



# Economic Benefits of Grand Gulf Nuclear Station

An Economic Impact  
Study by the  
Nuclear Energy Institute  
In Cooperation With  
Entergy





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## Executive Summary

Grand Gulf Nuclear Station in Claiborne County, Miss., is an integral part of the local economy. The plant, owned by System Energy Resources Inc., an Entergy subsidiary (90 percent), and the South Mississippi Electric Power Association (10 percent), makes purchases that stimulate the local economy in Claiborne and Warren counties, both directly and indirectly. Besides its economic output, the plant provides jobs, labor income, local property tax revenues and community services. And there are other intangible benefits, such as clean air, environmental stewardship and low, stable electricity prices. Grand Gulf's economic impact reaches beyond the local community to the state and nation.

In 2004, the latest year for which data is available, operation of the Grand Gulf plant increased Mississippi's economic output by \$63.9 million, including \$12.2 million in Claiborne and Warren counties, the local area studied in this report. If the direct value of plant output is included, state and county output attributable to Grand Gulf was \$536.9 million in Mississippi, including \$485.2 million in the local area.

The operation of Grand Gulf, and the increased economic output associated with it, accounts for 1,316 jobs in Mississippi, including 561 jobs in Claiborne and Warren counties. These jobs generate \$78.7 million in earnings for workers in Mississippi, including \$42.6 million for local employees. Additionally, the plant and its related economic activity resulted in \$29.5 million in state and local tax payments in 2004.

The Grand Gulf plant employs more than 600 people, with 20 percent living in Claiborne County and 45 percent living in Warren County. An estimated 370 full-time employees live in the cities of Vicksburg and Port Gibson alone. Approximately 3 percent of working Vicksburg residents and 15 percent of working residents in Port Gibson are employed at the plant. These jobs pay as much as 50 percent more than the average salaries for Claiborne and Warren counties. Further, economic activity generated by Grand Gulf creates another 150 jobs in the two counties.

The plant's primary expenditure in the local area is employee compensation. In 2004, Grand Gulf paid \$38.8 million to employees living in Claiborne and Warren Counties, and an additional \$20.4 million to employees residing elsewhere in Mississippi. The economic activity of the Grand Gulf plant resulted in the generation of an additional \$3.8 million in labor income within the local area and an additional \$15.7 million in other areas of the state. Together, the direct and indirect compensation from the plant resulted in \$42.6 million in labor income in Claiborne and Warren counties, and an additional \$36.1 million in other areas of Mississippi.

Grand Gulf makes substantial purchases in the local area. In 2004, the plant made \$32.5 million in purchases. Of this, \$1.8 million was made in Mississippi, including \$500,000 in Claiborne and Warren counties.

The Grand Gulf plant pays an estimated \$26.2 million in state and local taxes annually. Additionally, the economic activity generated by Grand Gulf contributes \$3.3 million in state and local taxes through increased income, property and sales taxes. By combining direct and indirect taxes, the Grand Gulf plant accounts for \$29.5 million in state and local tax payments.

Besides the economic benefits provided by Grand Gulf, the plant generated more than 10 billion kilowatt-hours of electricity in 2004, approximately 27 percent of Mississippi's electricity needs. Grand Gulf consistently ranks among the highest producers of nuclear power generation worldwide.

This low-cost electricity helps keep energy prices lower, playing a major role in reducing the effects on power customers of the volatile price of natural gas in the region. In 2004, Grand Gulf's production cost was 1.92 cents/kilowatt-hour, compared to an average production cost of 3.39 cents/kilowatt-hour for the rest of the Southeastern Electric Reliability Council regional market. Grand Gulf did all of this without producing the air pollution typical of some other power generation sources.

## Section I: Introduction

This economic impact study by the Nuclear Energy Institute<sup>1</sup> (NEI) examines the economic, fiscal and other benefits provided to the community by the Grand Gulf Nuclear Station, operated by Entergy Nuclear. The report estimates the economic and other benefits that Grand Gulf provides to the local area of Claiborne and Warren counties, as well as Mississippi and the United States. The study uses detailed data from the Grand Gulf plant and various government databases to assess the plant's benefits to the community.

Economic benefits from the Grand Gulf plant include direct impacts—such as people employed at Grand Gulf, plant expenditures within the community and tax payments—as well as indirect impacts, such as jobs created by plant expenditures in the local economy. This study also includes other benefits provided by the plant, such as reliable, low-cost electricity; the benefits of a clean-air source of electricity; and environmental stewardship.

Entergy Nuclear and NEI cooperated in developing this study. Entergy provided data on employment, operating expenditures and tax payments, as well as guidance on details specific to Claiborne and Warren counties and the plant.

NEI coordinated the project and applied a nationally recognized model to estimate the direct and indirect impacts of the plant on the local community. RTI International, a nonprofit research organization in Research Triangle Park, N.C., developed the methodology employed in this analysis, the 12th such study conducted by NEI.

The remainder of this report is presented in five sections:

- Section 2 provides background on Grand Gulf, including costs, employment, plant history and performance, and taxes. It also discusses local area details such as total employment and earnings, and regional electricity prices.
- Section 3 examines the economic and fiscal impacts of the plant at the local, state and national levels.
- Section 4 provides data on benefits not captured by the model, such as the plant's contributions to the community and the environment.
- Section 5 outlines recent trends in the nuclear industry as a whole, including cost, performance and safety.
- Section 6 discusses the methodology used to complete the study and Impact Analysis for Planning, the economic modeling software employed as part of this effort.

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<sup>1</sup> The Nuclear Energy Institute is the policy organization of the nuclear energy and technologies industry and participates in both the national and global policymaking process.



## Section 2: The Grand Gulf Nuclear Station

This section provides background information on the Grand Gulf plant and the local area of Claiborne and Warren counties, in order to frame the results of this report. Included is a brief history of Grand Gulf, as well as information on the plant’s costs, employment, performance and taxes. This section also provides information on local area details of Claiborne and Warren counties, their major cities, and the state of Mississippi, including earnings, local tax collections, regional electricity cost and total employment.

### 2.1 History and Information

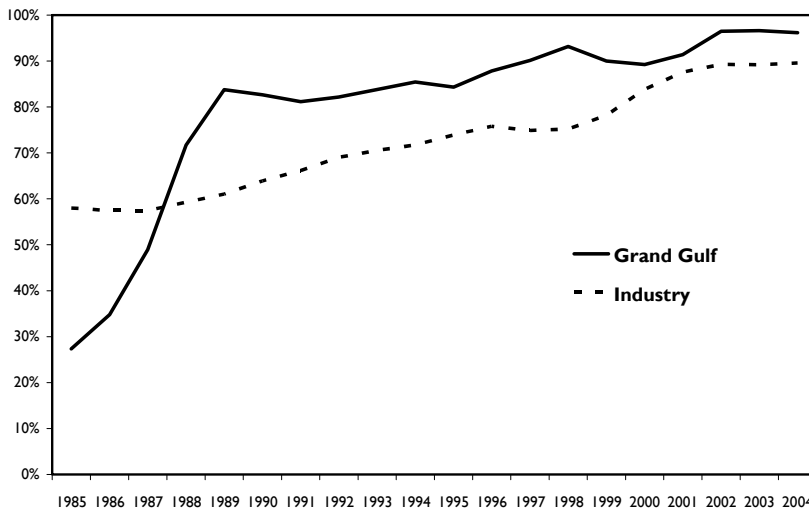
The Grand Gulf Nuclear Station comprises about 2,300 acres near Port Gibson, Miss., a town of about 1,800 residents on the eastern bank of the Mississippi River. The plant is situated near the Louisiana and Mississippi border, approximately 6 miles northwest of Port Gibson and about 25 miles south of Vicksburg. The plant lies in Claiborne County, which has a population of about 11,800.

**Table 2-1. Grand Gulf Nuclear Power Plant: At a Glance**

Reactor	Capacity	Commercial Operation Year	License Expiration Year	Reactor Type
I	1,207 megawatts	1985	2024	Boiling water

Grand Gulf Nuclear Generating Station, a 1,207-megawatt boiling water reactor, began commercial operation in 1985. The plant is owned by System Energy Resources Inc., an Entergy subsidiary (90 percent), and South Mississippi Electric Power Association (10 percent).

