New Jersey Natural Gas

March 5, 2020

VIA EMAIL & FEDERAL EXPRESS OVERNIGHT DELIVERY

Honorable Robert Gordon, Commissioner
New Jersey Board of Public Utilities
44 South Clinton Avenue, 9th Floor
P.O. Box 350
Trenton, NJ 08625-0350

Re: In the Matter of the Petition of New Jersey Natural Gas Company for Approval to Implement an Infrastructure Investment Program ("IIP") and Associated Cost Recovery Mechanism Pursuant to N.J.S.A. 48:2-21 and N.J.A.C. 14:3-2A
BPU Docket No. GR19020278

Dear Commissioner Gordon:

Attached please find, on behalf of New Jersey Natural Gas Company, its Cost Benefit Analysis ("CBA") prepared by Gabel Associates, Inc. ("Gabel Associates") along with the Direct Pre-Filed Testimony of Isaac Gabel-Frank accompanied by his supporting workpapers in the above captioned matter. The modeling utilized by Gabel Associates to perform the CBAs is proprietary and subject to the terms and conditions of the Non-Disclosure Agreement in this proceeding. Please note that the CBA model and supporting workpapers are only being provided on a CD via Fedex to the parties on the enclosed service list.

Case Mgmt

Respectfully submitted,

Andrew K. Dembia
Andrew K. Dembia
Regulatory Affairs Counsel

C: Hon. Aida Camacho-Welch, Secretary
Service List (via e-mail and Federal Express) ✓

In the Matter of the Petition of New Jersey Natural Gas Company for Approval to Implement an Infrastructure Investment Program ("IIP") and Associated Cost Recovery Mechanism Pursuant to N.J.S.A. 48:2-21 and N.J.A.C. 14:3-2A
BPU Docket No. GR19020278

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BPU Docket No. GR19020278

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BPU Docket No. GR19020278

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STATE OF NEW JERSEY
BOARD OF PUBLIC UTILITIES

IN THE MATTER OF THE PETITION OF NEW JERSEY NATURAL GAS COMPANY TO IMPLEMENT AN INFRASTRUCTURE INVESTMENT PROGRAM ("IIP") AND ASSOCIATED RECOVERY MECHANISM PURSUANT TO N.J.S.A. 48:2-21 AND N.J.A.C. 14:3-2A
DOCKET NO. GR19020278

PRE-FILED DIRECT TESTIMONY AND EXHIBITS

OF

ISAAC GABEL-FRANK

ON BEHALF OF

NEW JERSEY NATURAL GAS COMPANY

March 4, 2020

TABLE OF CONTENTS

I. INTRODUCTION

Q. Please state your name and business address.

A. My name is Isaac Gabel-Frank and my business address is 417 Denison Street, Highland Park, New Jersey, 08904. I am presently employed as a Vice President at Gabel Associates, Inc., an energy, environmental, and public utility consulting firm.

Q. Please summarize your professional experience and educational background.

A. As a Vice President at Gabel Associates, Inc., I perform specialized economic, financial, tariff, regulatory, and marketplace analysis for various energy projects including energy efficiency, renewable energy, cogeneration, and traditional generation sources. This includes extensive experience using models that estimate economic impact on investment decisions. This comprehensive analysis takes into account all critical cost and benefit factors and is designed to quantify the economic outcome of customized projects to support investment decisions. Through this work, I also monitor the electricity, natural gas, and renewable markets and offer tailored insights in that regard. Since beginning work at Gabel Associates, Inc. in 2009, I have evaluated a myriad of projects for both public and private clients and assisted in the analysis, development, and implementation for all types of technologies and contractual arrangements. This includes the development of proprietary models that evaluate the viability of projects, as well as long-term forecasts based on market signals and industry knowledge.

I use my knowledge of wholesale electricity and natural gas markets, paired with my experience working with models that estimate economic impacts and retail tariffs to deliver in-depth analysis which are used to assess and undertake project investment decisions. I am also versed on regional transmission organizations ("RTOs") including the offering of energy efficiency, demand response, renewable, and traditional generation resources into the PJM market, and was a lead contributor in the development of a proprietary statistical model that computes the risk exposure of capacity resources within the PJM and ISO-New England footprints.

I received a BA in Economics, Political Science, and English Writing from the University of Pittsburgh.

Further work experience is detailed in my resume provided in the attached Exhibit IGF-IIP-1.

Q. Please describe your experience conducting cost benefit analyses in the context of natural gas and electric utility filings in New Jersey and other matters?

A. Since 2017, I have prepared or assisted in the development of nearly a dozen cost-benefit analyses for consideration by the New Jersey Board of Public Utilities ("BPU" or "Board"). This includes development of cost-benefit analysis for Atlantic City Electric Company ("ACE"), Elizabethtown Gas Company ("Etown"), New Jersey Natural Gas Company ("NJNG" or "Company"), Public Service Electric & Gas Company ("PSE&G"), South Jersey Gas Company ("SJG"), and Ørsted.

I have also completed numerous cost-benefit analyses on energy projects for U.S. federal agencies, as a well as a multitude of counties, municipalities, and school districts within the State of New Jersey. This includes analysis and modeling of impacts on the State of economic factors that would occur as the result of local investments and expenditures.

The projects I have analyzed range in type and size and represent an array of different technologies and configurations. Having performed this analysis for projects with varying degrees of complexity, I am extremely familiar with the process and methodology to formulate an objective and balanced cost-benefit study.

II. PURPOSE OF TESTIMONY

Q. Please describe the purpose of this testimony.

A. The purpose of this testimony is to present the methodology and results of the cost-benefit analysis conducted to determine the cost-effectiveness of NJNG's Infrastructure

Investment Program ("IIP") filing. The assumptions, methodology, and findings of the cost-benefit analysis are also discussed and presented in the *Infrastructure Improvement Program Cost-Benefit Analysis* ("Report") which I prepared for NJNG, which is included as Exhibit IGF-IIP-2.

Q. Was this report and analysis conducted by you and/or under your direct supervision?

A. Yes.

Q. Did you conduct a cost-benefit analysis of the proposed New Jersey Natural Gas Company Infrastructure Investment Program?

A. Yes. I prepared the cost-benefit analysis (Exhibit IGF-IIP-2 attached hereto), with the help of others under my supervision, which calculates and evaluates the cost-effectiveness of the Company's proposed IIP overall, as well as each of the individual projects which comprise the proposed IIP. However, given the unique nature of the proposed projects which are primarily intended to improve reliability/resiliency, instead of conducting a 'traditional' cost-benefit analysis measuring the net present value of benefits and costs, I relied on a 'break-even' approach to determine the number of outage days that would need to be avoided for the benefits of these projects to meet or exceed the costs. I will expand more on the details of this approach later in this testimony, but a break-even analysis is a much better suited method of determining cost-effectiveness for projects that seek to avoid or reduce the duration of outages caused by extreme, typically weather-related events. This approach is also easier to interpret because it does not require that the Board attempt to forecast specific extreme events and future outages which are, by their nature, very difficult to predict with specificity.

III. SUMMARY OF CONCLUSIONS

Q. Please summarize your conclusions.

A. Based on a careful calculation of costs and benefits (as detailed in this testimony and attached exhibits), I determined that the Company's proposed IIP would be cost-effective after only 6.2 outage days are avoided by the projects over the lifetime of the projects. That equates to approximately 0.17 outage days per year over a 37-year period (which is the weighted-average useful life of all the projects contained in the proposed IIP).

Q. How should this conclusion be interpreted?

A. The finding that there is a break-even point of 6.2 avoided outage days over the useful life for the projects for the projects to be cost-effective provides the Board with a reference point against which to compare the reasonableness of the Company's proposed IIP. The projects contained in the proposed IIP are estimated to have a weighted-average useful life of 37 years. That means that on average, the projects will provide service to customers 37 years into the future. Over that 37-year period, if the IIP projects avoid a total of at least 6.2 outage days, the projects will have delivered more benefits than costs. These outage days are cumulative, and therefore do not need to be consecutive over the useful life of the projects. To the extent the projects outlast their useful life estimates, greater benefits will also likely accrue to customers.

For reference, the outage(s) caused by Superstorm Sandy resulted in over 32,000 NJNG customers experiencing prolonged outages of up to two months. Superstorm Sandy, along with other outage causing events, have resulted in more than 1.5 million customer outage days over the past ten years. For all NJNG customers, that equates to 0.30 outage days per year over the past decade. That is nearly twice times the estimated outage days per year necessary for the projects to break-even. To the extent the projects in the Company's proposed IIP were able to avoid outages related to even a single major event similar to Superstorm Sandy, the IIP, as filed, would be cost-effective.

When deliberating on the cost-effectiveness of the Company's proposed IIP, the Board should consider recent history, as well as take into account the prevalent research and data indicating that climate change will likely increase severe weather events in New Jersey,.

IV. COST-BENEFIT ANALYSIS METHODOLOGY

Q. Please describe your approach to the IIP cost benefit analysis?

A. For the Company's proposed IIP, I developed an analysis that reviewed the costs and benefits of each of the projects. Costs were provided by NJNG, while benefits were computed on a dollar-per-outage-day basis, where applicable. Rather than attempting to predict a certain specific quantity of avoided outage days that would or could occur over the useful life of the proposed IIP projects, I calculated the number of outage days that would need to occur for the benefits to match or break-even with the costs. This type of break-even analysis provides clear advantages when evaluating projects with benefits that are dependent on the occurrence of low probability outages.

Q. Why is the break-even analysis more appropriate for the Company's proposed IIP?

A. The break-even analysis is more appropriate because of the type of projects included in the proposed IIP and the types of benefits they generate. The majority of benefits for the projects in the IIP are intended to avoid or reduce the duration of outages driven by extreme weather or other events. 'Traditional' cost-benefit analyses rely on forecasting expected outcomes and measuring expected benefits against costs. Because of the near impossible challenge of attempting to forecast the specific dates, severity and duration of extreme weather events or infrastructure failures that would spur outages, I relied on a breakeven approach, which provides the number of outage days needed over the life of the projects that would justify the investment. To account for the fact that we did not know when, how often, or how long potential outages in the future would occur, I assumed that outages could occur at any time across the useful life of each of the sub-projects. This allowed for the costs and benefits to be discounted to present value terms for evaluation purposes, with the assumed occurrence (and related avoided costs, i.e. benefits) being evenly distributed across the useful life of the measures. To the extent that the likelihood of outages was to increase in the future due to climate change or other factors, this even distribution is a conservative estimate.

