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

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## PREPARED FOR

New York State IBEW Utility Labor Council

Rochester Building and Construction Trades Council

Central and Northern New York Building and Construction Trades Council


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## I. Executive Summary

At the request of the New York State IBEW Utility Labor Council, the Rochester Building and Construction Trades Council and the Central and Northern New York Building and Construction Trades Council, The Brattle Group has estimated the value of the nuclear plants located in Upstate New York (Ginna Nuclear Generating Station in Wayne County and FitzPatrick Nuclear Power Plant and Nine Mile Point Nuclear Generating Station in Oswego County) to the state's economy.<sup>1</sup>

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

- **contribute approximately \$3.16 billion to state gross domestic product (GDP)** (\$5.25 billion in gross output).
- **account for about 24,800 in-state full time jobs** (direct and secondary).
- **help keep electricity prices lower than they would otherwise be** – New York consumers would pay over \$1.7 billion annually (2015\$) and almost \$15 billion in the next ten years (on a present value basis) absent the Upstate nuclear plants.
- **are responsible for \$144 million in net state tax revenues** annually, including more than \$60 million in annual state and local property taxes.
- **avoid almost 16 million tons of CO<sub>2</sub> emissions** annually, that equates to a societal value of almost \$700 million annually based on federal estimates.

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 these nuclear plants. This approach nets off the contribution of the alternative generation that would be necessary if these nuclear plants did not exist, to determine their incremental contribution. Absent the nuclear energy from its Upstate plants, 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 overall incremental economic impact of these nuclear plants. 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.

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<sup>1</sup> The analysis described in this paper is an extension and refinement of a previous study that looked at the economic value of all the nuclear generators in New York. That study was done in conjunction with a nationwide study of the economic impact of the U.S. nuclear industry, and several other state-specific studies. The current study examines a subset of New York's nuclear plants, and also updates and refines the characterization of electricity markets to more closely reflect the specific features of New York's electricity markets.

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

## II. Background

Three nuclear plants, Fitzpatrick, Ginna, and Nine Mile Point comprising four nuclear reactors, operate in Upstate New York. These plants represent over 3,300 megawatts (MW) of capacity and almost 26 million megawatt hours (MWh) of annual electricity generation, as shown in Table 1 and illustrated in Figure 1.<sup>2</sup> New York is almost entirely served by the New York Independent System Operator, NYISO.<sup>3</sup> Upstate New York’s nuclear generation makes up 7% of NYISO’s total capacity and 15% of the state’s electricity generation, as shown in Table 2.