**Figure 2-1. Three-Year Average Capacity Factors**



Sources: Energy Information Administration, Nuclear Regulatory Commission

Throughout most of its operation, Grand Gulf has been competitive in the nuclear energy industry and consistently has been ranked at the highest levels of performance by the Institute of Nuclear Power Operations. Since 1987, the plant has maintained capacity factors at or above the industry average. Capacity factor, a measure of efficiency, is the ratio of actual electricity generated compared with the maximum possible generation if the plant were to operate at full capacity for one year. In 1997, Grand Gulf had its best year, with a capacity factor of 103 percent. The 100 percent level was exceeded because the plant generated slightly more than its rating for a portion of the year.

Figure 2-2. The Grand Gulf Plant and Surrounding Area



## 2.2 Generation

Grand Gulf generated more than 10 billion kilowatt-hours of electricity in 2004. The plant provides about 27 percent of the electricity generated in Mississippi each year. Plant output was driven by a high capacity factor. Grand Gulf operated at a 101 percent capacity factor in 2003 and a 92 percent capacity factor in 2004 (a refueling outage year). When evaluated on a per-reactor basis, the generation rate from Grand Gulf ranks among the highest generation of a single reactor worldwide.

Grand Gulf provides power for the Southeastern Electric Reliability Council (SERC) power area. Efficient performance has made the Grand Gulf power plant cost-competitive in the region. Grand Gulf had an average production cost in 2004 of 1.92 cents/kilowatt-hour. By comparison, the average production cost for electricity generators in the region was 3.39 cents/kilowatt-hour. Production costs represent the operations, maintenance and fuel cost of the plant.

**Table 2-2. SERC Entergy Sub-Region Production Cost and Generation in 2004**

	<b>Average Production Cost (in cents per kilowatt-hour)</b>	<b>Generation (in million megawatt-hours)</b>
Grand Gulf	1.92	10.23
<b>SERC Entergy Total (Including Grand Gulf)</b>	<b>3.39</b>	<b>163.93</b>

Source: Energy Velocity

Grand Gulf's low production costs help keep wholesale electricity prices down in Mississippi. Although Grand Gulf's exact contribution is difficult to measure, it can be estimated by determining how much average production costs in the SERC region would increase if Grand Gulf were replaced by a combined-cycle natural gas plant (the plant of choice for new generation). Substituting a combined-cycle natural gas plant for Grand Gulf would have resulted in an increase in average generation costs for the SERC region from 3.39 cents/kilowatt-hour to 4.41 cents/kilowatt-hour.

## 2.3 Employment

Besides providing inexpensive electricity to Mississippi, Grand Gulf is a substantial employer in Claiborne and Warren counties. The plant employs about 625 full-time workers, 128 of whom reside within Claiborne County and about 283 within Warren County. Full-time employees in 2004 included 283 people from Vicksburg,<sup>2</sup> 88 from Port Gibson, 46 from Clinton and 22 from Fayette. Grand Gulf employs 3 percent of working people in Vicksburg and 15 percent in Port Gibson.

<sup>2</sup> Refers to the Vicksburg greater metropolitan area. Vicksburg is the only incorporated municipality in Warren County.

**Table 2-3. Grand Gulf Employment by County**

County	Grand Gulf			City/County Total <sup>a</sup>	
	Permanent Employees	% Employed Work Force	Average Earnings	Employed Work Force	Average Earnings <sup>b</sup>
Warren	283	1.3%	\$75,300	21,900	\$50,500
Claiborne	128	3.4%	\$57,900	3,800	\$41,200
Hinds	90	0.1%	\$79,600	109,600	\$52,100
Franklin	40	1.3%	\$58,900	3,100	\$40,000
Copiah	30	0.3%	\$70,900	10,800	\$40,600
Adams	22	0.2%	\$62,700	12,900	\$44,200
Other	32	N/A	\$77,600	N/A	N/A

<sup>a</sup> Census 2000, adjusted to 2005 dollars.

<sup>b</sup> Earnings, defined as the sum of wage and salary income, represent the amount of income received regularly before deductions for personal income taxes, Social Security, Medicare, etc.

The jobs provided by the Grand Gulf plant are also typically higher-paying than most jobs in the area. Full-time Grand Gulf employees who live in Claiborne County earn, on average, about \$57,900 a year. This is 40 percent higher than the average earnings of workers in the county—about \$41,200 a year. Plant employees living in Warren County earn almost 50 percent more than the average earnings of workers in the county.

**Table 2-4. Top 10 Cities/Towns by Total Employed**

City/Town	County	Grand Gulf		City/County Total <sup>a</sup>	
		Employees	Average Earnings	Employed Work Force	Average Earnings <sup>b</sup>
Vicksburg <sup>c</sup>	Warren	283	\$75,300	10,800	\$44,900
Port Gibson	Claiborne	88	\$58,300	600	\$37,000
Clinton	Hinds	46	\$88,600	11,900	\$60,800
Fayette	Jefferson	22	\$48,000	500	\$31,900
Natchez	Adams	21	\$63,600	6,900	\$45,400
Brookhaven	Franklin	18	\$72,300	3,500	\$38,300
Wesson	Copiah	16	\$75,700	600	\$45,100
Jackson	Hinds	15	\$66,200	77,600	\$49,700
Lorman	Claiborne	14	\$48,800	N/A	N/A
Raymond	Hinds	12	\$75,700	700	\$41,900

<sup>a</sup> Census 2000, adjusted to 2005 dollars.

<sup>b</sup> Earnings, defined as the sum of wage and salary income, represent the amount of income received regularly before deductions for personal income taxes, Social Security, Medicare, etc.

<sup>c</sup> Refers to the Vicksburg greater metropolitan area. Vicksburg is the only incorporated municipality in Warren County.

## **2.4 Plant and Local Area Taxes**

In addition to employment and direct purchases in the area, the plant also makes large tax payments. In 2004, Grand Gulf made state and local tax payments of more than \$26 million.

## **2.5 Summary**

Grand Gulf provides low-cost electricity, high employment and a large tax base to Claiborne and Warren counties and Mississippi. However, these are only the direct economic benefits of the plant. As illustrated in the next section, the secondary benefits are as significant as the direct benefits.



## **Section 3: Economic and Fiscal Impacts**

Grand Gulf's spending boosts activity throughout the local and state economies. The effects of the plant's large wage and salary payments are evident throughout the local and state economies—in the private sector through increased sales and employment, and in the public sector through increased tax revenues to support public services.

Estimates of these effects were developed by applying the Impact Analysis for Planning (IMPLAN) model to expenditure data provided by Entergy, owner of the Grand Gulf plant. (For more information on IMPLAN, see Section 6.)

### **3.1 Plant Expenditures in Claiborne County**

Grand Gulf's expenditures for products and services (including labor) in the local area totaled \$39.3 million in 2004. Expenditures within Claiborne County represent approximately 64 percent of the plant's total spending of \$61 million in Mississippi, and approximately 43 percent of the plant's total spending of \$92.2 million.

Entergy provided the expenditure totals for Claiborne and Warren counties that appear in Table 3-1. Several categories that represent major local contracts are identified in the table to show the types of expenditures Grand Gulf makes in the local area. The categories were chosen from among a total of 528 IMPLAN sectors and are listed largely according to the IMPLAN description for each. Total compensation, which includes benefits, salaries and wages, is listed separately.

Tables 3-2 and 3-3 show expenditure totals for the state of Mississippi and the United States, respectively.

**Table 3-1. Grand Gulf Expenditures in Claiborne and Warren Counties**

<b>Description</b>	<b>Amount</b>
Offices of Physicians, Dentists and Other Health Care Providers	\$103,000
Gasoline Stations	\$63,000
Telecommunications	\$57,000
Optical Instrument and Lens Manufacturing	\$54,000
State and Local Government Electric Utilities	\$45,000
Industrial Machinery Manufacturing	\$39,000
Professional and Technical Services	\$31,000
State and Local Government Enterprises	\$30,000
Business Support Services	\$22,000
Facilities Support Services	\$16,000
Other	\$45,000
<b>Subtotal</b>	<b>\$505,000</b>
Total Compensation <sup>a</sup>	\$38.8 million
<b>TOTAL</b>	<b>\$39.3 million</b>

<sup>a</sup> Total compensation includes wages, salaries and fringe benefits based on data provided by Entergy.