V. COST-BENEFIT ANALYSIS DESIGN, INPUTS, AND ASSUMPTIONS

Q. Please describe the inputs necessary to develop the cost benefit analysis.

A. The break-even cost-benefit analysis was designed to calculate the number of outage days required to be avoided by the proposed IIP in order for the benefits to equal the costs of the program. To conduct this analysis, I needed to include the cost of each project, the number of affected customers, the value that would be avoided by preventing outages, and the economic multiplier value associated with construction and in-state spending

Q. How did you determine the number of impacted customers each project in the Company's proposed IIP would avoid?

A. The number of impacted customers each project could avoid is based on data provided by NJNG. The estimated customers affected for each project provided by NJNG were compared against customer counts from each municipality a project would impact to assure that the customer outage estimates contained only unique customer outages (i.e. did not double count any customers). This analysis is further explained in the Report, attached as Exhibit IGF-IIP-2.

IIP Costs

Q. Please summarize the costs you assumed in the cost benefit analysis.

A. The costs in the cost-benefit analysis include investment costs for the proposed IIP projects and the negative economic impacts of the rate increases related to the IIP revenue requirements on customers.

Q. What investment cost data did you include in the cost-benefit analysis?

A. The cost-per-project in the IIP was provided by NJNG in its initial filing. This provided both the estimated project cost, as well as the assumed in-service date. While the specific in-service dates contained in these sources are no longer accurate, the timing between projects and duration between investment and in-service can still be used for the analysis.

I calculated the estimated revenue requirement of each project based upon the costs, in-service dates, depreciation life, and capital structure approved in NJNG's recent rate case.[1]

Q. How did you calculate the economic impact of rate increases?

A. To calculate the economic impact of rate increases on customers, I relied upon IMPLAN, a well-known and recognized economic analysis tool based on input output modeling. IMPLAN has been used by consultants to the Board and to Rate Counsel and is recognized by the Bloustein School of Planning and Public Policy at Rutgers University as a model that can be used to estimate economic impacts from energy infrastructure investments.

The calculated impacts were evaluated separately for residential and commercial/industrial customers, and the economic impact analysis assessed the direct, indirect, and induced economic impacts on each customer category of the rate increases related to the IIP revenue requirements. This is further explained in the Report, attached as Exhibit IGF-IIP-2.

<u>IIP Benefits</u>

Q. What benefits did you consider in the cost-benefit analysis?

A. For the cost-benefit analysis, I quantified five distinct benefits:

(1) Residential value of lost load;
(2) Commercial value of lost load;
(3) Avoided restoration costs;
(4) Avoided methane emissions environmental impacts; and
(5) Construction economic multiplier benefits.

Each of these benefits was evaluated separately based upon the constituency of customers to which the benefits would accrue. In addition, there are a number of benefits which were

[1] In The Matter of the Petition of New Jersey Natural Gas Company for Approval of an Increase in Gas Base Rates and for Changes in its Tariff for Gas Service, Pursuant to N.J.S.A. 48:2-21 and 48:2-21.1; and For Changes to Depreciation Rates For Gas Property Pursuant To N.J.S.A. 48:2-18, BPU Docket No. GR19030420 (November 13, 2019).

not quantified, or were qualitative in nature, which should nonetheless be taken into consideration when evaluating the IIP. These include:

(1) Improved safety;
(2) Reduced carbon dioxide emissions;
(3) Avoided damage to customers pipes and plumbing;
(4) Reduced anxiety and customer responsibilities;
(5) Reduced school day losses; and
(6) Peak shaving cost savings.

While these benefits were not explicitly quantified, they provide real value to customers and should be taken into consideration in the decision-making process.

Q. What is residential value of lost load?

A. Residential value of lost load estimates the value associated with residential customers losing gas service for a period of time. In essence, during a gas outage, customers lose the ability to perform certain tasks and activities, like cooking and heating homes, and the utility of these tasks and activities has a certain quantifiable value. By defining that value lost by customers during an outage, the value which avoided outages will incrementally provide to customers (i.e. will allow customers to avoid) can be quantified. This value of lost load is primarily capped by the customer avoided cost of hotels, meals, and incidentals outside the home (i.e. the additional cost that a residential customer will incur to avoid the loss of these services during an outage).

Q. How did you calculate residential value of lost load?

A. Residential value of lost load was calculated based upon specific customer data in the NJNG utility service territory, as well as customers' willingness to pay for natural gas, based upon demand-elasticity estimates for the region. Demand elasticity is a simple economic measure of how customers respond to changes in prices. These factors were used to calculate a minimum and maximum value of lost load per customer, as well as how the value of lost load changes with respect to increases in gas price or reduction in gas supply. This is further explained in the Report, attached as Exhibit IGF-IIP-2.

Q. Is this methodology of calculating residential value of lost load a novel concept in cost-benefit analysis presented to the Board?

A. No. This type of analysis has been conducted previously and submitted to the Board. While I have not conducted an exhaustive search, PSE&G's Energy Strong Filing relied on a similar residential value of lost load analysis.

Q. What is commercial value of lost load?

A. Commercial value of lost load is similar to residential value of lost load, in that it represents the value associated with commercial customers losing gas service for a period of time. However, the value to commercial customers differs from residential customers as the lack of gas service may prevent businesses from operating which reduces sales, employment, and productivity.

Q. How did you calculate commercial value of lost load?

A. Commercial value of lost load was calculated based upon specific commercial and business data in the NJNG utility service territory. This data is sourced from IMPLAN, which provides information from over 90 economic data sources across 546 industries (identified by NAICS code). For each identified industry present in NJNG's service territory, I calculated the total economic value that would be lost if natural gas service was curtailed. The economic impact of an outage can vary significantly in accordance with the nature of each industry, and these varied impacts were accounted for using the approach described and summed to quantify the total commercial value of lost load in NJNG's service territory. This value represented the lost business from commercial customers from natural gas outages. This is further explained in the Report, attached as Exhibit IGF-IIP-2.

Q. Is this methodology of calculating commercial value of lost load a novel concept in cost-benefit analysis presented to the Board?

A. No. This type of analysis has been conducted previously and submitted to the Board. While I have not conducted an exhaustive search, PSE&G's Energy Strong Filing and Energy Strong II Filing relied on a similar commercial value of lost load analyses.

Q. How did you calculate the avoided restoration cost?

A. Avoided restoration cost represents the costs incurred by NJNG to fix and restore their system following an outage. The average restoration cost was calculated based upon data supplied by NJNG for restoration costs incurred during Superstorm Sandy. This is further explained in the Report, attached as Exhibit IGF-IIP-2.

Q. How did you calculate avoided methane release value?

A. Certain projects contained in the Company's proposed IIP will reduce the volume of methane released into the atmosphere during outage events. Methane is a potent greenhouse gas which contributes to climate change. The social cost of avoiding methane releases was based upon peer-reviewed research and studies published by the U.S. Environmental Protection Agency ("EPA") Interagency Working Group on the Social Cost of Greenhouse Gases. This is further explained in the Report, attached as Exhibit IGF-IIP-2.

Q. Is this methodology of calculating avoided methane released a novel concept in cost-benefit analysis presented to the Board?

A. No. This type of analysis has been conducted previously and submitted to the Board. While I have not conducted an exhaustive search, the EPA Interagency Working Group on the

Social Cost of Greenhouse Gases study was recently used by the Board's consultant[2] in the 2018 Offshore Wind Solicitation and was accepted by the Board[3] in that case.

Q. How did you calculate the economic impact of construction and in-state spending?

A. Construction and in-state spending benefits were also calculated using the IMPLAN platform. Construction and in-state spending were split into the expenditure categories of contract labor, materials, and internal labor. Each of these categories have specific multipliers within IMPLAN which designate the direct, indirect, and induced economic impacts of spending in these categories. This is further explained in the Report, attached as Exhibit IGF-IIP-2.

Q. Is this methodology of calculating economic impacts of construction and in-state spending a novel concept in cost-benefit analysis presented to the Board?

A. No. This type of analysis has been conducted previously and submitted to the Board. While I have not conducted an exhaustive search, IMPLAN and similar input output models have been presented to the Board numerous times, including instances by its own consultants and by consultants to Rate Counsel. IMPLAN is also one of the input output models suggested by the Board for evaluation of offshore wind investments.

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[2] Evaluation of New Jersey Solicitation for ORECs for Offshore Wind Capacity – Framework for Evaluation of Impacts. Prepared for New Jersey Board of Public Utilities. June 21, 2019. bpu.state.nj.us/bpu/pdf/boardorders/2019/20190621/6-21-19-8D%20-%20Public%20Version%20-%20Levitan%20NJ%20OREC%20Final%20Report.pdf

[3] Order in the Matter of the Board of Public Utilities Solicitation for 1,100 MW – Evaluation of the Offshore Wind Applications. New Jersey Board of Public Utilities. Docket No. QO18121289. June 21, 2019. bpu.state.nj.us/bpu/pdf/boardorders/2019/20190621/6-21-19-8D.pdf

VI. COST-BENEFIT ANALYSIS RESULTS

Q. Please summarize the results of the cost-benefit analysis you conducted for the Company's proposed IIP?

A. The cost-benefit analysis I conducted found that the Company's proposed IIP would be cost-effective after 6.2 days of outage are avoided over the useful life of the projects for the impacted customers.

Q. How should the 6.2 outage day break-even be interpreted?

A. The cost-benefit analysis considered outages over the useful life of the projects within the IIP. That means, on average, the 6.2 outage days must be avoided over a 37-year period for the investments to be cost effective. Over this period, that would equate to roughly 0.17 outage days per year. To the extent the IIP would prevent more than 6.2 outage days, or more than 0.17 outage days per year, the IIP would result in benefits that exceed its costs.

Q. How does 6.2 outage days compare to recent history?

A. Over the past 10 years, NJNG has been subject to few major outages. However, those major outages that did occur resulted in significant damage to the gas distribution system and caused considerable customer outages. Predominantly resulting from Superstorm Sandy, the past 10 years have resulted in roughly 0.30 outage days per year. This is nearly two times greater than the break-even computed for the proposed IIP.

In addition, future outages could be increased due to the effects of climate change. NJNG territory is exposed to a large amount of direct coastline and could be subject to more severe weather events as climate change intensifies.

VII. CONCLUSIONS

Q. Can you summarize the results of your analysis?

A. My cost-benefit analysis of NJNG's proposed IIP shows the investments will be cost-effective if they are able to prevent 6.2 days of outages over their useful life. The benefits generated from the proposed IIP vary from direct avoided costs to avoided lost value for residential and commercial customers, to direct, indirect, and induced benefits for the State stemming from the construction and in-state spending related to the projects.