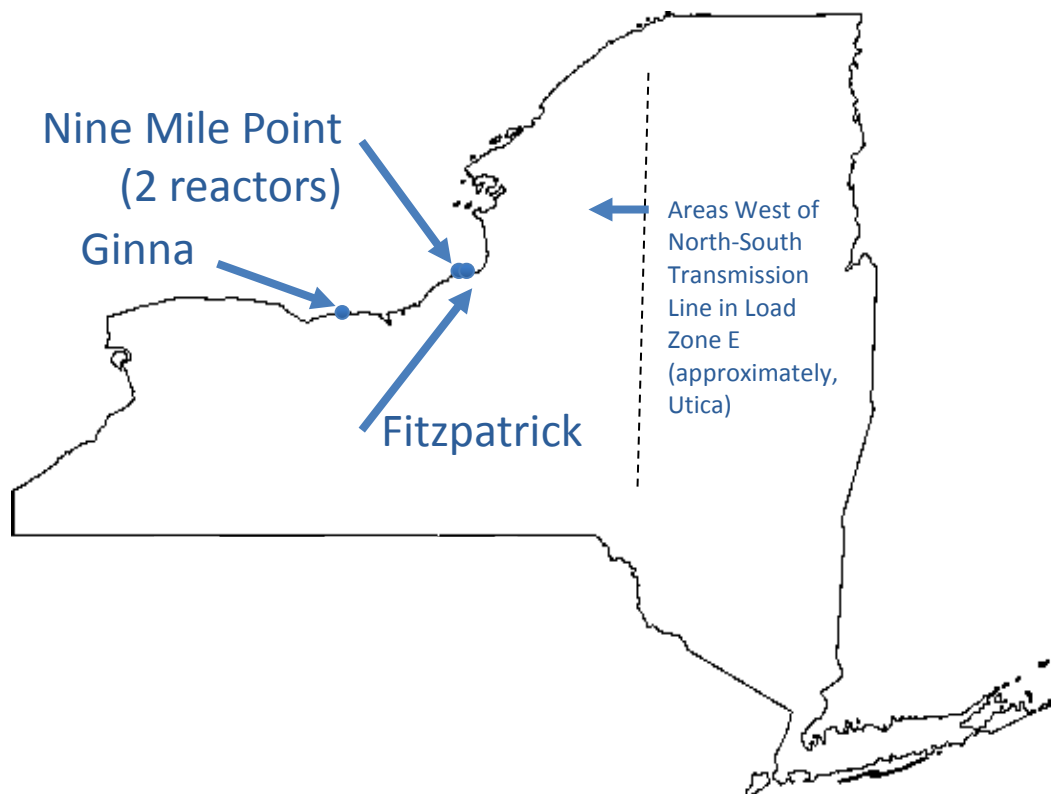
**Table 1: Summary of Nuclear Generation in Upstate New York**

Variable	Value
[1] Number of nuclear plants	3
[2] Number of nuclear reactors	4
[3] Total capacity (MW)	3,345
[4] Estimated generation (MWh)	25,730,400

<sup>2</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>3</sup> Independent system operators (ISOs) establish and maintain electricity capacity and energy markets.

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



**Table 2: Upstate New York Nuclear Power Share of Capacity and Generation in the NYISO**

Region	Upstate New York nuclear share of NYISO capacity	Upstate New York nuclear share of NYISO generation
[1] New York	7%	15%

Upstate New York’s nuclear plants account for 61% of carbon-free generation and 42% of carbon-free capacity in upstate New York defined as the region west of the North-South Transmission Line in Load Zone E in the State.<sup>4</sup>

<sup>4</sup> Carbon free as it is used here includes nuclear, hydro, wind, and solar powered plants. The region is essentially the State west of Utica.

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

We have estimated the economic value of the Upstate New York nuclear plants to New York's economy 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>5</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 Upstate New York nuclear plants 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 the Upstate New York nuclear plants would require a regional or national 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>6</sup>

This analysis indicates that the Upstate New York nuclear plants make a significant contribution to keeping New York's average 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, the Upstate New York nuclear plants are responsible for substantial economic output and accompanying employment and tax revenues. Table 3 summarizes our findings for the impacts within New York (not including the impact outside the state).

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<sup>5</sup> For more details on the REMI model, see [www.remi.com](http://www.remi.com).

<sup>6</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 across the country, and thus state impacts are influenced not only by plants located within a given state, but also by plants located in other states. The economic impacts presented in this report are limited to only the contributions of the Upstate New York nuclear plants. Also note that a previous report examined all the New York nuclear plants ("New York Nuclear Power Plants' Contribution to the State Economy," September 2015), rather than just the Upstate plants. In order to better reflect the impact of the specific Upstate nuclear plants on the NYISO power system and thus the state economy, the analysis here is more tailored to NYISO markets, and particularly the features of the NYISO capacity market and capacity demand curve, than the analyses that supported the national and the previous New York report.