Total compensation for labor is \$38.8 million and represents almost 99 percent of Grand Gulf's expenditures in the local area. This reflects the fact that most of Grand Gulf's expenditures for labor (employee benefits, salaries and wages) stay "home" in Claiborne and Warren counties. Naturally, the share of compensation within the local area is much larger than the share of compensation within Mississippi and the United States.

The largest non-labor expenditure is for offices of physicians, dentists and health care providers, at \$103,000. The bulk of this expenditure category represents fees paid to hospitals and physicians' offices to bring doctors on site to perform physicals and provide other medical services to plant employees.

The next-largest non-labor expenditures identified in the local area totaled \$63,000 for gasoline stations and \$57,000 for telecommunications.

Many of the top sectors in Table 3-1 involve service expenditures. The prevalence of service sectors illustrates the reliance on local contractors to provide specialized services at the plant. These include professional and technical services, and general business and facilities support services.

### 3.2 Plant Expenditures in Mississippi

In 2004, Grand Gulf's expenditures for products and services (including labor) in Mississippi totaled \$61 million. This total includes \$39.3 million dispersed in the local area and \$21.7 million in other areas of Mississippi. Spending within the state represents two-thirds of the plant's total expenditures of \$92.2 million.

Table 3-2 provides details on the plant's total spending within the state. Total compensation is the largest category, at \$59.2 million, and represents about 97 percent of the total. This is slightly less than the share of total compensation for spending in Claiborne and Warren counties. Instead, more money is spent on products and non-labor services in the rest of Mississippi.

**Table 3-2. Grand Gulf Expenditures in Mississippi**

Description	Amount
State and Local Government Services	\$271,000
Professional and Technical Services	\$234,000
Architectural and Engineering Services	\$152,000
Telecommunications	\$138,000
Machinery and Equipment Rental and Leasing	\$121,000
General Merchandise Stores	\$114,000
Services to Manufacturing and Industrial Buildings	\$111,000
State and Local Government Electric Utilities	\$105,000
Offices of Physicians, Dentists and Other Health Care Providers	\$103,000
Waste Management and Remediation Services	\$71,000
Other	\$427,000
<b>Subtotal</b>	<b>\$1.8 million</b>
Total Compensation <sup>a</sup>	\$59.2 million
<b>TOTAL</b>	<b>\$61 million</b>

<sup>a</sup> Total compensation includes wages, salaries and fringe benefits based on data provided by Entergy.

As in Table 3-1, large contracts have been identified to show the most significant expenditures at the state level. The largest category is state and local government services, at \$271,000. This category represents fees and payments made to organizations such as the Mississippi Department of Health and the State Department of Environmental Quality.

The next-largest expenditures in Mississippi are for professional and technical services, at \$234,000, and architectural and engineering services, at \$152,000. These expenditures are for specialized and highly technical contracted services that are generally unique to the industry, such as nuclear engineering.

Services for plant upkeep and maintenance continue to be a large part of plant spending at the state level. These include the leasing of machinery and equipment, services to plant buildings, and waste removal.

### **3.3 Plant Expenditures in the United States**

Grand Gulf expenditures for products and services (including labor) purchased in the United States totaled \$92.2 million in 2004. Besides expenditures of \$61 million in Mississippi, the plant spent \$31.2 million elsewhere in the United States, largely for specialized products and services unique to the nuclear industry.

National expenditures are detailed in Table 3-3. Total compensation (\$59.7 million) remains the largest category, representing 65 percent of the total. Total compensation as a share of the U.S. total is lower because most plant employees live in Mississippi (and particularly in Claiborne and Warren counties), while spending on products and non-labor services is concentrated outside the state.

Payments to the federal government, the largest spending category, represent expenditures made by the plant to government organizations such as the U.S. Nuclear Regulatory Commission and the Federal Emergency Management Agency. NRC fees paid by U.S. nuclear plants are used to cover the cost of nuclear plant regulation.

The security services category (\$4.7 million) represents one of the plant's largest expenditures in the United States. This is not unique to Grand Gulf, as spending for security is typically one of the largest expenditures at other nuclear plants, reflecting the strong emphasis on safe and secure operations, particularly since the attacks of Sept. 11, 2001.

Other large categories are similar to the state- and local-level expenditures, such as engineering, architectural and other specialized consulting services. Also included are expenditures for the removal of both high- and low-level waste from the plant site.

**Table 3-3. Grand Gulf Expenditures in the United States**

<b>Description</b>	<b>Amount</b>
Federal Government	\$4.7 million
Security Services	\$4.7 million
Architectural and Engineering Services	\$4.1 million
Waste Management and Remediation Services	\$3.4 million
Professional and Technical Services	\$2.7 million
Chemical Product Manufacturing	\$2.5 million
Scientific Research and Development Services	\$1.2 million
Environmental and Other Technical Consulting Services	\$1 million
Power Generation and Supply	\$1 million
Monetary Authorities and Depository Credit Intermediaries	\$900,000
Other	\$6.3 million
<b>Subtotal</b>	<b>\$32.5 million</b>
Total Compensation <sup>a</sup>	\$59.7 million
<b>TOTAL</b>	<b>\$92.2 million</b>

<sup>a</sup> Total compensation includes wages, salaries and fringe benefits based on data provided by Entergy.

### 3.4 Taxes Paid and Accrued

In 2004, Grand Gulf paid \$26.2 million in state and local taxes. A large component of taxes paid by the plant is for property taxes to the local areas surrounding the plant. In 2004, Grand Gulf paid a total of \$20 million in property taxes in the local area. Additionally, the plant made tax payments to the federal government of \$234.7 million, of which \$230 million was for federal income taxes.

**Table 3-4. Taxes Paid by Grand Gulf**

<b>Description</b>	<b>Amount (in millions of dollars)</b>
Total Federal Government	\$234.7
Total State and Local Government	\$26.2
<b>Total Taxes</b>	<b>\$260.9</b>

### 3.5 Economic Impacts on Geographic Area

Summary economic impacts for each of the three geographic areas—Claiborne and Warren counties, Mississippi, and the United States—are presented in Table 3-5. The four economic impact variables are:

- output—the value of production of goods and services
- labor income—the earnings of labor
- employment—measured in jobs provided
- taxes—the value of taxes paid.

**Table 3-5. Impact of Grand Gulf on Local, State and National Economies**

	Direct	Secondary <sup>a</sup>	Total
<b>Claiborne and Warren Counties</b>			
Output	\$473 million	\$12.2 million	\$485.2 million
Labor Income	\$38.8 million	\$3.8 million	\$42.6 million
Taxes	N/A	N/A	N/A
Employment	411	152	563
<b>State</b>			
Output	\$473 million	\$63.9 million	\$536.9 million
Labor Income	\$59.2 million	\$19.5 million	\$78.7 million
Taxes	\$26.2 million	\$3.3 million	\$29.5 million
Employment	621	695	1,316
<b>United States</b>			
Output	\$473 million	\$220.8 million	\$693.8 million
Labor Income	\$59.7 million	\$77.9 million	\$137.6 million
Taxes	\$234.7 million	\$18.6 million	\$253.3 million
Employment	625	2,081	2,706
<b>Total Economic Impact<sup>b</sup></b>	<b>\$793.6 million</b>	<b>\$320.6 million</b>	<b>\$1.1 billion</b>

<sup>a</sup> Secondary effects include indirect and induced impacts. Indirect impacts measure the effect of input suppliers on expenditures by Entergy, while induced impacts measure the effects produced by the change in household income resulting from Grand Gulf expenditures.

<sup>b</sup> Total Economic Impact is the sum of total U.S. output and labor income, plus state and federal taxes.

The plant's overall economic impact is shown as either a direct or secondary effect. The direct, or "first-round," effects reflect the industry sector and geographical distribution of Grand Gulf spending without any subsequent spending effects. The secondary, or "ripple," effects include subsequent spending effects, which can be further divided into two types: indirect and induced. Indirect effects reveal how the plant's spending patterns affect subsequent spending patterns among input suppliers. Induced effects reflect how changes in labor income affect the final demand for goods and services, which has a subsequent impact on all sectors producing basic, intermediate, and final goods and services.

