge for unproven technology, such as the first-of-a-kind risks of nuclear technologies using passive safety systems. The cost of new nuclear facilities can vary from about $7.5 billion to $11.5 billion in the U.S. depending on the size of the unit and the technology used, makes the proposition especially daunting for most U.S electric utilities that, unlike their international counterparts, generally do not have the market capitalization to finance large projects on their balance sheets. For instance, the balance sheets of large U.S electric utilities like Southern Co. and Exelon Corp. at about $50 billion are dwarfed by the balance sheet of Electricite de France S.A. at almost $325 billion.

As the first wave of nuclear units is not expected until 2017, depressed natural gas prices through the medium term should not hinder the expansion of the nuclear power sector. Yet, claims that the potential supply from the various shale gas plays in the U.S. can support needs for the next 75 to 90 years could lower natural gas prices for the long term. While it remains unclear what price levels support sustained production of shale gas, the horizontal rig (used predominantly in shale plays) count has risen, even though NYMEX gas prices have averaged only about $4.50 per million Btu (mmBtu) between July 2009 and June 2010. While spot prices have declined, so have the expectations for future prices. The back-end of the forward gas curve has flattened considerably. The 2013 strip in the current forward gas curve has declined to about $5.90 per mmBtu from about $7.50 per mmBtu in June 2009. The market appears to be communicating, via the deferred part of the curve, that the future does not warrant higher prices.

Nuclear Plants Versus Gas-Fired Plants

Through the levelized cost of energy (LCOE), we compared the construction costs for nuclear power plants and natural gas combined-cycle gas turbine (CCGT) plants, which we believe are currently the only realistic base-load alternative to nuclear generation. Levelized cost is the minimum price at which a technology produces electricity and generates enough revenue to pay all of a utility's costs and still provides a sufficient return to investors. Key variables include capital costs, gas prices, prices for carbon emissions, and government subsidies, along with incentives such as loan guarantee programs, production tax credits, and delay insurance (see Appendix). This hypothetical exercise excludes noneconomic reasons why nuclear generation may still be preferred at natural gas prices lower than what the theoretical "break-even" price might suggest. For instance, there will be a premium that sponsors will be willing to bear for the relatively stable cost structure of nuclear generation compared with the volatility of natural gas prices.

In the charts that follow we have plotted nuclear capital costs against natural gas prices, showing the natural gas price at which the nuclear unit will achieve the same LCOE as the CCGT plant. This analysis is necessarily fraught with over-simplifying assumptions and generalizations but provides a range of "break-even" natural gas prices corresponding to a range of capital cost for new nuclear generation (see note 3). Because construction costs are difficult to quantify, we have compared a generic nuclear plant with a capital cost range of $5,000 per kilowatt (kW) - $8,000 per kW to a CCGT plant with a $1,200 per kW capital cost.

Table 1

Key Assumptions

	Nuclear power	CCGT
Life (years)	40	30
Capital cost ($/kW)	Variable	1200
Heat rate (Btu/kwh)	10,000	7,000
Fixed O&M ($/Kw-yr)*	110	20
Variable O&M ($/MWh)	2.5	7
Capacity factor (%)¶	90	60
Gas price ($/MMBTU)	0.85	Goal Seek
Capital structure (debt/equity)	80/20 or 50/50	50/50
Cost of equity (%)§	15 or 10	10
Cost of debt (%)**	4 or 8	8
Tax rate (%)	40	40
Carbon price ($/ton)	N.A.	0/10/20
Incentives		
Production tax credit¶¶	$125 million per year	No
Investment tax credit (%)¶¶	10	No
Loan guarantee	Yes	No
MACRS§	15 years	20 years

Table 1

Key Assumptions (cont.)
*Fixed opearating and maintenance costs for nuclear includes decommissioning costs. ¶Combined-cycle gas turbine capacity factors are higher than those generally observed at present, but this is a reasonable scenario in future when no other baseload choices are available. §Nuclear is a higher risk investment that requires correspondingly higher returns. The 10% return is under a specific case explained later. **Nuclear plants are assumed to have the DOE loan guarantee. 8% is for the "rate based" case. ¶¶A project can avail either investment tax credits or production tax credits, depending on which is more beneficial. Pproduction tax credits at at $18 per megawatt-hour, subject to a maximum of $125 million per year. MACRS--Modified Accelerated Cost Recovery System.

