POTOMAC ECONOMICS

# Memorandum

**TO:** NYISO Board of Directors

**FROM:** David B. Patton and Pallas LeeVanSchaick

**DATE:** November 8, 2018

**RE:** Estimating Capacity Benefits of the AC Transmission Public Policy Projects

## A. Introduction

In the second quarter of 2018, the MMU reviewed the ISO's AC Transmission Public Policy Report and published a report ("MMU Report") evaluating the costs and economic value of the recommended projects (T027/29).[1] The MMU's Report examined the estimated costs and benefits of the projects, including:

- production cost savings;
- environmental benefits;
- capacity market benefits; and
- avoided maintenance and refurbishment costs for existing transmission that would be replaced by the new projects.

We found that the capacity market benefits can be quite large when transmission enhancements reduce the need for generating capacity in constrained localities. After the NYISO Board of Directors reopened the selection of projects, NYISO staff requested that the MMU:

a) Compare the capacity benefits for the recommended projects to an alternative pair of projects (T027/19), and
b) Comment on the methodology and results of the NYISO's estimates of the capacity benefits.

The next section of this memo addresses both requests. Appendix A summarizes the original benefit-cost assessment for the Recommended Projects that was provided in the MMU Report. Appendix B provides additional detail about the MMU's method for estimating the capacity benefits of transmission and the results for the Recommended and Alternative Projects.

[1] See https://www.potomaceconomics.com/wp-content/uploads/2018/06/MMU-Report-on-AC-TX-Projects.pdf

## B. Comparison of Methods for Estimating Capacity Market Benefits

The estimates of capacity market benefits produced by the MMU and the NYISO differ substantially, but these differences are not driven by fundamentally divergent perspectives about the nature of capacity market benefits. Rather, we conclude that the differences are explained primarily by assumptions related to the locations and quantities of new entry and retirement over the coming decade and how these will affect transmission flows and the locations of network bottlenecks. This section discusses the different methodologies and key factors driving the different estimates.

The following table summarizes the net present value of capacity market benefits of the Recommended Projects (T027/29) and Alternative Projects (T027/19) over the first 20 years of project life.[2] The table shows the MMU's estimates based on the Baseline Scenario and the CES + Retirement Scenario from the NYISO's AC Tx Study. It also shows the NYISO's estimates using the LCR Optimizer model.

| (in millions) | MMU w/Baseline Scenario | MMU w/CES+Retire Scenario | NYISO Optimizer |
|---|---|---|---|
| **Recommended Projects** | $218 | $523 | $584 to $816 |
| **Alternative Projects** | $237 | $592 | $744 to $1,040 |
| **Differential** | $19 | $69 | $160 to $224 |

Given the wide variation in estimated benefits, we evaluated key factors that differed among the three estimates. First, the methodologies for quantifying the benefits are slightly different. The two MMU estimates combine:

a) the investment cost savings from reduced need to build and maintain generating capacity, and
b) the value of improved reliability.

The improved reliability is quantified based on compensation generators would receive in the capacity market for providing reliability benefits comparable to the transmission project. In contrast, the NYISO's Optimizer calculates the estimated reduction in capacity payments by consumers from each project.[3] *We found this difference in methodology accounted for a small amount of the difference.*

The most important factor that explains the difference in capacity benefits is the assumed changes in supply that affect the transmission flows and bottlenecks in New York. The two

[2] The Appendices of this memo and the MMU Report assume a 45-year project life, but this memo provides estimates based on a 20-year life for easier comparison to the NYISO's estimates.

