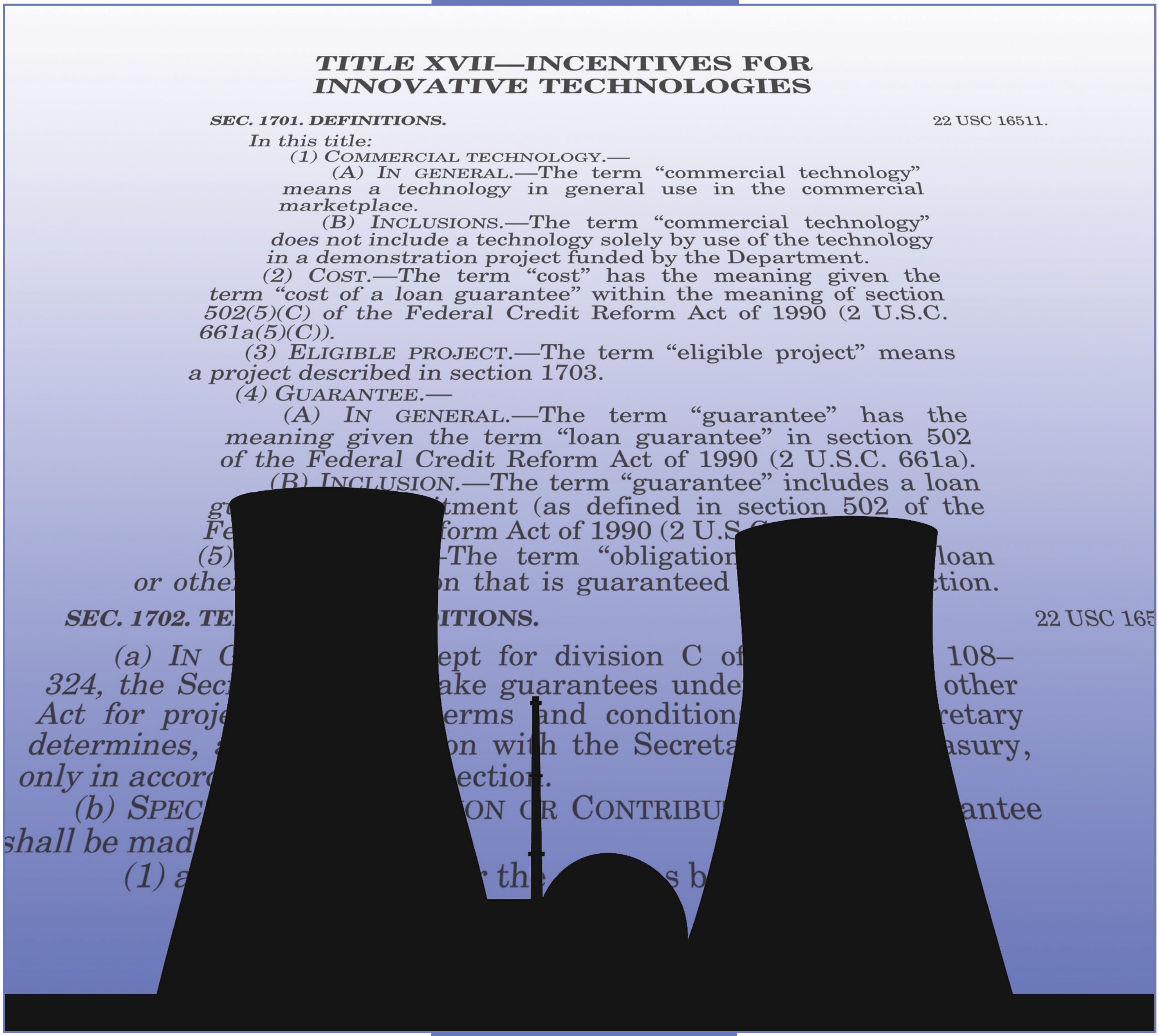
CONGRESS OF THE UNITED STATES
CONGRESSIONAL BUDGET OFFICE

CBO

Federal Loan Guarantees for the Construction of Nuclear Power Plants



TITLE XVII—INCENTIVES FOR INNOVATIVE TECHNOLOGIES

SEC. 1701. DEFINITIONS. 22 USC 16511.

In this title:

(1) COMMERCIAL TECHNOLOGY.—

(A) IN GENERAL.—The term “commercial technology” means a technology in general use in the commercial marketplace.

(B) INCLUSIONS.—The term “commercial technology” does not include a technology solely by use of the technology in a demonstration project funded by the Department.

(2) COST.—The term “cost” has the meaning given the term “cost of a loan guarantee” within the meaning of section 502(5)(C) of the Federal Credit Reform Act of 1990 (2 U.S.C. 661a(5)(C)).

(3) ELIGIBLE PROJECT.—The term “eligible project” means a project described in section 1703.

(4) GUARANTEE.—

(A) IN GENERAL.—The term “guarantee” has the meaning given the term “loan guarantee” in section 502 of the Federal Credit Reform Act of 1990 (2 U.S.C. 661a).

(B) INCLUSION.—The term “guarantee” includes a loan
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Fe form Act of 1990 (2 U.S
(5) —The term “obligation loan
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SEC. 1702. TE ITIONS. 22 USC 165

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Federal Loan Guarantees for the Construction of Nuclear Power Plants

August 2011

The Congress of the United States ■ Congressional Budget Office

Preface

Under the Energy Policy Act of 2005, the Secretary of Energy is authorized to guarantee loans used for the construction of advanced nuclear energy facilities. In exchange for providing a loan guarantee, the Department of Energy (DOE) is authorized to charge a fee that is meant to recover the guarantee's estimated budgetary cost. Because budgetary cost estimates are not a comprehensive measure of the taxpayer resources committed through a loan guarantee, and because of concerns about the accuracy of the methods and assumptions that DOE uses to estimate budgetary cost, some commentators have suggested that federal loan guarantees for the construction of nuclear power plants are being systematically underpriced, whereas others believe they are being overpriced.

This Congressional Budget Office (CBO) study, which was prepared at the request of the Ranking Member of the House Subcommittee on Regulatory Affairs, Stimulus Oversight, and Government Spending, examines the main factors that influence the cost of federal loan guarantees for nuclear construction projects. It provides illustrative estimates of the costs of such guarantees, using both the methodology specified in the Federal Credit Reform Act of 1990 and a more comprehensive fair-value approach. In keeping with CBO's mandate to provide objective, impartial analysis, the study contains no recommendations.

The study was written by Wendy Kiska and Deborah Lucas of CBO's Financial Analysis Division, with contributions from Mitchell Remy and Rebecca Rockey. The analysis benefited from comments provided by Kim Cawley, Wendy Edelberg, Justin Falk, Kathy Gramp, David Moore, and Marika Santoro. In addition, Jean Helwege of the University of South Carolina and Kevin O'Meara of the Public Power Council provided helpful comments. (The assistance of external reviewers implies no responsibility for the final product, which rests solely with CBO.)

Loretta Lettner edited the paper, and Kate Kelly proofread it. Jeanine Rees prepared the report for publication, and Maureen Costantino designed the cover. Monte Ruffin printed the initial copies, and Linda Schimmel coordinated the print distribution. This report is available on CBO's Web site (www.cbo.gov).

Douglas W. Elmendorf

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Director

August 2011

Contents

Summary and Introduction 1

Overview of DOE's Loan Guarantee Program 4

Estimating Loan Guarantees' Cash Flows and Riskiness 5

Key Drivers of Risk 6

Probability and Severity of Default 8

Comparing Budgetary and Fair-Value Costs 12

The Impact of Adverse Selection on Estimated Budgetary Cost 14

Selecting Discount Rates for Fair-Value Estimates 14

Illustrative Guarantee Costs and Sensitivity Analysis 15

Sensitivity to Credit Ratings, Recovery Rates, and the Inclusion of a Risk Charge 16

Sensitivity to the Timing of Defaults and Recoveries 16

Sensitivity to the Terms of the Loan Contract 18

Uncertainty in Default Rates Within a Single Credit Rating 18

Appendix A: The Federal Government's Role in Nuclear Power and a Historical Overview of Industry Performance 21

Appendix B: Applications for the Department of Energy's Loan Guarantee Program 27

Appendix C: Calculating the Value of a Loan Guarantee 29

Tables

1. Average Recovery Rates, by Type of Security 9

2. Credit Spreads and Estimated Risk Premiums 15

A-1. The Status of Nuclear Reactors in the United States, by Construction Start Date 23

Figures

1. Variations in the Estimated Cost of Loan Guarantees, by Credit Rating and Recovery Rate, as Measured Under the Federal Credit Reform Act and on a Fair-Value Basis 3

2. Rates of Default and Recovery on Corporate Bonds, 1985 to 2010 13

3. Sensitivity of Estimated Loan Guarantee Costs to Variations in Recovery Rates if Default Occurs During Construction 17

4. Sensitivity of Estimated Loan Guarantee Costs to the Probability of Default 19

C-1. A Typical Pattern of Contractual Payments on a Risky Loan for a Nuclear Construction Project 31

C-2. An Example of the Cash Flows to a Lender on a Risky Loan for a Nuclear Construction Project, with Default in the 11th Year 31

C-3. Expected Cash Flows and Contractual Cash Flows to a Lender on a Risky Loan for a Nuclear Construction Project 32

C-4. Expected Cash Flows from Guaranteeing a Risky Loan for a Nuclear Construction Project 32

C-5. Differences Between Expected Cash Flows and Contractual Cash Flows from a Risky Loan for a Nuclear Construction Project 33

Box

1. Credit Ratings as Predictors of Default 10

Federal Loan Guarantees for the Construction of Nuclear Power Plants

Summary and Introduction

Among the goals often posited for federal energy policy are to enhance energy security by diminishing the nation's reliance on foreign oil, to meet a growing demand for electricity, and to reduce greenhouse gas emissions by encouraging investment in clean energy production and technologies. To help further such objectives, the Energy Policy Act of 2005 (Public Law 109-58) established incentives to encourage private investment in innovative technologies, including advanced nuclear energy facilities. Much of the support for such investment is provided under title XVII of that legislation, which offers federal loan guarantees for the construction of nuclear power plants and other types of "alternative" energy facilities.

Administered by the Department of Energy (DOE), the loan guarantee program encourages private investment in nuclear energy by lowering the cost of borrowing and possibly increasing the availability of credit for project sponsors—usually an individual utility, a consortium of utilities, or a merchant power producer.[1] In exchange for providing a loan guarantee, DOE is authorized to charge sponsors a fee that is meant to recover the guarantee's estimated budgetary cost.

However, budgetary cost estimates—which are calculated as required under the Federal Credit Reform Act of 1990 (FCRA)—are not a comprehensive measure of the cost to taxpayers of those guarantee commitments.[2] Specifically, FCRA estimates do not recognize that the government's assumption of financial risk has costs for taxpayers that exceed the average amount of losses that would be expected from defaults; those additional costs arise because a borrower is most likely to default on a loan and fail to make the promised payments of principal and interest during times of economic stress, when the losses are especially painful for taxpayers. Consequently, the estimated budgetary cost of a guarantee is generally lower than its estimated "fair-value" cost, which approximates the market price that a private guarantor would charge for an obligation with similar risk and expected returns.

Because budgetary cost estimates are not a comprehensive measure of the taxpayer resources committed, and because of concerns about the accuracy of the methods and assumptions that DOE uses to forecast default rates and recovery values, some commentators have suggested that federal loan guarantees for the construction of nuclear power plants are being systematically underpriced, whereas others believe they are being overpriced.[3]

For this study, the Congressional Budget Office (CBO) reviewed the many factors that can influence the cost to the government of guaranteeing loans for the construction of advanced nuclear facilities; developed a model to estimate guarantee costs for a representative loan using both FCRA-based and fair-value methodologies; performed a sensitivity analysis of those estimated costs to changes in assumptions about key drivers of cost; and explored the challenges inherent in attempting to charge borrowers the full cost of a loan guarantee. CBO's findings are as follows:

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[1] Merchant producers are private companies that build independent generating capacity that is sold to utilities or to other customers that are not contractually obligated in advance to buy the power.

[2] Under FCRA, the budget records the lifetime cost of a loan guarantee, which is estimated by projecting the associated cash flows (amounts paid out to cover expected losses from defaults net of expected fees received) and discounting those cash flows to the present at Treasury interest rates.

[3] For example, see Nuclear Energy Institute, *Credit Subsidy Costs for New Nuclear Power Projects Receiving Department of Energy (DOE) Loan Guarantees: An Analysis of DOE's Methodology and Major Assumptions*, NEI White Paper (Washington, D.C.: NEI, September 2010), available at www.nei.org/filefolder/CreditSubsidyCostWhitePaper.pdf; and David Schlissel, Michael Mullett, and Robert Alvarez, *Nuclear Loan Guarantees: Another Taxpayer Bailout Ahead?* (Cambridge, Mass.: Union of Concerned Scientists Publications, March 2009).

- **The expected cost to the federal government of guaranteeing a nuclear construction loan will vary greatly depending on a project's characteristics and on the economic and regulatory environment in which the project will operate.** Important considerations include capital structure (the mix of debt and equity used to finance the project); ownership structure (whether it is a stand-alone project or part of a diversified company); whether construction costs may be passed on to utility ratepayers or local taxpayers; the regulatory environment; the degree of uncertainty about construction costs; the cost of competing generation technologies; and the demand for electricity. Although a serious nuclear accident could entail extremely large costs to investors and society, that risk has a small effect on the direct cost to the government of providing a guarantee because liability under the guarantee is limited to the amount of the debt, and the probability that such an accident will occur is low.

- **Default rates and recovery rates are likely to vary considerably, both across projects and over the lifetime of a given project.** CBO does not have enough information to independently estimate an average recovery rate for nuclear construction loans. However, assigning a similar expected recovery rate as a starting point for all projects—which is DOE's current practice—does not appear to make full use of the information available to DOE through its detailed project assessment process. For example, when sponsors of stand-alone projects cannot pass on construction costs to ratepayers, very low recoveries may result if bankruptcy occurs during the construction phase. By contrast, recovery rates may be considerably higher once projects become operational.

  Using a single recovery rate tends to increase the variability of estimated guarantee costs relative to their true values, which increases the government's exposure to a phenomenon known as adverse selection. Adverse selection occurs when borrowers are better able than the government to assess the value of a guarantee offer and take advantage of their superior information at the government's expense. For nuclear construction loans, borrowers will tend to turn down a guarantee if they believe the fee set by DOE is too high but go forward if they consider it fair or underpriced, which increases the likelihood that DOE's portfolio will include more projects for which the subsidy fee has been underestimated than overestimated.