We have determined nuclear capital costs and gas prices at which both technologies have the same LCOE. .And we have run three scenarios, each at three different carbon emission costs (see note 3) to show how the economics for "clean" nuclear generation energy will improve once a price is set for carbon emissions:

- Rate-based case: The return on equity is reduced to about 10% to mimic a regulated utility's rate-basing of a nuclear unit, and cost of debt is at 8%. While no company would likely finance a nuclear plant today without a loan guarantee, this reflects the fundamental economics of nuclear vis-à-vis natural gas.
- Loan guarantee case: Apart from cheaper financing, this case also assumes an 80/20 debt to equity proportion rather than the conventional 50/50 capital structure under rate base.
- Subsidies case: Most subsidies are provided, including the investment tax credit/production tax credit benefit.

Chart 1

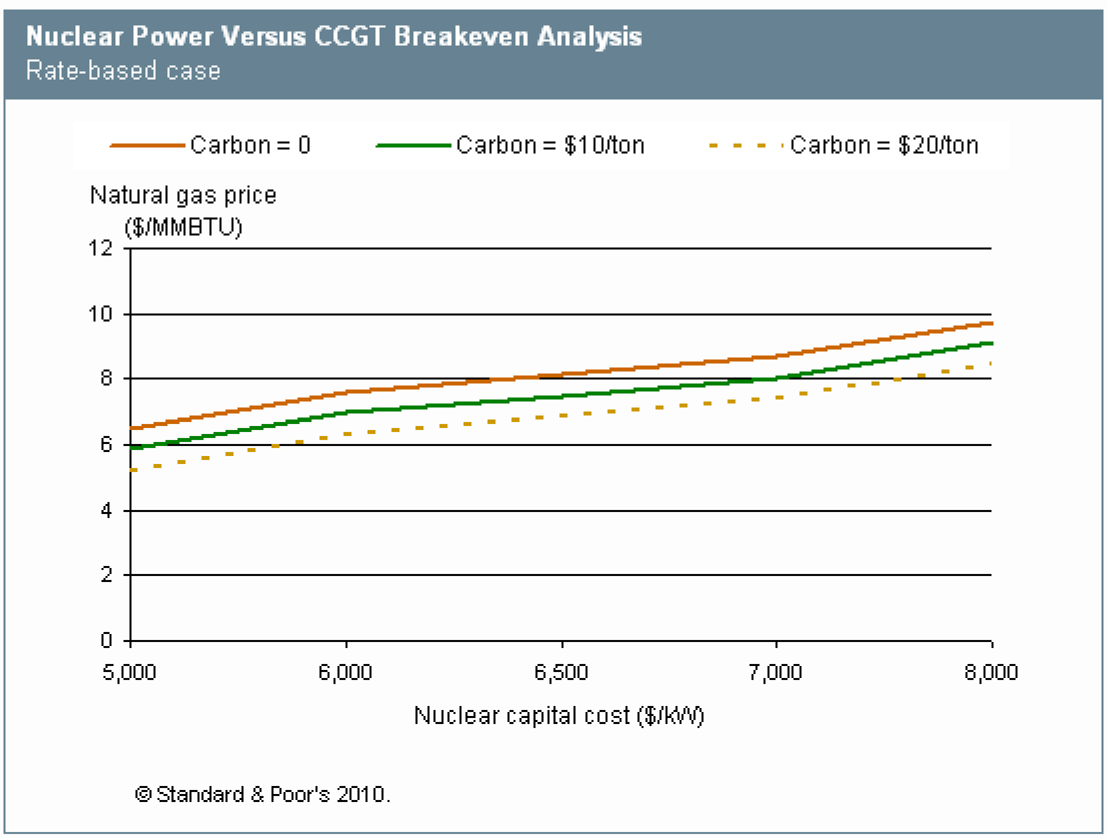


Chart 2

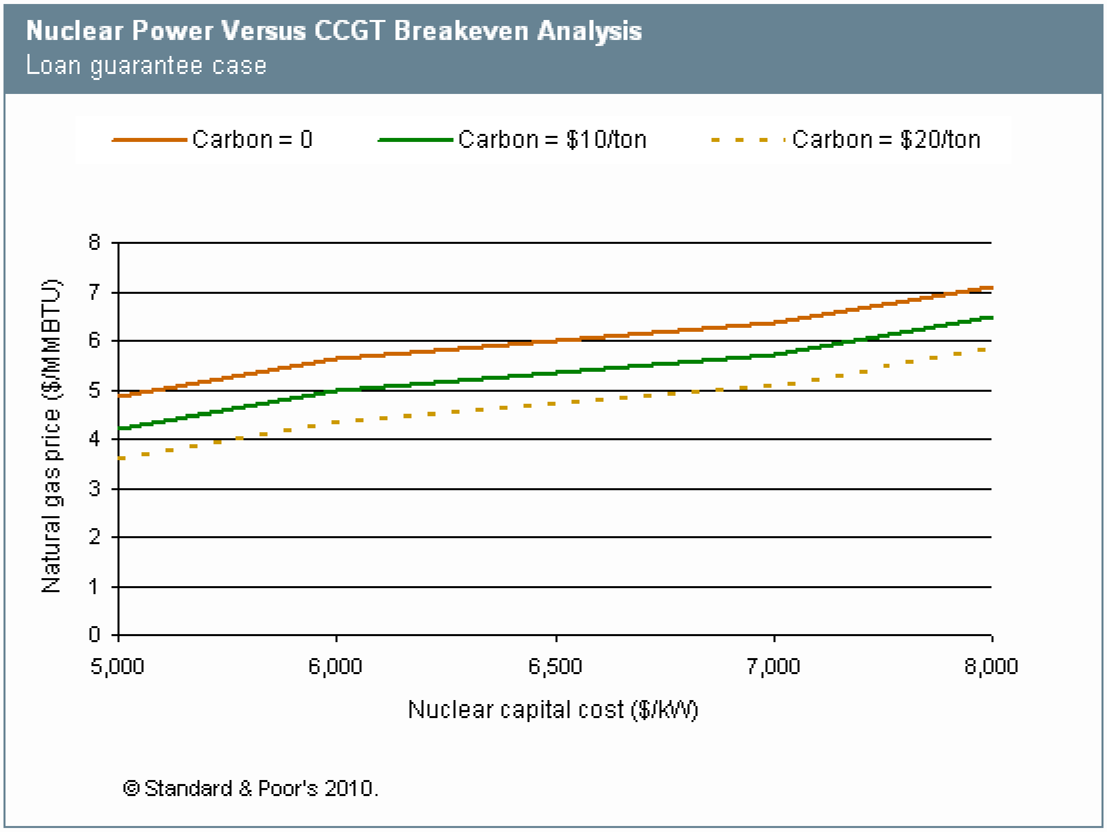
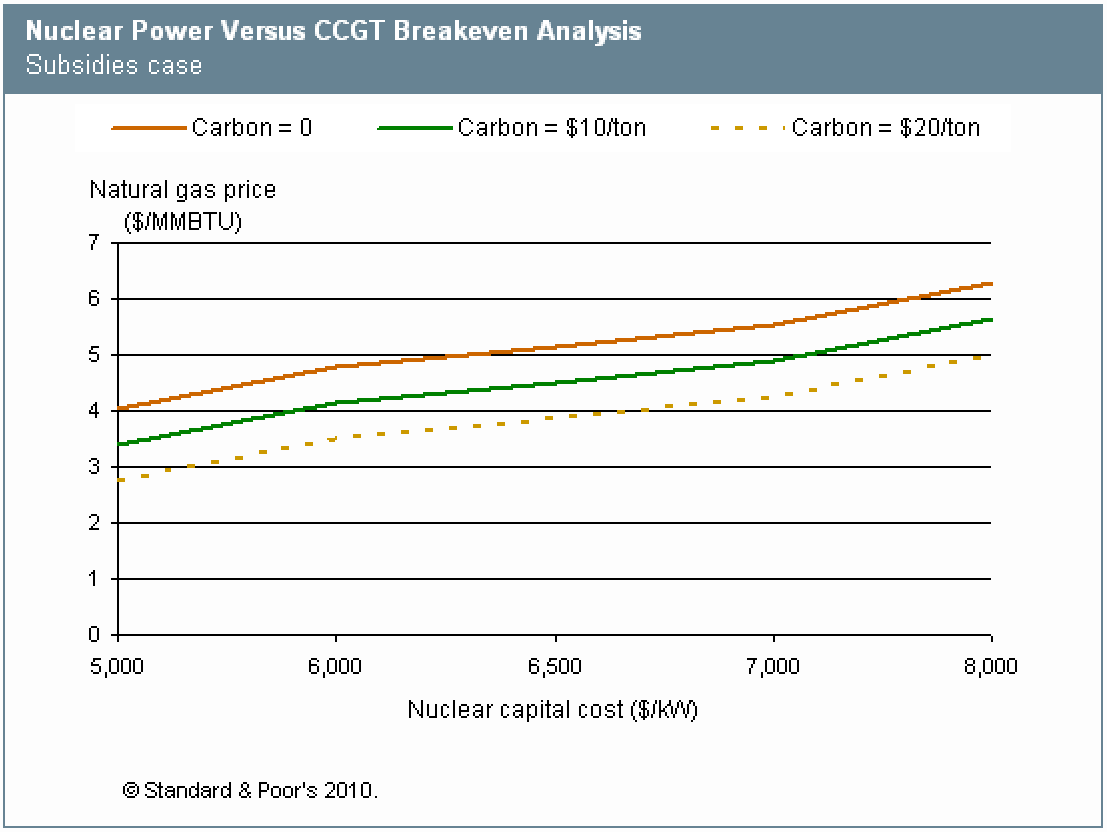