**Table 3: Net Contribution of Upstate New York’s Nuclear Plants to the New York Economy**

	Average Annual (2015-2024)
Direct and Secondary Employment (jobs)	24,800
Direct - Plant	2,305
Direct - Outages	352
Secondary	22,143
Direct and Secondary Output (2015 dollars)	\$5.25 billion
Direct and Secondary GDP (2015 dollars)	\$3.16 billion
Direct and Secondary State Tax Revenues (2015 dollars)	\$144.5 million
Direct and Secondary Federal Tax Revenues (2015 dollars)	\$576.4 million

Upstate New York’s nuclear plants contribute \$3.16 billion to the state’s GDP, and account for about 24,800 direct and secondary jobs.<sup>7</sup> The Upstate 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 Upstate nuclear plants’ incremental contributions to state output account for additional tax revenues. The Upstate plants’ effect on the economy leads to about \$144 million in additional state tax revenues and \$576 million in federal tax revenues, beyond what would be provided by the alternative electric supply that would be utilized in their absence.

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

- The electricity generation mix
- The cost of electricity

<sup>7</sup> We report both GDP and gross output since both are useful economic statistics in Table 3. 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.

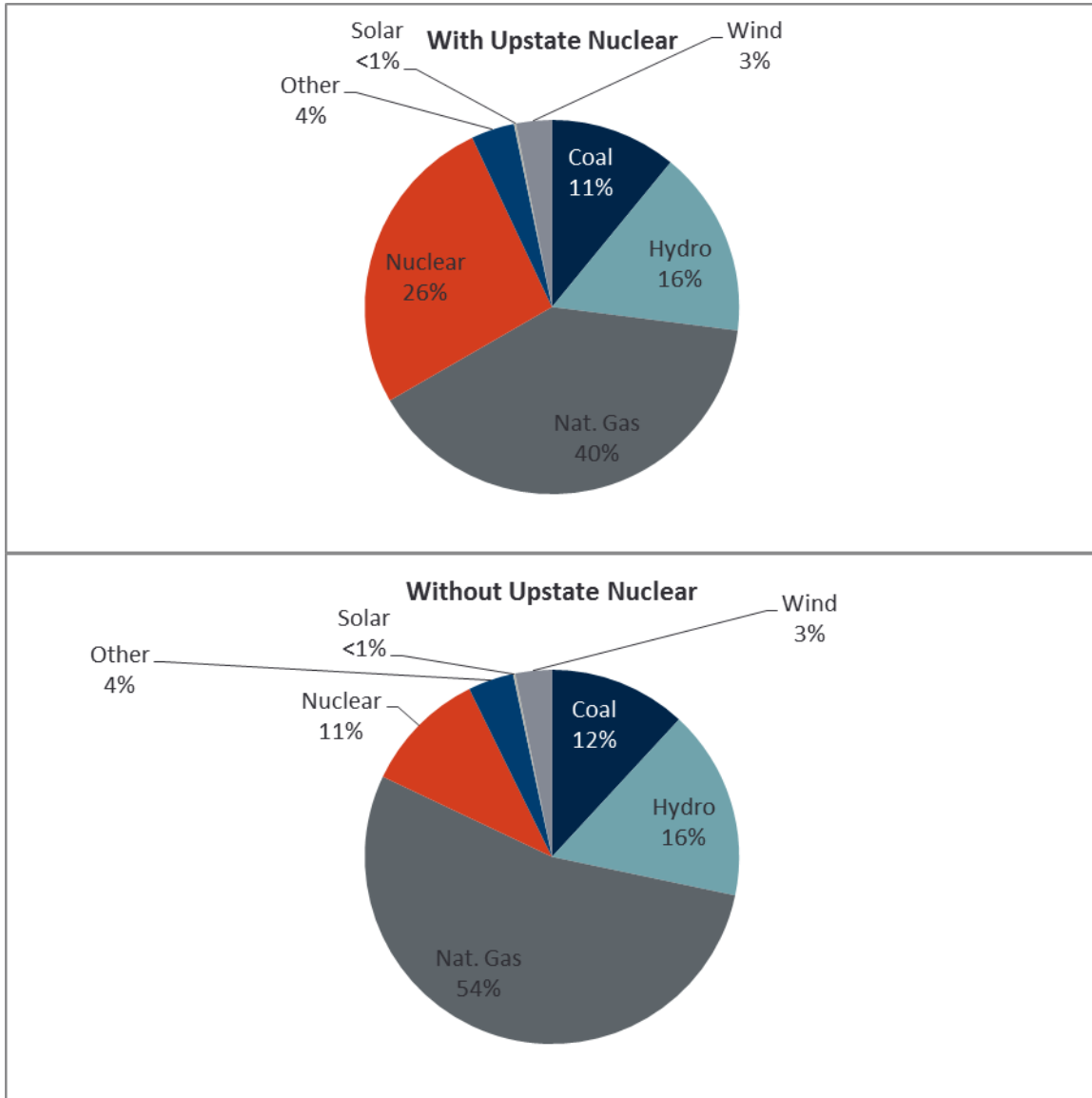
- Economic output and GDP
- Employment (direct and secondary)
- Federal and state tax revenues

