OFFICIAL COPY
Jul 22 2019

Financial Analysis of Transit Bus Electrification in North Carolina

July 2019

Prepared for:
EDF and Clean Energy Works

Prepared by:
Ryan Cook
Kelly Blynn

OFFICIAL COPY
Jul 22 2019

Contents

Tables

Figures

OFFICIAL COPY

Jul 22 2019

Executive Summary

Following a Fleet Assessment for the transit agency GoTriangle conducted by the NC Clean Energy Technology Center in 2018, Cadmus conducted a financial analysis of fleet electrification for GoTriangle with support from EDF through Clean Energy Works. Key findings included:

- The GoTriangle procurement plan from 2020-2023 called for 56 new buses, and the total incremental upfront cost for buying battery electric buses was $20 million.
- Even though the incremental upfront cost poses a barrier to procuring electric transit buses, the total cost of ownership was comparable between an electric and diesel bus.
- More than 75% of that total upfront incremental cost could be addressed through a potential utility tariffed on-bill investment program for the on-board battery and charging station that connects it to the grid.
- For the same amount of grant funds required to pay for the incremental upfront cost of one battery electric bus in 2020, the transit agency could by at least three battery electric buses if its electric utility offered to make such a tariffed on-bill investment, and by 2023, that multiplier would increase to more than five.

Following consultation with Duke Energy, EDF and Clean Energy Works engaged Cadmus to assess the cash flows for such a potential program for Duke Energy, which provides electric service to GoTriangle. This analysis is intended to help understand the costs and benefits to Duke Energy Progress of offering site-specific investment in the grid-connected infrastructure associated with battery-electric transit buses and their charging stations on tariffed terms with on-bill cost recovery.

This memo describes analysis that:

- **Assesses the value to program participants (transit agencies)** which compares the total cost of ownership for new buses of different fuel types, accounting for anticipated reductions in battery costs and ongoing increases in costs for conventional buses. This analysis also models changes in vehicle maintenance and fuel costs over time to inform the subsequent financing analysis.
- **Analyzes the value of offering a utility tariffed financing solution to the utility and to ratepayers.** This analysis shows results for the utility and ratepayers for offering tariffed on-bill financing on terms similar to Pay As You Save® (PAYS®) programs to invest in the upfront cost premium of the on-board battery and charging station for an all-electric bus that connects it to the grid. PAYS-based programs for financing building energy upgrades are currently offered in other parts of the state.

Duke Energy participated in the analysis by providing and validating data inputs and analytic assumptions that supplemented information previously gathered for the financial analysis prepared for

OFFICIAL COPY
Jul 22 2019

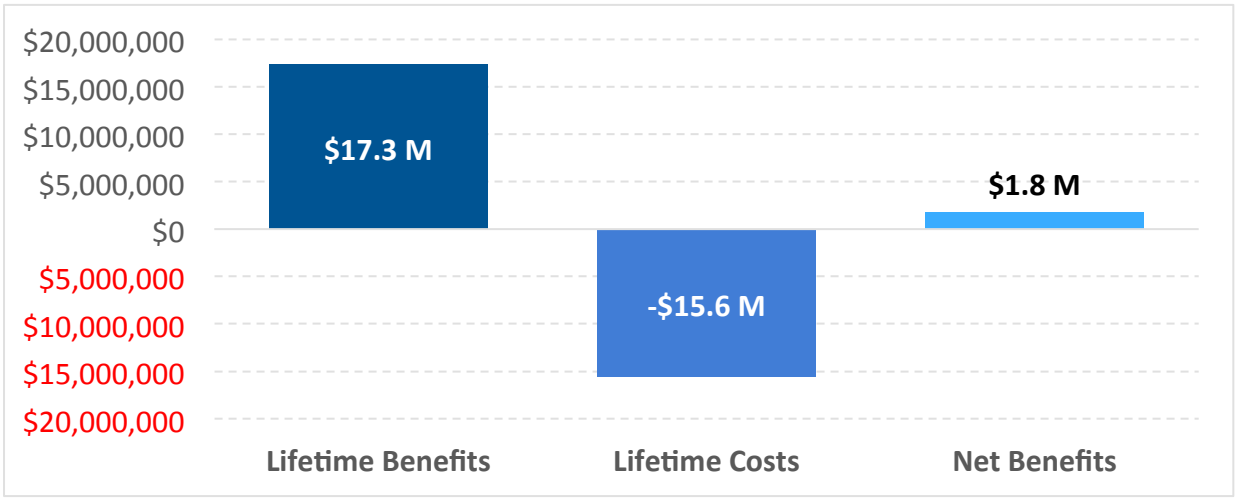
GoTriangle. All data used in this edition of the financial analysis for Duke Energy is from non-confidential sources.