The direct effects in Table 3-5 are based on the estimated value of the power production from the Grand Gulf plant of \$473 million for 2004. This output value is based on wholesale market values for the electricity from Grand Gulf in the Southeastern Electric Reliability Council market. The wholesale rate used was \$46.24 per megawatt-hour. The output value is divided among consumer benefits, investor returns, plant purchases, salaries and taxes. It reflects the total output of products and services associated directly with Grand Gulf, which includes the expenditures for products and services (including labor) itemized in Tables 3-1, 3-2 and 3-3. The direct employment entry (625 jobs) for the United States is Grand Gulf's employment level in 2004. The majority of these jobs (about 66 percent) are filled by workers who reside in Claiborne and Warren counties. The direct labor income entries reflect the geographic distribution pattern of Grand Gulf employment.

As Table 3-5 indicates, direct effects are the largest contributor to total effects for each of the measures of economic impact for Claiborne and Warren counties and Mississippi. Secondary effects are a much larger contributor to total effects at the national level.

These results reveal the multiplier effects of Grand Gulf spending. Multipliers show the ratio of the plant's "total economic impact" to its "direct economic impact" and can be measured for each geographical region. The most interesting multiplier is for the total effects, which is the ratio between the total and direct effects.

The total output multiplier reveals how much spending results in a geographic area of interest from each dollar of direct spending. The total output multiplier for the local area is 1.03 (or \$485.2 million divided by \$473 million). This indicates that for every dollar of output from the Grand Gulf plant, the local economy produces \$1.03. Using the same formula, the output multiplier is 1.14 for Mississippi and 1.47 for the United States.

### **3.6 Economic Impacts on Local Industry**

Grand Gulf's economic impacts are spread over virtually every economic sector. The direct effects are concentrated in a few sectors, but the secondary effects—and especially the induced effects—increase the dispersion of total effects across other sectors, which vary by geographic area. Table 3-6 presents the 10 sectors most affected by the plant in Claiborne and Warren counties, based on total output. Since Grand Gulf's spending is dominated by local salaries, the impacts are most notable in local areas that cater to the plant's employment base.

The sector most affected by total output is power generation and supply, which includes the value of electricity produced by the plant. Thus, all direct effects are included in this sector. It is the largest sector, based on total output, in the Mississippi and U.S. economies, as shown in Tables 3-7 and 3-8, respectively.

The second-most-affected sector is housing values. This is not a traditional business/industry sector, so it has no impact on labor income or employment. Instead, it is a special sector developed by the U.S. Department of Commerce’s Bureau of Economic Analysis. It estimates what homeowners would pay in rent if they rented, rather than owned, their homes. In essence, it creates an industry from owning a home. The sole product (or output) of this industry is home ownership, purchased entirely by personal consumption expenditures from household income. In effect, this sector captures increases in housing values caused by increased labor resulting from the plant.

The other sectors most affected by the Grand Gulf plant are related to providing goods and services to the plant’s large employment base, including hospitals, restaurants, medical and dental practices, real estate services, banks, and car dealership and repair services. Spending by plant employees indirectly boosts the sales and employment of these industries, which typically are operated by local small-business owners.

**Table 3-6. Impact of Grand Gulf on the Most-Affected Industries in Claiborne and Warren Counties**

<b>Description</b>	<b>Output</b>	<b>Labor Income</b>	<b>Employment</b>
Power Generation and Supply	\$473.5 million	\$38.9 million	412
Owner-Occupied Dwellings	\$2.2 million	N/A	N/A
Hospitals	\$769,000	\$395,000	7
Food Services and Drinking Places	\$702,000	\$242,000	19
Offices of Physicians, Dentists and Other Health Care Providers	\$599,000	\$404,000	9
Government Enterprises	\$530,000	\$128,000	3
Real Estate	\$460,000	\$69,000	5
Monetary Authorities and Depository Credit Intermediaries	\$431,000	\$107,000	3
Motor Vehicle and Parts Dealers	\$422,000	\$201,000	6
Automotive Repair and Maintenance	\$313,000	\$110,000	6
Other	\$5.3 million	\$2.1 million	93
<b>TOTAL</b>	<b>\$485.2 million</b>	<b>\$42.6 million</b>	<b>563</b>

### 3.7 Economic Impacts on State Industry

Table 3-7 uses the same sectors applied in Table 3-6 to illustrate the plant's economic impact on the state of Mississippi. Again, the power generation and supply sector is most affected, in terms of total output. The other entries in Table 3-7 are similar to those in the local area.

**Table 3-7. Impact of Grand Gulf on the Most-Affected Industries in Mississippi**

<b>Description</b>	<b>Output</b>	<b>Labor Income</b>	<b>Employment</b>
Power Generation and Supply	\$474.2 million	\$59.4 million	624
State and Local Government Enterprises	\$11.3 million	\$1.9 million	66
Owner-Occupied Dwellings	\$5.9 million	N/A	N/A
Offices of Physicians, Dentists and Other Health Care Providers	\$5.6 million	\$3.8 million	58
Food Services and Drinking Places	\$2.7 million	\$900,000	77
Wholesale Trade	\$1.9 million	\$800,000	17
Real Estate	\$1.9 million	\$300,000	18
Hospitals	\$1.8 million	\$700,000	20
Monetary Authorities and Depository Credit Intermediaries	\$1.3 million	\$300,000	8
Motor Vehicle and Parts Dealers	\$1.3 million	\$600,000	17
Other	\$29 million	\$10 million	411
<b>TOTAL</b>	<b>\$536.9 million</b>	<b>\$78.7 million</b>	<b>1,316</b>

### 3.8 Economic Impacts on U.S. Industry

Table 3-8, similar to Tables 3-6 and 3-7, illustrates the impact on the United States. Again, the most-affected sector in terms of total output is power generation and supply, followed by owner-occupied dwellings.

The 10 most-affected sectors (on the basis of output) in the United States are very similar to the 10 most-affected sectors in the local area and in Mississippi. The major exception is in the investigation and security services sector, a large expenditure area for nuclear plants. Impacts for this category are derived from direct expenditures by the plant, rather than indirect or induced effects.

**Table 3-8. Impact of Grand Gulf on the Most-Affected Industries in the United States**

<b>Description</b>	<b>Output (in millions of dollars)</b>	<b>Labor Income (in millions of dollars)</b>	<b>Employment</b>
Power Generation and Supply	\$476.8	\$60.5	631
Owner-Occupied Dwellings	\$13.2	N/A	N/A
Real Estate	\$10.3	\$1.6	61
Wholesale Trade	\$9.6	\$3.9	66
Food Services and Drinking Places	\$6.4	\$2.5	162
Monetary Authorities and Depository Credit Intermediaries	\$6.4	\$1.6	29
Hospitals	\$6.1	\$2.9	63
Offices of Physicians, Dentists and Other Health Care Providers	\$5.9	\$4	64
Insurance Carriers	\$5.3	\$1.5	26
Investigation and Security Services	\$5.1	\$3.4	150
Other	\$148.7	\$55.8	1,454
<b>TOTAL</b>	<b>\$693.8</b>	<b>\$137.7</b>	<b>2,706</b>

### 3.9 Tax Impacts

Grand Gulf’s spending has effects on tax payments that extend beyond the taxes paid directly on the plant. This spending has direct impacts on income and value creation, which affect taxes paid on that income and value. Similarly, the ripple effects of Grand Gulf purchases on other spending and economic activity lead to additional income and value creation, resulting in the payment of additional taxes.

These additional or “induced” effects on tax payments are much larger than the taxes paid directly. These results are presented in Table 3-9.

Grand Gulf is responsible for almost \$30 million in state and local tax revenue, either directly or indirectly, most of which is the plant’s \$20-million-a-year annual property tax payment. A Mississippi state statute mandates that \$8 million of the annual tax payment go directly to Claiborne County as host county. The remaining \$12 million must be distributed to the cities and counties in the 44-county Entergy Mississippi service area, divided pro rata based on the percentage of kilowatt-hours purchased by customers in each of those 44 counties. The city of Port Gibson receives its pro rata share in addition to Claiborne County’s direct share of \$8 million.

Much of the indirect expenditures come through additional property tax revenue created by the large number of employees at the Grand Gulf plant. In addition, the plant is responsible for generating more than \$250 million in federal tax revenue.

**Table 3-9. Tax Impacts of Economic Activity Induced by Grand Gulf**

	<b>Taxes Paid by Plant</b>	<b>Taxes Induced by Plant Expenditures</b>	<b>Total Tax Impact</b>
Federal Government	\$234.7 million	\$18.6 million	\$253.2 million
State and Local Government	\$26.2 million	\$3.3 million	\$29.5 million
<b>Total Taxes</b>	<b>\$260.9 million</b>	<b>\$21.8 million</b>	<b>\$282.7 million</b>

<sup>a</sup> The total tax impact includes taxes paid by Grand Gulf and other entities as a result of the economic activity created by plant expenditures.

