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# New York Nuclear Power Plants' Contribution to the State Economy

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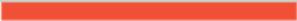
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## I. Executive Summary

At the request of Nuclear Matters, The Brattle Group has estimated the value of the nuclear plants in New York to the state's economy.

Our analysis has determined that nuclear plants operating in New York:

- **contribute approximately \$2.47 billion to state gross domestic product (GDP)** (\$3.77 billion in gross output).
- **account for about 18,000 in-state full time jobs** (direct and secondary).
- **help keep electricity prices lower than they would otherwise be** – New York consumers would pay over \$1 billion annually (2015\$) and over \$11 billion in the next ten years (on a present value basis) absent the state's nuclear plants.
- **are responsible for \$113 million in net state tax revenues** annually.
- **avoid 26 million tons of CO<sub>2</sub> emissions** annually.

These values reflect the incremental contribution of these nuclear plants to the economy, measured by comparing the performance of New York's economy with and without its nuclear plants. This approach nets off the contribution of the alternative generation that would be necessary if the nuclear industry did not exist, to determine its incremental contribution. Absent nuclear energy, New York's economy would rely more heavily on existing natural gas-fired generating plants. This greater reliance on fossil generation would mean higher electricity prices – wholesale prices would be higher on average in New York. It is this effect on electricity prices that accounts for the majority of nuclear's overall incremental economic impact. Note that these measures do not reflect the impacts outside New York, although the absence of in-state nuclear plants will have significant additional consequences beyond the state's borders.

The absence of New York's nuclear plants would also result in much higher carbon dioxide (CO<sub>2</sub>) emissions and greater emissions of criteria pollutants, such as nitrogen oxides (NO<sub>x</sub>) and sulfur dioxide (SO<sub>2</sub>). These impacts are not limited to New York, because air pollution impacts can cross state borders – they are often regional in the case of criteria pollutants, and global in the case of carbon. Large-scale renewable energy probably would not substitute significantly for nuclear; intermittent renewable generation is not a direct substitute for the baseload profile of nuclear.

Absent New York's nuclear plants, consumers would pay more for electricity, the economy would suffer both in terms of GDP and jobs, and we would face substantially higher emissions of CO<sub>2</sub> and other pollutants.

## II. Background

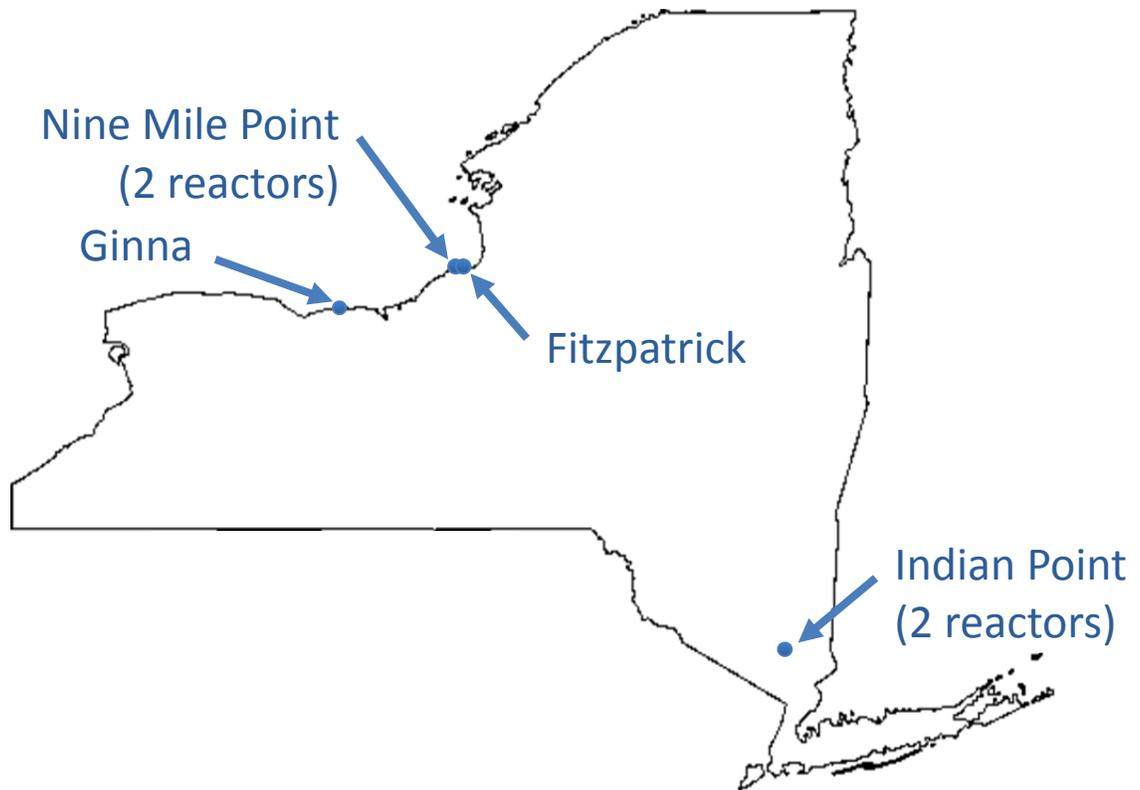
Four nuclear plants, comprising six nuclear reactors, operate in New York, representing over 5,000 megawatts (MW) of capacity and almost 42 million megawatt hours (MWh) of annual