Nuclear Power Versus CCGT Breakeven Analysis
Loan guarantee case
Carbon = 0
Carbon = $10/ton
Carbon = $20/ton
Natural gas price ($/MMBTU)
0
1
2
3
4
5
6
7
8
5,000
6,000
6,500
7,000
8,000
Nuclear capital cost ($/kW)
© Standard & Poor's 2010.

Chart 3



Our results show that a merchant nuclear plant with $6,500 per kW in capital costs is likely uncompetitive without a federal loan guarantee under the prevailing forward gas prices, but can be competitive at natural gas prices as low as $4 per mmBtu with subsidies.

Falling natural gas prices and uncertainty over the climate change bill, which will impose costs on greenhouse gases emitting utilities, have impaired the nuclear power expansion. For instance, in a scenario without carbon emission costs, nuclear plant construction without loan guarantees but with utility rate base treatment requires natural gas prices of $6.50 to $10 per mmBtu for capital costs between $5,000 per kW to $8,000 per kW, to be competitive with CCGT plants (see chart 1). Capital costs of $6,000-$6,500 per kW, which appear to be a reasonable estimate of for the construction costs for of nuclear plants in the U.S., would require gas prices of $7.60-$8.20 per mmBtu. Even at a carbon emission cost of $20 per ton, the breakeven natural gas price is in the range of $5.50-$8.50 per mmBtu for capital costs of $5,000-$8,000 per kW. The charts thus indicate that at current gas prices and without high carbon emission costs, nuclear power requires government subsidies to be viable.