The analysis is calculates the cash flows associated only with the case of GoTriangle, which has planned to procure 56 buses over the next five years. The analysis considers a scenario where Duke Energy makes a tariffed on-bill investment in the on-board battery storage and charging equipment that connects it to the grid. Duke Energy would recover its tariffed on-bill investment through a dedicated cost recovery charge on the bill for GoTriangle that would be capped at 85% of the estimated operational savings.

Key findings from this analysis include:

- Procuring 56 battery electric buses between 2020-2023 would require a total capital cost of more than $47 million for GoTriangle, which is **$20 million** above the cost of purchasing new diesel buses.
- The energy and operational savings of battery electric buses compared to diesel are sufficient to **recover more than 75% of the incremental upfront cost,** or just over $15 million. GoTriangle would retain 15% of the value of energy and operational savings in this assessment.
- Such an investment program would be expected to provide **$1.8 million on net utility ratepayer value** (less program administration costs, which are not projected in this analysis), due to increased retail sales to the utility. As tariffed cost recovery charges would incorporate the utility's cost of capital, there would be no net financing cost to the utility.
- The combined cash flows for the utility from the tariffed on-bill program and the cost of serving new load over the operating life of the battery aboard the electric bus yields a benefit-cost ratio of 1.11.

Figure ES: Lifetime discounted total cash flows for the utility (2020-2023 procurement of 56 BEBs)



OFFICIAL COPY

Jul 22 2019

1 Value to Program Participants (Transit Agencies)

GoTriangle is a regional bus transit agency connecting the service areas of multiple local bus transit agencies in the Research Triangle area of North Carolina, and its electric service provider is Duke Energy. To seek funding for its first electric buses, GoTriangle applied jointly in 2017 with other transit agencies in the region for a $3.3 million Low or No Emission (Low/No) grant from the Federal Transit Administration to purchase electric buses. The Low/No grant program is highly competitive and often oversubscribed, and the joint grant application led by GoTriangle was declined in 2017.

In 2018, GoTriangle sought a Fleet Assessment from the NC Clean Energy Technology Center in order to identify which bus routes could be served by electric buses based on the performance of current technology. Following that technical analysis, Cadmus conducted a financial analysis of fleet electrification for GoTriangle with support from EDF through Clean Energy Works. The analysis was intended to help understand the costs and benefits of transitioning GoTriangle's bus fleet, and to explore potential financing strategies to accelerate fleet electrification with less dependence on grant funds.

The analysis:

- **Compared the projected cost of ownership over time** for new buses of different fuel types.
- **Analyzed the use of a utility on-bill investment** for the upfront cost premium of the on-board battery and charging station for an all-electric bus that connects it to the grid.

This analysis calculates the resulting cash flows of a tariffed on-bill program from the perspective of GoTriangle. Assumptions made in the financial analysis were made consistent with those in the technical fleet assessment developed by the NCSU Clean Energy Technology Center, ensuring that the two reports would provide a compatible basis for decision-making. Cadmus developed a complete memo that documents all data inputs and results for the financial analysis, which are summarized in this section.

1.1 Data Inputs for Transit Agency

For the financial analysis of a potential utility on-bill investment for Battery Electric Buses (BEBs) prepared for GoTriangle, the key data inputs used include:

OFFICIAL COPY

Jul 22 2019

Table 1: Summary of financial analysis inputs and assumptions for GoTriangle

Inputs	Assumptions
Bus lifespan and battery warranty period	12 years
Annual electric consumption per BEB	~100,000 kWh/year per BEB
Monthly billing demand	37.5 kW per BEB, each month
Vehicle procurement schedule	56 BEBs procured from 2020-2023
Vehicles charging patterns	Illustrative hourly load profile for depot charging determined based on timing of GoTriangle fleet use
Cost of capital embedded in cost recovery	6.75%, consistent with the most recent Duke DSM plan
Assumed retail energy tariff	Duke Progress SGS-TOU rate