The cost-benefit analysis was reasonably conducted and accounted for all costs, including the impacts of rate increases on residential and commercial customers. However, because there are additional benefits that are more qualitative in nature and were therefore not quantified in my study, the results of this analysis can be considered conservative. The Board should take into consideration the fact that there are additional non-quantified and qualitative benefits (such as improved safety, reduced carbon emissions, avoided damage to customers pipes and plumbing, reduced anxiety, reduced school day losses, and peak shaving cost savings) that also accompany the Company's proposed IIP.

Q. Does this conclude your testimony?

A. Yes. However, I reserve the right to update this testimony to account for additional information I may receive. Thank you.

Isaac Gabel-Frank
Vice President

Overview of Experience

Isaac Gabel-Frank, Vice President at Gabel Associates, has over 10 years of experience supporting complex energy issues related to cost-benefit analysis, energy efficiency and renewables, energy project development, economic and tariff analysis, electric vehicles, regional transmission organizations (RTOs), and energy procurement.

Mr. Gabel-Frank is an expert on cost-benefit analytics and has supported a multitude of clients in quantifying cost and benefit dynamics related to the economic impact of energy projects. This includes past and present work for Federal agencies, state and local governments, school districts, and private sector clients on energy efficiency, renewable energy, cogeneration, and traditional generation projects. Mr. Gabel-Frank also performs sensitivity analysis to help identify risk boundaries and market deviations. This analysis is critical to investment decisions as it allows clients to understand the full value proposition associated with energy initiatives.

Mr. Gabel-Frank has submitted expert testimony to the New Jersey Board of Public Utilities (NJBPU) in matters regarding the cost effectiveness of energy efficiency. He is also currently supporting analytical and filing preparation activities for energy efficiency, renewable, energy storage, and electric vehicle matters for a range of clients.

Mr. Gabel-Frank has also performed in-depth project valuation and levelized cost of energy studies to support a proposed asset transaction.

Mr. Gabel-Frank assists in the development of numerous renewable and energy efficiency projects including in-depth economic, technical, and utility tariff analysis, which incorporates long-term utility and energy forecasts. He has developed various tariff models from the ground up, which are customized to reflect the specific parameters of each project. He is also skilled at calculating energy savings associated with various project structures. As a result of his strong analytical skill set, Mr. Gabel-Frank has served an integral role on various progressive projects throughout the region.

He supports solar projects through the request for proposal (RFP) process as well as reviews utility tariffs and performs cost/benefit analysis. He is also knowledgeable on the solar renewable energy certificate (SREC) market and has provided transactional support.

He has specialized knowledge on the demand response market and can effectively support clients in evaluating this revenue opportunity. Mr. Gabel-Frank also developed a model that calculates energy savings and potential rebates associated with energy efficiency projects.

In addition, he is extremely knowledgeable on RTO issues and actively monitors activities related to energy and capacity markets, energy efficiency, demand response, ancillary services, interconnection, and general grid issues. Mr. Gabel-Frank helps clients formulate and strategize positions on current PJM rules as well as provides analysis on potential market changes. This includes development of offer and bid strategies for energy efficiency, demand response, renewable, and traditional generation resources into the PJM market.

He was a key contributor in the development of the Analytical Likelihood of Availability and Non-Performance Risk (ALAN) model, a proprietary stochastic modeling tool that computes the exposure of capacity resources within the PJM and ISO-NE footprints. ALAN uses resource outage data as well expected performance assessment event information to determine the probabilistic coincidence of outages and performance assessment events.

Professional Qualifications

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March 4, 2020

Infrastructure Investment Program Cost-Benefit Analysis

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Acknowledgements

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EXECUTIVE SUMMARY

New Jersey Natural Gas Company ("NJNG") tasked Gabel Associates, Inc. ("Gabel Associates") with conducting a cost-benefit analysis of the Infrastructure Investment Program ("IIP") filed by NJNG with the New Jersey Board of Public Utilities ("BPU" or "Board") on February 27, 2019.

The NJNG IIP will provide increased resilience, reliability, and safety for NJNG's customers. The IIP is made of up seven project groups, consisting of:

1. Reliability and Resiliency Projects;
2. Replacement and Reinforcement Projects;
3. LNG Transmission Interconnection Project;
4. Regulator Station Reconstruction Project;
5. Trunk Line Replacement Projects;
6. Excess Flow Valve ("EFV") Installation Project; and,
7. Regulator Protection Project.

The benefits of these projects will be felt by a wide range of NJNG customer types, including residential, commercial, and industrial customers. The benefits range from increased reliability and resiliency, increased operating pressures, replacement of aging infrastructure (with related reliability and/or resiliency benefits), and installation of technology that will reduce leaks and increase safety during outages. Each of these projects is defined in greater detail in Section 2 of this report, as well as in the pre-filed testimony and exhibits of Craig A. Lynch.

Because these projects are resilience, reliability or safety projects, their value is best determined during outages, thus, the application of 'traditional' cost-benefit evaluation approaches, whereby benefits can be ascertained in a rather straightforward manner and compared against costs, is not adequate to evaluate benefits. Rather than attempting to determine the probability of future outages, both in magnitude of how many will occur and time of when they will occur, we performed a 'break-even' analysis to determine how many outages are required for the benefits of the IIP to meet or exceed its costs. A 'break-even' analysis approach removes the necessity to debate outage probabilities, and instead allows decision makers to assess whether the number of avoided outage days required to achieve a 'break-even' is reasonable.

Therefore, where possible, we calculated benefits on a per avoided outage day basis. This variable benefit rate allowed the analysis to sensitize avoided outage days against costs to determine the minimum number of avoided outage days which are required for benefits to equal costs. The primary quantified benefits include residential value of lost load, commercial value of lost load, avoided restoration costs, value of avoided methane release, and the economic impacts of construction and in-state spending. This is not an exhaustive list of benefits for these projects. To the extent decision makers wish to consider non-quantified or other qualitative benefits (detailed later in this report), the benefits of the IIP will only be improved (and the number of outage days required reduced).

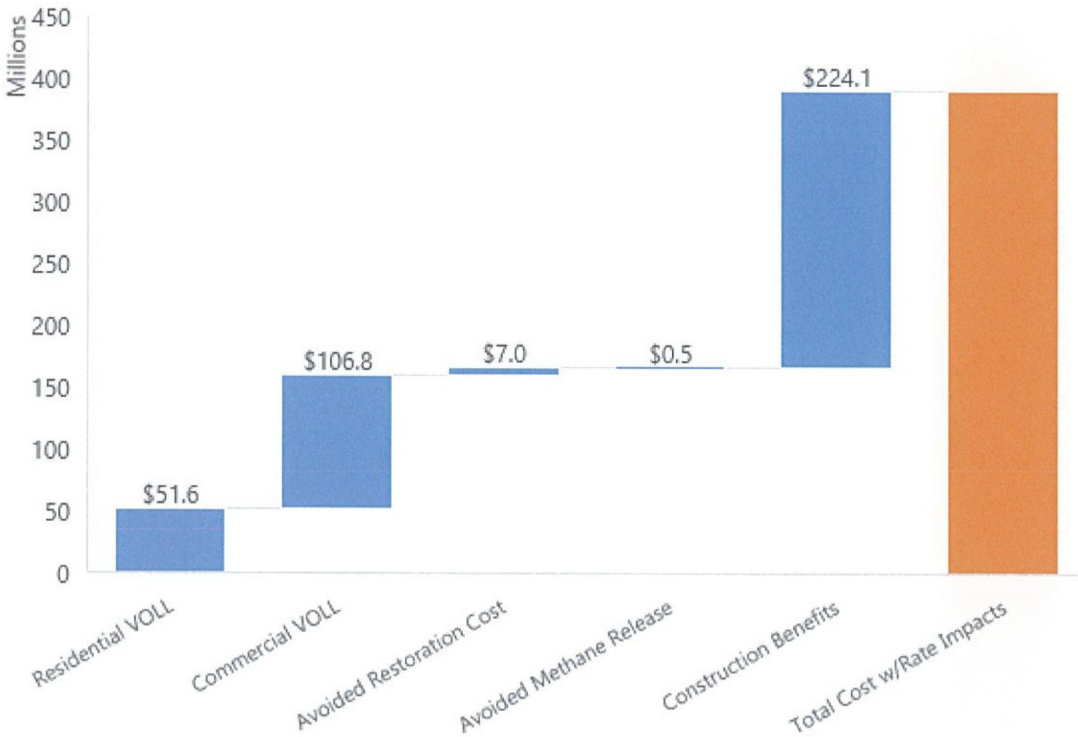
The cost estimates for IIP projects, as well as in-service dates and depreciation assumptions, were provided by NJNG. The revenue requirement estimate for each of the projects is calculated based on this data. The economic impacts of forecasted rate increases related to the estimated revenue requirement are calculated based upon the IMPLAN platform, a well-known input output economic analysis tool that has been accepted by the BPU in other matters.

The annual avoided outage assumption (and therefore the benefits generated from avoided outages) is calculated as a fraction of the total number of avoided outage days divided by the useful life of each of the projects. Because the weighted-average useful life of all the projects is estimated at 37 years, the total number of avoided outages is divided by 37 in order to create an annual avoided outage value. This method assures that avoided outages are split evenly across the investigated period, which is appropriate given the relative randomness in terms of when during the useful life of the projects that events that would lead to an outage would occur, and given that the time-value of when benefits are generated is accounted for in the analysis. This is important as all costs and benefits were evaluated on a present value basis.

When costs and benefits were compared against each other, it was determined that to be cost-effective the IIP would require an avoidance of 6.2 outage days across the useful life of the projects, estimated at a weighted average of 37 years, or 0.17 outage days per year. The largest driver of benefits is the economic benefit to New Jersey from the construction of the projects and its related activities. This is followed by the commercial value of lost load, which is nearly $120 million over 6.2 avoided outage days. While the construction benefits would remain the same under any level of avoided outages, if avoided outages were to increase above 6.2 days, the commercial and residential value of lost load would increase.

Figure 1 below illustrates the comparison of benefits and costs assuming the avoidance of 6.2 outage days.

Figure 1: Benefits and Costs of NJNG IIP Assuming 6.2 Outage Days



We also reviewed each of the individual projects and determined the number of avoided outage days needed to 'break-even' between costs and benefits. The following figure provides project specific data for each of the seven projects proposed by NJNG.