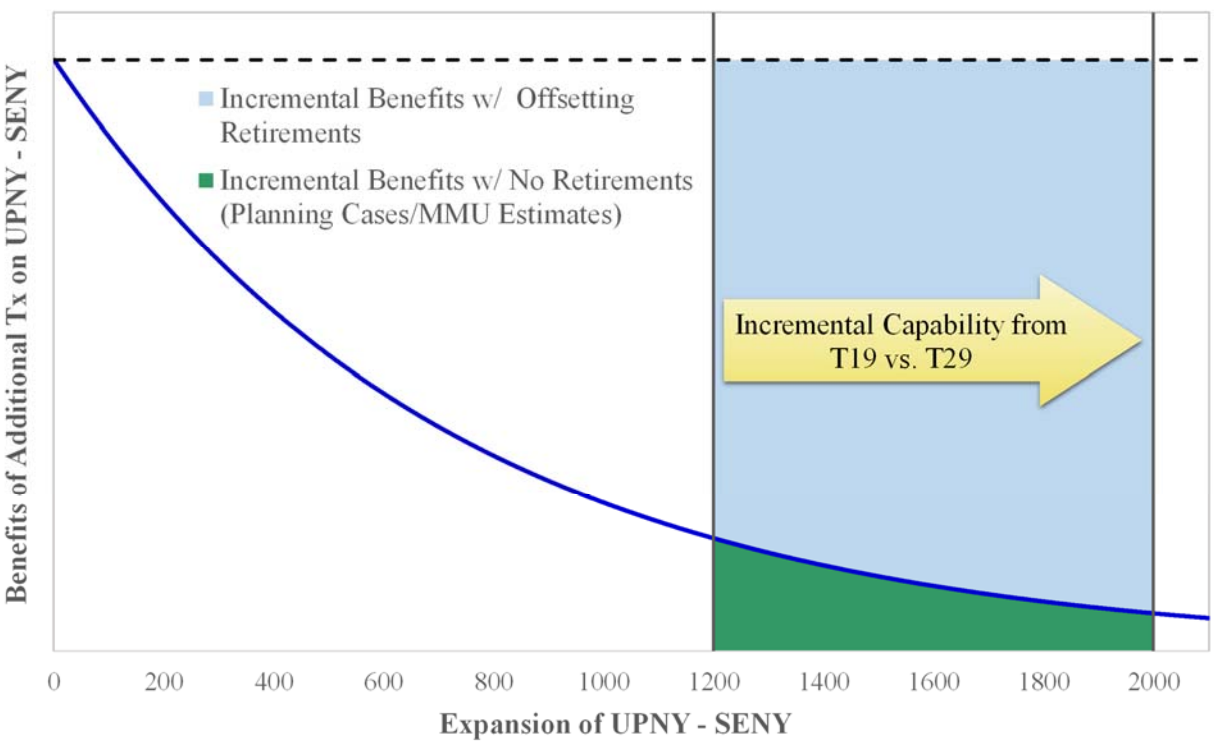
[3] Appendix A provides additional details about the MMU's method of estimating capacity benefits.

MMU estimates were based on planning cases from NYISO's AC Transmission Study the assume capacity additions and retirements that cause the UPNY-ConEd interface to be the primary transmission bottleneck, and the UPNY-SENY interface to not be a substantial bottleneck. Alternatively, the assumed supply changes under the NYISO's Optimizer leads the primary transmission bottleneck to be the UPNY-SENY interface, even after the AC Tx Projects are built. Since the two projects vary mainly in their effects on the UPNY-SENY interface, *the difference in supply assumptions is the primary factor explaining the wide variation in estimates.*

## C. Assumed Changes in Supply and Transmission Bottlenecks

As a transmission constraint is relieved, the incremental benefits of further relief falls. This reduction is depicted illustratively in the Figure 1 for the Recommended Projects and the Alternative Project. The Alternative Projects provide much more transfer capability than the Recommended Projects on the UPNY-SENY interface: 2,000 MW vs. 1,200 MW. The solid blue line in this figure represents the diminishing marginal benefit of increasing the interface capability. The shaded areas in this figure show the aggregate benefits of the additional 800 MW of transmission capability provided by the Alternative Projects. These areas vary based on the assumed supply changes (additions and retirements) in different scenarios, which is discussed later in this section.