### 3.10 Summary

The economic and fiscal impacts of Grand Gulf are substantial. These impacts are greater at the national level than at the state level, where they, in turn, are greater than at the county level. When compared with their respective economies, those relative impacts are reversed: relative impacts are highest for Claiborne County, next-highest for Mississippi and lowest for the United States.

As is the case with other nuclear plants, Grand Gulf buys many specialized products and services not available in local and state economies. National and international markets typically provide these products and services.

The state and local economic and fiscal effects are great, in large part because of the buying power that is created by Grand Gulf’s high wages, salaries and benefits. In turn, plant employees buy goods and services provided locally. This spending supports many small businesses in the area.



## Section 4: Additional Benefits Provided by Grand Gulf

In addition to the economic benefits that Grand Gulf contributes to Claiborne and Warren counties in the form of jobs, income and taxes, the plant also enhances the local community in ways that are difficult to capture with these measures.

### 4.1 Introduction

Because of its rural location, Port Gibson and surrounding Claiborne County are essentially a self-sufficient municipality and county, with the infrastructure required by any small city and county. Because of the size of Grand Gulf and the breadth of its resources, the plant and its employees are able to provide many additional benefits to the surrounding community beyond the direct and indirect economic impact of the plant itself. Educational, community and environmental programs are the primary beneficiaries of the plant's outreach efforts.

### 4.2 Lower Homeowner Property Taxes and Personal Property Tax

Grand Gulf's \$20 million annual property tax payment—\$8 million of which remains in Claiborne County each year—permits the city and county to levy lower tax rates on privately owned property, both residential and commercial, resulting in lower property tax bills.

The estimated annual local property tax in 2004 on a home valued at \$100,000 with a standard homestead exemption on one acre of land in Claiborne was \$404, which was lower than those in adjacent counties.

**Table 4-1. Annual Local Property Tax in 2004**

<b>County</b>	<b>Local Property Tax (of \$100,000 home on one acre)</b>
Claiborne County	\$404
Warren County	\$911
Hinds County (Jackson, Miss.)	\$1,393

Source: Tax Assessor's Office of each respective county

The estimated annual license tag cost (personal property tax) in 2004 on a 2003 Nissan Frontier 4x4 pickup truck in Claiborne was \$118, which was lower than those in adjacent counties.

**Table 4-2. Personal Property Tax on License Tag in 2004**

County	Personal Property Tax for License Tag
Claiborne County	\$118
Hinds County (Jackson, Miss.)	\$404
Warren County	\$440

Source: Tax Collector's Office of each respective county

## 4.2 Education

Claiborne County Schools benefit significantly from Grand Gulf, Superintendent Annie Kilcrease told a U.S. Nuclear Regulatory Commission public hearing in August 2006. The nuclear plant's property taxes—which result in a teacher salary supplement of \$5,500 a year, among other benefits—enable the school district to pay the second-highest teacher salaries in the state of Mississippi. As a result, Claiborne can successfully attract and retain highly qualified teachers.

“We have a strong partnership with Grand Gulf,” Kilcrease said. “It is easy for us to recruit the highest-quality teachers in Mississippi, and we do.”

Grand Gulf employees are active in Claiborne County Schools. Employees participate in the annual Community Awareness Night program and the Business and Education Standing Together program.

Grand Gulf also provides guest speakers for workshops and volunteers for the Partner in Education program. Employees tutor students after school and are actively engaged in the Parent Teacher Association. The plant purchases test workbooks in math and science subjects.

When the local schools' science fairs approach each year, Grand Gulf employees aid students in the most difficult aspect of their science fair experience—getting inspiration. Employees suggest topics and help students brainstorm ways to develop these topics into projects.

Employees also serve as science fair judges at 11 schools: Port Gibson Middle School and A.W. Watson Elementary in Claiborne County; and South Park Elementary, Bowmar Elementary, Sherman Avenue Elementary, Warren Central Intermediate, Redwood Elementary, Vicksburg Intermediate, Warrenton Elementary, Dana Road Elementary and Beechwood Elementary in Vicksburg.

### **4.3 Community Involvement**

The plant's community outreach meetings, established in 2003 by the site vice president, help foster a partnership between Grand Gulf, Entergy Mississippi (the local utility distribution subsidiary) and local agencies. Through these outreach meetings, Grand Gulf employees inform the community's elected and business leadership about nuclear energy issues and industry developments that could affect the plant and the community.

In these outreach meetings, Port Gibson's elected leaders and other residents also learn about various job requirements and education needed in the local schools to help prepare students to join the work force at Grand Gulf, if they so desire.

The plant's Community Involvement Committee hosts blood drives several times during the year. Employees donate blood for the Claiborne County area, as well as for Grand Gulf employees in need of blood transfusions because of serious illnesses.

Grand Gulf employees also support two organizations for their annual Christmas toy and clothing drive: the Claiborne County Christian Volunteer Service and the Vicksburg Child Abuse Prevention Center. Employees show their generosity by donating toys, clothing and funds.

Grand Gulf employees also contribute annually to such local efforts as Port Gibson Main Street, Area 10 Special Olympics, Miss Cultural Crossroads, Port Gibson-Claiborne County Chamber of Commerce, Mississippi Chapter of the Juvenile Diabetes Research Foundation International, Susan G. Komen Breast Cancer Drive and Alcorn State University Relay for Life.

In its largest community effort, in terms of dollars, Grand Gulf raises funds through the United Way Campaign. Those funds are matched dollar-for-dollar by Entergy Corp. to help fund critical services in Claiborne and Warren counties and surrounding areas.

Under its Open Grants Program, Community Partnership Grants and the Entergy Charitable Foundation, Entergy has made grants totaling \$69,610 over the past five years to various nonprofit civic and social service agencies in Port Gibson and Claiborne County. An additional \$56,315 in grants has been donated to organizations in Warren County and Vicksburg.

In addition, Grand Gulf is the signature sponsor of the Port Gibson Heritage Festival, an annual community gathering where employees help staff the admission gates.

### **4.4 Environment**

Another benefit that Grand Gulf brings to Claiborne County is its positive impact on the environment. Nuclear power is one of the cleanest conventional means of producing electricity.

Grand Gulf operations avoid significant greenhouse gas emissions that otherwise would be generated if the same amount of electricity were produced by fossil fuels. In 2004, Grand Gulf avoided the emission of 48,000 tons of sulfur dioxide, 16,000 tons of nitrous oxide and 9.4 million tons of carbon dioxide. Sulfur dioxide can produce acid rain, and nitrous oxide is a precursor to ground-level ozone.



## Section 5: Nuclear Industry Trends

The U.S. nuclear energy industry steadily has improved performance and cost, while also becoming a model of industrial safety.

Total electricity production for U.S. nuclear power plants reached a near-record 782 billion kilowatt-hours in 2005, or about 20 percent of America's electricity production. In Pennsylvania, nuclear power generates 36 percent of the state's electricity.

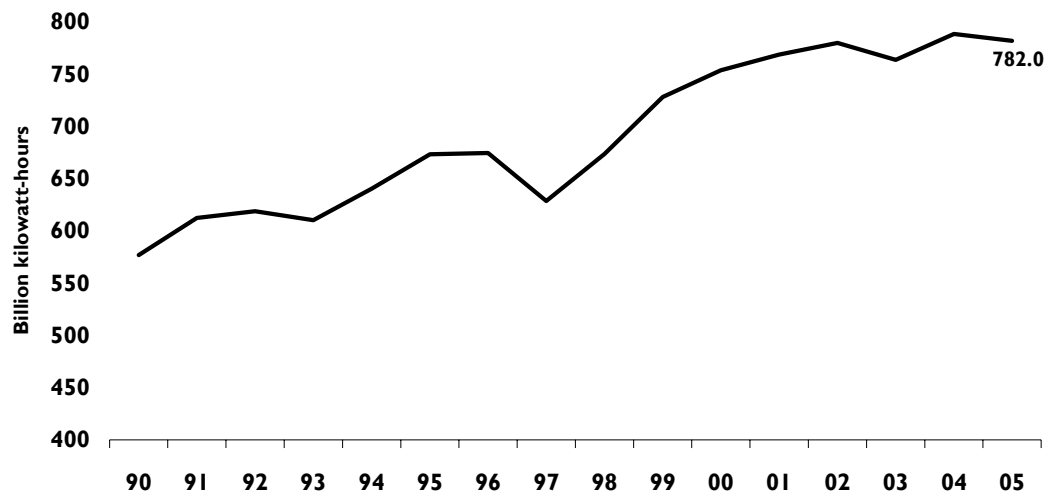
Power plant performance is measured by capacity factor, which compares the amount of electricity actually produced by a plant with the maximum production achievable. U.S. nuclear power plants achieved an average capacity factor of 89.3 percent in 2005. At the same time, production costs for those plants have been among the lowest of any baseload fuel source.