Figure 2: Project Cost-Benefit Overview

Project	Benefits	Costs	Net Benefits	Days Needed
Reliability and Resiliency Projects	162,933,287	-145,192,863	17,740,424	4.7
Replacement and Reinforcement Projects	31,320,752	-16,035,847	15,284,905	1.7
LNG Transmission Interconnection Project	12,192,486	-20,865,883	-8,673,397	n/a
Regulator Station Reconstruction Project	9,289,194	-6,095,647	3,193,547	3.1
Trunk Line Replacement Projects	118,709,417	-114,887,380	3,822,036	5.9
EFV Installation Project	34,601,145	-54,072,200	-19,471,056	262.7
Regulator Protection Project	20,846,530	-32,742,990	-11,896,460	47.9
Total Portfolio	**389,892,811**	**-389,892,811**	**0**	**6.2**

On a project basis, four of the seven projects are cost-effective when evaluated based on 6.2 days of avoided customer outages over weighted average 37-year useful life of the projects. There are varying reasons why the other three projects did not break even across the 6.2 avoided outage days. For example, the LNG Transmission Interconnection Project could provide benefits that were not accounted for in this analysis. Because we did not have information that would support the assumption that the LNG project would decrease the likelihood of outages we therefore attributed no avoided outage related savings to the LNG project and this project could not be evaluated from a 'break-even' perspective. With regard to the EFV Installation Project and Regulator Protection Projects, each do provide numerous benefits, but the monetary and economic benefits included in this analysis were largely focused on outage avoidance which, based upon information available to us, neither of these projects provide.

Overall, the NJNG portfolio of projects 'breaks-even' at only 6.2 avoided outage days over the weighted-average 37-year useful life. While individual projects require differing lengths of time to 'break-even', the comprehensive portfolio would deliver tangible and direct benefits to NJNG's customers over their lifetime with minimal avoided outages required for benefits to exceed costs.

To determine whether 6.2 avoided outage days over the 37-year weighted-average useful life is reasonable, there are a number of factors that must be considered. Natural gas outages typically stem from extreme weather events, and the frequency and severity of extreme weather events is expected to increase in the coming years as a product of climate change. Properly strengthening New Jersey's natural gas infrastructure is vital to combating the changing environment.

We can look to the past as a baseline reference concerning the frequency and severity of natural gas outage events in order to quantify a value associated with prospective avoided outages related to these projects. Over the past decade, NJNG has experienced over 1.5 million customer outage days[1] for customers in its service territory. For all customers, that equates to 0.30 outage days per year, or 11.1 outage days over 37-years. In the event the IIP projects were to help prevent an event similar to Superstorm Sandy, the benefits to customers would greatly exceed the costs by a ratio of nearly two-to-one.

[1] This occurred predominantly during Superstorm Sandy when over 32,000 customers were without service for up to two months.

The IIP projects are a cost-effective investment given the high likelihood of increased extreme weather events and the historic outage data over the previous ten years. The projects provide insurance for NJNG customers against potential outages and many other additional benefits, including increased safety.

1 INTRODUCTION

Gabel Associates, Inc. ("Gabel Associates") was retained by New Jersey Natural Gas Company ("NJNG" or the "Company") to undertake a Cost-Benefit Analysis ("CBA") of NJNG's proposed Infrastructure Investment Program ("IIP") which was filed with the New Jersey Board of Public Utilities ("BPU" or "Board") on February 27, 2019 under Docket Number GR19020278.

Gabel Associates is an energy, environmental and public utility consulting firm with its principal office in Highland Park, New Jersey. For over 25 years, the firm has provided highly focused and specialized energy consulting services and strategic insight to its clients. Gabel Associates has applied its expertise to improve the bottom line for hundreds of clients involved in virtually every sector of the energy industry. The firm has built its reputation on its extensive knowledge and rigorous analysis of energy markets. We have successfully assisted public and private sector clients implement energy plans and projects that reduce costs and enhance environmental quality. The firm possesses strong economic, financial, project development, technical, and regulatory knowledge.

Firm personnel also serve as expert witnesses on a wide range of issues at the Federal Energy Regulatory Commission ("FERC") and at State Commissions, including those related to energy and capacity markets, economic impact, ratemaking and tariff design, energy efficiency, reactive rates, interconnection, renewable energy, electric vehicles, and mergers/acquisitions.

1.1 Purpose of Report

This report contains a written summary of the analysis of the benefits related to the NJNG IIP, including the methodology undertaken to estimate the costs and benefits of various projects proposed by NJNG under its application in Docket Number GR19020278. The report also presents a comparison of estimated costs and benefits to provide the Board with an understanding of the potential cost-effectiveness of projects outlined in the NJNG application.

1.2 Organization of Report

This report focuses on the cost-effectiveness of each of the projects proposed by NJNG. This includes a review of potential gas outages, including a brief discussion on potential causes of outages and historic natural gas activity in New Jersey. We describe the underlying rationale for our overall methodological approach in considering the cost-effectiveness of these types of investments due to the fact that the majority of the projects requested by NJNG are intended to improve the reliability and resiliency of the NJNG delivery system, or stated differently, how the projects reduce the probability of outages. We also outline the specific details of how we quantified the potential costs and benefits of each project, with a specific focus on our methodology and data sources. Finally, we present the overall results of the analysis and a discussion of how the Board should use the information presented herein.

The report is broken into the following sections:

1. Introduction
2. Overview of IIP Projects
3. General Approach
4. Methodology
5. Results
6. Conclusion

2 OVERVIEW OF IIP PROJECTS

The NJNG IIP is a capital investment proposal by NJNG to improve the resiliency, reliability, and safety of its gas transmission and distribution system. According to NJNG, "The Company's IIP will improve the durability, redundancy, stability, and integrity of NJNG's gas distribution infrastructure, making it better able to withstand the impacts of major storm events, avoiding customer outages, and enabling a faster response to customer outages that may occur."[2] The majority of the seven project areas are proposed to improve the reliability and resilience of system operations by providing redundancy and reinforcement of the existing system. Other projects, specifically the EFV installation and regulator protection projects, are intended to improve the safety of customers while reducing the potential for serious accidents and further damage to the system. The NJNG IIP consists of seven project areas, including:

1. **Reliability and Resiliency Projects**

The reliability and resiliency projects include 19 specific reinforcement pipeline projects. These projects are intended to provide benefits during normal and adverse weather conditions through enhanced operating pressures and reliability/resilience improvements driven by increasing system redundancies. These projects are located throughout the NJNG service territory and are expected to be completed within five years of approval.

2. **Replacement and Reinforcement Projects**

The replacement and reinforcement projects include replacement or addition of 7.7 miles of mains through four pipeline reinforcement projects. These projects are intended to enhance operating pressures of the systems, which drive reliability and flexibility of the system. These projects are expected to be completed within two years of approval.

3. **LNG Transmission Interconnection Project**

The Howell LNG project will reconfigure the NJNG system to directly connect the Howell LNG facility to the Company's transmission system. This will allow LNG supply to be directly injected into the backbone transmission system in the event of supplier curtailments, scheduled in-line inspection activities, and emergency stand-by operations. The supply has the ability to support all of the Monmouth and Ocean Counties service territory area during

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[2]In the Matter of the Petition of New Jersey Natural Gas Company to Implement an Infrastructure Investment Program ("IIP") and Associated Recovery Mechanism Pursuant to N.J.S.A. 48:2-21 And N.J.A.C. 14:3-2A Docket No. GR19020278, page 6.

non-winter days. Currently, the LNG plant only provides pressure support to the system serving southeastern Monmouth and northeastern Ocean counties. The project would also increase efficiencies by providing higher pressures into the liquefaction process. This project is expected to be completed within five years of approval.

4. **Regulator Station Reconstruction Project**

The Cedar Bridge regulator station reconstruction project will reconstruct and relocate this regulator station to mitigate existing storm related risks. This project is expected to be completed within five years of approval.

5. **Trunk Line Replacement Projects**

The trunk line replacement projects include two (Lakewood and Denville) replacement projects and one (Roxbury Route 46) extension project. The replacement projects will replace approximately 23 miles of aging pipeline with new steel pipeline, which will improve capacity and system pressures. The Roxbury extension project will include the installation of 2.3 miles of new steel trunk main, a new regulator station, and 1 mile of plastic main. This project is intended to improve system pressure and reliability to the western portion of the NJNG distribution system. The trunk line replacement projects are expected to be completed within five years of approval.

6. **Excess Flow Valve Installation Project**

The EFV installation project will install 16,000 new EFVs to storm threatened areas in NJNG's service territory. EFVs automatically cutoff gas flows that exceed a preset rate of flow, which reduces the potential for a serious accident and provides safety benefits to affected customers. The EFV installation project is expected to be completed within five years of approval.

7. **Regulator Protection Project**

This project will install approximately 60,000 protective devices on regulator vents in potential flood areas. These devices will reduce the likelihood of water infiltrating into regulators and meters during high water events, which will reduce the likelihood of storm related outages and replacement of meter and regulator sets due to storm damage. This project is expected to be completed within five years of approval.

Further detail on these projects can be found in the pre-filed testimony and exhibits of Craig A. Lynch.

3 GENERAL APPROACH

Understanding the value of the proposed IIP projects requires inquiry into the macro-level circumstances that NJNG faces as a natural gas delivery company, and how the changing regulatory and natural environment impact the ability to reliably deliver natural gas. In consideration of these aspects, we describe a cost-benefit evaluation approach that is most applicable to reliability and resiliency projects and ultimately used for this report.

3.1 Gas Outage Events

Although far less frequent than electric outages, natural gas outages do occur. The causes of natural gas outages vary but can include equipment failure, third party damage, pipeline incidents, extreme weather, and supply shortages resulting in pressure loss on the system. Natural gas outages can cause severe economic disruptions when they unexpectedly stop service to hundreds or thousands of residential and commercial facilities.

Some examples of recent outages include:

- January 21, 2019 - National Grid shut down a large portion of its natural gas distribution system in Newport and Middletown, Rhode Island. The resulting outage disrupted service for 7,455 customers, some of which lost service for seven consecutive days. The outage was caused by supply shortages driven by extreme cold temperatures and equipment failure.[3]
- April 29, 2016 – The Delmont Line 27 pipeline ruptured due to corrosion, causing a fire and sustained outage. Four parallel transmission lines were isolated, and curtailments continued for months after the event.
- October 30, 2012 – Superstorm Sandy made landfall in New Jersey causing severe flooding. Natural gas service interruptions lasted several weeks for tens of thousands of affected customers.

These three events are not an exhaustive list of recent natural gas outage events but are intended to highlight the range of potential drivers of natural gas outages. The Delmont Line 27 outage was caused by aging infrastructure while the other two events were driven by

[3] Summary Investigation into the Aquidneck Island Gas Service Interruption of January 21, 2019. Investigation Report. Rhode Island Division of Public Utilities and Carriers. October 30, 2019. ripuc.ri.gov/eventsactions/AI_Report.pdf.

extreme weather. As we discuss in more detail below, the likelihood of extreme weather events is increasing for coastal states like New Jersey.