- **When credit ratings are used to assess default probabilities, cost estimates will vary widely with the assigned ratings category, the assumed recovery rate, and whether Treasury interest rates or estimated market interest rates are used for discounting** (see Figure 1). CBO relied on the information in historical credit ratings to impute default probabilities (as does DOE) and considered a range of recovery rates that might apply to different projects depending on their characteristics. As required under FCRA, budgetary estimates use Treasury interest rates for discounting future cash flows; fair-value estimates rely on estimates of the applicable market interest rates for discounting.

- **Budgetary estimates of guarantee costs are significantly lower than the corresponding fair-value estimates, which provide a more comprehensive measure of the cost to taxpayers.** CBO used the credit rating associated with a project to derive the discount rate the market would most likely assign to the loan cash flows. For example, if the risks associated with a guaranteed loan are in the range of those posed by bonds rated A (less risky) and bonds rated BB (riskier), and if 55 percent of the amount owed is expected to be recovered in the event of a default, the budgetary cost, measured on a FCRA basis, ranges from 1 percent to 6 percent of the principal loaned. In contrast, the fair value of the guarantee ranges from 9 percent to 21 percent of the principal loaned. (Compare the first and second panels of Figure 1.)

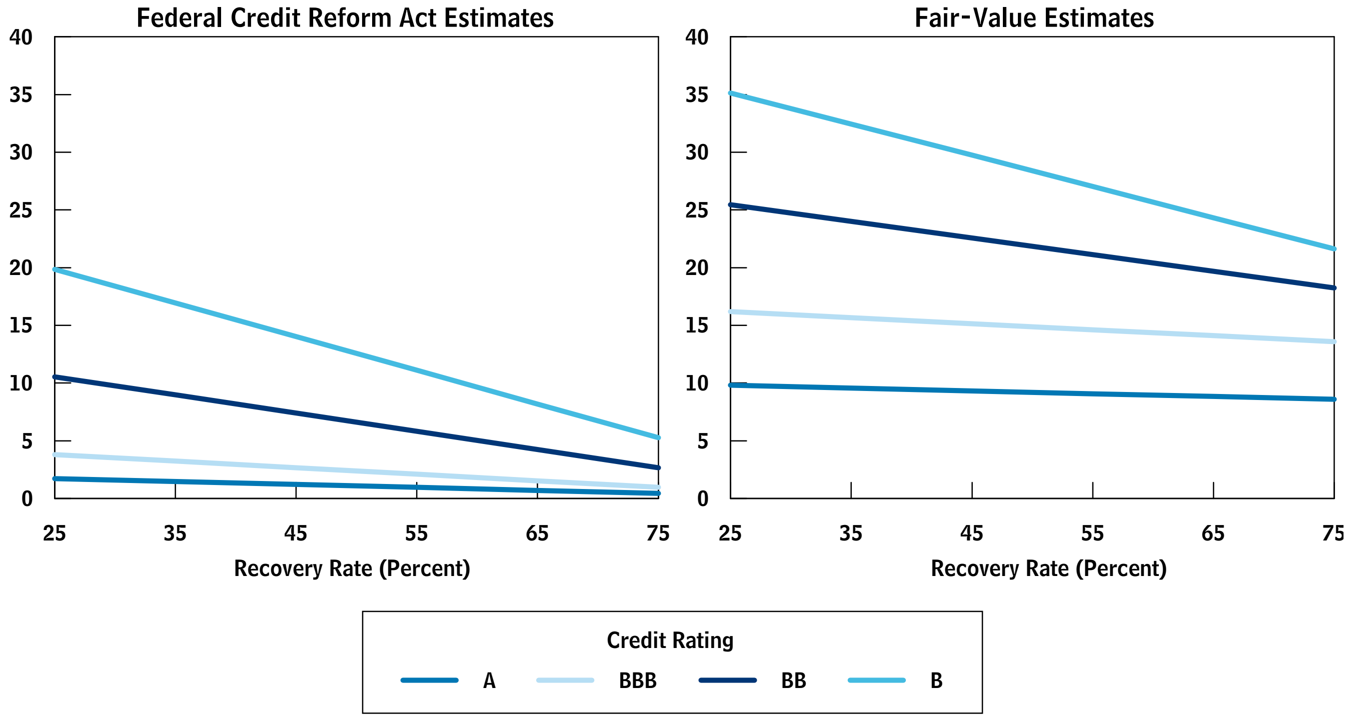
- **Because of the high degree of uncertainty involved, it may not be possible to charge borrowers the full cost of a loan guarantee.** When adverse selection is severe, attempts to offset expected losses with an increase in fees can backfire because the higher fees drive away creditworthy borrowers, making it impossible to provide a loan guarantee that does not involve a subsidy.

CBO relied on a credit-ratings-based approach to evaluate the probability of default rather than on the historical experience of the nuclear industry, for which not enough

Figure 1.

Variations in the Estimated Cost of Loan Guarantees, by Credit Rating and Recovery Rate, as Measured Under the Federal Credit Reform Act and on a Fair-Value Basis

(Guarantee costs as a percentage of loan principal)



Source: Congressional Budget Office.

Notes: Cost estimates under the Federal Credit Reform Act of 1990 use Treasury rates for discounting projected cash flows. Fair-value estimates approximate what a private guarantor would charge for the guarantee; they are based on the same projected cash flows, but the discount rates are adjusted to include a market risk premium.

Recovery rates measure the fraction of the present value of outstanding principal and interest that the lender receives in the event of a default.

data exist to draw quantitative inferences. However, historical experience suggests that investing in nuclear generating capacity engenders considerable risk. One study found that of the 117 privately owned plants in the United States that were started in the 1960s and 1970s and for which data were available, 48 were canceled, and almost all of them experienced significant cost overruns.[4] As a consequence, most of the utilities that undertook nuclear projects suffered ratings downgrades—sometimes several downgrades—during the construction phase.[5] However, bondholders experienced losses from defaults in only a few instances. Losses for the most part were borne by the projects' equity holders, the regions' electricity ratepayers, and the government. Supporters of nuclear power argue that newer plant designs and changes in the regulatory environment make nuclear investments less risky now, but recent experience abroad suggests that cost overruns and delays are still common phenomena, and concerns remain about an uncertain regulatory environment and changes in demand for electricity. (See Appendix A for a more detailed historical review of the industry's performance.)

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[4] Werner F. M. De Bondt and Anil K. Makhija, "Throwing Good Money After Bad? Nuclear Power Investment Decisions and the Relevance of Sunk Costs," *Journal of Economic Behavior and Organization*, vol. 10-2 (September 1988), pp. 173–199.

[5] Moody's Global Infrastructure Finance, *New Nuclear Generation: Ratings Pressure Increasing,* Special Comment Report 117883 (New York: Moody's Investors Service, June 2009), available at www.scribd.com/doc/18057014/Moodys-New-Nuclear-Generation-June-2009.

Finally, although the federal budget is intended to account for the costs of federal activities, it does not account for the benefits of such activities. As is the case with other types of federal spending, loan guarantees for the construction of nuclear plants might increase well-being by supporting activities that are valuable to society but that are unlikely to be economically viable without governmental support. In assessing the value of the program, such benefits must be weighed against the costs of those activities. However, an analysis of the benefits of loan guarantees for nuclear construction is beyond the scope of this study.

Overview of DOE's Loan Guarantee Program

Under title XVII of the Energy Policy Act of 2005, the Secretary of Energy, in conjunction with the Secretary of the Treasury, is authorized to provide loan guarantees for qualifying energy projects that use certain innovative technologies. To qualify, projects must "avoid, reduce, or sequester air pollutants or anthropogenic emissions of greenhouse gases" and "employ new or significantly improved technologies as compared to technologies in service in the United States at the time the guarantee is issued."[6] Among the types of projects meeting those criteria are advanced, or third-generation, nuclear reactors. Third-generation reactors are designed to be safer to operate and less expensive to build and maintain than the first- and second-generation reactors used in existing nuclear power plants.

Borrowers who qualify for a federal guarantee can obtain low-cost debt financing from private financial institutions or from an arm of the Treasury known as the Federal Financing Bank. Under the title XVII program, sponsors of a qualifying nuclear power project can finance up to 80 percent of the project's total construction costs. For example, a project estimated to cost $3 billion to build could qualify for a guarantee on as much as $2.4 billion of debt. Guarantees may assure the lender of receiving full repayment of principal and any interest owed on the guaranteed amount (in which case the borrowers can obtain the loan from the Federal Financing Bank) or they may protect the lender against only a portion of potential losses. In exchange for a guarantee, DOE is authorized to charge sponsors a fee that covers the guarantee's estimated budgetary cost.

In 2008, the Congress authorized $18.5 billion to cover the cost of guaranteeing loans for the construction of advanced nuclear power facilities and $2 billion to cover the cost of guaranteeing loans for the construction of facilities for front-end fuel processing.[7] The President's budget proposal for fiscal year 2012 includes a request for an additional $36 billion of guarantee authority for advanced nuclear facilities. As of April 2011, DOE had received a total of 19 applications for credit assistance from 17 different companies for the construction of 14 nuclear power plants.[8] The requested loan guarantees amounted to $188 billion.[9] Of those applications, only one—an $8.33 billion guarantee for the addition of two new reactors at Southern Company's Plant Vogtle in Georgia—has been reported to be close to completion.[10] A guarantee offer was also extended to Constellation Energy last October to build a plant in Maryland, but the company declined to take it, citing the high cost of the guarantee fee.[11] Observers pointed to lower projections of energy demand in the region as another possible factor. In general, the subsidy provided by a loan guarantee may be insufficient to make a project economically viable. (For additional information on the applications that have been made to DOE for loan guarantees, see Appendix B.)

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[6] P.L. 109-58, §1703(a); 119 Stat. 1120; 42 U.S.C. § 16513(a)

[7] Front-end fuel processing comprises the various steps necessary to turn raw uranium ore into fuel that can be used in a nuclear reactor.

[8] A plant (which can have one or more reactors) may have multiple sponsors, and a sponsor may participate in building more than one plant.

[9] Standard & Poor's Financial Services, "Special Report: U.S. Nuclear Power—The Challenges Ahead," *CreditWeek* (New York: McGraw-Hill, August 25, 2010). The program has been closed to new applicants since September 2008.

[10] The amount of the up-front guarantee fee has not been publicly disclosed, but press reports suggest it ranged from 0.5 percent to 1.5 percent of the loan principal. That would translate to a fee ranging from $41.65 million to $125 million for the investors. See Regina Griffin, "Constellation Unmoved by New Offer on Loan Guarantee," *Electric Power Daily* (October 12, 2010), available at www.plattsenergyweektv.com/story.aspx?storyid=115313&catid=293.

[11] Ibid.

To apply for a guarantee, a project sponsor must pay a fee and complete a two-part application process that DOE uses to determine the project's eligibility and pricing of the guarantee.[12] The application asks for general information, a description of the project, technical information, a business plan, a financing plan, and regulatory and other certifications.

The project evaluation process is intended to determine the likelihood that a project will generate revenues that are sufficient to cover the required payments on the guaranteed loan. The process involves extensive conversations with the applicant as well as input from independent consultants and outside legal counsel. In addition, DOE obtains an independent credit rating from a rating agency. DOE also conducts a financial and technical review that evaluates project and loan characteristics—such as the creditworthiness of the borrower, construction factors, legal and regulatory issues, the technical relevance and merit of the project, the proposed technical approach and work plans, and environmental and energy security benefits.

On the basis of the information obtained during the evaluation process, DOE assigns its own credit rating to a project, following the scale that Standard & Poor's (S&P's) Rating Services uses for industrial firms. It then relies on several rating agencies' (including S&P's) tabulations of the historical default experience for corporate bonds with a similar credit rating and on an assumed recovery rate to determine the guarantee fee and other terms offered to the borrower.

Projects that pass DOE's internal review process must then go through a credit approval process, starting with a review by the agency's Loan Guarantee Program Office, continuing with an assessment by the Treasury and the Office of Management and Budget, and concluding with an evaluation by DOE's Credit Review Board (CRB). The CRB, which is chaired by the Deputy Secretary of the Department of Energy, establishes the overall policies of the loan guarantee program and coordinates credit management and debt collection. If approval from the CRB is obtained, the applicant receives a "term sheet," which lists the conditions required to enter into a loan guarantee agreement with the DOE. If after further negotiations an agreement is reached between the CRB and the applicant, the final term sheet becomes a conditional agreement with the DOE. Final approval of a loan guarantee agreement must then be obtained from the Secretary of Energy.

Estimating Loan Guarantees' Cash Flows and Riskiness

Many of the key drivers of the risk that a sponsor will default on a loan for the construction of a nuclear power plant are common to most capital investments. They include the project's capital structure (the mix of debt and equity used to finance the project); whether it is a stand-alone project or backed by the sponsor's other assets; and uncertainty about construction costs, costs of operation, and product demand. Certain risk factors, however, are more specific to the nuclear industry: the regulatory environment, the high proportion of fixed relative to variable costs (which causes any savings from temporarily suspending electricity production to be small), and the extent to which costs can be passed on to utility ratepayers or taxpayers.

To estimate expected cash flows for loan guarantees, analysts generally reduce the many drivers of cost and risk to two factors: the probability that a default will occur in each year and the expected severity of defaults. The loss severity rate is measured as the present value of lifetime principal and interest losses in the event of default as a percentage of the principal balance.[13] Severity is inversely related to the recovery rate, which measures the fraction of the present value of outstanding principal and interest that the lender receives in the event of a default. The probability of a default and its expected severity can differ significantly depending on project-specific characteristics and over time. A potentially important source of variation is that defaults may be more likely, and losses more severe, during the construction phase of a project than after a project becomes operational.

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[12] The sponsor pays an application fee of $200,000 for the first stage of the evaluation and $600,000 for the second phase. DOE issues an initial project ranking on the basis of its initial review. Upon receiving that feedback, an applicant can decide whether or not to proceed so as to avoid the full cost of the application if the project gets a negative first-stage review. A more detailed description of the program requirements, process, and evaluation procedures for a Nuclear Power Facility Loan Guarantee Application is available online from the Department of Energy's Loan Guarantee Program Office at http://lpo.energy.gov/wp-content/uploads/2010/09/NuclPowerSol7-11-08Amend1.pdf.

[13] "Present value" is a single number that expresses a flow of current and future income (or payments) in terms of an equivalent lump sum received (or paid) today. The present value depends on the rate of interest (known as the discount rate) that is used to translate future cash flows into current dollars.