**Figure 1: Incremental Benefits of Additional Capacity on the UPNY-SENY Interface**




As discussed in the prior section, the most important factor that determines the incremental benefits of expanding UPNY-SENY from 1200 MW to 2000 MW is the assumed changes in supply over time. At a high level, the changes that *increase* the incremental capacity benefits include:

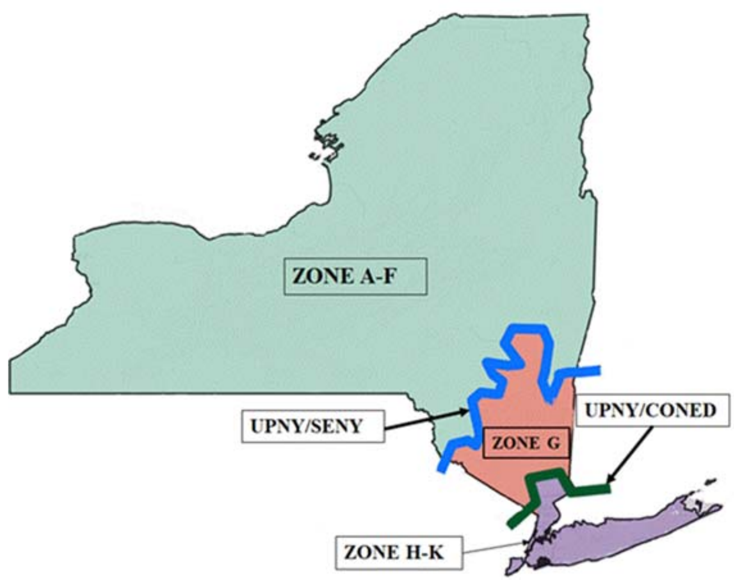
- ✓ Low-cost units entering North of UPNY-SENY; and
- ✓ Retirements South of UPNY-SENY (particularly in Zone G).

Alternatively, the changes that *decrease* the incremental capacity benefits include:

- ✓ New entry South of UPNY-SENY; and
- ✓ Retirements North of UPNY-SENY.

In the MMU results based on the AC Transmission planning cases, no retirements are assumed in Zone G, which is just south of UPNY-SENY. The current surplus capacity in SE NY tends to limit the benefits of continuing to expand this interface. The total benefits of the incremental 800 MW expansion of UPNY-SENY is illustrated in the green area. However, if one assumes large quantities of retirements in Zone G and SE New York occur such that UPNY-SENY remains just as congested after the AC Transmission Projects are built as before, the incremental benefits of the additional 800 MW of transfer capability are much greater. These additional benefits are illustrated in the blue area in Figure 1. One of the key elements of this evaluation, therefore, is to project a reasonable quantity of retirements in Zone G.

Before discussion the alternative assumptions in different cases, it is also important to note the location and importance of UPNY-SENY versus the UPNY-ConEd interface. This map shows the location of these interfaces. In reality, when the UPNY-ConEd constraint binds and becomes a bottleneck in the dispatch, additional flows over the UPNY-SENY interface will be restricted. Neither project expands UPNY-ConEd substantially. This limits the capacity benefits of expanding UPNY-SENY. The Alternative Projects provide slightly more additional transfer capability on UPNY-ConEd than the Recommended Projects: 375 MW vs. 350 MW. The benefits of this additional 25 MW are included in the MMU benefit estimates.