3.2 Increasing Frequency of Severe Weather Events and Flooding Due to Climate Change

New Jersey is often recognized as one of the most vulnerable states to the effects of climate change due to the increased hurricane risk and sea level rise along its coast-dependent economy. A recent study by the New Jersey Science and Technical Advisory Board on Sea-Level Rise and Coastal Storms found that climate change will increase the impact of hurricanes as well as sea-levels and flooding risk for coastal areas.[4] The study posits that climate change will make hurricanes more intense, increasing the proportion of storms that reach the category 4-5 range. The study notes that sea level rise alone, regardless of the increasing intensity of storms, will exacerbate the impact of future weather events, as the threshold for flooding will become increasingly lower.

3.3 Resilience-Based Analysis Versus Traditional Cost-Benefit Analysis

As discussed in Section 2 of this report, the IIP projects proposed by NJNG will improve reliability, resiliency, and overall service quality. Reliability is a commonly understood term in the electric and natural gas utility. The U.S. Department of Energy defines operational reliability as "the ability of the system to withstand sudden disturbances to system stability or unanticipated loss of system components."[5] Resilience refers to a similar but different benefit. According to the National Infrastructure Advisory Council, infrastructure reliance is "the ability to reduce the magnitude and/or duration of disruptive events. The effectiveness of a resilient infrastructure or enterprise depends upon its ability to anticipate, absorb, adapt to, and/or rapidly recover from a potentially disruptive event."[6]

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[4] Kopp, R.E. et al. 2019. New Jersey's Rising Seas and Changing Coastal Storms: Report of the 2019 Science and Technical Advisory Panel. Rutgers, The State University of New Jersey. Prepared for the New Jersey Department of Environmental Protection. nj.gov/dep/climatechange/pdf/nj-rising-seas-changing-coastal-storms-stap-report.pdf.

[5] United States Department of Energy. Staff Report to the Secretary on Electricity Markets and Reliability. August 2017. energy.gov/sites/prod/files/2017/08/f36/Staff%20Report%20on%20Electricity%20Markets%20and%20Reliability_0.pdf

[6] North American Electric Reliability Corporation. Severe Impact Resilience Task Force, Severe Impact Resilience: Considerations and Recommendations. May 2012. ourenergypolicy.org/wp-content/uploads/2012/05/SIRTF_Final_May_9_2012-Board_Accepted.pdf.

Reliability and resiliency benefits are heavily dependent on the occurrence and severity of outages. However, outages driven by severe weather events, third party damage and equipment failure are difficult to forecast. The events driving significant natural gas outages have historically been quite rare and the timing is by nature very difficult to predict, but these events do occur over time. Therefore, traditional approaches to cost-benefit analysis which focus on expected value assessment from a very specific outcome are much less useful in the context of resilience investments.

Quantifying the benefits of resilience-driven improvements is unlike quantifying the benefits of other types of investments such as energy efficiency or renewable projects. With energy efficiency or renewables, there is a clear counterfactual from which to draw cost and expected value estimates. For example, upgrading a boiler or furnace has a clear and calculable savings for a household or business, and engineering formulas can provide the applicable savings which will occur each hour, day, week, month, or year. Likewise, investment in renewables (such as solar) have direct electrical production which avoid the purchase of grid-supplied energy.

Resilience and reliability benefits on the other hand are less clear due to the challenging nature of forecasting the frequency and duration of outage events. In a perfect world, investment in resilience and reliability would not be needed because our distribution infrastructure would never be subject to damage or failure due to extreme weather events or other reasons. However, investing in resilience and reliability is analogous to investing in insurance; while we hope nothing bad ever happens, we must be prepared for the worst.

Calculating the probability of outages is a tenuous task, particularly in light of the discussion above regarding the increasing frequency of extreme weather events due to climate change and their effect on distribution infrastructure. Therefore, and as discussed in greater detail in Section 4 below, our analysis uses the known, defined elements of the NJNG IIP to calculate how many outages would need to occur in order for the projects to be cost-effective. This analysis removes the need to "guess" on outages and allows decision makers to focus on evaluating whether the number of outages required to achieve economic 'break-even' is reasonable moving into the future.

Instead of presenting a simple "pass or fail" metric based on a comparison of the net benefits versus costs, we present the number of outage days necessary to 'break-even' on the investments, i.e. where the benefits exceed the proposed project costs. The 'break-even' number represents the number of outage days over the lifespan of the projects needed to produce the value necessary to make the projects cost-effective.

4 METHODOLOGY

As discussed previously, evaluating cost-effectiveness can take many different forms. Because of the nature of the types of projects being installed, we constructed the cost-benefit analysis for the IIP projects in a manner that would calculate the benefit requirement needed to meet or exceed the costs of the projects. This 'break-even' style analysis avoids many of the pitfalls related to 'traditional' cost-benefit analysis, whereby the costs and benefits are stacked against one another to compare their quantities. Because the NJNG IIP is designed to avoid outages, increase resilience, and improve reliability, all of which protect against events that by their nature have a low likelihood of occurrence, the analysis cannot be conducted in a 'traditional' fashion. Rather, our cost-benefit analysis computes the number of outage days that would result in the IIP investments achieving 'break-even' and thereby becoming cost-effective. This approach allows decision makers to evaluate how many outage days are reasonable, rather than assume the analysis made reasonable assumptions on probabilities of occurrence. It is important to note that 'break-even' analyses have precedent in these types of matters before the Board.[7]

Our analysis focused on two main factors:

(1) program costs; and,
(2) benefits from avoiding a single-day outage for an individual customer.

The calculation of each factor is discussed in detail throughout this section. The 'break-even' cost-benefit analysis can be thought of as analogous to a payback calculation for an investment. At a high level, we calculated costs, calculated single period benefits, then divided the costs by the savings to determine the number of periods (in this case outage days) necessary for the benefits to meet the costs.

A factor often ignored in these types of analyses is the impact of time on benefits. Both costs and benefits were evaluated in present value terms (discounted at the approved weighted-average cost of capital ("WACC") from NJNG's November 2019 rate case). However, while the benefits associated with each single day customer outage are supported throughout this Section, determining when those outages occur has an impact on benefit totals when evaluated in present value terms.

[7] *See* New Jersey Board of Public Utilities Docket Nos. EO13020155 and GO13020156.

Because the probability, duration, and date of future outage events is unknown, we assumed that outages could occur at any time across the useful life of each of the sub-projects. From the portfolio perspective, outages were split evenly across the 37-year weighted-average useful life of the sub-projects. This means, for example, that if 37 outage days was required for the benefits to meet the costs, that we assumed one outage day would occur each year for 37 years. Although actual outages are unlikely to occur with that degree of frequency and regularity, this approach provided a measured, evenly distributed probability across the examined time period, and allowed benefits in future years to be discounted greater than benefits in more current years.

Program costs were calculated consistent with the data provided by NJNG using a revenue requirement approach for each sub-project. The revenue requirement forecast was also used to determine the economic impacts of rate increases from the project investment. Time value of the collection of revenue requirements, as well as its resulting economic impacts, is accounted for in the analysis.

Program benefits were calculated separately for each benefit type. Some benefits, such as residential and commercial value of lost load ("VOLL"), increase in proportion with the number of outage days, while other benefits are constant regardless of the number of outage days (such as economic impacts of construction and in-state spending). Where applicable, each of the benefit values were escalated to real 2020 dollars using Bureau of Economic Activity ("BEA") data. Values were further escalated to nominal terms using the Energy Information Administration ("EIA") 2020 Annual Energy Outlook ("AEO") GDP chain-type price index or consumer price index for its macroeconomic indicators reference case forecast.

The magnitude of benefits was estimated by multiplying each benefit against the single-period probability of an outage (in this case, $1/37^{th}$ likelihood of occurrence denoting an equal probability across the 37-year useful life of all the sub-projects contained in the NJNG IIP portfolio) and again against the number of impacted customers from each sub-project. This provided a yearly cashflow of benefits by sub-project, which was discounted to present value terms to evaluate against program costs.

Further explanation of each of the factors that comprised the cost-benefit analysis are summarized in greater detail below, with a specific emphasis on methodology and assumptions.

4.1 Customers Impacted

NJNG provided estimates of numbers of customers impacted by each project in the initial filing and in subsequent data request responses. These estimates represented the absolute customers impacted from each sub-project but did not account for the fact that some sub-projects may provide benefits to the same customers (i.e. there may be some overlap in the specific customers impacted by each project). To control for potential double counting of impacted customers, we compared the list of customers impacted provided by NJNG against the number of customer meters located in each of the affected towns. This allowed us to generate an estimate of unique customers impacted by each sub-project. This estimate was used throughout the analysis as the assumed number of customers that would experience outages were these sub-projects not to be installed.

Figure 3 shows our estimate of individual customers impacted.

Figure 3: Summary of Impacted Customers

Project	Individual Customers
Excess Flow Valves	16,000
Vents	60,000
Brielle Pump Line Reinforcement	5,630
Denville-Randolph Reinforcement	1,200
Dover Chester Reinforcement	2,000
Toms River East Reinforcement	7,500
Joe Parker Reinforcement	1,500
Southern Randolph Reinforcement	2,000
Bayville-Forked River Reinforcement Loop	5,500
Beachwood Reinforcement Loop	3,548
Eastern Montville Reinforcement Loop	4,000
Flanders Route 206 Reinforcement Loop	3,500
Hope Chapel Reinforcement Loop	9,000
Lincoln Park Reinforcement Loop	1,200
Mt. Arlington - Jefferson Reinforcement Loop	1,703
Netcong-Stanhope Reinforcement Loop	3,635
Northern Boonton Reinforcement Loop	558
Sandy Hook Reinforcement Loop	2,797
Southern Jackson Ridgeway Reinforcement Loop	5,500
Taylortown Reinforcement Loop	-
Western Freehold Reinforcement Loop	8,500
Western Jackson Bowman Reinforcement Loop	4,500
Western Randolph Reinforcement Loop	118
Whiting-Lacey Reinforcement Loop	8,000
Whiting-Toms River Reinforcement Loop	12,000

Project	Individual Customers
Cedar Bridge Regulator Station	9,500
Howell LNG Transmission Improvement	-
Denville Trunk Line Replacement	5,371
Lakewood Trunk Line Replacement	51,670
Roxbury Route 46 Trunk Extension	6,046

4.2 Costs

Each of the projects and sub-projects are described in detail in Section 2 of this report. On the sub-project level, NJNG provided the estimated investment cost and a schedule of when those sub-projects would likely be placed into service. Revenue requirements were calculated for each sub-project, which was used as the basis of the cost comparison in the cost-benefit analysis. Revenue requirement by project were also adjusted to account for economic impacts of rate increases to customers.

4.2.1 Cost of Projects

NJNG provided the costs and dates that the sub-projects were expected to be placed into service in its initial filing. These dates have shifted because of delays in the procedural schedule; but the timing between project spending and in-service date was preserved. Figure 4 shows the total cost of each sub-project. Project costs are further detailed in Appendix A.