Evaluating the prospects for success of a nuclear investment project, and translating that evaluation into estimates of the probability and severity of default, requires significant technical expertise and necessarily involves judgment; even the best-informed estimate of the cost of a loan guarantee has considerable uncertainty associated with it. CBO did not attempt to assess DOE's technical evaluation process or the means by which DOE translates those evaluations into credit ratings to assess default probabilities, nor did it consider the details of any specific application for a guarantee. However, to illustrate the sensitivity of projected guarantee costs to alternative assumptions about a project's credit rating and recovery rate, CBO adopted the following methodology: It relied on historical default rates derived from credit ratings and considered a range of recovery rates that were intended to capture variations in recovery amounts caused by factors such as whether or not construction costs could be immediately passed on to ratepayers.[14]

Key Drivers of Risk

Nuclear power entails the risk that a serious accident or other incident could occur that would result in catastrophic losses—the costs of which would be borne by the plant's owners, the government, and the public. However, only a small fraction of such costs would be absorbed by bondholders or guarantors. The reason for the small effect is twofold: The maximum loss to bondholders and the maximum liability arising from a loan guarantee are limited to the principal value of the debt (which represents a small fraction of the total potential cost to society); and most experts believe that the probability of a catastrophic event is very small, particularly for new reactor designs.[15] Even so, recent events in Japan have heightened concern about the potential for similar incidents in the United States, and such concern could increase the risk of default by causing costly construction delays or the imposition of new safety measures.[16]

In comparison to conventional approaches to generating electricity, the risk of investing in nuclear power is heightened by the relatively high proportion of costs that are fixed rather than variable. Compared with facilities that use coal or natural gas to produce electricity, nuclear plants have high fixed costs (for construction and decommissioning) but low variable costs (for fuel). Total operating costs are similar to those for coal-fired plants, but operating costs for nuclear power plants have a larger fixed component because they require relatively large and fixed expenditures on safety systems. Fixed costs increase the risk of investing in nuclear power because if demand turns out to be low, cutting back on a plant's output does not save much money. The relatively high cost of nuclear power also is a source of risk: Widespread use of nuclear power is unlikely to become economically viable in the absence of subsidies unless a sufficiently high price is levied on the emission of greenhouse gases or the price of fossil fuels escalates more rapidly than most forecasters predict. Hence, even with subsidies, the economic viability of nuclear power may be marginal in today's economic and regulatory environment.[17]

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[14] CBO independently developed its model for translating default rates and recovery rates into expected cash flows, using standard formulas. Although both CBO and DOE employ a ratings-based methodology to estimate cash flows, CBO's model differs in some respects from DOE's model in implementation.

[15] In its analyses, the Nuclear Regulatory Commission assumes a probability of one severe nuclear event in a million reactor years for reactors currently in operation. See Nuclear Regulatory Commission, *State-of-the-Art Reactor Consequence Analysis (SOARCA)* (November 2010). The International Nuclear Safety Advisory Group produces risk assessments for two types of nuclear events: core damage frequency (for which it assumes a chance of 1 in 10,000 for existing plants and 1 in 1,000,000 for new plants); and a large release of radioactive material (for which it assumes a chance of 1 in 100,000 for existing plants and 1 in 1,000,000 for new plants).

[16] Standard & Poor's Financial Services, *The U.S. Nuclear Power Industry Looks at Japan and Awaits More Scrutiny* (New York: McGraw-Hill, March 16, 2011), available at www.standardandpoors.com/prot/ratings/articles/en/us/?assetID=1245300367992.

[17] Many studies indicate that a carbon tax could make nuclear power economical. For example, CBO found that a carbon tax of $45 per metric ton of CO_2 emissions would make nuclear power competitive; see Congressional Budget Office, *Nuclear Power's Role in Generating Electricity* (May 2008). Similar conclusions are reported in John Deutch and others, *The Future of Nuclear Power: An Interdisciplinary MIT Study* (Cambridge, Mass.: Massachusetts Institute of Technology, July 29, 2003), available at http://web.mit.edu/nuclearpower/pdf/nuclearpower-full.pdf; and in International Energy Agency and Organisation for Economic Co-operation and Development/Nuclear Energy Agency, *Projected Costs of Generating Electricity* (Paris: OECD Publishing, 2010).

The risk associated with providing loan guarantees is increased by the phenomenon known as adverse selection—the likelihood that borrowers who have reason to think their project is riskier than the guarantor believes it to be will accept the guarantee fee offered, whereas borrowers who believe their project is relatively safe will be more likely to decline the offer of a guarantee they view as overpriced. DOE's methodology may elevate the risk of adverse selection by categorizing nuclear construction projects into fairly broad credit-rating groupings and treating projects, regardless of how they are structured, as having similar recovery rates.

The cost to the government of guaranteeing a loan depends critically on the likelihood that the borrower will default and on the expected recovery rate, which in turn depend on a variety of factors. Those include the project's capital structure, its ownership structure, the structure of debt payments, allowable charges to ratepayers, the potential need for additional financing, and other considerations.

Capital Structure. Even a very risky project can support a small amount of safe debt because debt holders' claim to any recoveries from the sale of assets takes priority over that of equity holders. Conversely, the debt of a relatively safe project can prove to be risky if the project is backed by only a small amount of equity. In general, equity financing makes a project's debt safer because the equity serves as a cushion to absorb unanticipated losses. Title XVII limits federally guaranteed loans to 80 percent of construction costs, and the law requires that the guaranteed amount not be subordinate to other financing, so that the insured debt holders have the first claim on any recoveries in the event of a default. Nevertheless, the composition of the other 20 percent of the financing can affect expected losses; risk is lower if equity rather than other debt comprises the balance of funding because firms with higher total debt levels are more likely to default. DOE can reduce the government's risk and lower the fee offered on a guarantee by requiring a higher proportion of equity financing.

Ownership Structure. Another aspect of capital structure that affects the government's exposure to risk is whether a proposed nuclear power plant is legally organized as a stand-alone project—a financially independent, single-purpose entity that relies on "project finance"—or whether it is part of a larger corporation.[18] Project finance involves the creation of a legally and economically independent project company financed with equity from one or more sponsors and with nonrecourse debt that can be repaid only from project cash flows. By contrast, corporate debt is a general obligation of the issuing corporation; it does not rely on the success of any particular investment for repayment.

Which structure poses greater risk depends on several factors. All else being equal, a stand-alone project tends to be riskier because no other revenue streams are available to provide diversification. For example, defaults that occur during the construction phase of a stand-alone project that is 80 percent debt-financed and with no recourse to ratepayers or taxpayers could have negligible recoveries. However, historical data for nonnuclear projects shows that, on average, recovery rates on debt issued by entities using project finance have been higher than those on corporate issues, despite the latter having recourse to multiple revenue streams. Risk can be higher for a diversified firm if the possibility of adverse shocks to other parts of its business more than offset the benefit of diversification, and there can be organizational advantages to a project finance structure as well.

For nuclear construction projects, sponsors that are merchant producers are more likely to depend on project finance than are utilities. However, utilities that invest in nuclear power may be able to limit the liability to their shareholders—and thereby increase the risk to the government—by structuring their nuclear facilities as legally separate entities.

Structure of Debt Payments. How payments on guaranteed debt are structured can affect the likelihood of a default. Spreading payments out over a longer period, or delaying the start of the repayment period, may reduce risk by making it more likely that the sponsor will have sufficient earnings from operations to cover the debt payments. However, prolonging or delaying the repayment period also could increase the risk and severity of defaults. Accumulated interest payments increase total indebtedness and the size of required payments, and the longer the debt is outstanding the more exposed it is to the possibility of an adverse event.

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[18] Project finance is used for various types of projects, including construction and commercial real estate development, equipment finance, industrial and manufacturing projects, oil and gas facilities, petrochemical projects, power transmission and distribution projects, telecommunications projects, and transportation infrastructure.

Allowable Charges to Ratepayers. For projects sponsored by public or investor-owned utilities, the risk to the government from a loan guarantee is affected by two important considerations: how quickly the utility is allowed by regulators to include construction costs in the rate base and the extent to which cost overruns can be passed on to ratepayers. (Merchant producers cannot pass on construction costs to ratepayers except perhaps indirectly through the price of the energy that they eventually sell.) In localities where utilities can include a charge for construction work in progress, much of the risk during the construction phase is absorbed by ratepayers rather than by bondholders. Even in such cases, however, bondholders face the risk that regulators or the courts will determine that certain costs cannot be passed on to ratepayers and hence accentuate the risk of a default on the bonds.

The Potential Need for Additional Financing. Although DOE guarantees may cover up to 80 percent of the estimated cost of construction, construction costs are difficult to predict accurately. Historically, construction costs for nuclear plants were often many times higher than the amounts initially predicted. Similar overruns in the future would pose the risk that project sponsors might require additional funding to complete construction and that the government might be the only available source of those funds. Thus, some may believe that the government is providing an implicit guarantee on a larger amount of debt than the amount formally contracted and paid for under the guarantee program.

Other Considerations. Many uncertainties about costs and revenues affect the ultimate profitability of a nuclear power plant, which in turn affects the risk of losses related to default: construction and operating costs (including the possibility of cost increases caused by delays); the costs of competing types of electricity generation over time that will affect the price path of electricity; and future demand for electricity.[19] Those risks are exacerbated by regulatory uncertainty. Regulatory changes governing the design, construction, operational security, or decommissioning of nuclear plants could adversely affect (or, on the contrary, improve) profitability. Furthermore, the title XVII program is designed to support new technologies, which may be riskier than established designs. The prospect that policies will be adopted that require electric utilities to reduce their emissions of carbon dioxide is a potential, but also uncertain, mitigating factor.

Probability and Severity of Default

Rating agencies define default as the first occurrence of a missed payment on any financial obligation, bankruptcy, or a distressed exchange (wherein the debt holders are forced to accept substitute instruments that may have less favorable financial terms, such as a lower coupon, lower seniority, or longer maturity).[20]

The probability of default varies with the risk factors just discussed, but it is difficult to directly translate those factors into default probabilities. Defaults on bonds are fairly rare, and there is not enough historical data to draw reliable statistical inferences, particularly for an individual industrial sector. However, extensive data are available from ratings agencies about the historical default experience of corporate bonds with a particular credit rating. Therefore, a common approach is to distill an analysis of a project into a ratings category and then use the historical default experience of firms with that rating to infer the probability of default for the project under consideration (see Box 1). DOE follows that approach and assigns ratings to loan guarantee applications that correspond to ratings for corporate bonds.

The severity of defaults varies widely and is also difficult to predict. In some cases, missed payments are rescheduled and bondholders are able to fully recover their money. In other cases, bondholders may recover little of what they are owed, if anything. The severity of default is influenced by most of the same drivers as the probability of default. For instance, projects with a higher proportion of equity financing are less likely to experience large losses because the amount owed represents a smaller fraction of assets. For stand-alone nuclear projects, the severity of loss is likely to be greater before the plant becomes operational because cash on hand is likely to be low and any assets may have very limited salvage value.

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[19] To minimize its exposure to loan losses attributable to a project's potential cost overruns, DOE has the authority to require that engineering, procurement, and construction contracts have built-in provisions for cost overruns.

[20] Minor violations of covenants (legal restrictions on the firm contained in debt contracts) generally are not treated as defaults.

CBO

Table 1.

Average Recovery Rates, by Type of Security

(Percent)

	Average Recovery Rate				Standard Deviation of Recovery Rate	
Lien Position	**2008**	**2009**	**1982–2009**	**1992–2009**	**Investment-Grade Securities**	**Noninvestment-Grade Securities**
Bank Loans						
First lien	62	54	66	n.a.	n.a.	n.a.
Second lien	40	16	33	n.a.	n.a.	n.a.
Senior unsecured	32	35	49	n.a.	n.a.	n.a.
Bonds						
Senior secured	55	38	50	n.a.	24	26
Senior unsecured	34	38	37	n.a.	24	24
Senior subordinated	24	22	31	n.a.	24	24
Subordinated	24	47	31	n.a.	24	22
Junior subordinated	n.a.	n.a.	25	n.a.		
All Project Finance Debt	n.a.	n.a.	n.a.	72	n.a.	n.a.

Sources: Kenneth Emery and Sharon Ou, *Special Comment: Corporate Default and Recovery Rates, 1920-2009*, Report 123042 (New York: Moody's Investors Service, February 2010), Exhibit 7, available at http://v2.moodys.com/cust/content/Content.ashx?source=StaticContent/Free%20Pages/Regulatory%20Affairs/Documents/corporate_default_and_recovery_rates_02_10.pdf; Standard & Poor's Financial Services, *Recovery: Figuring the Recovery Rates When Global Project Finance Transactions Default* (October 21, 2010), Table 1, available at www.standardandpoors.com/prot/ratings/articles/en/us/?assetID=1245277624007; and Edward I. Altman, Andrea Resti, and Andrea Sironi, *Default Recovery Rates in Credit Risk Modeling: A Review of the Literature and Empirical Evidence*, NYU Working Paper S-CDM-03-11 (New York: New York University, December 2003), Table 2, available through SSRN at http://ssrn.com/abstract=1295797.

Notes: The standard deviation of the recovery rate measures the variation from the average recovery rate. A low standard deviation indicates that most values are closely distributed around the average recovery rate, wheras a high standard deviation indicates that recovery rates are spread out among a wide range of values.

The type of bank loan indicates whether the borrower has pledged specific assets as collateral for the loan and the seniority of the debt over other types of obligations in bankruptcy proceedings. First and second lien loans are backed by collateral; senior unsecured loans are not collateralized. First lien loans will receive payment before second lien loans, and second lien loans will receive payment before senior unsecured loans.

The type of bond indicates whether the borrower has pledged specific assets as collateral for the loan and the seniority of the debt over other types of obligations in bankruptcy proceedings. Senior secured bonds are backed by specific collateral; senior unsecured bonds and all levels of subordinated bonds are not collateralized. In the event of bankruptcy, bondholders receive payment in the following order: senior secured, senior unsecured, senior subordinated, subordinated, junior subordinated.

Project finance debt is issued on the basis of the expected cash flows from a particular project, rather than those of the sponsor. In the event of bankruptcy, a lender can recover losses only from the project-specific assets and not from the general assets of the borrower.

n.a. = not available.

The data available to predict recovery rates are extremely limited, but some patterns have been documented on the basis of bond characteristics. (Recovered amounts are generally measured as the present value of payments received by bondholders as of the default date; that value is often measured by the price of defaulted bonds at the time of default.) Debt that is owed to banks or that has a higher priority for repayment tends to have higher recovery rates, as do project finance bonds (see Table 1).