### 5.1 Nuclear Industry Performance

U.S. nuclear power plants have increased their output and improved their performance significantly over the past 10 years. Since 1990, the industry has increased total output equivalent to that of 26 new, large nuclear plants. This increase in output occurred without building any new nuclear plants.

Overall capacity factors for U.S. nuclear power plants have increased dramatically over the past decade, reaching 89.3 percent in 2005. By contrast, the industry's average capacity factor was 60 percent in the late 1980s. One of the key reasons for the increased capacity factor has been the shortening of refueling outage times.

**Figure 5-1. U.S. Nuclear Industry Net Electricity Generation  
(36% increase from 1990 to 2005)**

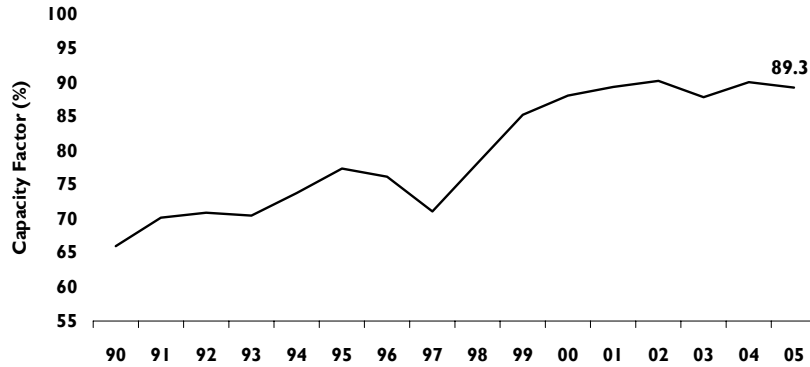


Sources: *Global Energy Decisions/Energy Information Administration*

Nuclear plants need to shut down to refuel approximately every 18 to 24 months. Refueling represents one of the major determinants of nuclear plant availability.

In the past 10 years, the durations of refueling outages have been declining. In 1990, the average refueling outage took 105 days to complete.

**Figure 5-2. U.S. Nuclear Industry Average Capacity Factors (1990-2005)**



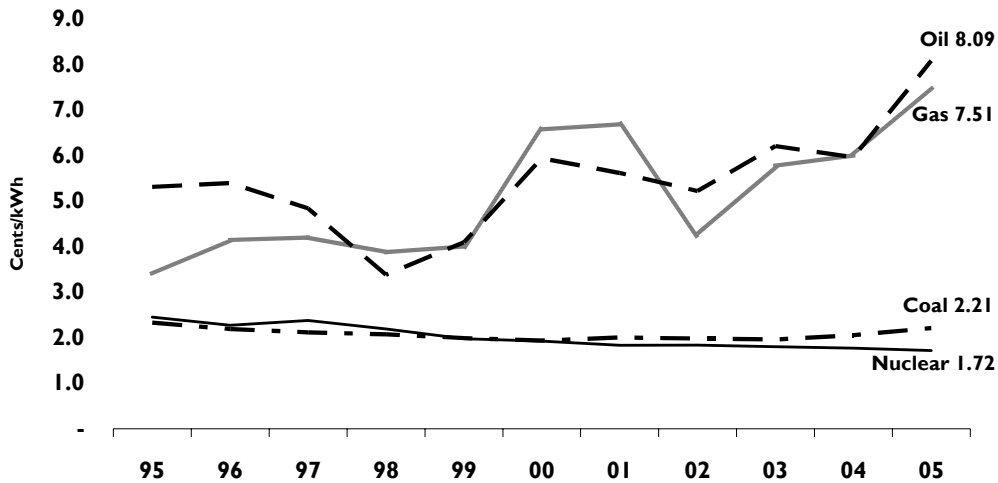
Sources: Global Energy Decisions/Energy Information Administration

By 2005, this number declined to an average of 38 days, and companies continue to apply best practices to reduce further this average length of refueling. The record for the shortest outage is 14.67 days for a boiling water reactor and 15.67 days for a pressurized water reactor.

## 5.2 Cost Competitiveness

Along with increasing output, the U.S. nuclear industry has continued to decrease the cost of its operations. In 2005, nuclear power had a production cost of 1.72 cents per kilowatt-hour. In the past decade, nuclear production costs have dropped by about one-third because of the increased capacity factor of U.S. plants. Since most nuclear plant costs are fixed, greater electricity production lowers costs. However, nuclear plants also have taken steps to reduce their total cost through improved work processes.

**Figure 5-3. U.S. Electricity Production Costs (1995-2005, in 2005 cents per kilowatt-hour)**



Source: Global Energy Decisions

**Table 5-1. Wholesale Electricity Prices by Region**

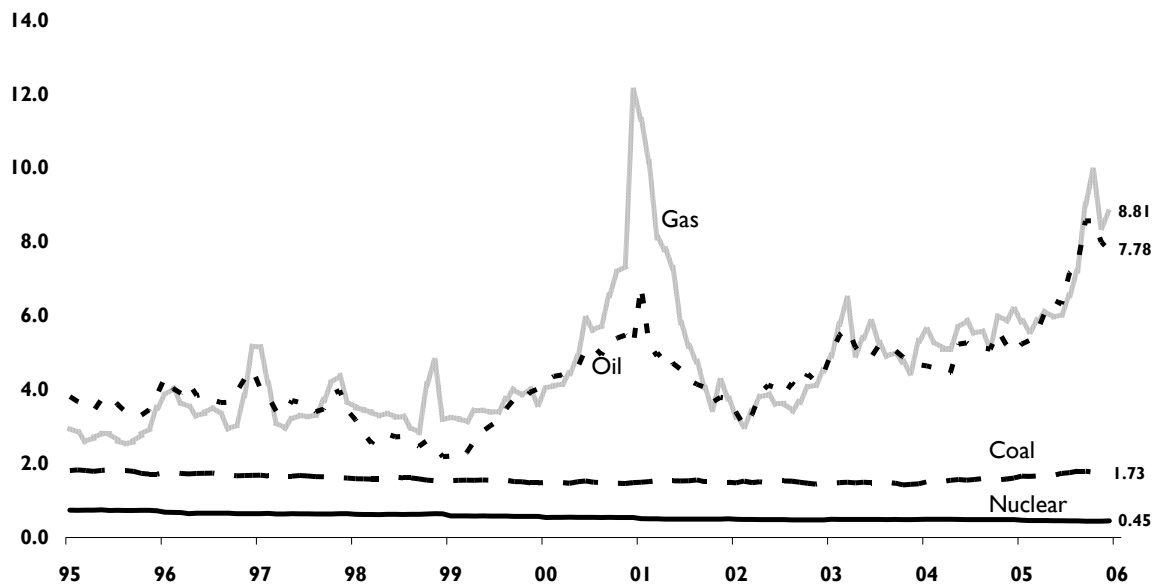
Region	2005 Average 24/7 Power Prices (in cents per kilowatt-hour)
East	7.89
Midwest	5.56
Southeast	6.78
West	6.75

Sources: Global Energy Decisions/InterContinental Exchange

Because of low production costs and excellent safety performance, nuclear plants are highly competitive in today’s energy markets. Ultimately, the primary test of nuclear energy’s competitiveness is how well it performs against market prices. In this respect, nuclear energy is highly competitive. The average 2005 production cost at the nation’s 103 reactors of 1.72 cents per kilowatt-hour was lower than the average price in all regional markets. Nuclear energy also is competitive with futures market prices, one of the best ways to judge what prices will be in the year ahead.