Figure 4: Summary of Sub-Project Costs

Sub-Project	Total Cost ($000)
Excess Flow Valves	40,000
Vents	24,200
Brielle Pump Line Reinforcement	3,000
Denville-Randolph Reinforcement	5,000
Dover Chester Reinforcement	2,000
Toms River East Reinforcement	4,000
Joe Parker Reinforcement	1,750
Southern Randolph Reinforcement	2,500
Bayville-Forked River Reinforcement Loop	2,500
Beachwood Reinforcement Loop	1,000
Eastern Montville Reinforcement Loop	5,000
Flanders Route 206 Reinforcement Loop	4,000
Hope Chapel Reinforcement Loop	2,500

Sub-Project	Total Cost ($000)
Lincoln Park Reinforcement Loop	1,000
Mt. Arlington - Jefferson Reinforcement Loop	4,000
Netcong-Stanhope Reinforcement Loop	18,000
Northern Boonton Reinforcement Loop	1,250
Sandy Hook Reinforcement Loop	5,000
Southern Jackson Ridgeway Reinforcement Loop	1,500
Taylortown Reinforcement Loop	2,500
Western Freehold Reinforcement Loop	2,500
Western Jackson Bowman Reinforcement Loop	4,000
Western Randolph Reinforcement Loop	6,000
Whiting-Lacey Reinforcement Loop	21,000
Whiting-Toms River Reinforcement Loop	15,000
Cedar Bridge Regulator Station	5,000
Howell LNG Transmission Improvement	17,000
Denville Trunk Line Replacement	25,000
Lakewood Trunk Line Replacement	50,000
Roxbury Route 46 Trunk Extension	12,000
Total	**288,200**

4.2.2 Revenue Requirements

A full lifetime revenue requirement was calculated for each sub-project based upon the cost, in-service estimates provided by NJNG, and expected depreciated lifetimes. We used the NJNG capital structure approved by the Board in the NJNG November 2019 rate case order.[8] The revenue requirement forecast represents the expected costs to be paid by customers to support the proposed IIP projects.

Revenue requirements are further detailed in Appendix A.

4.2.3 Economic Impacts of Rate Increases

Any incremental revenue requirement increase represents an additional cost to customers, and therefore will have an impact on both residential and commercial customers as they will be required to pay higher natural gas bills to support the IIP expenditures. We used IMPLAN,

[8] *See* New Jersey Board of Public Utilities Docket No. GR19030420.

a well-known and recognized economic analysis tool based on input output modeling, to estimate the economic impact of the forecasted rate increases.

The model allows the user to conduct economic analyses that estimate changes to the economy or impacts based on specific events. Because the model focuses on interdependences of various industries and economic activities in a region, it allows the user to estimate the ripple effects of specific events. IMPLAN relies on over 90 economic data sources to efficiently conduct economic impact analysis across 546 industries. IMPLAN is a well-respected, widely used economic modeling tool. The Bloustein School of Planning and Public Policy at Rutgers University also cites IMPLAN as a model that can be used to estimate economic impacts from energy infrastructure investments.[9]

The economic impacts of rate increases on residential customers were estimated by computing the household income change associated with the percentage of the revenue requirements allocated to residential customers. Increased household expenses can be treated as a reduction in household income, as it is a direct reduction in the disposable or other income for a household.

The economic impacts of rate increases on commercial customers were estimated by increasing the cost of natural gas distribution service based on the projected increase in revenue requirements for commercial customers. Increased natural gas distribution costs can be treated as an additional operating expense to businesses. However, because businesses are able to deduct expenses from revenues, the total value added (or value removed) to commercial customers is reduced as it can be deducted from profits and reduces tax burdens on some businesses.

The economic impact of rate increases are further detailed in Appendix A.

4.3 Benefits

Customers, both commercial and residential, are willing to pay for natural gas every month because of the value it provides to their businesses and their lives. Natural gas keeps stoves operating and makes hot dishwater available at restaurants, keeps the heat and hot water on

[9] Lahr, M., E. Coughlin, and F. Felder. 2010. Economic Impacts of Energy Infrastructure Estimates. Edward J. Bloustein School of Planning and Public Policy. Rutgers, The State University of New Jersey. ceeep.rutgers.edu/wp-content/uploads/2013/11/2010NJNG_Economic_Impact_Report.pdf.

at offices and shopping malls, keeps manufacturing processing running, allows schools to stay open, and provides residential customers with warmth in the winter and with the ability to cook and take hot showers year-round. As such, the loss of load equates to a loss of value in the lives of customers. Natural gas permeates so many aspects of customers' lives that it can be challenging to attach a single value to it. However, there are clearly enormous benefits related to the availability of natural gas for both residential and commercial customers, and a variety of methods exist which can be used to quantify those benefits.

4.3.1 Residential Value of Lost Load

Natural gas is a critical commodity for residential customers relying on it primarily for heating, domestic hot water, cooking, and laundry needs. The loss of natural gas service, even if temporary, can be detrimental and disruptive. While customer behavior can adjust to long-term rising prices of natural gas service, there are limited options in the home in the short run to avoid the loss of heating, hot water, cooking, and laundry facilities due to unexpected short-term outages.

A primary benefit of avoiding a natural gas outage is the economic value to customers of avoiding an alternative cost. In the case of a natural gas outage at home, the alternative would include leaving the home for meals because a customer is unable to cook with gas or leaving the home entirely to sleep (when the temperature drops below a comfortable range) and/or bathe because the home's space and domestic hot water is heated with natural gas. The alternative can also represent the price customers would be willing to pay to maintain the same service. This value is also known as consumer surplus. Estimating consumer surplus for natural gas service is the method we used to quantify the value of lost load. By understanding what consumers would have been willing to pay, and by quantifying the additional financial burden that not having that product places on them, a lower boundary can be established on the true value of lost load.

Consumer surplus represents the difference between the price customers usually pay and the amount they would be willing to pay for the same service. The consumer surplus for residential customers can be estimated using a demand-elasticity curve, which models how customers would adjust consumption based on price increase. Demand elasticity is an economic measure that shows how consumer behavior would change based on changes in prices. We relied on a short run elasticity for the Mid-Atlantic region of -0.1, which implies that for every 1% increase in price, demand decreases by 0.1%.[10]

The price of natural gas alternatives creates a natural ceiling on the demand-elasticity curve. Since most residential natural gas usage is for heating, domestic hot water, cooking, and laundry, the cost of a hotel and meals would determine the limit of what a residential customer should be willing to pay for natural gas service. As such, in order to calculate the consumer surplus, we estimated how much each incremental unit of natural gas is valued above the regular price per unit of gas at different prices, bounded by the equivalent cost of a hotel and meals to each unit of gas.

This methodology was carried out on a monthly basis to calculate a maximum limit on consumer surplus. In winter months, the maximum limit was assumed to be the summation of the cost of a hotel room, the cost of meals for a partial day, and incidental costs.[11] In summer months, the maximum limit was assumed to be the summation of the cost of one hotel room every four days, one meal per day, and incidental costs. All costs are based US General Services Administration per diem rates for Monmouth, Morris, or Ocean counties, proportionally adjusted to the ratio of NJNG customers living in each county.[12] We also accounted for the fact that families in NJNG territory are on average 2.55 people, so the cost of meals was increased to account for all family members. Hotel rooms were assumed to be one per family, although some families may require multiple hotel rooms.

The lower bound on the value of the consumer surplus was set as the average price per MMBtu that customers normally pay for natural gas service. This "non-incremental cost" is removed from the analysis to account for the fact that it would be paid regardless of whether an outage occurred or not.

Based on our analysis, we determined that the residential value of lost load was equal to $114 per customer per day. The residential value of lost load is further detailed in Appendix B.

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[10] United States Association of Energy Economics. Estimating Short-Run and Long-Run Price Elasticities of Residential Natural Gas Demand in the U.S. 2008. usaee.org/usaee2008/submissions/OnlineProceedings/Estimating%20Regional%20Short%2008.pdf.

[11] The residential VOLL does not include the cost of laundry. The inability to do laundry for customers using gas clothes dryers would require a trip to a laundromat, which is an added cost beyond hotel, meals, and incidental costs.

[12] United States General Services Administration. FY 2020 Per Diem Rates for New Jersey. gsa.gov/travel/plan-book/per-diem-rates/per-diem-rates-lookup/?action=perdiems_report&state=NJ&fiscal_year=2020&zip=&city=

4.3.2 Commercial Value of Lost Load

Similar to residential customers, commercial customers in New Jersey also depend on natural gas service to operate their businesses. However, the commercial value of lost load was calculated using a different methodology than the residential value of lost load, due to the abundant commercial data available for businesses in New Jersey.

To calculate commercial value of lost load, we again relied on IMPLAN. However, instead of estimating the economic effects of a specific change, we used IMPLAN as a data source for economic production by industrial sector. IMPLAN contains 546 unique industries, which are used to estimate ripple effects through the economy of various events. These 546 industries are matched to thousands of North American Industry Classification System ("NAICS") codes. Each sector has its own spending pattern derived from the United States Bureau of Economic Analysis ("BEA").

The dataset contains the value added (the value added to the gross regional domestic product) of every business located within NJNG's service territory. This exercise provided us with an understanding of the total economic value produced by businesses served by NJNG across the year. We evaluated whether specific industries would likely be affected by a natural gas outage, and even if affected, whether the lost work could be made up in the short-term. For example, we assumed that retail – food and beverage stores that use natural gas service would not be able to heat their establishments, cook meals, or clean dishes, and therefore would be forced to close their doors during an outage. This lost business would not be able to be made up in the near-term as customers who did not eat at a restaurant the previous day will not come in for two meals the next. Conversely, we assumed that construction of new buildings would not be impacted by a natural gas outage, and therefore would not represent an avoided reduction to the economy.

We conducted this review on the largest 110 industries in the NJNG service territory (largest referring to the total value added to the New Jersey economy). These 110 industries represent 90% of the economy in the NJNG service territory. Our review estimated that approximately 52% of economic production would be lost in a sustained natural gas outage. Based upon data from the EIA Commercial Buildings Energy Consumption Survey ("CBECS"), we determined that 67% of commercial customers rely on natural gas for heat. We used this value to further adjust the economic value added lost during an outage to only consider those industries that rely on natural as a heating fuel. We then used this value to calculate the total value added lost per customer per outage day, which was used in the final cost-benefit analysis.

Based on our analysis, we determined that the commercial value of lost load was equal to $2,890 per customer per day. Appendix B provides additional detail for the commercial value of lost load analysis.