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 the Upstate New York 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 54%. 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**

The Upstate nuclear plants' impact on the New York economy is primarily the result of their influence on electricity prices. As noted above, absent these nuclear plants, electricity demand would be met by increased utilization of natural gas-fired plants. This alternative generation mix would mean higher average electricity prices in New York, driven in part by energy market effects, but perhaps more importantly by the effect on NYISO capacity markets.<sup>8</sup> As shown in

<sup>8</sup> To estimate the effect on capacity market prices, we utilized the slope of the NYISO capacity demand curve for the New York Control Area (NYCA). The loss of the Upstate nuclear capacity would

Table 4, average electricity prices in New York would increase by about \$10/MWh on a wholesale basis. New York consumers will spend over \$1.7 billion more annually on electricity absent the Upstate nuclear plants. Between 2015 and 2024 they will spend almost \$15 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 4: Upstate New York Nuclear Plants Avoid Higher Electricity Prices (Average Statewide all-in Wholesale Electricity Prices with and without Upstate Nuclear, Average Annual \$/MWh, 2015-2024)<sup>9</sup>**

Region	State average	State average	State average	Electricity consumption (millions of MWh)	Total annual electricity cost change (millions of 2015 dollars)	Total electricity cost increase 2015-2024 (millions of dollars) <sup>1</sup>
	wholesale price with nuclear	wholesale price without Upstate nuclear	wholesale price change			
[1] New York	\$55.21	\$65.52	\$10.31	166	\$1,706	\$14,550

<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 New York, as with most U.S. regions.<sup>10</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>11</sup>

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increase the NYCA capacity price, which would effectively increase the price in the upstate zones, but would leave prices in the other zones mostly unaffected, since their capacity prices are already well above the NYCA price. The price effect shown in Table 4 is the average effect across the NYISO.

- <sup>9</sup> This analysis shows the impact that the Upstate nuclear plants have on the all-in average NYISO electricity price, including both energy and capacity components. 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 have historically experienced significantly lower electricity prices, and New York City and Long Island have had higher prices. The loss of the Upstate nuclear plants would cause Upstate prices in particular to rise.
- <sup>10</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, since these nuclear plants partially shield consumers and businesses from the effect of high gas prices that can push up electricity prices.
- <sup>11</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 the

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### C. IMPACT ON ECONOMIC OUTPUT

The Upstate nuclear plants contribute \$3.16 billion to annual state GDP and \$5.25 billion to gross output, largely through the electricity price effects shown above. These figures include both direct and secondary economic activity attributable to the Upstate 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 5. The largest effects are found in the manufacturing, construction, and real estate sectors.

**Table 5: 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	\$773
Construction	\$710
Real Estate and Rental and Leasing	\$664
Finance and Insurance	\$473
Retail Trade	\$369
Health Care and Social Assistance	\$319
Accommodation and Food Services	\$298
Professional, Scientific, and Technical Services	\$291
Information	\$238
Wholesale Trade	\$211
Other	\$902
Total	\$5,249

Note: Numbers may not sum due to rounding.