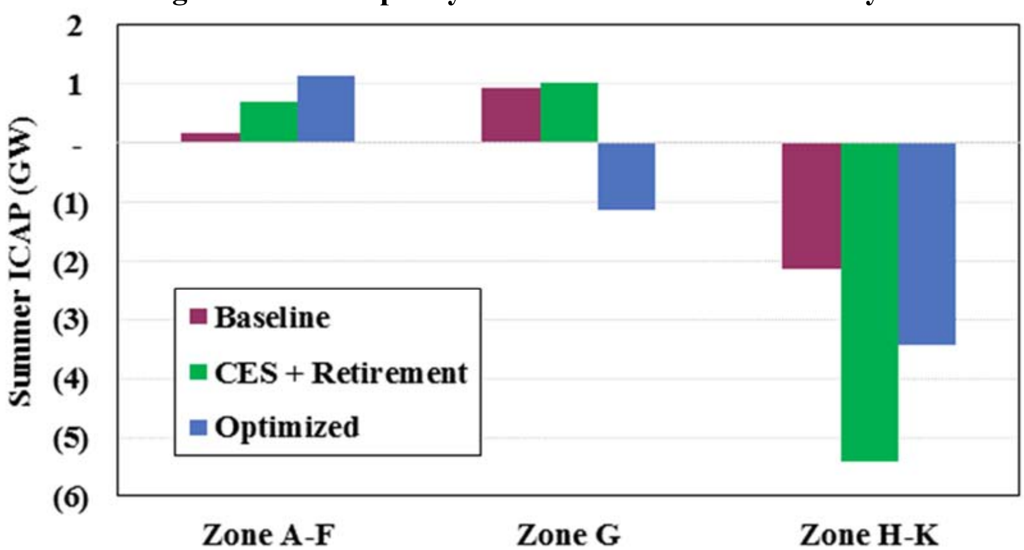

Additionally, the lack of substantial additional transfer capability over the UPNY-ConEd interface explains why the incremental capacity benefits are sensitive to where resources are assumed to retire in SE New York. Retirements in Zones H-K will tend to make the UPNY-ConEd interface more binding and limit the incremental benefits of expanding UPNY-SENY.

Retirements in Zone G, however, will not contribute to congestion on UPNY-ConEd and will maximize the benefits of expanding UPNY-SENY.

Hence, it is important to assess whether the assumptions about future additions and retirements are reasonable in each scenario. Figure 2 summarizes capacity additions and retirements that were assumed in each region of the state in each scenario (relative to the existing generation fleet in October 2018). The Baseline scenario assumes 1 GW of capacity additions in Zone G (Cricket Valley) and 2 GW of retirements in Zones H-K (Indian Point in Zone H). These baseline changes reduce flow across UPNY-SENY and increase flow across UPNY-ConEd, which limits the capacity benefits of the additional 800 MW of expanded capability on UPNY-SENY offered by the Alternative Projects.

The CES + Retirement Scenario includes the baseline changes, but also assumes sizable net capacity additions in Zones A to F (a large quantity of renewables partially offset by retirement of coal resources). It also assumes a large quantity of retirements in Zones J-K (peaking resources), which increases flow mainly across UPNY-ConEd. Although the upstate net additions increase the value of the UPNY-SENY interface, the retirements in Zones J-K cause a bottleneck on UPNY-ConEd that limit the increase in capacity benefits.

**Figure 2: Net Capacity Additions and Retirements by 2025**




In contrast, the Optimizer results assume even larger capacity additions in Zones A to F and more than 2 GW of incremental retirements in Zone G from the Baseline Scenario. This case also includes more than 1 GW of additional retirements in Zones J and K beyond the Baseline Scenario. These assumed supply changes substantially increase the projected transmission flows and congestion on the UPNY-SENY interface. This predictably leads to much higher capacity benefits of the additional 800 MW of transfer capability provided by the Alternative Projects over the UPNY-SENY interface.

A key takeaway from this analysis is that future retirements and additions will dictate where new transmission would be most valuable. In particular, large amounts of retirement in Zone G would make the AC Tx Projects much more valuable, but if retirements are more concentrated in downstate areas (i.e., Zones H-K), the capacity benefits from the new AC Tx Projects will be much lower.