One natural point of reference for nuclear construction loans is senior unsecured bonds, which are medium- to long-term general obligations of corporations.[21] Those bonds have an average historical recovery rate of about 37 percent. However, some have suggested that federally

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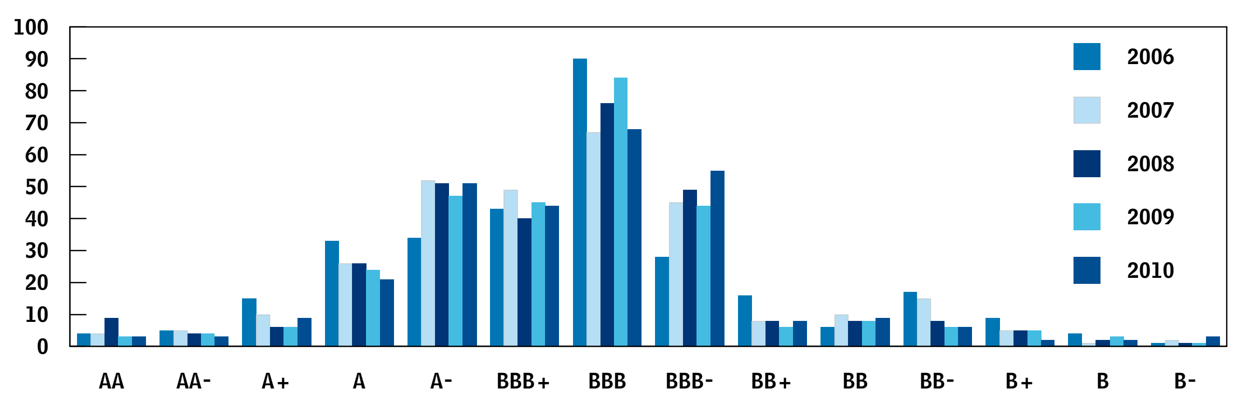
[21] In the United States, senior unsecured corporate bonds generally are not explicitly backed by specific collateral but have a claim on all of a corporation's assets that have not been otherwise pledged.

Box 1.

Credit Ratings as Predictors of Default

Distribution of Credit Ratings Among U.S. Utilities, 2006 to 2010



Source: Congressional Budget Office based on data from Standard & Poor's CreditPro®—Corporate Ratings, accessed April 6, 2011.

Notes: Standard & Poor's classifies electric, gas, and water utilities, and companies that operate as independent producers or distributors of power, as "utilities."

Standard & Poor's uses letter designations to identify a company's credit quality rating. For example, AAA and AA (high credit quality) and A and BBB (medium credit quality) are considered investment grade. Credit ratings for bonds below those designations (BB, B, CCC, etc.) are considered noninvestment grade.

Rating agencies such as Standard & Poor's (S&P), Moody's Investors Service, and Fitch Ratings assign credit ratings to issuers of corporate bonds (and to specific bond issues) to provide investors a metric for judging the relative creditworthiness of corporate obligations. The top credit ratings indicate that the obligations are believed to be of the highest quality and pose minimal risk of loss; lower ratings imply a higher expected likelihood of loss.[1] Ratings reflect analysts' judgments about the future and thus may vary over time as economic conditions and a firm's situation change.

For nuclear construction projects sponsored by utilities that probably will be able to pass on most costs to ratepayers, a relevant reference point is the rating of the sponsoring utility. The distribution of credit ratings for electric power utilities is concentrated in a range from A- to BBB-, with BBB as the most frequent rating. In recent years, the average credit quality of utilities has declined (see figure above). The current rating of a utility, however, is not necessarily indicative of what the utility's rating would be if it were to undertake a nuclear construction project. For example, Moody's recently reported that it was considering taking a more negative view of bond issuers who were seeking to finance the construction of new nuclear power plants.[2] A primary concern cited by Moody's was whether the proposed plants were economically viable, especially given uncertainties about the effects of energy-efficiency programs and national

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[1] Although the probability of default is clearly linked to credit ratings, the extent to which ratings predict recovery rates is less certain. The major rating agencies differ in whether or not the likely severity of a default is a factor in determining the credit rating. However, evidence suggests that default and recovery rates are to some extent negatively correlated. For a discussion of that relation, see Edward I. Altman and others, "The Link Between Default and Recovery Rates: Theory, Empirical Evidence, and Implications," *Journal of Business*, vol. 78, no. 6 (November 2005), pp. 2203–2228.

[2] Moody's Global Infrastructure Finance, *New Nuclear Generation: Ratings Pressure Increasing*, Special Comment Report 117883 (New York: Moody's Investors Service, June 2009), available at www.scribd.com/doc/18057014/Moodys-New-Nuclear-Generation-June-2009.

Continued

Box 1. **Continued**

Credit Ratings as Predictors of Default

Historical Frequency of Defaults on Corporate Bonds

Ratings Category	Average 15-Year Cumulative Default Rate (Percent)	Standard Deviation of Default Rate
AAA	1.1	1.0
AA+	0.3	2.1
AA	0.9	0.5
AA-	1.4	2.1
A+	2.8	1.4
A	3.0	0.8
A-	3.2	2.3
BBB+	5.9	2.2
BBB	7.1	1.5
BBB-	13.2	3.5
BB+	14.8	7.0
BB	19.7	3.7
BB-	27.1	8.1
B+	33.6	5.3
B	36.6	5.0
B-	40.1	14.1

Source: Standard & Poor's Financial Services, *Default, Transition, and Recovery: 2009 Annual Global Corporate Default Study and Rating Transitions* (New York: McGraw-Hill, March 17, 2010), Table 26.

Note: The standard deviation of the default rate measures the variation from the average default rate. A low standard deviation indicates that most values are closely distributed around the average default rate, whereas a high standard deviation indicates that default rates are spread out among a wide range of values.

clean electricity standards on the demand for new nuclear generating capacity, the availability of capital for such projects, and the effect of such investment on the sponsoring utilities' balance sheets.

The same rating for different broad categories of debt obligations—for instance, corporate bonds, sovereign debt, asset-backed securities, municipal bonds, and project finance—may not mean the same thing. For instance, project-finance bonds with an A rating have historically experienced higher recovery rates than corporate bonds with the same rating. Some observers contend that bonds issued to finance nuclear projects that use project finance are therefore safer investments than might be assumed on the basis of data associated with corporate bonds. However, it is uncertain whether bonds backed by nuclear projects are as safe as the typical project-finance investment because of differences in the characteristics of the projects.[3] For nuclear projects, project financing may be more likely to be used for riskier merchant plants that cannot pass on cost overruns to ratepayers. (Merchant power producers are private companies that build independent generating capacity that is sold to utilities or to other customers that are not contractually obligated in advance to buy the power.)

The linking of credit ratings with expected default rates relies on historical data collected by rating agencies. The rating agencies conduct annual corporate default studies using "static" (or fixed) pools of bonds issued by corporate entities—including industrial firms, financial institutions, utilities, and insurance companies—grouped by initial ratings category. This method allows default rates to be calculated over long horizons while also accounting for changes in ratings over time. Average default rates vary significantly across ratings categories, and the default rate varies significantly over time within each category. (See the accompanying table for the cumulative default rates over 15 years by ratings category, as reported by S&P, and for a measure of the uncertainty associated with those rates.)[4]

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[3] Project finance is used for a variety of types of projects that include construction and commercial real estate development, equipment finance, industrial and manufacturing projects, oil and gas facilities, petrochemical projects, power transmission and distribution projects, telecommunications projects, and transportation infrastructure.

[4] The slightly higher rate of defaults experienced by AAA bonds relative to AA bonds is probably attributable to a combination of two factors: there are a very small number of AAA corporate bonds; and, because the likelihood of default is so low, one or two events can have a large effect on the sample average. The reversal does not affect CBO's analysis because a nuclear construction project would not get a rating of AAA.

guaranteed debt for nuclear construction would behave more similarly to project finance, which has an average recovery rate of 72 percent.[22] Individual recovery rates vary considerably within each of those categories, and the recovery rate expected for a particular project could lie well outside of the range implied by those averages.[23]

DOE assumes a base recovery rate of 55 percent for both nuclear and nonnuclear projects (although it sometimes adjusts expected recoveries somewhat to take into account project-specific factors). That estimate falls between the historical average rates of recovery for senior unsecured corporate bonds and for project finance. CBO does not have enough information to independently evaluate whether the choice of 55 percent is the best estimate of the average recovery rate on nuclear construction loans.[24] However, in CBO's view, finding the best estimate of the recovery rate for a given project would require an assessment based on the specific risk factors discussed earlier. The practice of assigning a similar expected recovery rate as a starting point to all projects does not appear to make full use of the information available to DOE through its detailed project-assessment process. Moreover, using a single recovery rate rather than a project-specific one tends to increase the variability of estimated guarantee costs relative to their true worth. Because project sponsors have the option to accept the guarantee offer or decline it, that variability makes it more likely that the guarantees accepted will be those that were priced below their true budgetary cost, whereas those turned down may be those that were priced above it.

Comparing Budgetary and Fair-Value Costs

Under current policy, DOE requires borrowers to pay the initial estimate of the cost of a loan guarantee. The estimation approach used to calculate that amount is also used to determine the initial budgetary cost of a loan guarantee. Hence, the Office of Management and Budget records a zero cost in the budget when nuclear construction loan guarantees are made.[25]

The Federal Credit Reform Act of 1990 specifies the procedures that are used to estimate the budgetary impact of most of the federal government's loan and loan guarantee programs. Under FCRA, the budgetary cost of a loan guarantee (or a direct loan) is calculated as the net present value of expected cash flows over the life of the obligation. The net present value is calculated by discounting cash flows to the time of loan disbursement using rates on Treasury securities of comparable maturity. (For example, the cash flows a year after disbursement are discounted using a one-year rate, cash flows five years out are discounted using a five-year rate, and so on.)

The budgetary cost of a loan guarantee is not intended to be a comprehensive measure of economic cost, and in practice it is generally less than its fair-value cost—the amount that a private financial institution would charge for the guarantee in a well-functioning market. The main difference between the cost that appears in the federal budget and the fair-value cost of a guarantee is that investors require compensation for bearing market risk, which is not treated as a budgetary cost.

Market risk is the component of risk that investors cannot protect themselves against by diversifying their portfolios. Investors require compensation for market risk because investments exposed to such risk are more likely to have low returns when the economy as a whole is weak and resources are more highly valued. In general, loan guarantees have significant exposure to market risk because private enterprises default on their debt obligations more frequently and with greater severity (meaning that recoveries from the borrowers are lower) when the market is weak (see Figure 2). In the case of nuclear construction guarantees provided to investor-owned utilities or merchant power providers, for example, plant construction may be more likely to be slowed or canceled

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[22] For example, see Nuclear Energy Institute, *Credit Subsidy Costs for New Nuclear Power Projects Receiving Department of Energy (DOE) Loan Guarantees*.

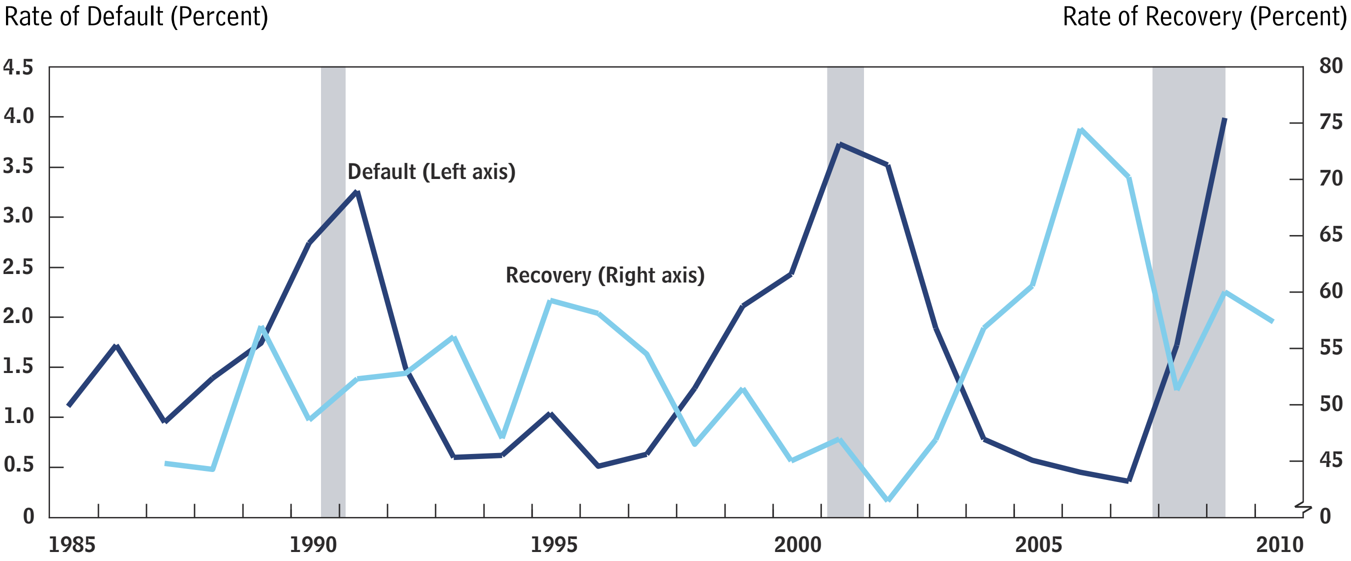
[23] For an analysis of the performance of project finance loans relative to corporate loans, see Chris Beale and others, "Credit Attributes of Project Finance," *Journal of Structured and Project Finance* (Fall 2002), pp. 5–9.

[24] Technically, DOE's model begins with the assumption that pre- and postconstruction recovery rates are equal to 55 percent.

[25] DOE's authority to guarantee loans under the title XVII program is subject to annual appropriation action. The Office of Management and Budget periodically reestimates the cost of federal loan guarantees to capture changes in expected and realized losses. Under FCRA, the costs of those reestimates are covered by an unlimited appropriation (and not by the borrower).

Figure 2.

Rates of Default and Recovery on Corporate Bonds, 1985 to 2010



Source: Congressional Budget Office based on data from Standard & Poor's Financial Services, *Default, Transition, and Recovery: 2009 Annual Global Corporate Default Study and Rating Transitions* (New York: McGraw-Hill: March 17, 2010), Table 1; and on data from Standard & Poor's CreditPro®—Corporate Ratings, accessed January 28, 2011.

Notes: Shaded bars indicate periods of recession, which extend from the peak of a business cycle to its trough.

The rate of default is the percentage of outstanding securities that are rated by Standard & Poor's that default in a given year. The rate of recovery measures the percentage of the present value of outstanding principal and interest that the lender receives in the event of a default.

when the demand for electricity is depressed by a weak economy.

A common view is that the government has a lower cost of capital than private financial institutions because it can borrow at Treasury rates. Treasury rates are low, however, because holders of Treasury bonds are protected against losses by taxpayers, who absorb the risk of the government's activities. Specifically, when the government provides a loan guarantee, taxpayers are at risk because if the borrower defaults and guarantee fees are not sufficient to cover the losses, the shortfall must be covered with higher future taxes, lower future government benefits, or cuts in other spending. Therefore, when the government provides such a guarantee, it is effectively shifting financial risk to taxpayers who, like investors in a financial institution, are averse to bearing that risk. From that perspective, market risk is a cost to taxpayers that is not included in budget estimates.