### D. IMPACT ON EMPLOYMENT

The Upstate nuclear plants account for about 24,800 direct and secondary jobs in the New York economy, as shown in Table 3. Direct jobs include those positions necessary for plant operations such as engineers and technicians as well as security and administration. Direct jobs are also defined to include positions necessary to make necessary fuel changes, plant repairs, and

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transition to other generation sources do not enter this comparison. Transmission costs could, however, be substantial if a premature transition to natural gas occurred.

improvements that are completed during scheduled outages. Between the three upstate nuclear plants, there are, on average, two refueling outages per year. Performing the necessary work in the outage requires upwards of 1000 supplemental workers, which creates an additional 352 full time equivalent positions in New York, largely from the local trade unions. These workers include welders, electrician, and other high skill occupations.

In addition to the direct workers, the three plants generate secondary employment in industries that provide goods and services to the plants. In addition, plant employees support secondary employment through their purchase of goods and services. As shown in Table 6, the employment sectors most influenced are sales, construction, and food service.

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 6: 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	6,390
Construction and extraction occupations	2,660
Food preparation and serving related occupations	2,480
Management, business, and financial occupations	2,370
Building and grounds cleaning and maintenance, personal care and service occupations	2,040
Healthcare occupations	1,710
Transportation and material moving occupations	1,380
Education, training, and library occupations	1,290
Installation, maintenance, and repair occupations	1,120
Production occupations	1,010
Other	2,360
<b>Total</b>	<b>24,800</b>

Note: Numbers may not sum due to rounding.

## **E. IMPACT ON FEDERAL AND STATE TAX REVENUES**

New York’s Upstate 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. As shown in Table 7, average incremental annual federal tax payments attributable to the plants

total \$576 million, and average annual state tax payments total \$144 million. The plants report annual state and local property taxes of \$59 million.

**Table 7: Net Annual Federal and State Tax Payments Attributable to Economic Activity Related to Upstate New York Nuclear Plants**

	Average Annual (2015-2024)
Direct and Secondary State Tax Revenues (2015 dollars)	\$144.5 million
Direct and Secondary Federal Tax Revenues (2015 dollars)	\$576.4 million
<b>Total Federal and State Tax Revenues (2015 dollars)</b>	<b>\$720.9 million</b>

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

The Upstate 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 almost 16 million tons higher absent the generation from the Upstate nuclear plants. This represents a substantial increase over current power sector emissions in NYISO – about 27%. Similarly, power sector SO<sub>2</sub> emissions would be over 3,000 tons higher, and NO<sub>x</sub> emissions would be over 13,000 tons greater – about a 4% and 21% increase in NYISO, respectively. Particulate matter emissions (such as PM-2.5 and PM-10) would be approximately 18% and 16% higher in NYISO. These effects are summarized in Table 8. Note that the beneficiaries of these avoided emissions are not necessarily all located in New York. CO<sub>2</sub>, for example, is a global pollutant, and 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 8: Emissions Prevented by Upstate New York’s Nuclear Plants (Average Annual, 2015-2024)**

Pollutant	Avoided emissions (tons)
CO <sub>2</sub>	15,577,982
SO <sub>2</sub>	3,418
NO <sub>x</sub>	13,353
PM 2.5	1,075
PM 10	1,179

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 9, the avoided social cost of CO<sub>2</sub> is \$675 million, and the avoided costs of SO<sub>2</sub> and NO<sub>x</sub> are \$23 million and \$25 million, respectively. The avoided costs of particulate matter emissions are approximately \$13 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 9: Value of Emissions Prevented by Upstate 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>	15,578	\$43	\$675
SO <sub>2</sub>	3	\$6,789	\$23
NO <sub>x</sub>	13	\$1,873	\$25
PM 2.5	1	\$11,119	\$12
PM 10	1	\$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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