electricity generation, as shown in Table 1 and illustrated in Figure 1.<sup>1</sup> New York is almost entirely served by one independent system operator, NYISO.<sup>2</sup> New York’s nuclear generation makes up 12% of NYISO’s total capacity and 26% of its electricity generation, as shown in Table 2. Within the boundaries of New York State as a whole, nuclear power represents a similar share of capacity and generation at 13% and 26% respectively, as shown in Table 3.

**Table 1: Summary of Nuclear Generation in New York**

Variable	Value
[1] Number of nuclear plants	4
[2] Number of nuclear reactors	6
[3] Total capacity (MW)	5,281
[4] Estimated generation (MWh)	41,828,387

**Figure 1: Locations of New York Nuclear Plants**



<sup>1</sup> Data comes from Ventyx’s Energy Velocity. There are some plants in New York that fall outside of NYISO, but this is a small share.

<sup>2</sup> Independent system operators (ISOs) establish and maintain electricity capacity and energy markets.

**Table 2: New York Nuclear Power Share of Capacity and Generation by Reliability Region**

Region	New York nuclear share of region's capacity	New York nuclear share of region's generation
[1] New York	12%	26%

**Table 3: Nuclear Power Provides a Large Share of New York Capacity and Generation**

Category	New York nuclear share
[1] New York capacity	13%
[2] New York generation	26%

### III. Nuclear Plants Make a Considerable Contribution to the New York Economy

We have estimated the economic value of New York’s nuclear plants to New York using REMI, a widely-used dynamic input output model of the U.S. economy, linked with a simplified Brattle model of the electricity sector to better capture the dynamics of power markets and prices.<sup>3</sup> By linking these models, we are able to measure the economic output, employment, and tax revenue in New York with and without its nuclear plants, providing the most accurate picture of their incremental contribution to the economy. The economic impacts presented here are limited to New York, but the nuclear plants operating in New York have significant economic impacts well beyond the state’s borders. Economic markets do not generally coincide with state borders. As a result, estimating the overall economic impacts of New York’s nuclear plants would require a regional model. Although we have not created such a regional model for New York, we have developed a national model that looks at the entire U.S. nuclear fleet, accounting for electricity and other market activities both within and across states.<sup>4</sup>

<sup>3</sup> For more details on the REMI model, see [www.remi.com](http://www.remi.com).