To provide a more comprehensive measure of the cost of the subsidy associated with nuclear construction loan guarantees, CBO evaluated guarantee costs on a fair-value basis as well as on a budgetary basis.[26] In recent years, CBO has provided supplementary information to the Congress on the fair-value cost of several major federal credit and insurance programs.[27] For a liability such as a loan guarantee, the fair value is the price that would have to be paid to induce a market participant to assume the liability. Fair values are often based on market prices when those are available. However, the fair value of an obligation may diverge from its market value, for instance, during a financial crisis when the few transactions that occur are likely to be at distressed prices or when comparable obligations are not publicly traded. In such cases, fair value can be estimated using standard financial modeling and extrapolation. A private market for nuclear construction loan guarantees does not exist. However, the cost that investors would assign to the risk of such guarantees can be estimated from the prices of debt securities that have similar risk characteristics as evaluated through credit ratings, and CBO took that approach in this study.

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[26] CBO's analysis considered direct losses to the government from defaults but excluded certain indirect effects. For instance, no cost was included to account for the fact that the offer of a guarantee increases the likelihood that a plant will be constructed, which in turn increases the probability of future damages that could be costly to the government.

[27] See, for example, Congressional Budget Office, *The Budgetary Impact and Subsidy Costs of the Federal Reserve's Actions During the Financial Crisis* (May 2010); letter to the Honorable Judd Gregg about the budgetary impact of the President's proposal to alter federal student loan programs (March 15, 2010); *Costs and Policy Options for Federal Student Loan Programs* (March 2010); and *Federal Financial Guarantees Under the Small Business Administration's 7(a) Program* (October 2007).

The federal budget is intended to account for program costs but not their benefits. Credit guarantees, like other federal spending, might increase public well-being by supporting activities that are valuable to society but that are unlikely to be economically viable without government support. In evaluating a program, those benefits must be weighed against the costs to taxpayers of those activities, but such an analysis for nuclear construction loan guarantees is beyond the scope of this study.

The Impact of Adverse Selection on Estimated Budgetary Cost

In practice, it may not be possible to charge borrowers the full budgetary cost of a loan guarantee, either on a FCRA or fair-value basis. When projects involve a high degree of uncertainty and adverse selection is severe, increasing fees would only serve to drive away more-creditworthy borrowers. Under such circumstances, private lenders may refuse to offer credit at any price (a situation known as credit rationing). Indeed, fully private financing does not appear to be available for nuclear power plant construction. For investments that provide significant social benefits, avoiding credit rationing in the private marketplace is a rationale for offering federal credit assistance. However, such assistance is likely to involve a cost to taxpayers, regardless of the fees that the government charges.

In CBO's view, adverse selection is likely to be a significant factor for nuclear construction loan guarantees, and it is probably not possible for DOE to set fees that would entirely cover the estimated budgetary cost of the program. To account for that difficulty, and to avoid a downward bias in its official cost estimates, CBO adds 1 percentage point to its FCRA estimates for the cost of title XVII guarantees.

Selecting Discount Rates for Fair-Value Estimates

When estimating the cost of nuclear construction loan guarantees, the difference between budgetary (or FCRA) estimating practices and a fair-value approach is in the choice of discount rates. Whereas FCRA calls for Treasury rates to be used to discount expected future cash flows, a fair-value methodology employs discount rates that reflect the market risk inherent in the specific credit obligation, which gives rise to investors' requiring a risk premium.

As noted above, the frequency and severity of defaults on credit obligations varies considerably over time and with the state of the economy. Still, expected recovery rates on such obligations depend more on "idiosyncratic," or project-specific, risk than on market risk. For example, expected recovery rates during the construction of a nuclear plant may be low because the unfinished plant has little value when it comes to alternative uses, whether the aggregate economy is performing well or poorly. Conversely, an operating plant could default because revenues from electricity sales during a recession are too low to support the promised debt payments, but expected recovery rates in that case may be high because the operating plant remains a valuable asset.[28]

To determine the appropriate risk premium for estimating the fair value of loan guarantees for nuclear construction, CBO relied on information in yield spreads—the difference between what investors expected to earn on bonds of a particular credit rating and Treasury rates. The key advantages of that approach are that extensive historical data are available on credit spreads and that the discount rates are consistent with the translation of project risk into a ratings category.

The yield spread on a risky bond can be decomposed into four components: a market risk premium, an expected default loss rate, a liquidity premium (which is compensation to investors for the higher costs of buying and

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[28] For a further discussion of the theory and evidence, see Edward I. Altman and others, "The Link Between Default and Recovery Rates: Theory, Empirical Evidence, and Implications," *Journal of Business*, vol. 78, no. 6 (November 2005), pp. 2203–2228.

Table 2.

Credit Spreads and Estimated Risk Premiums

Ratings Category	Bond Yield Over U.S. Treasuries	Risk Premium
AAA	83	38
AA	90	43
A	120	69
BBB	186	115
BB	347	160
B	585	200

Source: John Hull, Mirela Prediscu, and Alan White, "Bond Prices, Default Probabilities, and Risk Premiums," *Journal of Credit Risk*, vol. 1, no. 2 (Spring 2005), pp. 53–60, available at www.rotman.utoronto.ca/~hull/DownloadablePublications/CreditSpreads.pdf.

Note: The risk premium is the additional rate of return that investors require to bear market risk—the risk that losses will be greatest during times of economic stress.

selling non-Treasury debt), and a tax adjustment (to account for differences in tax treatment). For the purposes of discounting expected loan guarantee cash flows, CBO used only the estimated market risk premium to adjust Treasury discount rates. The expected default loss rate was incorporated in the projections of cash flows; including it in the discount rate would cause expected losses to be counted twice. CBO chose not to include an estimated liquidity premium or tax adjustment in the discount rate for its fair-value calculations; although a broader interpretation of fair value would also include those effects, CBO chose to focus only on the risk that most directly affects taxpayers. Finally, CBO selected the size of the risk premium for each ratings category on the basis of the findings of academic studies.[29] Those studies show, as expected, that the market risk premium increases with the riskiness of the debt as measured by its credit rating (see Table 2).

CBO's estimates of guarantee costs rely on the fact that the cash flows associated with a loan guarantee are identical to the combined cash flows from directly making a risky loan and, at the same time, borrowing the promised cash flows risk-free. (To value a partial guarantee, both the risky loan and the corresponding amount borrowed risk-free are reduced proportionally.) The value of the guarantee is then calculated as the difference between the value of the risk-free loan and the risky loan. Using that approach follows standard industry practice, and it produces the same results as using FCRA methodology when the risk premium is set to zero.[30] (Appendix C explains CBO's procedure for calculating the fair value of a guarantee in more detail.)

Illustrative Guarantee Costs and Sensitivity Analysis

The estimated cost of a nuclear construction loan guarantee varies widely with the assumptions made about a project's credit rating, recovery rate, and whether the cost of market risk is taken into account. Therefore, CBO estimated the guarantee cost for a hypothetical nuclear construction loan under a variety of assumptions about those key parameters and the loan contract itself.

The ratings-based approach that CBO used reflects the assumption that it is appropriate to evaluate the cost of loan guarantees for nuclear construction by summarizing the proposed project's risk characteristics with a credit rating and then using the typical default rates and risk premiums for those ratings categories to infer the cost of the guarantees. That approach is frequently used in the private sector for investments that are difficult to evaluate, such as those considered here. An alternative approach would be to model the cash flows and the uncertainty associated with them for each individual project. For example, a simulation model that incorporated assumptions about the capital structure and other features specific to a project could be used to predict the probability and severity of defaults. Such an approach might produce more-accurate estimates than the more generic ratings-based approach used here. However, it would require a significant investment in modeling for each project, and the results would still have a great deal of uncertainty associated with them.

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[29] For its estimates, CBO relied primarily on the analysis of John Hull, Mirela Predescu, and Alan White, "Bond Prices, Default Probabilities and Risk Premiums," *Journal of Credit Risk*, vol. 1, no. 2 (Spring 2005), pp. 53–60. Other studies also conclude that a market risk premium is an important component of yield spreads. See Edwin J. Elton and others, "Explaining the Rate Spread on Corporate Bonds," *Journal of Finance*, vol. 56, no. 1 (February 2001), pp. 247–277.

[30] Alternatively, practitioners sometimes use an options-pricing approach to value loan guarantees.

The reference loan that CBO considered has features that are fairly typical for loans that might be guaranteed by DOE under the federal guarantee program. The loan has a maturity of 30 years. Principal is paid in equal increments semiannually, starting at the end of an assumed 6-year construction period. Interest on the outstanding balance is paid semiannually over the life of the loan. The interest rate charged equals the 10-year Treasury rate plus a small spread; CBO assumed that the rate charged is 3.4 percent.

Sensitivity to Credit Ratings, Recovery Rates, and the Inclusion of a Risk Charge

Estimated guarantee costs vary widely with changes in the assumed credit rating, recovery rate, and discount rate on risky loans (see Figure 1 on page 3). The choice of credit rating is a key determinant of estimated costs for both FCRA-based and fair-value estimates. In particular, estimated costs increase significantly for ratings that are below BBB, which is the lower cutoff for bonds that are considered “investment grade.” That variation reflects the much higher default rates historically for bonds in lower ratings categories. Most utilities have ratings that fall within the range of A- to BBB-, and initiating a new nuclear construction project could cause a utility’s rating to be revised slightly downward by the rating agencies. For stand-alone projects or weaker utilities, lower ratings for potential nuclear projects are a possibility. However, such projects may not be economically viable even with the subsidies provided by a loan guarantee, and DOE might be reluctant to approve those applications.

The assumed recovery rate also has a significant effect on the estimated cost of a loan guarantee, particularly for projects with a rating below investment grade.[31] Therefore, for projects with low ratings, assigning a project-specific recovery rate could significantly change the estimated cost. The relative insensitivity to the recovery rate for investment-grade projects is explained by the low probability of default on highly rated bonds, which reduces the importance of recovery.

The fair-value estimates, which include a risk premium, are significantly higher than budgetary estimates for guarantees with the same credit ratings and recovery rates. The pattern of higher costs for projects with lower ratings and lower recovery rates remains the same; however, including a risk charge has a larger effect on lower-rated bonds because riskier bonds have greater exposure to market risk and therefore have a higher associated risk premium. For example, for a project that has an A rating and the 55 percent recovery rate often assumed by DOE, market risk increases the guarantee cost rate from 1 percent to 9 percent of the loan principal; but for a project with a B rating and the same recovery rate, market risk increases the cost from 11 percent to 27 percent. As is the case with the FCRA-based estimates, the effect on fair-value estimates of changing the recovery rate on highly rated bonds is muted because the underlying default probability is low, so expected losses are small regardless of the recovery rate. However, investors still require a risk premium because when the rare default occurs, it is most likely to be during a severe economic downturn.

Sensitivity to the Timing of Defaults and Recoveries

Assuming a fixed recovery rate at all stages of a project’s life may neglect significant variation over time in expected recoveries.[32] For example, it may be that expected recoveries for a project that is limited in its ability to pass on costs to ratepayers are lower during the construction phase than when that project is producing revenue from power sales. Lowering the recovery rate in the early years tends to increase the estimated cost of a loan guarantee because more principal is outstanding and because the recovered payments are discounted less.

To illustrate the potential size of the effect of recovery rates that vary over time and in particular the possibility that recovery rates are much lower during the construction phase, CBO compared the estimated guarantee costs across an assumed recovery rate during construction that varied from 0 percent to 40 percent, while assuming a

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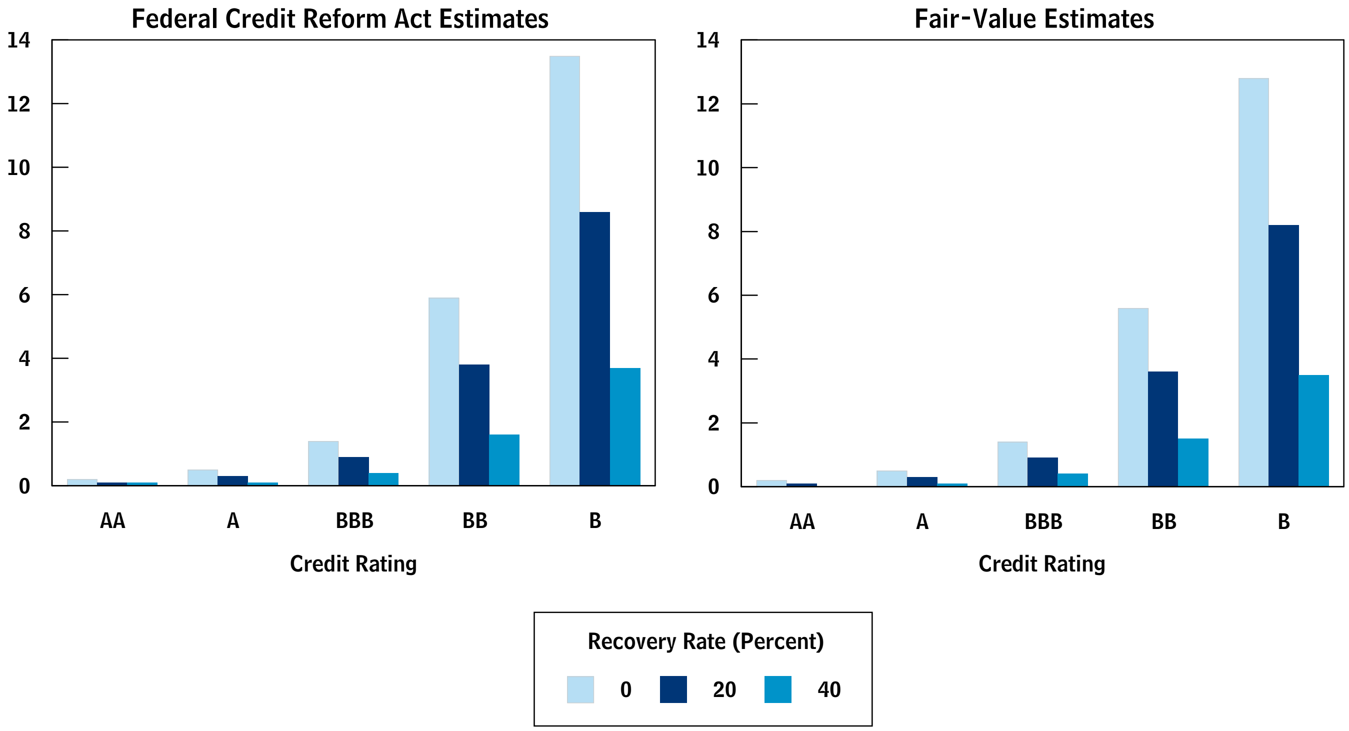
[31] An investment-grade rating indicates that a bond or other credit obligation has a relatively low risk of default. Bond-rating firms, such as Standard & Poor’s, often use letter designations to identify a bond’s credit quality rating. For example, AAA and AA (high credit quality) and A and BBB (medium credit quality) are considered investment grade. Credit ratings for bonds below those designations (BB, B, CCC, etc.) are considered low credit quality.