4.3.3 Avoided Restoration Costs

Avoided restoration costs represent the cost that NJNG would incur to restore its transmission and distribution system in the event of an outage, but that are avoided as a result of the IIP investments. These costs include items such as prudently incurred O&M, meals, mutual aid charges, and other factors.

The avoided restoration cost was calculated based upon the approved restoration cost for NJNG during the Superstorm Sandy outage event. In Superstorm Sandy, NJNG accumulated O&M restoration costs of $15.2 million[13] that were ultimately approved by the BPU and deemed prudent and reasonable. This cost was converted to a unitized dollar per customer per outage day basis for use in the analysis.

This benefit is applicable for all projects with the exception of EFVs and the Howell LNG Transmission Improvement.

Based on our analysis, we determined that the avoided restoration cost was equal to $9.89 per customer per day. The avoided restoration cost is further detailed in Appendix B.

4.3.4 Avoided Methane Release

Methane, also known as CH_4, is the primary chemical compound contained in natural gas and is a potent greenhouse gas that contributes to climate change. During outage events, damage to the gas distribution can result in methane being vented directly into the atmosphere.

The Environmental Protection Agency ("EPA") recognizes methane as a harmful element, and in fact has published social cost estimates on the damage methane produces when emitted into the atmosphere. This EPA social cost estimate was the basis of analysis of avoided

[13] *See* New Jersey Board of Public Utilities Docket Nos. AX13030196 and G013070610.

methane releases. In particular, we used the estimates provided in the Interagency Working Group on Social Cost of Greenhouse Gases Addendum to Technical Support Document on Social Cost of Carbon for Regulatory Impact Analysis under Executive Order 12866: Application of the Methodology to Estimate the Social Cost of Methane and the Social Cost of Nitrous Oxide.[14] This analysis forecasted economic, environmental, and health related damages to estimate the social cost of methane.

The EFV project is the only project expected to generate any meaningful reduction in methane gas released. The amount of potential methane gas avoided from atmospheric release was calculated based upon the average natural gas consumption per day of a residential customer in NJNG's service territory, as well as the volume of methane located in a distribution pipe at any given time. In effect, the volume represents the weight (in tons per million cubic feet of natural gas) of methane that could be avoided from being released into the atmosphere. When multiplied against the outage days per year methodology as described above, we were able to calculate the quantity of methane gas avoided from release.

The product of the social cost of methane (in dollars per ton) and the magnitude of methane avoided from release (in tons) results in the total social cost of avoided methane release.

Based on our analysis, we determined that the value of avoided methane release was equal to $1,563 per customer per day in 2020. The value of avoided methane release is further detailed in Appendix B.

4.3.5 Economic Impacts of Construction and In-State Spending

The in-state spending on labor and materials produce economic benefits in New Jersey. For labor, the economic benefit is realized through labor income for the employees installing the projects. The labor income produces tax benefits and increases the discretionary income of the employee, producing ripple effects throughout the New Jersey economy. Increased discretionary spending boosts local economies through spending on restaurants, as well as other local goods and services. For materials, the in-state economic benefit is realized through

[14] Interagency Working Group on the Social Cost of Greenhouse Gases. 2016. Addendum to the Technical Support Document on Social Cost of Carbon for Regulatory Impact Analysis under Executive Order 12866: Application of the Methodology to Estimate the Social Cost of Methane and the Social Cost of Nitrous Oxide. 19january2017snapshot.epa.gov/sites/production/files/2016-12/documents/addendum_to_sc-ghg_tsd_august_2016.pdf.

materials manufactured in New Jersey. In-state manufacturing provides economic benefits through increased employment, capital investments in facilities, and associated supply chains.

We used IMPLAN to estimate the economic benefits of increased labor spending and the purchase of materials manufactured in New Jersey. To estimate the economic impacts of construction and in-state spending from the NJNG IIP, we categorized known project spending as internal labor, contract labor, and associated materials. The vast majority of materials are pipe and related products. For the materials, we assumed 5% would be sourced from New Jersey manufactured materials. This assumption is based on discussions with NJNG staff. We did not assume any in-state economic impacts for the remaining 95% of materials because it is likely these materials would be sourced from out of state. Contract labor was assumed to be New Jersey union construction labor and internal labor was assumed to be additional spending on NJNG internal costs.

Based on our analysis, we determined that the economic impacts of construction and in-state spending on contract labor had a value-added economic multiplier of 1.2 for every dollar spent, in-state materials had a value-added economic multiplier of 0.8 for every dollar spent, and internal labor had a value-added economic multiplier of 0.9 for every dollar spent. These value-added economic multipliers are inclusive of direct, indirect, and induced impacts to the gross state product. The economic impacts of construction and in-state spending are further detailed in Appendix B.

4.3.6 Non-Quantified and Qualitative Benefits

There are many benefits of the NJNG IIP projects that were not quantified for the purposes of this report. These benefits range from very difficult to quantify to qualitative. While these benefits were not included in the direct estimated quantitative benefits, they should still be recognized and carefully considered as the Board weighs the decision to approve the IIP projects. This list is not exhaustive but highlights the significant non-quantified and qualitative benefits.

Improved safety. Many of the projects proposed by NJNG in this filing, specifically the EFV and Regulatory Protector projects, improve the safety of the NJNG system. The EFV valves shut off gas flow at a specific customer premise, potentially alleviating an explosion which may cause damage, injury, or death.

Reduced carbon dioxide emissions. There are multiple potential reductions in carbon. dioxide emissions gained through the installation of the NJNG IIP projects. The reduction could occur through reduced leakage through new state of the art pipes, avoiding the additional electric usage from space heaters in an outage event, or improved system efficiency of the LNG facility.

Damage to customer owned pipes. Damage can occur when a gas outage occurs during a period of sub-zero weather causing pipes to freeze and break. Plumbing damage is not only costly to repair, but can damage inventory, furniture, and personal belongings, while requiring additional repairs due to water damage.

Reduced anxiety and customer responsibilities. Circumstances which cause natural gas outage events often coincide with extreme weather or other natural disasters. During these times, customers are already dealing with numerous responsibilities. Loss of natural gas service is one additional item that can add to personal anxiety and workload to take care of one's family and loved ones. Reliable and resilient natural gas service can remove one negative factor during times of high stress and anxiety.

Reduced school day losses. It is likely that local schools, daycares, and other educational institutions will need to close for an outage event, especially during cold months. On top of inconveniencing thousands of students, faculty and staff, this would also require parents to stay home with their children and miss work or spend money on child-care.

Peak shaving cost savings. The LNG project would enhance the ability of NJNG to use the facility as a local peaking source of gas in times of extreme system demand when additional pipeline sources gas cost may spike. This benefit was not quantified in a potential outage scenario but will provide an economic benefit.

5 RESULTS

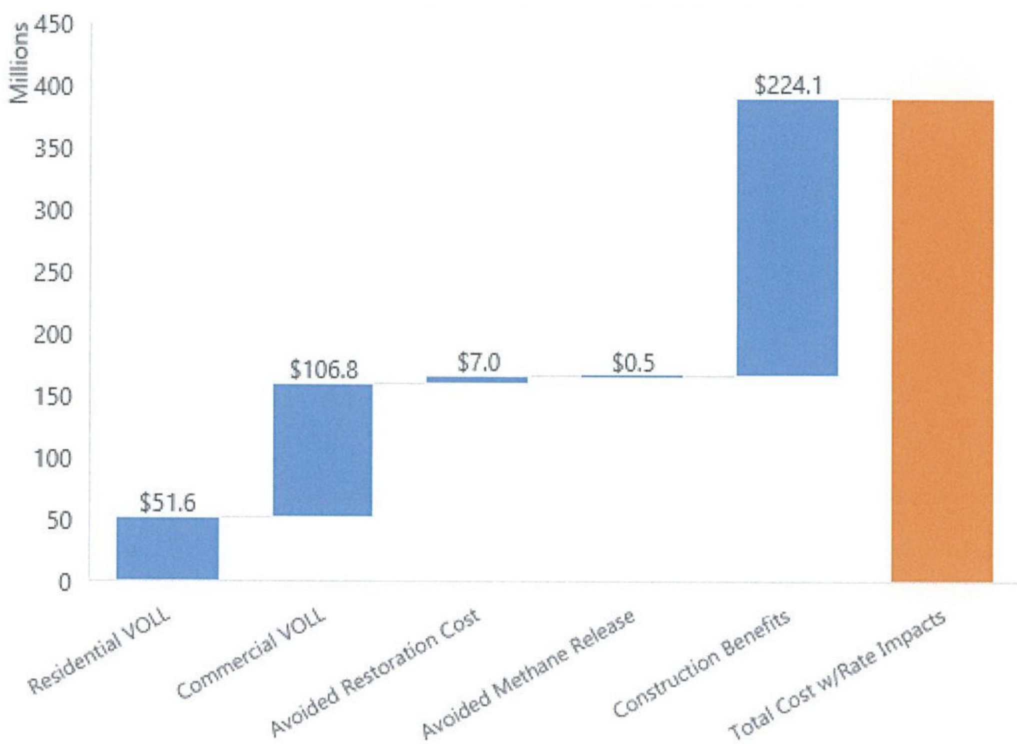
Our analysis found that the proposed NJNG IIP portfolio is cost-effective after only 6.2 days of avoided outages across the useful life of the projects, estimated to be 37-years on average. This equates to 0.17 outage days per year. The benefits of the NJNG IIP portfolio are divided into five categories:

(1) residential value of lost load;
(2) commercial value of lost load;
(3) avoided restoration costs;
(4) avoided methane release; and
(5) economic impacts of construction and in-state spending.

Each of these benefits are detailed in Section 4.3.

Figure 5 illustrates how these five benefits combine to equal the total costs associated with the IIP (inclusive of economic effects of rate impacts) in present value terms.

Figure 5: Comparison of Benefits and Costs Assuming 6.2 Outage Days



The largest driver of benefits is the economic benefit to New Jersey from the construction of the projects and its related activities. This is followed by the commercial value of lost load, which is nearly $120 million over 6.2 avoided outage days. While the construction benefits would remain the same under any level of outages, if avoided outages were to increase above 6.2 outage days over the weighted-average 37-year period, the commercial and residential value of lost load would increase.

Figure 6 shows the project level cost-benefit overview with a focus on net-benefits and the number of avoided outage days needed to 'break-even' on expected project costs. This table is inclusive of all quantified costs and benefits reviewed in this report, including the economic multiplier effects of the rate impacts.