<sup>4</sup> The Brattle Group, “The Nuclear Industry’s Contribution to the U.S. Economy,” July 7, 2015. Note that economic impacts presented for New York in the national study will differ substantially from those reported in this study. In the national report, we measure the contribution of all nuclear plants. Consequently, state impacts are influenced not only by plants located within a given state, but also by

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This analysis indicates that New York’s nuclear plants make a significant contribution to keeping New York’s electricity costs down, and this has a substantial effect on the New York economy. Netting out the value of the alternative electric generation that would substitute if they did not exist, New York’s nuclear plants are responsible for substantial economic output and accompanying employment and tax revenues. Table 4 summarizes our findings for the impacts within New York (not including the impact outside the state).

**Table 4: Net Contribution of New York Nuclear Plants to the New York Economy**

	Average Annual (2015-2024)
Direct and Secondary Employment (jobs)	18,000
Direct and Secondary Output (2015 dollars)	\$3.77 billion
Direct and Secondary GDP (2015 dollars)	\$2.47 billion
Direct and Secondary State Tax Revenues (2015 dollars)	\$113.3 million
Direct and Secondary Federal Tax Revenues (2015 dollars)	\$452.0 million

New York nuclear plants contribute \$2.47 billion to the state’s GDP, and account for about 18,000 direct and secondary jobs.<sup>5</sup> New York’s nuclear plants’ owners also pay substantial federal and state taxes, as do businesses providing good and services to the plants and their employees. In addition, the nuclear plants’ incremental contributions to state output account for additional tax revenues. New York plants’ effect on the economy leads to about \$113 million in additional state tax revenues and \$452 million in federal tax revenues, beyond what would be provided by the alternative electric supply that would be utilized in their absence.

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plants located in other states. The economic impacts presented in this report are limited to only the contributions of in-state nuclear plants.

<sup>5</sup> We report both GDP and gross output since both are useful economic statistics in Table 4. GDP is the most widely-used measure of national income. It reflects value added, which includes industry sales to other industries and to final users minus the value its purchases from other industries. Gross output is a measure of industry sales, which includes sales to final users and intermediate sales to other industries. This leads to a form of double counting, but does not prevent the measure from being a meaningful indicator of how individual industries perform relative to one another.

Below, we provide further detail regarding the impact of New York nuclear plants on:

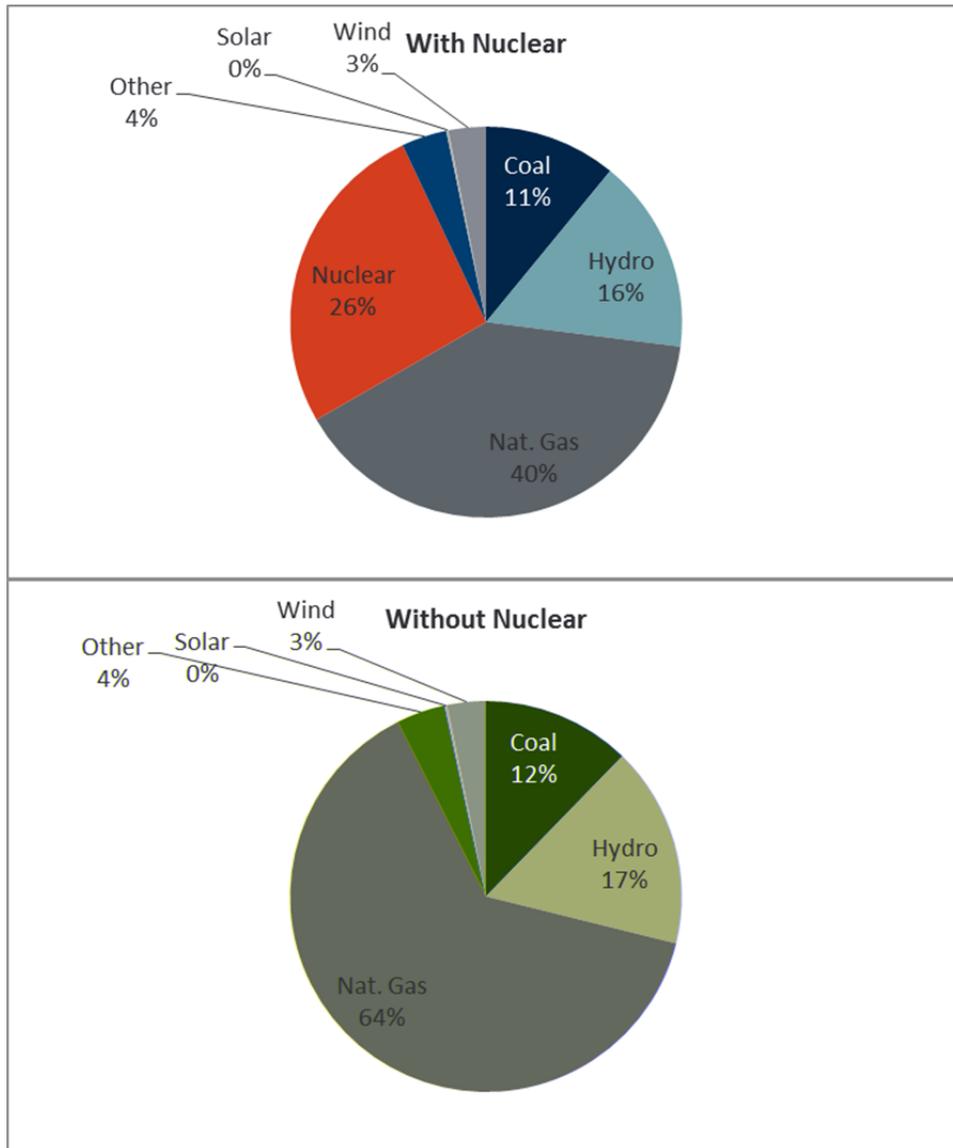
- The electricity generation mix
- The cost of electricity
- Economic output and GDP
- Employment (direct and secondary)
- Federal and state tax revenues

Further details regarding our data, assumptions, and modeling results can be found in “The Nuclear Industry’s Contribution to the U.S. Economy,” prepared for Nuclear Matters by The Brattle Group, July 7, 2015.

### **A. IMPACT ON ELECTRIC GENERATION MIX**

As shown in Figure 2, without New York’s nuclear power plants, electricity demand would be met mostly by increased reliance on existing natural gas-fired generation. The share of New York generation from natural gas-fired plants would increase from 40% to 64%. Large-scale renewable energy probably would not be significantly different; intermittent renewable generation alone is not a direct substitute for the baseload profile of nuclear, and at current capital and fuel prices (absent other policy changes), natural gas generation is generally more cost-effective. Higher electricity prices, however, might somewhat reduce demand for grid-based electricity, by inducing efficiency, conservation, and switching to alternative fuels or electricity sources.

**Figure 2: Electric Generation Mix in New York in 2015**



## **B. IMPACT ON ELECTRICITY PRICES**

New York nuclear plants' impact on the New York economy is primarily the result of their influence on electricity prices. As noted above, absent New York's nuclear plants, electricity demand would be met by increased utilization of natural gas-fired plants within New York. This alternative generation mix would mean higher electricity prices across NYISO. As shown in Table 5, on average electricity prices in New York would be on a wholesale basis. These increases are substantial. New York consumers will spend over \$1.3 billion more annually on electricity absent the state's nuclear plants. Between 2015 and 2024 they will spend over \$11.3 billion more on a present value basis. Higher electricity prices hurt the economy primarily by reducing residential, commercial, and industrial spending on other goods and services.