[32] For example, see Nuclear Energy Institute, *Credit Subsidy Costs for New Nuclear Power Projects Receiving Department of Energy (DOE) Loan Guarantees*; and Statement of Richard W. Caperton, Energy Policy Analyst, Center for American Progress Action Fund, before the Domestic Policy Subcommittee of the House Committee on Oversight and Government Reform, “Taxpayer Protection and the Nuclear Loan Guarantee Program,” April 20, 2010, available at www.americanprogressaction.org/issues/2010/04/pdf/caperton_testimony.pdf.

Figure 3.

Sensitivity of Estimated Loan Guarantee Costs to Variations in Recovery Rates if Default Occurs During Construction

(Percentage point change in guarantee cost)



Source: Congressional Budget Office.

Notes: The change in the guarantee cost is calculated relative to the base case and is expressed as a percentage of the loan amount.

Cost estimates under the Federal Credit Reform Act of 1990 use Treasury rates for discounting projected cash flows. Fair-value estimates approximate what a private guarantor would charge for the guarantee; they are based on the same projected cash flows, but the discount rates are adjusted to include a market risk premium.

In determining the percentage point change in the cost of a loan guarantee, CBO assumed that recovery rates on defaults that occurred during construction would vary from 0 percent to 40 percent of the outstanding principal and interest owed to the lender. For the postconstruction period, CBO assumed a fixed recovery rate of 55 percent. Recovery rates, which are estimated at the time a default occurs, measure the fraction of the present value of outstanding principal and interest that the lender receives in the event of a default.

fixed recovery rate of 55 percent after the construction period (see Figure 3). CBO estimated that the effect on the estimated cost of a loan guarantee for nuclear construction is less than 2 percentage points for ratings of BBB and higher, but much larger for lower-rated projects. For a project rated BB, for example, the effect of recovering only 20 percent early on increases the lifetime cost by 3.6 percentage points relative to the assumption of a flat 55 percent recovery rate.

Similarly, default rates may be higher during the construction phase, which would shift the pattern of defaults forward relative to a typical bond with the same rating. Shifting defaults forward in time increases the estimated cost of a loan guarantee because more principal is outstanding and losses are discounted less. CBO examined the effect of increasing the baseline default rate for a given credit rating during the construction phase by either 10 percent or 20 percent and then decreasing the probability afterward so that the lifetime default rate remained unchanged. The recovery rate was again assumed to be 55 percent over the project's lifetime. Shifting forward the timing of defaults has the expected effect of increasing the estimated guarantee cost, but the size of that effect is less than half a percentage point for projects rated BB and higher. The combined effect of assuming higher default rates and lower recovery rates during construction would be to increase the estimated cost of low-rated projects significantly.

Sensitivity to the Terms of the Loan Contract

The terms of the loan contract can have a significant impact on the guarantee cost. For example, in the case of a direct loan, the guarantee cost is affected by the interest rate charged to the borrower; higher interest paid to the government reduces the subsidy cost required to be paid up front by the borrower.

In some cases, the guaranteed loan may be structured so that payments are deferred for some number of years to better match the pattern of project revenues. For instance, DOE may allow stand-alone merchant projects that do not have the resources of a utility available to them to defer the payment of principal and interest during the construction phase, whereas only principal repayment may be deferred for rate-based projects. Such deferrals can affect guarantee cost. For instance, if interest payments are deferred until after the construction phase (and the deferred amounts are added to the principal balance owed), then the estimated cost of a loan guarantee for a project receiving a BBB rating and with a flat 55 percent recovery rate is 2.4 percent on a budgetary basis (16.5 percent on a fair-value basis). In contrast, without any interest deferral, the estimated cost is 2.1 percent on a budgetary basis (14.6 percent on a fair-value basis). All else being equal, the cost of the guarantee increases with the length of deferral because, on average, a smaller portion of the loan is repaid before a default occurs.

The 30-year maturity of nuclear construction loan guarantees amplifies the effect of including a charge for market risk compared with the effect on the cost of shorter-term guarantees. Over a 30-year period, the present-value cost of even a small amount of market risk each year becomes significant.

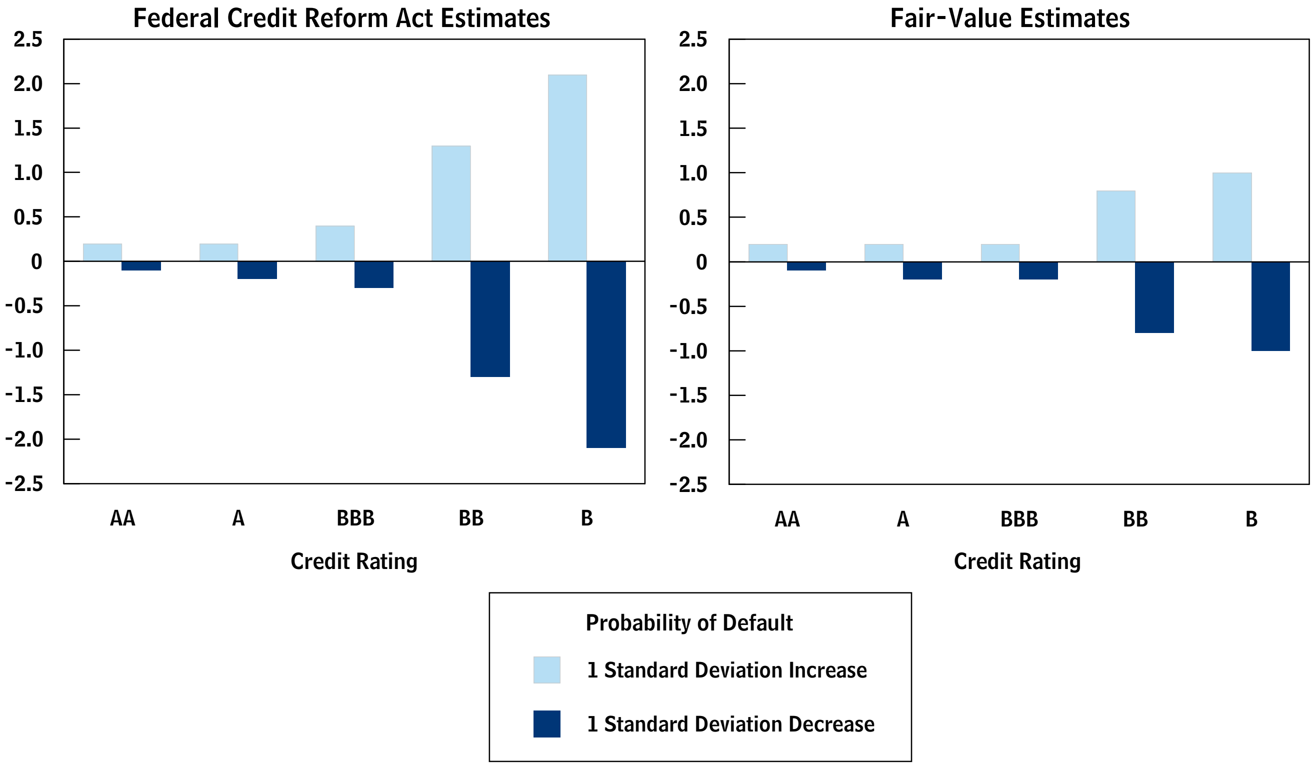
Uncertainty in Default Rates Within a Single Credit Rating

A further source of uncertainty in estimating the cost of loan guarantees is that, within a given ratings category, there is considerable variation in the expected default rate. Standard & Poor's reports those uncertainties in terms of standard deviations. The standard deviation of the recovery rate measures the variation from the average recovery rate; realized values should fall within a range of one standard deviation below the average to one standard deviation above the average about 68 percent of the time. (See Figure 4 for an illustration of how uncertainty about default rates translates into uncertainty about guarantee costs for different ratings.) For instance, a one-standard-deviation increase in the assumed default probability for bonds rated BB would increase the estimated guarantee cost on a budgetary basis by about 1.5 percentage points. That variation underscores the significant uncertainty associated with estimates of subsidy costs that are based on credit ratings. Estimating such costs using alternative methodologies, however, would also involve considerable uncertainty.

Figure 4.

Sensitivity of Estimated Loan Guarantee Costs to the Probability of Default

(Percentage point change in guarantee cost)



Source: Congressional Budget Office.

Notes: The change in the guarantee cost is calculated relative to the base case and is expressed as a percentage of the loan amount.

Cost estimates under the Federal Credit Reform Act of 1990 use Treasury rates for discounting projected cash flows. Fair-value estimates approximate what a private guarantor would charge for the guarantee; they are based on the same projected cash flows, but the discount rates are adjusted to include a market risk premium.

In determining the percentage point change in the cost of a loan guarantee, CBO assumed that the probability of default would vary plus or minus one standard deviation. The standard deviation of the default rate measures the variation from the average default rate. A low standard deviation indicates that most values are closely distributed around the average default rate, while a high standard deviation indicates that default rates are spread out among a wide range of values.

Appendix A: The Federal Government's Role in Nuclear Power and a Historical Overview of Industry Performance

A review of the historical financial performance of the nuclear industry provides a useful reference point for assessing the risk the government assumes when it provides loan guarantees for the construction of nuclear power plants. However, because not enough data exist to draw statistical inferences, it is difficult to use this information to form quantitative conclusions about expected future costs, and the Congressional Budget Office (CBO) did not attempt to do so. Historically, the U.S. nuclear industry has received considerable federal support and has been subject to extensive federal regulation. After an initial period of growth in the industry, many nuclear projects ran into problems with delays, cost overruns, and cancellations. In a few cases, those circumstances led to the bankruptcy of the project sponsor and to losses by some debt holders, although much more often losses were absorbed by ratepayers or the government rather than by bondholders. More recent experience from abroad suggests that the risk of cost overruns and delays remains a concern even with modern reactor designs.

Federal Regulations

In 1946, the Congress created the Atomic Energy Commission (AEC), which led the effort to develop the first breeder reactor for generating electricity; that reactor became operational in 1951. Under the Atomic Energy Act Amendments enacted in 1954, private companies were allowed to apply for operating licenses for nuclear power plants.

To encourage private investment in nuclear power, the Congress passed the Price-Anderson Act in 1957. That legislation, which was extended through 2025 by the Energy Policy Act of 2005 (EPAct 2005), limits the liability of private owners in the event of a nuclear incident. Damages that exceed the Price-Anderson liability limits are expected to be covered by the federal government. This catastrophic insurance, which is provided free of charge by the federal government, represents a subsidy to the nuclear industry, though its size is subject to debate.[1]

The Private Ownership of Special Nuclear Materials Act, which was passed in 1964, allowed private operators of nuclear power plants to own the fuel for their units. A decade later, the Energy Reorganization Act of 1974 created two new entities to assume responsibility for activities formerly shared by the AEC: The role of promoting research and development became the purview of the Energy Research and Development Administration (ERDA); and the role of regulating new and existing nuclear power plants became the responsibility of the Nuclear Regulatory Commission (NRC). A few years later, in 1977, the Department of Energy (DOE) was established by the Department of Energy Organization Act. DOE took over the functions for which ERDA had been established.

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[1] A study from the Massachusetts Institute of Technology suggests that the estimated expected fair value of this subsidy would be no higher than about $3 million per year per plant; see John Deutch and others, *The Future of Nuclear Power: An Interdisciplinary MIT Study* (Cambridge, Mass.: Massachusetts Institute of Technology, July 29, 2003), available at http://web.mit.edu/nuclearpower/pdf/nuclearpower-full.pdf. CBO estimated the subsidy at $600,000 per year per plant; see Congressional Budget Office, *Nuclear Power's Role in Generating Electricity* (May 2008).

In late 1979, after the nuclear accident at Three Mile Island, the NRC started to impose stricter safety and inspection regulations. The following year, DOE initiated a program to develop technology for disassembling and defueling damaged reactors. The Nuclear Waste Policy Act of 1982 (NWPA) determined locations and procedures for disposing of high-level radioactive waste. In 1987, the Congress amended NWPA to allow research on using Yucca Mountain as a disposal site for high-level radioactive waste.[2]

The Energy Policy Act of 1992 provided additional support to the nuclear industry. It introduced competition into the electric utility industry's wholesale sector, allowing new practices, such as retail wheeling (using one supplier's transmission system to carry power for other suppliers). It also took steps to reduce regulatory uncertainties for nuclear power plants by proposing new waste-removal and storage processes, streamlining licensing procedures, clarifying regulations of the uranium enrichment and mining sectors, and creating a fund for the decommissioning of reactors.

In 2002, DOE introduced the Nuclear Power 2010 Program, which created a government-industry cost-sharing partnership for the construction of advanced energy (third-generation) nuclear power plants. Some project sponsors who applied for loan guarantees used the Nuclear Power 2010 Program to identify potential sites for reactor construction and to improve reactor design.

As well as establishing a nuclear construction loan guarantee program, the Energy Policy Act of 2005 extended the Price-Anderson Act to cover reactors that are built through 2025. It also required the government to pay for cost overruns of up to $500 million for the first two reactors under construction and of up to $250 million for the following four in the event of certain regulatory delays. Finally, EPAct 2005 included a tax credit of up to $125 million per nuclear plant for carbon-free energy production.[3]

Private Nuclear Investment in the United States

Throughout the 1950s and 1960s, private investment in the construction of nuclear power plants expanded. However, investment activity slowed in the 1970s, and no new plants have been started in the United States since 1978. From 1964 to 1973, the average generating capacity per plant under construction more than doubled from 537 megawatts (MW) to over 1100 MW. During the 1980s, nuclear reactors continued to be connected to the electrical grid and enter into commercial operation. Today there are 104 nuclear reactors in operation in the United States, of which 98 are not federally owned. Those plants generate more than 1020 MW of power, supplying about 20 percent of electricity used in the country.

The decline in nuclear power investment in the United States, which started in the mid-1970s, can be attributed to a variety of factors: decreases in the forecast demand for electricity, growing concerns over waste disposal, changing regulatory policies that increased construction compliance costs, and concerns about nuclear proliferation. In addition, following the accident at Three Mile Island in 1979, construction times lengthened because of additional quality controls, increased regulatory uncertainties, and reactor designs that became larger and more complex.