Fuel markets tend to be volatile, so the production costs of generation sources tied to fuel expenses are highly volatile, as they swing with variations in the market. Fuel costs comprise 75 percent to 90 percent of the cost of natural gas-, coal- and petroleum-fired generation. Nuclear fuel, however, represents only 25 percent of the production cost, so nuclear plants provide a unique degree of price stability. In addition, nuclear fuel prices are much more stable than those of fossil fuels, particularly natural gas and petroleum. Because of its stable, low production cost, nuclear energy can help mitigate large electricity price swings.

**Figure 5-4. Monthly Fuel Cost to Electric Generators  
(1995-2005, in 2005 cents per kilowatt-hour)**



Source: Global Energy Decisions

### 5.3 Industry Safety

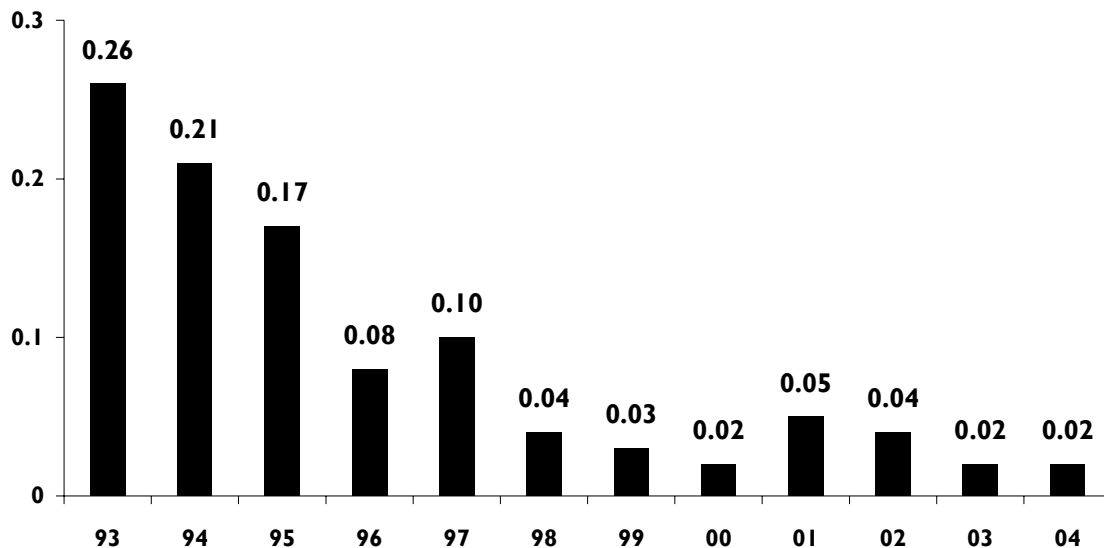
The nuclear industry's recent performance and cost achievements occurred in an era of outstanding safety at U.S. nuclear plants. In 2005, the nuclear energy industry was close to meeting all 2005 safety goals set by the Institute of Nuclear Power Operations (INPO) and the World Association of Nuclear Operators (WANO). These entities track safety and performance data in 10 important areas.

One key indicator tracked by INPO and WANO is the number of unplanned automatic plant shutdowns. The U.S. industry has made dramatic improvements in the number of unplanned automatic shutdowns, dropping from a median of 7.3 shutdowns per reactor in 1980 to zero in 2005.

Other safety and performance indicators tracked by the U.S. Nuclear Regulatory Commission confirm the excellent safety performance of U.S. nuclear plants. The NRC tracks data on the number of "significant events" at each nuclear plant. (A significant event is any occurrence that challenges a plant's safety system.) The average number of significant events per reactor declined from 0.77 per year in 1988 to 0.02 in 2004.

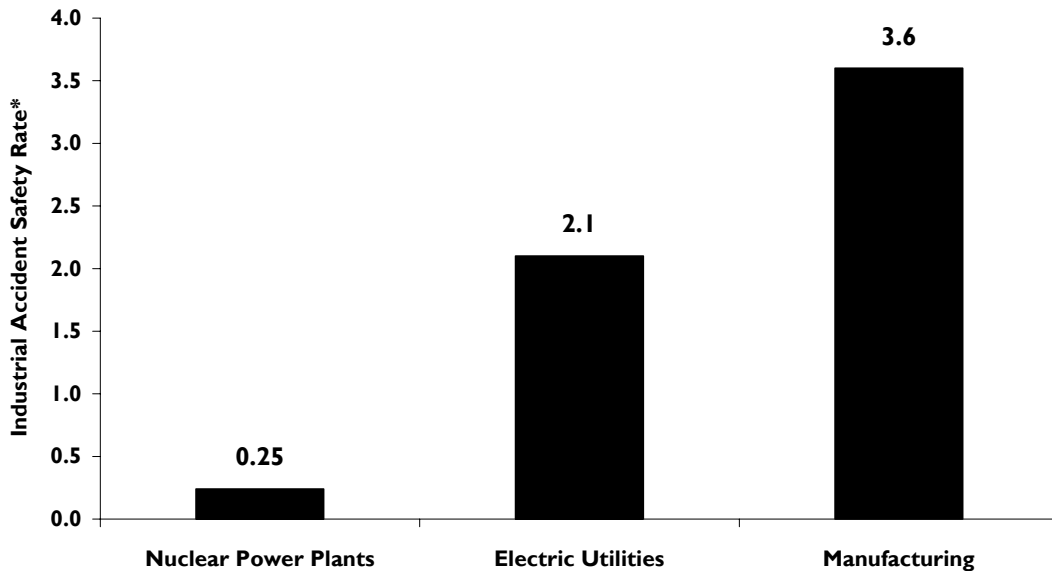
In addition to safe operations, U.S. nuclear plants continue to improve their already high levels of worker safety. According to NRC data, radiation exposure to workers (measured in rems) decreased from an average of about 1 rem per year in 1973 to 0.16 rem per year in 2003. Both the historical and current doses per employee are far below the regulatory limit of 5 rem per year.

**Figure 5-5. Significant Events: Annual Industry Average  
(Number of events per reactor 1990-2004)**



Source: Nuclear Regulatory Commission Information Digest

**Figure 5-6. Nuclear's Superior Safety Record**  
**(2005 Nuclear Industry's Industrial Accident Safety Rates Compared to Other Industries)**



\* Number of accidents resulting in lost work, restricted work or job transfer per 200,000 worker-hours  
 Sources: Nuclear (World Association of Nuclear Operators); others (U.S. Bureau of Labor Statistics)

General worker safety also is excellent at U.S. nuclear power plants—far safer than in the U.S. manufacturing sector. WANO and the U.S. Bureau of Labor Statistics provide information on the industrial accident safety rate. This statistic measures the lost workday accidents per 200,000 worker-hours. The nuclear industry has improved its industrial accident safety rate from 0.46 in 1996 to 0.25 in 2005. By comparison, the U.S. manufacturing industry had an industrial accident safety rate of 3.6.

## 5.4 Current Industry Events

The excellent economic and safety performance of U.S. nuclear plants has increased interest in nuclear energy by the electric utility industry, the financial community and policymakers. This is evidenced by the increasing number of plants seeking license renewals from the NRC.

Originally licensed to operate for 40 years, nuclear plants can operate safely for longer periods. The NRC granted the first 20-year license renewal to the Calvert Cliffs plant in Maryland in 2000. As of December 2006, 47 reactors have received license extensions, and 34 reactors either have submitted applications or formally announced that they will seek to renew their licenses. License renewal is an attractive alternative to building new electric capacity because of nuclear energy's low production costs and the return on investment provided by extending a plant's operational life.

Besides relicensing current plants, interest recently has increased in building new nuclear plants. Four companies—Entergy, Dominion Energy, Exelon and Southern Co.—have submitted early site permit applications to the NRC to test the agency's permitting process for new reactor sites.

Several companies and consortia are collaborating with the U.S. Department of Energy to test a revised licensing process for building and operating new nuclear reactors. The effort is part of DOE's Nuclear Power 2010 program, established to foster the development of next-generation nuclear power plants.

## Section 6: Economic Impact Analysis Methodology

The methodology used to estimate the economic and fiscal impacts of Entergy’s Grand Gulf nuclear power plant is commonly referred to as input/output analysis. Several operational input/output models are available in the marketplace. The market leaders are Impact Analysis for Planning (IMPLAN), Regional Economic Models Inc. and Regional Input-Output Modeling System II. The study’s authors selected the IMPLAN model for use in this study, primarily because of the availability of the model and data sets. Other important factors were its relevance to the particular application, as well as its transparency and ease of use.