**Table 5: New York Nuclear Plants Avoid Higher Electricity Prices  
(All-in Wholesale Electricity Prices with and without Nuclear,  
Average Annual \$/MWh, 2015-2024)<sup>6</sup>**

Region	Wholesale price with nuclear	Wholesale price without nuclear	Wholesale price change	Electricity consumption ( <i>millions of MWh</i> )	Total annual electricity cost change ( <i>millions of 2015 dollars</i> )	Total electricity cost increase 2015-2024 ( <i>millions of dollars</i> ) <sup>1</sup>
New York	\$55.21	\$63.26	\$8.05	166	\$1,332	\$11,366

<sup>1</sup> Present value for the periods 2015-2024 at a 3% discount rate.

The magnitude of the power price effects, and ultimately the economic and jobs effects, could depend on movements in the price of natural gas, since it plays a primary role in setting power prices in most U.S. regions.<sup>7</sup> In addition, although local and possibly regional transmission needs might differ, perhaps significantly, in the absence of nuclear plants, we do not consider changes in transmission investment levels as costs in this report.<sup>8</sup>

### C. IMPACT ON ECONOMIC OUTPUT

New York’s nuclear plants contribute \$2.47 billion to annual state GDP and \$3.77 billion to gross output, largely through the electricity price effects shown above. These figures include both direct and secondary economic activity attributable to New York nuclear plants, net of the economic activity associated with alternative generating capacity that would be necessary in their absence. The economic sectors most affected are shown in Table 6. The largest effects are found in the manufacturing, real estate, and construction sectors.

<sup>6</sup> This analysis shows the impact that nuclear plants have on the overall average NYISO energy price. The prices shown are the estimated 10 year average across the entire NYISO system, rather than at any particular location. Due to transmission constraints and differences in generation mix, upstate locations typically experience significantly lower energy prices, and New York City and Long Island typically have higher prices.”

<sup>7</sup> For example, the economic and jobs effects could be up to twice the values shown here if gas prices were to return to levels seen just a few years ago.

<sup>8</sup> These transmission costs, are not captured here because the contribution of nuclear plants to the economy is measured by comparing scenarios with and without nuclear plants – the costs of transition to other generation sources do not enter this comparison. Transmission costs could, however, be substantial if a premature transition to natural gas occurred.

**Table 6: Net Economic Output Impacts by Sector in New York  
(Average Annual Direct and Secondary Impacts, 2015-2024)**

Sector	Direct and Secondary Output <i>(millions of 2015 dollars)</i>
Manufacturing	650.3
Real Estate and Rental and Leasing	553.6
Construction	451.2
Finance and Insurance	419.3
Retail Trade	269.2
Health Care and Social Assistance	249.2
Professional, Scientific, and Technical Services	229.4
Accommodation and Food Services	215.6
Information	200.2
Wholesale Trade	163.9
Other	373.2
Total	3,775

Note: Numbers may not sum due to rounding.

#### **D. IMPACT ON EMPLOYMENT**

New York’s nuclear plants account for about 18,000 direct and secondary jobs in the New York economy, as shown in Table 4. The employment sectors most influenced are sales, business and financial occupations, and food service as shown in Table 7. As with the economic impact, the jobs impact occurs mostly indirectly; not as employment within the nuclear sector itself, but as enhanced employment in other sectors primarily caused by the economic effect of lower power prices.

**Table 7: Net Employment Impacts by Sector in New York  
(Average Direct and Secondary Impacts, 2015-2024)**

Sector	Direct and Secondary Employment <i>(jobs)</i>
Sales and related, office and administrative support occupations	4,820
Management, business, and financial occupations	1,750
Food preparation and serving related occupations	1,750
Construction and extraction occupations	1,630
Building and grounds cleaning and maintenance, personal care and service occupations	1,420
Healthcare occupations	1,380
Transportation and material moving occupations	1,010
Education, training, and library occupations	850
Production occupations	820
Installation, maintenance, and repair occupations	780
Other	1,780
Total	18,000

Note: Numbers may not sum due to rounding.