Figure 6: Project Cost Benefit Overview

Project	Benefits	Costs	Net Benefits	Days Needed
Reliability and Resiliency Projects	162,933,287	-145,192,863	17,740,424	4.7
Replacement and Reinforcement Projects	31,320,752	-16,035,847	15,284,905	1.7
LNG Transmission Interconnection Project	12,192,486	-20,865,883	-8,673,397	n/a
Regulator Station Reconstruction Project	9,289,194	-6,095,647	3,193,547	3.1
Trunk Line Replacement Projects	118,709,417	-114,887,380	3,822,036	5.9
EFV Installation Project	34,601,145	-54,072,200	-19,471,056	262.7
Regulator Protection Project	20,846,530	-32,742,990	-11,896,460	47.9
Total Portfolio	**389,892,811**	**-389,892,811**	**0**	**6.2**

On a project basis, four of the seven projects are cost-effective when evaluated based on 6.2 days of customer outages over the useful life of the projects, estimated at 37-years. There are varying reasons why the other three projects did not accrue as many benefits across the 6.2 outage days.

The LNG Transmission Interconnection Project likely provides benefits that were not accounted for in this analysis. Because we attributed no outage related savings to the LNG project, this project could not be evaluated from a 'break-even' perspective. According to the NJNG, following these upgrades the LNG facility would be able to maintain service to the entire NJNG service territory for several days of 65-degree temperatures or warmer. This benefit was not quantified in this analysis. The LNG project would also enhance the ability of NJNG to use the facility as a local peaking source of gas in times of extreme system demand when additional pipeline sources gas cost may spike. This benefit was not quantified in an outage scenario but will provide an economic benefit.

The EFV Installation Project and Regulator Protection Project provide numerous benefits, but the monetary and economic benefits included in this analysis were largely focused on outage avoidance, which neither of these projects provide. The primary benefits of these projects are related to safety of NJNG customers and employees. EFV installations avoid potential explosions which could save human lives in NJNG service territory. While these projects would require significant outage days to 'break-even' from a cost-benefit standpoint, the BPU should consider the other benefits provided by these projects that are not quantified in the net-benefits value.

Overall, the NJNG portfolio of projects 'breaks-even' at only 6.2 outage days over the useful life of the projects, calculated at 37-years. While individual projects require differing lengths of time to 'break-even', the comprehensive portfolio would deliver tangible value to NJNG's customers over their lifetime with minimal outages required for benefits to exceed costs.

6 CONCLUSION

This report provides the methodology and analysis that reasonably calculates the number of outage days each of the NJNG IIP projects must avoid in order to be deemed cost-effective. From the perspective of the entire portfolio, these projects will be cost-effective as long as they offset at least 6.2 days of outages in aggregate for the impacted customers over the useful life of the projects, which is estimated at a weighted-average of 37-years.

To determine whether 6.2 total days of avoided outages over the 37-year weighted-average useful life of the projects is a reasonable benchmark, there are a number of factors that must be considered. As we have discussed, natural gas outages typically stem from extreme weather events, and the frequency and severity of extreme weather events is expected to increase in the coming years as a product of climate change. Properly strengthening the State's natural gas infrastructure is vital to combating the changing environment.

Alternatively, and, likely conservatively, we can look to the past as a baseline reference of whether these projects would have provided value during previous gas outages. Over the past decade, NJNG has experienced over 1.5 million customer outage days[15] for customers in its service territory. For all customers, that equates to 0.30 outage days per year, or 11.1 outage days over 37-years. That means that if these projects were to help avoid another Superstorm Sandy, the benefits accrued to customer would be nearly twice that of the costs.

Because extreme weather events are likely to increase in the future, and the quantitative review of the past decade indicate that 6.2 days of avoided outages over the 37-year weighted-average useful life of the projects, or 0.17 outage days per year, is a reasonable outcome from a cost-effectiveness perspective. To the extent more than 6.2 days of outages occur, these projects would surpass 'break-even' and deliver benefits which exceed their costs.

In addition, the non-quantified and qualitative benefits summarized in Section 4.3.6 provide additional benefits to NJNG customers which further support the findings of the cost-benefit analysis.

[15] Predominantly during Superstorm Sandy when over 32,000 customers were without service for up to two months.

Appendix A: Project Cost Detail

Figure 7: A1. Estimated Project Cost by Category

Project	Contract Labor ($)	Material ($)	Internal Labor ($)
Reliability and Resiliency Projects	78,187,500	12,510,000	13,552,500
Replacement and Reinforcement Projects	8,062,500	1,290,000	1,397,500
LNG Transmission Interconnection Project	11,900,000	2,890,000	2,210,000
Regulator Station Reconstruction Project	2,750,000	1,650,000	600,000
Trunk Line Replacement Projects	53,940,000	21,750,000	11,310,000
EFV Installation Project	30,400,000	5,600,000	4,000,000
Regulator Protection Project	15,972,000	4,840,000	3,388,000
Total Portfolio	**201,212,000**	**50,530,000**	**36,458,000**

Figure 8: A2. Project Revenue Requirements

Project	Nominal Costs ($)	NPV Costs ($)
Reliability and Resiliency Projects	258,524,783	105,616,390
Replacement and Reinforcement Projects	27,100,635	11,664,817
LNG Transmission Interconnection Project	44,054,047	15,178,289
Regulator Station Reconstruction Project	10,611,780	4,434,104
Trunk Line Replacement Projects	219,443,620	83,571,534
EFV Installation Project	97,833,251	39,333,274
Regulator Protection Project	52,119,574	23,817,951
Total Portfolio	**709,687,689**	**283,616,358**

Figure 9: A3. Project Economic Rate Impacts

Project	Nominal Costs ($)	NPV Costs ($)
Reliability and Resiliency Projects	355,398,944	145,192,863
Replacement and Reinforcement Projects	37,255,759	16,035,847
LNG Transmission Interconnection Project	60,561,938	20,865,883
Regulator Station Reconstruction Project	14,588,217	6,095,647
Trunk Line Replacement Projects	301,673,324	114,887,380
EFV Installation Project	134,493,234	54,072,200
Regulator Protection Project	71,649,771	32,742,990
Total Portfolio	**975,621,186**	**389,892,811**

Appendix B: Project Benefit Detail

Figure 10: B1. Residential Customer VOLL Analysis

Month	Residential Customers	Price per MMBtu ($)	Consumption (MMBtu)	Value per Customer per Day ($)
Jan	505,387	10.47	9,630,854	187.85
Feb	506,130	10.47	7,767,828	186.26
Mar	506,590	10.47	6,375,309	181.89
Apr	506,867	10.47	3,055,896	67.45
May	507,276	10.47	1,837,219	64.54
Jun	508,203	10.47	1,302,706	62.79
Jul	508,319	10.47	1,137,064	65.90
Aug	508,987	10.47	989,711	65.05
Sep	509,344	10.47	977,188	61.16
Oct	501,539	10.47	2,260,148	65.74
Nov	503,065	10.47	5,503,435	180.27
Dec	504,542	10.47	7,604,683	184.54
Total	**6,076,247**		**48,442,040**	**113.98**

Figure 11: B2. Commercial Customer VOLL Analysis

Category	Value	
Total Value-Added to GDP in NJNG Territory	$85,999,810,515	[a]
Total Value-Added from Impacted Industries	$45,099,476,667	[b]
Percentage of Economy Impacted	52%	[c]=[b]/[a]
Total Value-Added Lost per Day	$123,560,210	[d]=[b]/365
NJNG C&I Customers	28,653	[e]
Total Value-Added Lost per C&I Customer per Day	$4,312	[f]=[d]/[e]
Percentage of Customers with Natural Gas	67%	[g]
Total Value-Added Lost per C&I Customer per Day from Gas	**$2,890**	[h]=[f]x[g]

Figure 12: B3. Avoided Restoration Cost

Category	Value	
Authorized Restoration Cost from Sandy	$15,201,449	[a]
Customer Outage Days from Sandy	1,536,817	[b]
Avoided Restoration Cost per Customer per Day	**$9.89**	[c]=[a]/[b]

Figure 13: B4. Avoided Methane Value by Year

Year	Value ($)
2010	996.59
2011	1,064.19
2012	1,120.35
2013	1,176.40
2014	1,235.23
2015	1,248.09
2016	1,387.10
2017	1,413.23
2018	1,447.66
2019	1,606.95
2020	1,563.02
2021	1,601.49
2022	1,778.45
2023	1,821.73
2024	2,006.63
2025	2,052.16
2026	2,100.26
2027	2,304.11
2028	2,359.42
2029	2,576.78
2030	2,636.86
2031	2,696.49
2032	2,928.55
2033	2,993.40
2034	3,238.35
2035	3,308.87
2036	3,569.55
2037	3,648.86
2038	3,926.87
2039	4,014.76
2040	4,104.53
2041	4,407.43
2042	4,508.57
2043	4,831.90
2044	4,944.50
2045	5,291.39
2046	5,417.04
2047	5,789.29
2048	5,932.11
2049	6,332.85
2050	6,487.98
2051	6,787.28
2052	7,062.59
2053	7,377.39
2054	7,664.40
2055	7,990.44
2056	8,323.18
2057	8,672.03
2058	9,029.74
2059	9,407.50
2060	9,799.42
2061	10,207.71
2062	10,632.37
2063	11,075.64
2064	11,536.98
2065	12,017.53
2066	12,518.06
2067	13,039.58
2068	13,582.74
2069	14,148.53
2070	14,737.89

Figure 14: B5. Project Construction Benefits (nominal)

Project	Direct Benefits ($)	Indirect Benefits ($)	Induced Benefits ($)
Reliability and Resiliency Projects	46,953,902	20,112,365	41,294,251
Replacement and Reinforcement Projects	4,841,769	2,073,937	4,258,160
LNG Transmission Interconnection Project	7,244,472	3,101,726	6,320,554
Regulator Station Reconstruction Project	1,741,438	745,061	1,486,584
Trunk Line Replacement Projects	33,698,812	14,416,130	28,962,326
EFV Installation Project	17,597,571	7,556,824	15,852,977
Regulator Protection Project	9,966,692	4,261,889	8,564,316
Total Portfolio	**122,044,656**	**52,267,933**	**106,739,169**

Figure 15: B6. Project Construction Benefits (NPV)

Project	Direct Benefits ($)	Indirect Benefits ($)	Induced Benefits ($)
Reliability and Resiliency Projects	38,475,983	16,480,909	33,838,229
Replacement and Reinforcement Projects	4,368,840	1,871,361	3,842,236
LNG Transmission Interconnection Project	5,299,660	2,269,053	4,623,772
Regulator Station Reconstruction Project	1,273,941	545,046	1,087,504
Trunk Line Replacement Projects	24,871,581	10,639,899	21,375,794
EFV Installation Project	14,645,142	6,288,979	13,193,246
Regulator Protection Project	8,337,216	3,565,104	7,164,117
Total Portfolio	**97,272,362**	**41,660,352**	**85,124,899**