A federal loan guarantee improves the economics of reactor construction significantly (see chart 2). Our analysis indicates that without carbon costs, and $6,500 per kW in capital costs scenario, natural gas prices should be about $6 per mmBtu for new nuclear plants to be competitive. This equation tilts in favor of nuclear generation for models that assume carbon emission costs with "break-even" natural gas prices roughly lower by $1 per mmBtu for every $15 per ton carbon costs, i.e., declining to about $5 per mmBtu under our $6,500 per kW capital cost illustration. Models that add other subsidies (see chart 3) can make the $6,500 per kW nuclear option competitive at $5 per mmBtu without carbon emission costs, and dipping below $3.90 per mmBtu for a $20 per ton carbon price.

We note that this analysis is contingent on important assumptions, including fixed costs, economic life of the plant, and the use of the tax depreciation system. For instance, increasing the reactor's economic life to 60 years (while maintaining the Modified Accelerated Cost Recovery System [MACRS;see note 4] depreciation over 15 years) lowers the break-even natural gas price for the $6,500 per KW capital costs to about $5.50 from $6 per mmBtu. Adoption of an aggressive five-year MACRS, which is included in the Kerry-Lieberman bill, would also improve nuclear economics.

Natural Gas Prices And Subsidies Are Important Factors

For regulated utilities, the principal risk to recovery of reactor construction costs is regulatory prudence reviews (see note 5). While the currently weak natural gas prices support the construction of gas-fired plants, prospects for nuclear expansion are favorable due to carbon emission costs and the stability of nuclear power's cost structure, whereas natural gas prices in recent years have been volatile at best. Thus, from an integrated resource perspective, the construction of new nuclear units is not a difficult argument to defend in front of state regulators, especially if the federal government provides loan guarantees for the first several plants.

However, low natural gas prices pose a conundrum for merchant nuclear developers. The ability to secure power purchase agreements (PPA), which are likely necessary to finance the construction, will depend on the cost of nuclear power relative to other sources of power. While evidence from the past suggests that downturns have been followed by sharp demand rebounds, the expectation of higher natural gas prices appears a quaint notion for counterparties that would need to commit to long-term nuclear PPAs amid natural gas prices languishing in the $5 per mmBtu area. We believe visibility on the prospects of shale production will be key before any long-term purchase commitments will be forthcoming.

Notes

(1) Constellation Energy Co.'s Calvert Cliff and NRG Energy Inc.'s South Texas Project. SCANA Corp. has indicated that it will consider a loan guarantee for its Summer unit.

(2) The House planned to meet President Obama's 2011 funding target of an additional $36 billion in nuclear loan guarantee program (a $9 billion amendment to the defense supplemental bill and $25 billion in the 2011 budget). The Senate couldn't pass the $9 billion amendment. The Senate Appropriations' Energy & Water subcommittee acted on the DOE's 2011 budget on July 20, 2010. However, the Senate draft only appropriates funds to support $10 billion in 2011 nuclear loan guarantees, versus the $25 billion the House version would support.

(3) The plots are linear because we've held all other variables constant and compared only capital costs with natural gas prices.

(4) The MACRS is the current tax depreciation system. The capitalized cost (basis) of tangible property is recovered over a specified life by annual deductions for depreciation.

(5) Supportive regulation is important to a regulated utility's decision for building new nuclear. For instance, Georgia Power is allowed to collect construction work in progress during construction, lowering the in-service costs

significantly. On the other hand, on Aug. 9, 2010, the South Carolina high court reversed the state Public Utility Commission's decision to permit SCANA from recovering nearly $450 million of nuclear project contingency costs.

Appendix: Government Subsidies For Nuclear Power

While the DOE's Loan Guarantee Program is the most visible, there are many other subsidies available or under consideration at both the federal and state levels.