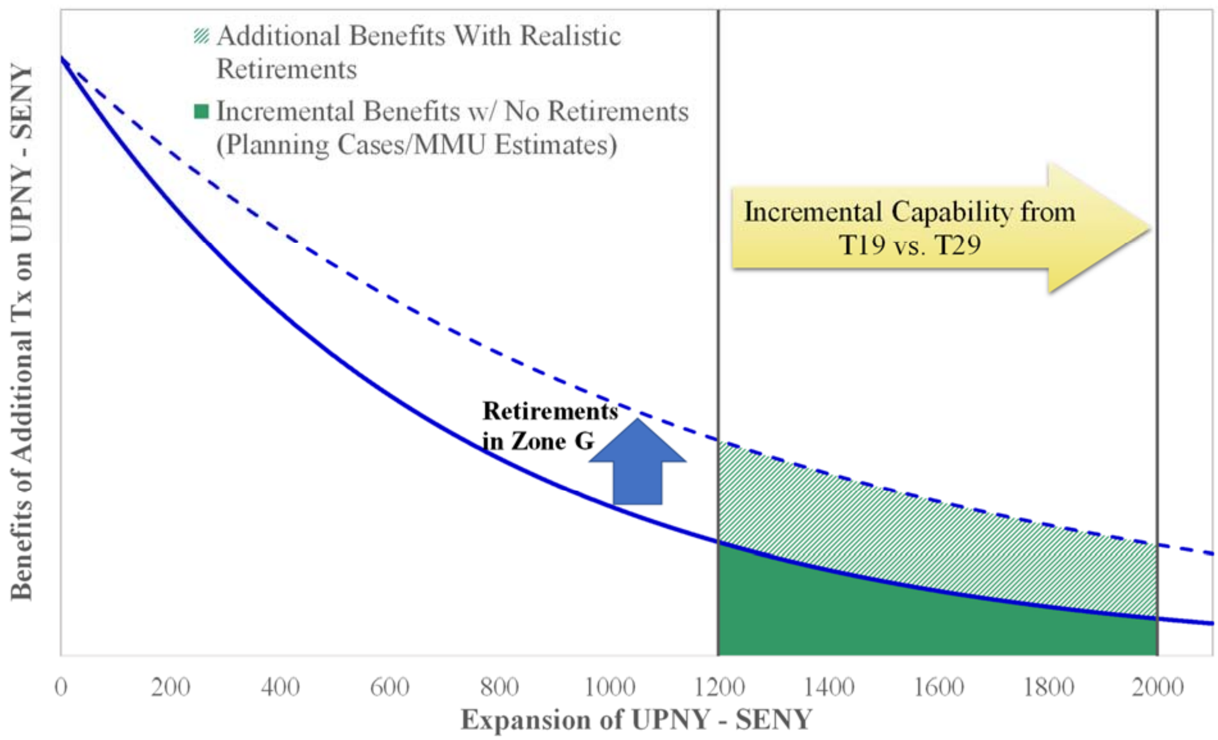
Given the current large capacity surplus, it is reasonable to expect significant retirements in the coming years, however, the location of those retirements will depend on state environmental policies and the economics of existing generation. We have considered these factors and find that none of the three scenarios that currently exist are realistic:

- The Baseline scenario's assumption of no retirements in Zone G after the entry of Cricket Valley is unrealistic because this would result in capacity prices that are substantially below the going forward costs of some of the existing generation in Zone G.
- The CES + Retirement scenario assumes no retirements in Zone G after the entry of Cricket Valley. This assumption is more reasonable in this scenario because the large amounts of assumed retirements in Zones J and K would raise statewide capacity prices and cause the resources in Zone G to be much more economic to continue operating. However, we believe these assumed policy-induced retirements in Zones J and K are unrealistic.
- The Optimizer results in 2 GW of generation retirements in Zone G. While the Optimizer is an improvement for determining the short-term locational demands for capacity (i.e., the LCRs), it is not designed to predict where retirements will occur over the longer run because it does not consider the going forward costs of the existing generation. For example, the Optimizer may indicate that the NYISO's LCRs in Zone G should be zero, but that does not mean that the resources in Zone G will retire because they may be economic to meet the statewide requirements if their going-forward costs are low.

We evaluation of the economics of capacity in New York after: a) Indian Point retires, b) AC Transmission is built, and c) state policies lead to retirements outside of Zone G (including 1 GW of coal generation in western New York and some of the older peaking units downstate). We find that these factors will support statewide capacity prices and make older Zone G generation more profitable. Based on these capacity price projections, we do not anticipate more than 1 GW of retirements in Zone G after the entry of the new Cricket Valley plant.