## E. IMPACT ON FEDERAL AND STATE TAX REVENUES

New York’s nuclear plants and the businesses providing goods and services to these plants pay substantial federal and state taxes. In addition, since these plants avoid higher electricity prices, they create incremental economic output and associated tax revenues. Average incremental annual federal tax payments attributable to the plants total \$452 million, and average annual state tax payments total \$113 million.

**Table 8: Net Annual Federal and State Tax Payments Attributable to  
Economic Activity Related to the New York Nuclear Plants**

	Average Annual (2015-2024)
Direct and Secondary State Tax Revenues <i>(2015 dollars)</i>	\$113.3 million
Direct and Secondary Federal Tax Revenues <i>(2015 dollars)</i>	\$452.0 million
Total Federal and State Tax Revenues <i>(2015 dollars)</i>	\$565.3 million

## F. NEW YORK NUCLEAR PLANTS PREVENT SUBSTANTIAL CARBON DIOXIDE AND CRITERIA POLLUTANT EMISSIONS

New York’s nuclear power plants prevent substantial emissions of CO<sub>2</sub>, SO<sub>2</sub>, and NO<sub>x</sub> compared to the alternative of natural gas and coal-fired generation. Average annual CO<sub>2</sub> emissions would be about 26 million tons higher absent the generation from New York nuclear plants. This represents a substantial percentage increase over current power sector emissions in NYISO. Similarly, power sector SO<sub>2</sub> emissions would be over 6,000 tons higher, and NO<sub>x</sub> emissions would be over 22,000 tons greater – about a 7% and 35% increase in NYISO, respectively. Particulate matter emissions (such as PM-2.5 and PM-10) would be approximately 30% and 27% higher in NYISO. These reductions are summarized in Table 9. Note that the beneficiaries of these reductions are not necessarily located in New York. CO<sub>2</sub>, for example, is a global pollutant. The higher fossil generation and associated criteria pollutant emissions originating in New York can be transported beyond the point of emissions into other states.

**Table 9: Emissions Prevented by New York Nuclear Plants  
(Average Annual, 2015-2024)**

Pollutant	Avoided emissions ( <i>tons</i> )
CO <sub>2</sub>	25,922,979
SO <sub>2</sub>	6,376
NO <sub>x</sub>	22,429
PM 2.5	1,796
PM 10	1,981

The social cost of these emissions can be estimated using the federal government’s social cost of CO<sub>2</sub> emissions (\$43.31/ton) and the National Academy of Science’s externality estimates for SO<sub>2</sub>, NO<sub>x</sub>, PM-2.5, and PM-10. Evaluated at these rates as shown in Table 10, the avoided social cost of CO<sub>2</sub> is \$1,123 million, and the avoided costs of SO<sub>2</sub> and NO<sub>x</sub> are \$43 million and \$42 million, respectively. The avoided costs of particulate matter emissions are approximately \$20 million. These costs reflect environmental and human health damages and are independent of and in addition to the direct and secondary economic impacts addressed elsewhere in this report. They reflect costs incurred by society, not directly by the economy; the subsequent economic implications of these social costs are not reflected in the economic results above.

**Table 10: Value of Emissions Prevented by New York Nuclear Power Plants  
(Average Annual, 2015-2024)**

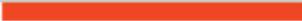
Pollutant	Avoided emissions (thousands of tons)	Emissions social cost per ton (\$/ton)	Avoided emissions value (millions of 2015 dollars)
CO <sub>2</sub>	25,923	\$43	\$1,123
SO <sub>2</sub>	6	\$6,789	\$43
NO <sub>x</sub>	22	\$1,873	\$42
PM 2.5	2	\$11,119	\$20
PM 10	2	\$538	\$1

Sources:

Carbon costs come from the Interagency Working Group on Social Cost of Carbon, United States Government.

SO<sub>2</sub>, NO<sub>x</sub>, PM-2.5, and PM-10 costs come from "Hidden Cost of Energy: Unpriced Consequences of Energy Production and Use" by the National Research Council.

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