Production tax credits (PTC)

The Energy Policy Act of 2005 (EPAct) provides a 1.8 cent per kilowatt-hour tax credit for energy produced during the first eight years of operation of new nuclear plants using advanced reactor designs and placed in operation before Jan. 1, 2021. The credit is limited to $125 million per year for eight years per 1,000 megawatts (MW) of capacity allocated to a project, scaled up and down with the amount of capacity allocation a plant receives. This annual limit is not indexed to inflation. Credits are however available only for the first 6,000 MW of capacity, likely allocated pro rata to qualified applicants. To qualify for the PTC, applicants must:

- Have "filed" a combined operating license (COL) application by Dec. 31, 2008;
- Start pouring safety-related concrete before Jan. 1, 2014; and
- Obtain a certification from DOE that the reactor qualifies as an "advanced reactor" and that it's feasible to complete construction by Dec. 31, 2010.

Treasury will formally allocate the tax credits by Dec. 31, 2014. Treasury's guidelines also provide for a reallocation of the credits if projects are cancelled or if plants are disqualified.

Standby support program

An insurance program that provides compensation (likely equal to debt service payments) for delays caused by failures in the regulatory process. It's intended to address the perceived (based upon experience in the late 1970s and 1980s) "extraordinary" risks that the regulatory process will fail and cause delay in the operation of new nuclear plants through no fault of the project developers, or that protracted litigation will cause such delay. There is coverage exclusion for delays from normal project risks, such as technology risk, project management failures, construction errors, or equipment manufacturing or delivery delays

Only six plants will be eligible for the program, and only up to three technologies can qualify. The first two eligible plants will receive "first-dollar" coverage (no deductible) for up to $500 million and 100% of any covered losses (e.g., debt payments). The next four eligible plants will be subject to a 180-day waiting period, or deductible, and will receive coverage for up to $250 million and 50% of covered losses. Qualification to receive insurance coverage will be based on the first plants that have both received a COL from the Nuclear Regulatory Commission (NRC) and commenced pouring safety-related concrete. A key schedule point for applying coverage will be the publication of a Federal Register notice providing the last opportunity for public hearings 180 days prior to the initial fuel load.

The Kerry–Lieberman bill

Any climate change legislation will almost certainly provide subsidies for nuclear power. We look at the Kerry–Lieberman bill as representative of what maybe available for nuclear plants. Subsidies for nuclear power are found in Subtitle A of Title I (Domestic Clean Energy Development).

- Section 1102 increases the DOE Loan Guarantee Program for nuclear power to $54 billion.

- Section 1103 amends the EPAct to provide regulatory risk insurance for up to 12 reactors, rather than the current six. Directs the Secretary to pay the full amount of covered delay costs for each reactor up to $500 million.
- Section 1121 provides five-year accelerated MACRS for nuclear plants.
- Section 1122 provides a 10% investment tax credit for certain expenditures for the construction of nuclear power plants.
- Section 1124 modifies the PTC benefit to allow allocation of credit to private partnerships with public power entities.
- Section 1125 allows tax-exempt bonds to be used for public-private partnerships for advanced nuclear power facilities.

State-level subsidies

Georgia and South Carolina have permitted development of reactors, using commercially unproven technology, with the support of the utility's rate base. This is easily the greatest support possible, but there are also other forms of state support that reduce economic risks. An example is Nuclear Decommissioning Legislation in Texas.

Under NRC rules, unregulated nuclear plant developers would need to fund the entire cost of decommissioning a unit prior to the first fuel-load. However, a statute enacted in 2007 in Texas allows owners of new merchant nuclear plants in ERCOT to fund decommissioning obligations on a yearly basis over the NRC license term by relying on a state-backed trust funding mechanism. The Public Utility Commission of Texas (PUCT) will establish the annual funding requirements for the trust fund using a process similar to that of regulated utilities. Annual payment is a condition to continued operation of the units. If the plant owner defaults, the PUCT is required to collect any deficiencies from retail electric customers.

There are penalties for failure to make ongoing payments and a requirement for subsequent owners (post any default) to make up any shortfalls, including any retail customer payments to the trust, before receiving state permission to operate the plant. The statute requires a 16-year financial assurance of the estimated future annual funding obligations in the form of cash, letter of credit, surety, or other measures. The PUCT rule also allows parent guarantees if the parent maintains at least 10 times tangible net worth of the 16-year assurance amount and net working capital of at least 10 times the annual amount.