Without additional modeling, we cannot quantify the capacity market benefits that would result from the AC Transmission Projects under a "realistic" retirement scenario (e.g., assuming 1 GW of retirements in Zone G). However, we expect the answer would be substantially higher than the estimate for the Baseline scenario and substantially lower than the estimate produced by the NYISO's Optimizer. The effects of such a scenario are illustrated in Figure 3.

**Figure 3: Incremental Capacity Benefits under a Realistic Retirement Scenario**




The actual incremental capacity benefits will depend on a number of uncertain quantities, including the ultimate outcome of the State polices in Western New York, New York City, and Long Island. Additionally, the State has announced plans to build sizable amounts of off-shore wind resources that would interconnect in SE New York. This would place downward pressure on the incremental capacity benefits.

Taking all of these factors into account, we believe the most likely range of incremental capacity benefits offered by the Alternative Projects is $30 to $100 million.

## D. Conclusion

Capacity benefits are relatively uncertain because they depend on decisions over a long time horizon by participants and the State. Because of the uncertainty, it would be reasonable to give these benefits less weight in the selection then more certain costs and benefits.

Estimated capacity benefits employing the most likely or reasonable assumptions regarding retirements and additions have not been produced and would require significant additional work by NYISO planning staff. Nonetheless, we believe that the incremental capacity benefits of the Alternative Projects compared to the Recommended Projects will likely range between $30 to $100 million. If the State builds substantial offshore wind interconnecting to SE New York, the capacity benefits are likely to be on the lower side of this range.

In our initial report on the Recommended Projects, we evaluated a number of other significant factors that together determine whether the project is economic. These factors included:

- production cost savings;
- environmental benefits; and
- avoided maintenance and refurbishment costs for existing transmission that would be replaced by the new projects.

We have not evaluated these factors for the Alternative Projects. This evaluation could cause our final conclusions to vary for the Alternative Projects, which should be considered before a final selection is made.

## Appendix A: Summary of Benefit-Cost Assessment for the Recommended Transmission Projects

In the course of its evaluation, the NYISO analyzed the effects of proposed transmission projects on the system using an array of production cost, resource adequacy, and other models. We used these modeling results to quantify the benefits of proposed projects. Our evaluation is discussed further in the MMU Report on the AC Tx Projects.[1]

### 1. Categories of Benefits included in our Benefit-Cost Ratio

*Environmental Benefits* – Includes the value of $CO_2$ emissions abatement across New York, New England, Ontario, and PJM, assuming the New York state continues to participate in the Regional Greenhouse Gas Initiative ("RGGI").

*Production Cost Savings* – Includes reductions in fuel costs, variable O&M costs, and other production costs (excluding RGGI allowance costs) across the same region.

*Capacity Benefits*, which include both:

- *Generation Investment Cost Savings* – Includes the reduced cost of investment in generation needed to satisfy the minimum resource adequacy planning standard.
- *Reliability Benefits* – The capacity value of more reliable service (than the minimum resource adequacy standard of 1 day in 10 years) is best measured by how the projects affect the loss of load expectation ("LOLE"). We quantify this based on the compensation that a generator would receive in the capacity market for providing comparable LOLE benefits.[4]

*Avoided Costs from Replacement of Aging Equipment* – When new transmission equipment replaces existing equipment, there are two types of potential cost savings. First, there is an O&M cost reduction that helps offset the O&M costs of the new equipment. Second, if the existing equipment is at the end of its useful life and needs to be replaced or otherwise refurbished, it would require capital expenditures that are made unnecessary by the new equipment.

These categories above are included in a single benefit-cost ratio, which provides the best overall measure of the value of a project relative to costs.

Our review focuses on two scenarios that were evaluated by the NYISO:

- Baseline Case, which used assumptions from the 2017 CARIS study with several updates, reflects conditions that might be expected without significant public policy intervention by New York State; and

[4] Additional reliability benefits are embedded in the economic benefits because transmission reduces the cost of satisfying the system's real-time reliability needs.