Those factors reduced the payoff of investing in nuclear power plants. Cost overruns averaged more than 200 percent for plants on which construction started between 1966 and 1977. Additionally, many projects were canceled after construction had started but before completion, and a number of reactors were shut down (see Table A-1). The first reactor cancellations occurred in 1977; and in 1980 alone, 21 projects were canceled. In total, 40 projects were canceled after construction had started. Moreover, several reactors in operation were shut down before the end of their normal operating lives because of safety or operational problems or political opposition. Into the 1990s, reactors that were either under construction or that had been completed but not yet connected to the grid saw little progress.

Federal Investment in Nuclear Power

The federal government is directly invested in the nuclear power sector through various programs and agencies. For example, the Rural Utilities Service (RUS), which is

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[2] See Nuclear Waste Policy Amendments Act of 1987, Public Law 100-203, 101 Stat. 1330-227.

[3] For a summary of the act's provisions and the incentives it provides, see Congressional Budget Office, *Nuclear Power's Role in Generating Electricity*, Table 1-1.

Table A-1.

The Status of Nuclear Reactors in the United States, by Construction Start Date

Construction Start Date	Number of Reactors Started	Number of Reactors Canceled	Number of Reactors Shut Down: In operation fewer than 20 years	Number of Reactors Shut Down: In operation at least 20 years
1951–1955	1	0	0	1
1956–1960	14	0	12	2
1961–1965	6	0	2	2
1966–1970	67	7	4	4
1971–1975	70	33	1	0
1976–1980	14	0	0	0
Total	**172**	**40**	**19**	**9**

Source: Congressional Budget Office based on data from the International Atomic Energy Agency's Power Reactor Information System (PRIS) database.

administered by the Department of Agriculture, guarantees loans for electricity-generation projects owned by rural cooperative utilities, including nuclear reactor investments. The Tennessee Valley Authority (TVA) is a federally owned corporation that provides electrical generation, flood control, economic development, and other services to states in the Tennessee Valley region. As part of TVA's effort to guarantee the provision of affordable electricity, it is heavily invested in nuclear projects. In 1966, TVA announced plans to build 17 nuclear reactors. By the early 1980s, after reassessing the changes in electricity demand and safety regulations, TVA canceled 8 of those planned reactors. TVA had invested about $5 billion in those units. In 2001, TVA wrote off more than $3.4 billion on existing assets with estimated future cash flows that were likely to be less than the recorded book values. Of that amount, $2.22 billion was attributable to deferred nuclear power units.

The first three nuclear power plants sponsored by Washington Public Power Supply System (WPPSS, now Energy Northwest) received considerable, if indirect, financial support from the federal government through the Bonneville Power Administration (BPA), a federal agency. Although BPA was prohibited by statute from owning generation resources, a technique known as net billing allowed utilities participating in plant construction to assign their shares to BPA; the participants' costs for servicing the bonds that WPPSS issued to finance plant construction were deducted from the power bills that the utilities paid BPA.[4] Although only one of those three plants was ever completed, no WPPSS bonds were defaulted on—BPA recovered the money needed to make the bond payments for the three plants by passing on the costs to BPA's power customers through rate increases. The maturity dates of those bonds have been pushed back through refinancings, but final payments on the bonds outstanding for the two uncompleted plants are scheduled for 2018.[5] BPA has received all the electrical output from the one completed WPPSS nuclear plant (WNP-2, now Columbia Generating Station) since the plant began operation. Initially, the costs of operating the plant were also recovered through net billing, but in 2006 a new "direct-pay" agreement was negotiated wherein BPA simply pays for all of the costs of the Columbia Generating Station and receives all the output. (The payments on outstanding Energy Northwest bonds are now paid directly by BPA as well.)

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[4] Net billing arrangements with BPA may have provided implicit financing subsidies in several other cases: WPPSS used such arrangements to pay for an electricity-generating facility at the Hanford Nuclear Reservation in 1966; and the Eugene Water and Electric Board used net billing to support payments for a share of the Trojan Nuclear Plant constructed by Portland General Electric. See Daniel Pope, *Nuclear Implosions: The Rise and Fall of the Washington Public Power Supply System* (New York: Cambridge University Press, 2008).

[5] Northwest investor-owned utilities had a 30 percent share in one of the three plants, WNP-3. The utilities financed their share of the plant without federal support through BPA. In 1985, BPA bought out that 30 percent share through an agreement that gave the utilities BPA power to replace the power that would have been generated by the uncompleted plant.

Default and Loss Experience

Although nuclear investments frequently encounter financial problems, episodes in which bondholders lose money have been fairly rare because shareholders, ratepayers, or the government have usually absorbed the losses. A study conducted in 1983 by DOE found that for cancellations, most jurisdictions allowed utilities to partially recover their costs through rate increases, and a substantial portion of the unrecovered costs are borne by the government, primarily because of tax write-offs. Nevertheless, in several notable cases, bondholders have taken sizable losses. Although the federal government had not provided guarantees in those cases, it has experienced losses from federal nuclear guarantees in a number of instances.

The largest and most famous default triggered by losses on nuclear power plants occurred in 1983 when WPPSS defaulted on $2.25 billion in municipal bond obligations.[6] Seventeen utilities founded WPPSS in 1957, and by 1971 some members of the organization were planning to invest in five nuclear units. The initial cost estimate for the five plants was $4 billion. A decade after construction started, cost overruns were $19 billion, causing four of the five units to be canceled. However, it was the delays associated with the construction of units 4 and 5, combined with a legal ruling that blocked WPPSS from passing on losses to ratepayers, that forced the consortium to default on $2.25 billion in municipal bonds. Bondholders eventually received between 10 cents and 40 cents on the dollar.[7] Ratepayers also were affected by losses resulting from the Bonneville Power Administration's take-or-pay contracts on portions of the output from units 1, 2, and 3. Under those contracts, Bonneville was required to either purchase the output at an agreed-upon price or pay a penalty for output not purchased. Thus, Bonneville ratepayers were obligated to pay $7 billion over 30 years for electricity that was never delivered.

Bondholders also experienced losses in the bankruptcy of the Public Service Company of New Hampshire (PSNH). That utility was the main investor in 10 utilities that sought to build the Seabrook nuclear power plant. By 1979, investors planned to have two units in commercial operation for a cost of about $970 million. Unit 1 was finally put into commercial operation in 1990 at a cost of $6.6 billion; unit 2 was canceled in 1988 because of cost overruns, which had reached $5 billion. PSNH, which had funded about $2.9 billion of the project, was forced to declare bankruptcy after defaulting on a $37.5 million debt payment in 1987. At the time, that was the fourth largest bankruptcy on record. Holders of unsecured bonds lost about two-thirds of the interest owed to them but recovered all principal. A similar story of cost overruns, delays, and cancellations at the Palo Verde Nuclear Generating Station in Arizona forced El Paso Electric into bankruptcy in 1992.

In several instances, nuclear projects caused financial distress that did not end in default. An example is the experience of the Shoreham Nuclear Power Plant, a reactor completed in 1984 after being in various stages of construction for more than 11 years. Its owner, the Long Island Lighting Company, had incurred construction cost overruns of more than $2 billion by the end of 1979. Although Shoreham generated electricity from 1985 to 1989, the reactor never produced power on a commercial scale. By 1994, the reactor had been fully decommissioned at a cost of $184 million. Over its lifetime, losses totaled about $6 billion. That cost was largely borne by Long Island electricity consumers through a 3 percent surcharge on electricity bills for a 30-year period starting in 1989. (Cost recovery by the utility on $1.35 billion of the losses was disallowed on the grounds that the costs were imprudently incurred.) Equity holders also experienced a large decline in the value of their shares. Bondholders, however, did not lose any money. Other examples include the cancellation of construction in 1982 of the Cherokee Nuclear Power Plant by the utilities that had invested in the project. With a $633 million investment, Duke Power lost 30 percent of its pre-cancellation net worth. The owners of the William H. Zimmer Power Station in Ohio incurred unrecoverable costs of about $1.8 billion after construction of the nuclear plant was canceled. Cincinnati Gas & Electric, which had invested $716 million in the project, lost 90 percent of its net worth.

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[6] Moody's Investors Service, *U.S. Municipal Bond Defaults and Recoveries, 1970–2009,* Special Comment Report 122579 (New York: Moody's Invenstors Service, February 2010), available at http://v2.moodys.com/cust/content/Content.ashx?source=StaticContent/Free%20Pages/Regulatory%20Affairs/Documents/us_municipal_bond_defaults_and_recoveries_02_10.pdf.

[7] Because the recoveries involved years of delay, the present value of recoveries, and hence the recovery rate, was lower than the dollar percentage recovered.

The federal government experienced losses from nuclear-related investment guarantees through the RUS program. In 1979, Cajun Electric Power Cooperative invested in the construction of two units at the River Bend Nuclear Generating Station, which included the use of government guaranteed debt through RUS.[8] River Bend's unit 1, completed in six years, cost $7.2 billion to construct and is currently in operation; it was 400 percent over budget at the end of construction. Unit 2 was canceled 10 years after construction started in 1982. As cost estimates increased during construction, Cajun was forced to take out deficiency loans to supplement its RUS debt. In 1988, the Louisiana Public Service Commission ordered Cajun to lower its electricity rates because of statewide economic circumstances. Unable to meet its debt obligations or to restructure its $4.2 billion in total outstanding debt, Cajun filed for bankruptcy. Government losses were about $3.0 billion.

Foreign Experience

Foreign experience is a source of more recent information about the cost of nuclear power plant construction. Although regulatory and other differences from one country to another may limit the relevance of international comparisons, other nations continue to have problems with construction cost overruns for a variety of reasons.

Reliance on nuclear power varies considerably around the world. With 75 percent of its electricity generated using nuclear power and with generating capacity of 63 gigawatts, France leads the world in the proportion of electricity generated from nuclear power by a large country. Some smaller nations also generate a relatively large proportion of domestic electricity from nuclear power plants. According to the Nuclear Energy Institute, 16 nations generated over one-quarter of their electricity from nuclear power in 2009. Although the United States obtains only about 20 percent of its power from nuclear energy, it continues to have the largest number of reactors in the world.

Plans for the rate of future nuclear expansion also vary internationally. Currently, 60 reactors are under construction worldwide, one of which is in the United States. China, South Korea, and Russia have the largest number of new nuclear reactors under way with 27, 6, and 7 reactors, respectively.

Comprehensive statistics on the financial performance of foreign investments in nuclear power are not available, but it appears that delays and construction cost overruns continue to be a problem in many instances. Recent studies show that French projects and collaborations with other European governments are experiencing cost overruns because of input price increases (for example, for concrete and steel) and other factors, such as quality control. Construction costs for reactors in Canada, Japan, India, and the United Kingdom are all exceeding original estimates. The Darlington reactor in Canada, originally estimated to cost about $3.9 billion, ended up costing $14 billion. General Electric and its Japanese partners, Toshiba and Hitachi, are about five years behind schedule on two reactors being built in Taiwan, costing an extra $4 billion to $5.5 billion. Information about the Chinese nuclear power sector is scarce, though external estimates of capital costs indicate that construction costs are probably lower in China.

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[8] Cajun Electric entered into an agreement with Gulf State Utilities in 1979 to purchase 30 percent of the River Bend plant. The other main investor, Gulf State Utilities, was nearly driven into bankruptcy as well.

Appendix B: Applications for the Department of Energy's Loan Guarantee Program

As of July 2011, 19 applications had been submitted to the Department of Energy (DOE) for loan guarantees for the construction of advanced nuclear power facilities. All of those applications were received before the program was closed to new applicants in September 2008, and they are in various stages of the application and approval process. The projects vary as to whether they are sponsored by public utilities or merchant power providers (independent private producers) and in other characteristics that would affect the cost and risk to the government of providing a loan guarantee. According to press accounts, the $18.5 billion in budget authority that was made available for such purposes in 2008 would probably cover at most four of the proposed projects. The three projects described below—as well as Southern Company's Plant Vogtle in Georgia, which is discussed in the main text—have pending applications and appear from press accounts to have advanced the farthest, although it is not clear that any of them will reach a final agreement.

In October 2010, DOE offered a loan guarantee for the joint venture Unistar, owned by Baltimore-based Constellation Energy and France's Électricité de France, to build a new reactor at Calvert Cliffs in Maryland that was projected to cost $10 billion. Constellation rejected the $880 million guarantee fee offer, which translated into an 11.6 percent credit subsidy rate. DOE proposed a modification to the terms of the contract that would have reduced risk to the government and lowered the required fee, but Constellation declined to reconsider. Constellation's decision may have been influenced by the combination of relatively low expected regional electricity prices and the significant guarantee fee that may have made it unprofitable for the sponsors to invest in new nuclear power capacity (even though the federal credit guarantee might have been offered at a below-market price).

South Carolina Electric & Gas Company (SCE&G) and its state-owned partner Santee Cooper proposed a plan for the construction of two new units at the Virgil C. Summer Nuclear Station in South Carolina and have a pending application for a loan guarantee. Santee Cooper is currently searching for partners to share its 45 percent stake in the project and may raise rates in April 2012 and November 2013 in part to fund its share of construction costs. SCE&G was authorized to raise rates by 1.1 percent in September 2009 to begin recovering financing costs associated with its stake in the project.

The final pending application that has advanced is for the South Texas Project, although its future has become more uncertain following the recent events in Japan. The plan calls for the construction of two new units by Nuclear Innovation, a joint venture in Texas owned by New Jersey–based NRG Energy, Inc., and Toshiba's Tokyo Electric Power Company.[1] Together they applied for a $7 billion loan guarantee from the United States and for $3.5 billion in financing from Japan. The rest of the costs, an estimated $2.5 billion, are to be funded with equity investments.

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1. NRG energy has withdrawn from the project and recorded a $481 million charge-off to reflect associated losses incurred by one of its subsidiaries.

Appendix C:
Calculating the Value of a Loan Guarantee

A standard approach to calculating the fair value of a loan guarantee relies on determining the difference between the fair value of the underlying risky loan in the absence of a guarantee and the value of a safe loan with the same promised cash flows but no possibility of defaulting.[1] The value under the Federal Credit Reform Act of 1990 (FCRA) can be found using the same method, replacing the fair value of the underlying risky loan with its budgetary value. This appendix explains the methodology the Congressional Budget Office (CBO) uses to value loan guarantees for the construction of nuclear power plants and the logic behind that methodology.

When the federal government makes a risky loan directly to a borrower, it provides a cash outflow at the beginning of the agreement that represents the payment of loan principal to the borrower. The borrower promises to repay that principal to the government, along with interest, over the term of the loan. For an initial principal outlay of $100 million, a typical pattern of contractual payments on a federally guaranteed loan for nuclear construction would involve payments of interest in the first 6 years followed by payments of interest and principal over the remaining 24 years of the loan (see Figure C-1 on page 31). The risk to the federal government is that the borrower will cease making periodic payments of principal and interest, which constitutes default. In that case, the government may not receive the full amount of the principal and interest due from the borrower, even if the loan is collateralized by assets that can be sold to recover a portion of this loss. (For an example of cash flows from a loan with default in the 11th year and recovery of 60 percent, see Figure C-2 on page 31.)