This section presents typical applications of input/output analysis and explains the methodology and its underpinnings. It also describes how Grand Gulf data and the IMPLAN model were used to estimate local, state, and national economic and fiscal impacts of the plant’s operation.

### 6.1 Use of Input/Output Models

Input/output models capture input, or demand, and output, or supply, interrelationships for detailed business, industry and government sectors in a geographic region. They also capture the consumption of goods and services for final demand by these sectors and by the household sector.

The basic geographic region is a county, but model results can be developed at the multi-county, state, multi-state and national levels. These results are particularly useful in examining the total effects of an economic activity or of a change in the level of that activity.

These models are typically used when the following key questions need to be addressed:

- How much spending does an economic activity (such as a power plant) bring to a region or local area?
- How much of this spending results in sales growth by local businesses?
- How much income is generated for local businesses and households?
- How many jobs does this activity support?
- How much tax revenue is generated by this activity?

These models also are useful in addressing related questions, such as the geographic and industry distribution of economic and fiscal impacts. Typical applications of these models include facility or military base openings and closings, transport or other public infrastructure investments, industrial recruitment and relocation, and tourism.

### 6.2 Overview of the Input/Output Methodology

Input/output models link various sectors of the economy—e.g., agriculture, construction, government, households, manufacturing, services and trade—through their respective spending flows in a reference year. These include geographic linkages, primarily at national, state and county levels.

As a result of these linkages, the impact of an economic activity in any sector or geographic area on other sectors and areas can be modeled. These impacts can extend well beyond the sector and area in which the original economic activity is located. They include not only the direct, or

initial, effects of the economic activity, but also the secondary, or “ripple,” effects that flow from this activity. Direct effects are analogous to the initial “splash” made by the economic activity, and ripple effects are analogous to the subsequent “waves” of economic activity (new employment, income, production and spending) triggered by the splash. A full accounting of the effect of the splash must include the waves as well as the splash itself.

The sum of the direct and ripple effects is called the total effect, and the ratio of the total effect to the direct effect is called the “total effect multiplier,” or simply the multiplier effect. Multipliers can be developed for any of the model outputs, such as earned income, employment, industry output and total income (which includes the effect of transfers between institutions).

“Multipliers” also can be developed for any industry/business sector or geographic area in the model. Multipliers for a county are smaller than for a larger area, such as the state in which the county is located, because some spending associated with an economic activity migrates from the small area into the larger area. At the local area level, multipliers are larger if the local area tends to produce the types of goods and services that the plant requires.

Secondary effects include two components—indirect and induced effects—modeled separately within input/output models. Indirect effects are those influencing the supply chain that feeds into the business/industry sector in which the economic activity is located. For example, when Grand Gulf buys a hammer for \$5, it contributes directly to the economy.

Consequently, the company that makes the hammer also has to increase its purchases of steel and wood to maintain its inventory, increasing output in the steel and wood industries. The steel and wood industries then will have to purchase more inputs for their production processes, and so on. The result will be an economic impact that is greater than the \$5 initially spent for the hammer.

The increased income of plant employees and other regional workers leads to higher spending at the household level. That increased spending is called the induced effect. To illustrate, when Grand Gulf pays \$5 for a hammer, a portion of the \$5 goes to pay wages of employees at the company that makes the hammer. This portion contributes to labor income, which provides an additional contribution to the economy through its effects on household spending for goods and services.

This purchase also will affect labor income in the wood and steel industries, and the resulting household spending on goods and services. Entergy’s wage and salary expenditures at the plant create induced effects as well, primarily in the plant’s host and surrounding counties.

As with any model, input/output models incorporate some simplifying assumptions to make them tractable. There are several key simplifying assumptions in input/output models, including the assumption of a fixed commodity input structure. In essence, the “recipe” for producing a product or service is fixed, and there is no substitution of inputs, either of new inputs (which were not in the mix before) for old inputs, or among inputs within the mix.

Input substitution does not occur if technical improvements in some inputs make them relatively more productive. Nor does input substitution occur if there are relative price changes among inputs. Were any of these types of substitutions to be allowed, they might dampen the multiplier effects, especially for larger geographic areas.

Another key simplifying assumption is constant returns to scale. A doubling of commodity or service output requires a doubling of inputs, and a halving of commodity or service output

requires a halving of inputs. There is no opportunity for input use relative to commodity or service production levels to change, as those levels expand or contract, so there are no opportunities for either economies or diseconomies of scale. This will not dramatically alter the overall results as long as the economic activity whose effects are being modeled is not large relative to the rest of the sectors.

In other words, the models assume that for every dollar of output, the same dollar amount is required for the various input categories. Returning to the hammer example, if a \$5 hammer requires \$3 of steel, then two hammers would require \$6 of steel.

Although that works for steel and hammers, some inputs do not vary directly with output. For instance, if an oil refinery's efficiency and output increases, a corresponding increase in personnel operating the plant is unlikely. The constant-return-to-scale assumption considers such differences and is necessary for modeling.

Input/output models assume no input supply or commodity/service production capability constraints. This simplifying assumption is related in part to the constant-returns-to-scale assumption, for if there were supply constraints, diseconomies of scale likely would result. As in the case of the constant-returns-to-scale assumption, this "no supply constraints" assumption is not a major concern as long as the economic activity of interest is not large relative to the rest of the sectors.

To illustrate, the assumption presupposes that a hammer manufacturer would purchase all the steel for the same price. If not, doubling the number of hammers sold could mean that the dollar value of the steel might more than double if the manufacturer had to buy more steel at a higher price. This would violate the constant-returns-to-scale assumption, which simplifies modeling.

Homogeneity, another key simplifying assumption, characterizes firms and technologies within sectors as very similar. Although the model allows some editing of its sector files to characterize specialized firms, there is no ability to reflect full diversity of firms within sectors.

### **6.3 The IMPLAN Model and Its Application to Grand Gulf**

IMPLAN was originally developed by the U.S. Department of Agriculture's Forest Service in cooperation with the Federal Emergency Management Agency and the U.S. Department of the Interior's Bureau of Land Management to assist in land and resource management planning. IMPLAN has been used since 1979 and is supported by the Minnesota IMPLAN Group Inc.

The IMPLAN system consists of two components: the software and the database. The software performs the necessary calculations, using the study area data, to create the models. It also provides an interface for the user to change the region's economic description, create impact scenarios and introduce changes into the local model. The software is described in a user's guide provided by the Minnesota IMPLAN Group.

The IMPLAN software was designed to serve three functions: data retrieval, data reduction and model development, and impact analyses.

The IMPLAN database consists of two major parts:

- national technology matrices
- estimates of regional data for institutional demand and transfers, value added, industry output, and employment for each county in the United States, as well as state and national totals.

The model's data and account structure closely follow the accounting conventions used in the input/output studies of the U.S. economy by the Department of Commerce's Bureau of Economic Analysis. The comprehensive and detailed data coverage of the entire United States by county, and the ability to incorporate user-supplied data at each stage of the model-building process, provides a high degree of flexibility in terms of both geographic coverage and model formulation.

In applying the IMPLAN model to the plant, Entergy provided three basic types of data: purchase order expenditures by purchase order code, employee compensation expenditures and tax payment data for 2004.

The purchase order data mapped IMPLAN's 528 sector codes in two ways. First, by identifying the largest contracts at each geographic level and assigning them an industrial classification code within IMPLAN sector codes. For the remaining expenditures, the data were mapped into IMPLAN codes based on average distributions obtained through detailed studies of six nuclear reactors. The purchase order data also were mapped into IMPLAN based on the areas where these purchases were made.

The purchase order and compensation data then were augmented by an estimate of revenues from electricity sales from Grand Gulf into the wholesale market in 2004. This augmentation was necessary because purchase orders and compensation do not reflect all the economic value of the nuclear plant, while total output (approximated by total revenues) better reflects the full economic impacts of the plant.

Because revenues are not available for the plant, they were estimated based on kilowatt-hours sold and the average wholesale price for electricity sold by Grand Gulf during this time period. The estimated revenues were above the expenditure data provided by Grand Gulf, indicating a nuclear generation profit margin that was incorporated into IMPLAN as profits associated with the operation of the plant.

These data then were incorporated into the IMPLAN model, which combined specifics of the local economy with data on economic activity of Grand Gulf to provide estimates of the plant's total impacts. IMPLAN then developed the economic and fiscal impact estimates for this report.



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