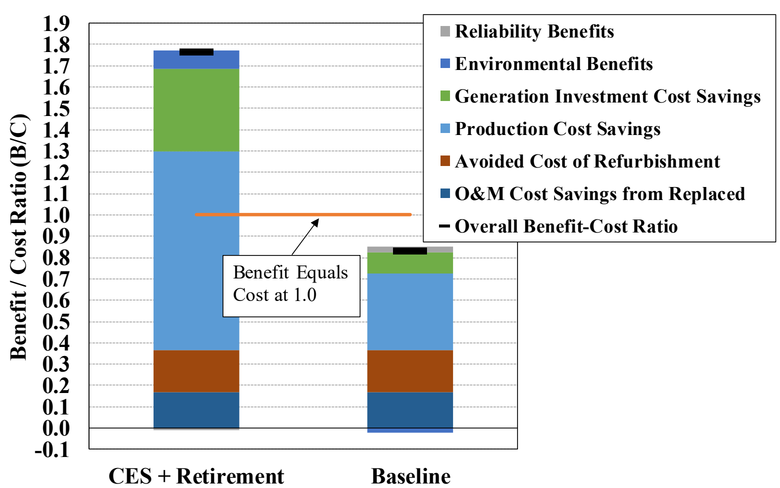
- CES+Retirement Scenario, which assumed that New York achieves the Clean Energy Standard ("CES") by constructing 16.2 GW of new renewable generating capacity and retiring all coal-fired generation and 3.5 GW of older peaking generation in downstate areas. This reflects conditions if the state moves forward with several initiatives to retire existing generation and achieves the CES with land-based wind and solar generation primarily in upstate areas.

### 2. Summary of the Benefit-Cost Assessment for the Recommended Projects

Figure 1 shows that based on the combined Environmental, Economic, and Reliability benefits, the overall Benefit-Cost Ratio is 0.83 in the Baseline Case and 1.77 in the CES+Retirement Scenario over a 45-year period. These estimates are based on a total cost of $1.77 billion, including:

- Overnight costs,
- Costs of associated local upgrades,
- Interest during construction and financing costs, and
- O&M costs over the 45-year period.

**Figure 1: Results for T027 and T029 Combination**




Thus, the recommended projects are unlikely to be cost-effective if significant changes in the resource mix do not occur because of key public policy initiatives.

There is considerable uncertainty regarding the benefits from the recommended transmission projects because the benefits would depend on where renewable resources are placed to satisfy the CES. The NYISO assumed that 14 GW of land-based wind and utility-scale solar additions would be made outside Southeast New York ("SENY") and that just 226 MW of offshore wind would be placed in downstate areas. However, after the NYISO's study was underway, NYSERDA announced plans to solicit 2.4 GW of offshore wind in downstate areas by 2030, including 800 MW in 2018 and 2019.

In general, increased offshore wind in downstate areas would reduce the need for renewables outside SENY to satisfy the CES, and ultimately reduce congestion into the downstate areas. Hence, the recent shift in the planned placement of renewable generation (from upstream to downstream of the projects) would make the AC Transmission Projects less beneficial.

## Appendix B: Comparison of Capacity Benefits for Recommended and Alternative Projects

### 1. Capacity Benefit Metric Methodology

*Generation Investment Cost Savings* – An important economic benefit from the proposed transmission projects is that they would reduce the need to build and/or maintain installed capacity to satisfy minimum planning criteria for resource adequacy and inter-zonal transmission security, particularly capacity in downstate areas where investment costs are generally higher. We estimate the investment cost savings from the recommended projects based on how they would affect the Compensatory MWs necessary to satisfy the resource adequacy standard (i.e., 0.1 LOLE). The following example illustrates how we calculated this type of economic benefit:

- Suppose that in the base case, 400 MW of Compensatory MWs would be needed in Zone J to maintain LOLE below 0.1 in particular year.
- In the project case, upstate capacity would be more deliverable to downstate loads, so assume that the LOLE could be maintained below 0.1 with Compensatory MWs of 300 MW in Zone C and 50 MW in Zone J.
- With these assumptions, and assuming net CONE values of $177 and $100/kW-year in Zones J and C, respectively, the net investment cost savings is calculated as follows:
    - ✓ Investment Cost Savings in Zone J in one year = $62 million = (400 MW – 50 MW) × Net CONE of $177/kW-year
    - ✓ Investment Cost Increase in Zone C in one year = $30 million = 300 MW × Net CONE of $100/kW-year
    - ✓ Net Investment Cost Savings in one year = $32 million = Investment Cost Savings in Zone J minus Investment Cost Increase in Zone C

*Reliability Benefits* – This metric captures the market value of more reliable service (i.e., more than the minimum resource adequacy standard requires). We estimate this based on how additional reliability is valued in the installed capacity market. These benefits are best measured by how the projects affect the loss of load expectation ("LOLE"). We quantify this based on the compensation that a generator would receive in the capacity market for providing comparable LOLE benefits.

We estimate the reliability benefits from the recommended projects to the extent that they improve the NYCA LOLE in each year of the study. The value of improved LOLE is consistent with the compensation that surplus generation resources in the capacity market receive that also improve the LOLE. Based on our evaluation of the capacity demand curves and locational capacity requirements for the 2018/19 Capability Year, we estimate that generating resources are paid $2.9 million per 0.001 change in the LOLE per year.

The following example illustrates how we calculated these benefits for the transmission projects.

- Assuming that:
  - ✓ In the base case for a particular year, the LOLE is 0.08 days per year;
  - ✓ In the project case for the same year, the LOLE is 0.06 days per year; and
  - ✓ The implied value of a 0.001 change in LOLE is $2.9 million.
- The annual reliability benefit = $58 million:
  - ✓ (0.08 – 0.06 days per year change in the LOLE) × $2.9 million per 0.001 change in LOLE annually.

The net present value of the Investment Cost Savings and Reliability Benefits are calculated over an assumed 45-year project life cycle, using the benefits from the last year of the evaluation period to estimate savings in years 21 to 45.

### 2. Results of Comparison between the Recommended Projects and Alternative Projects

For the Baseline Case, the estimated capacity market benefits were:

- $259 million for the Recommended Projects (T027/29) or 15 percent of the lifecycle cost of the projects.
- $290 million for the Alternative Projects (T027/19).[5]

For the CES+Retirement Case, the estimated capacity market benefits were:

- $716 million for the Recommended Projects (T027/29) or 40 percent of the lifecycle cost of the projects.
- $819 million for the Alternative Projects (T027/19).

Thus, the Alternative Projects would provide an estimated $31 to $103 million of additional capacity market benefits over a 45-year project life. The actual difference will depend on where additions and retirements occur in the future and how this affects the location of transmission bottlenecks. The low end of this range is based on the Baseline Case, which assumes there is no state policy to contract for new renewable generating capacity. The high end of this range is based on the CES+Retirement Case, which would satisfy the CES ("Clean Energy Standard") primarily with renewables in upstate New York. However, the NYPSC and NYSERDA have signaled their intention to rely more on offshore wind in downstate areas, which would reduce the value of the AC Transmission Projects.

[5] We did not estimate the lifecycle costs of the Alternative Projects.

The Alternative Projects provide larger capacity market benefits primarily because they would increase transfer capability from upstate New York into the ConEd service territory by 375 MW compared to 350 MW for the Recommended Projects. The Alternative Projects would also provide more additional transfer capability into Southeast New York than the Recommended Projects.

Our capacity benefit estimates rely on modeling results that were produced by the NYISO in the course of its evaluation. Consequently, our estimates of investment cost savings were based on scenarios where the future generation investments were not made in the most cost-effective areas (because these scenarios were designed for a different purpose). It is likely that the investment cost savings were over-estimated for the CES+Retirement Case by up to 15 percent because the NYISO's future generation investment scenarios relied on investment in New York City when more cost-effective opportunities were available in Long Island. On the other hand, it is likely that the investment cost savings were under-estimated for the Baseline Case by up to 25 percent because of where the NYISO's future generation investment scenarios assumed new resources would enter.