Different borrowers would exhibit different default patterns—some would default early in the life of the loan, some would default later, and some would not default at all. Those possibilities are reflected in the expected cash flows, which depend on an estimate of the probability of a default in a particular period and the expected recovery amount if a default occurs (see expected loan cash flows in Figure C-3 on page 32).

For a loan guarantee, in the event of a borrower's default, the government must pay the lender the outstanding principal balance of the loan and the interest that has accrued on the loan since the borrower last made a payment, and the government can probably recover at least part of those costs. The expected payouts by the government vary over the lifetime of a loan, reflecting changes in the probability of default, the outstanding principal balance, and the expected recovery rate (see Figure C-4 on page 32). In exchange for providing the loan guarantee, the government may collect fees from the borrower, which for this example are assumed to be paid in the form of an up-front premium.

When the government makes a loan itself, the expected cash flows are quite different from those associated with its guaranteeing a loan that has the same terms but is funded by a private lender (compare Figure C-3 with Figure C-4). However, the cash flows from the loan guarantee are exactly the same *as if* the government had made the risky loan directly and financed it by borrowing the contractual cash flows on that loan at a risk-free rate. (See Figure C-5 on page 33, which is constructed by subtracting the contractual cash flows on the risk-free loan from the expected cash flows on the risky loan in Figure C-3, and compare Figure C-5 with Figure C-4.)

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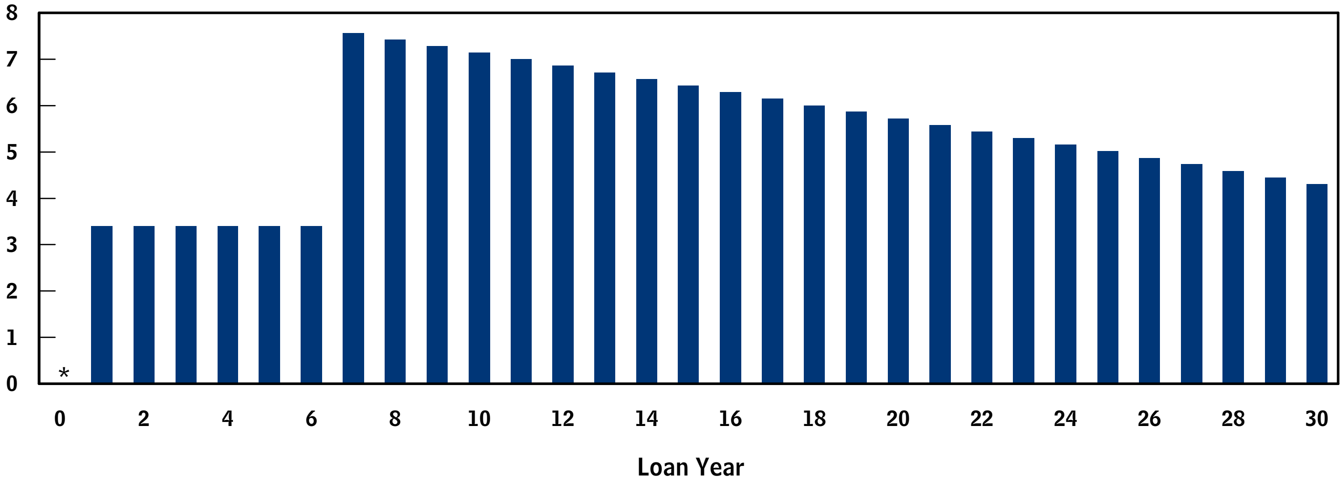
[1] Fair-value approximates what a private guarantor would charge for an obligation with similar risk and expected returns. An alternative method for valuing loan guarantees is to use an options-pricing approach. See Congressional Budget Office, *Estimating the Value of Subsidies for Federal Loans and Loan Guarantees* (August 2004).

Because the federal guarantee produces net cash flows that are identical to those produced when the government makes a loan directly and borrows the promised cash flows at a risk-free rate, the guarantee can be valued by finding the difference between the value of the risk-free borrowing and the risky loan. On either a fair-value or FCRA basis, the value of the risk-free loan is the same; both values are found by discounting the promised cash flows at the corresponding Treasury rate. The value of the risky loan is generally lower on a fair-value basis than on a FCRA basis because the expected cash flows are discounted at the Treasury rate plus a risk premium instead of just the Treasury rate. Therefore, the fair-value estimate of the loan guarantee is greater than the FCRA estimate of that guarantee.

Figure C-1.

A Typical Pattern of Contractual Payments on a Risky Loan for a Nuclear Construction Project

(Millions of dollars)



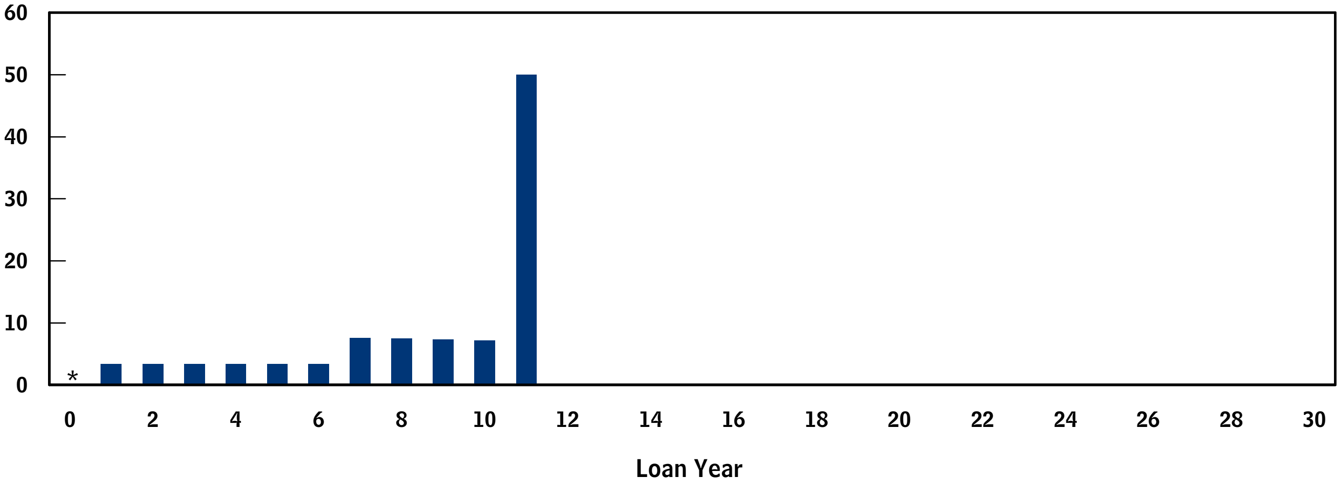
Source: Congressional Budget Office.

Note: * = Initial principal outlay of $100 million.

Figure C-2.

An Example of the Cash Flows to a Lender on a Risky Loan for a Nuclear Construction Project, with Default in the 11th Year

(Millions of dollars)



Source: Congressional Budget Office.

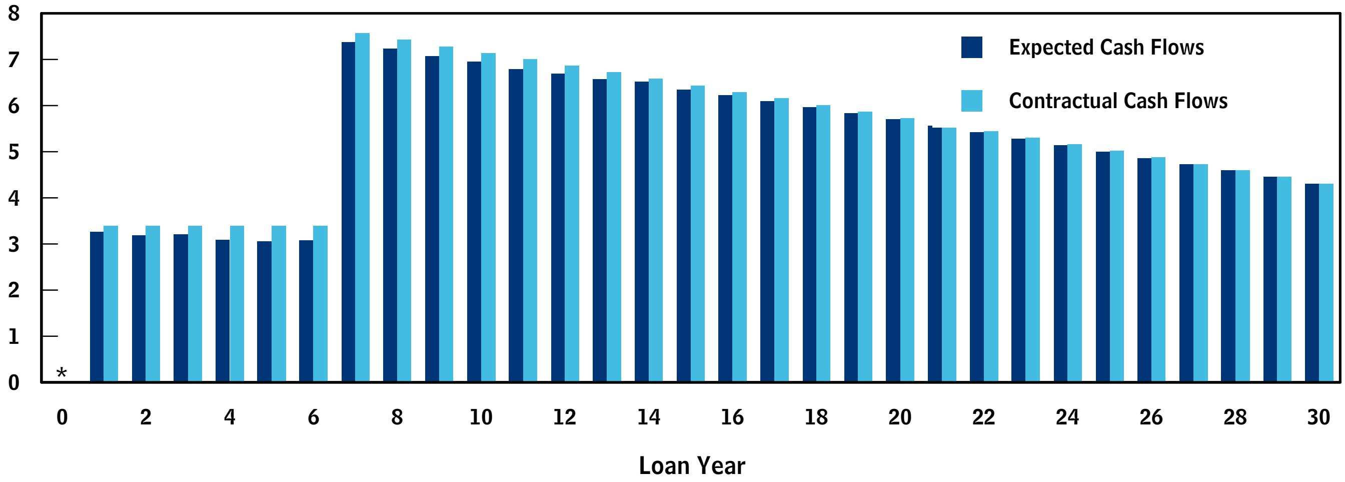
Notes: This figure assumes a recovery rate of 60 percent.

* = Initial principal outlay of $100 million.

Figure C-3.

Expected Cash Flows and Contractual Cash Flows to a Lender on a Risky Loan for a Nuclear Construction Project

(Millions of dollars)



Source: Congressional Budget Office.

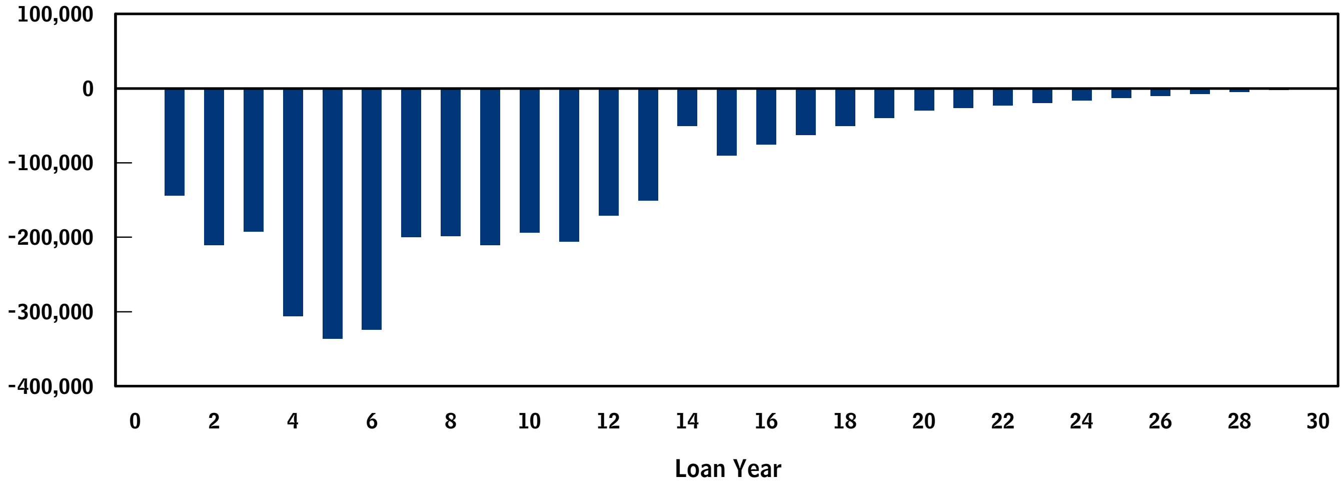
Notes: The expected cash flows to a lender equal the contractual cash flows to the lender minus the average defaulted amount (net of recoveries) in each year.

* = Initial principal outlay of $100 million.

Figure C-4.

Expected Cash Flows from Guaranteeing a Risky Loan for a Nuclear Construction Project

(Dollars)



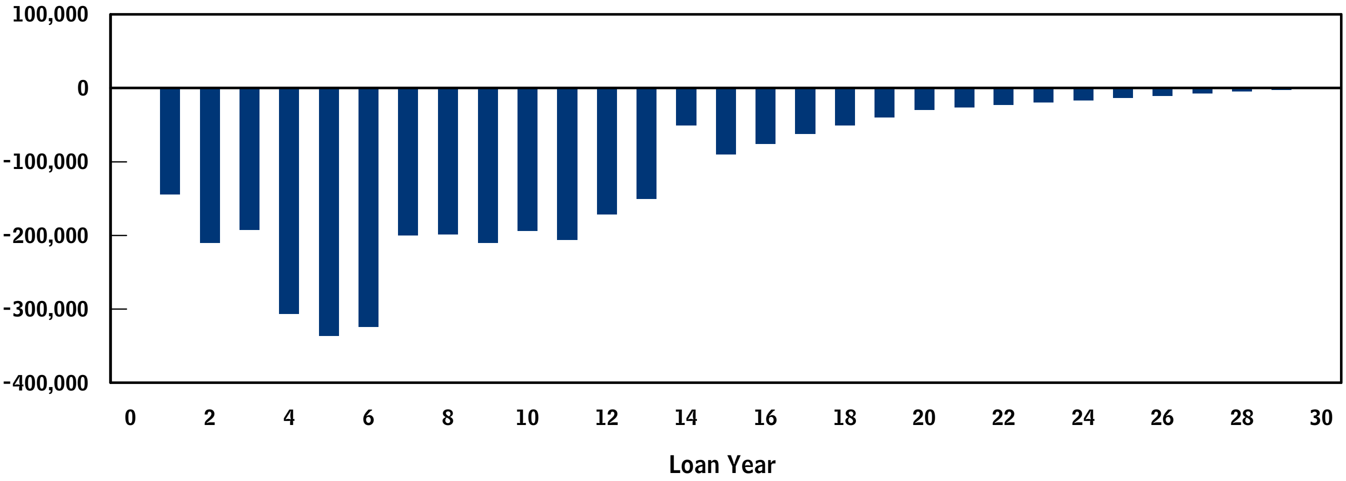
Source: Congressional Budget Office.

Note: The expected cash flows on a loan guarantee equal the average defaulted amount (net of recoveries) in each year.

Figure C-5.

Differences Between Expected Cash Flows and Contractual Cash Flows from a Risky Loan for a Nuclear Construction Project

(Dollars)



Source: Congressional Budget Office.

Notes: The expected cash flows to a lender equal the contractual cash flows to the lender minus the average defaulted amount (net of recoveries) in each year.

The difference between the expected and contractual cash flows is identical to the expected cash flows on a loan guarantee (compare this figure with Figure C-4).