1.2 Total Costs of Ownership in 2019 for Transit Buses

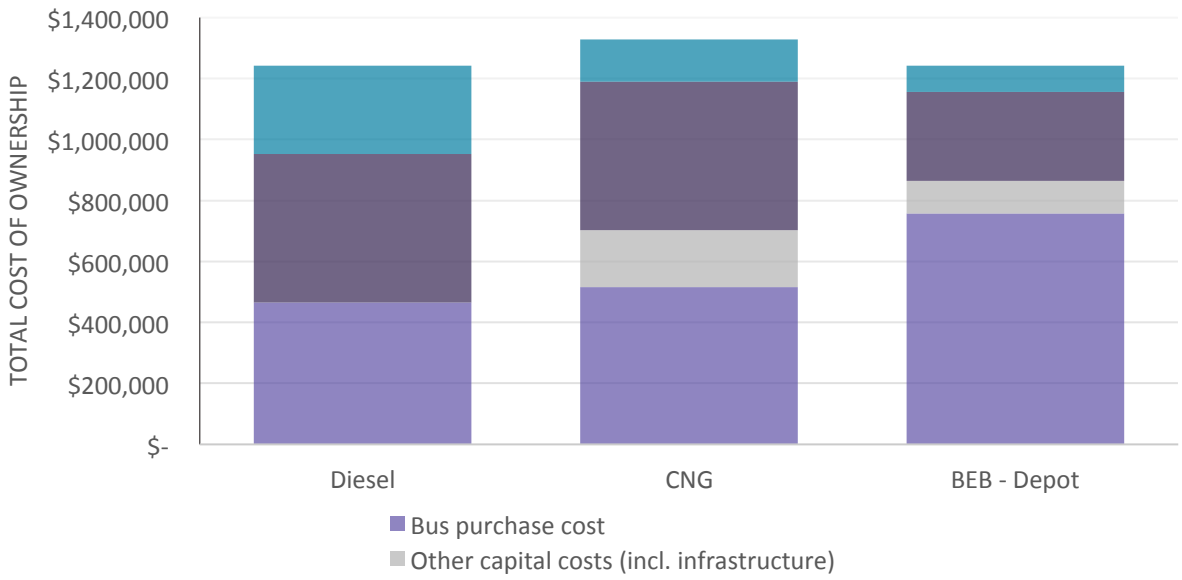
The total cost of ownership (TCO) for transit buses is a financial metric that considers costs over the economic life of the bus, including upfront capital costs as well as operation, maintenance, and fuel costs. Transit bus lifecycle cost models have previously been developed by federal research agencies such as the Transit Cooperative Research Program and by agencies with expertise in electric buses such as the California Air Resources Board through its Innovative Clean Transit initiative.

The analysis compares the total cost of ownership of a transit bus 40 feet in length across three different technology types: (1) depot-charge battery electric buses (BEBs), (2) compressed natural gas (CNG) transit buses, and (3) diesel transit buses.

Figure 1 provides a high-level cost comparison for a single bus procured in 2019 for each type of bus technology by cost category. The comparison includes first year capital costs, such as bus purchase costs, charging infrastructure, and a 12-year battery warranty, as well as average annual costs over 12 years, such as fuel and maintenance costs.

OFFICIAL COPY
Jul 22 2019

Figure 1: Total cost of ownership for a bus purchased in 2019 (Discounted)



The total cost of ownership (TCO) analysis prepared for GoTriangle found that battery electric transit buses (BEBs) are competitive with compressed natural gas (CNG) transit buses and diesel transit buses over the anticipated lifetime of the bus.

Key findings include:

- Compared to diesel transit buses, BEBs are expected to (1) require a greater upfront investment and (2) generate annual savings on maintenance and fuel.
    - Battery electric buses (BEBs) are expected to have first-year costs that are more than 75% higher than conventional diesel purchases ($865,000 per bus compared to $466,000 in 2019, accounting also for fueling infrastructure and other capital costs).
    - BEBs are expected to require annual fuel and maintenance costs that are approximately 50% lower than conventional diesel alternatives ($39,100 compared to $80,400 in 2019).
- Overall, the lifetime discounted total cost of ownership of BEBs and conventional diesel to GoTriangle are expected to be similar. Both a 2019 BEB and conventional diesel purchase are projected to have lifetime discounted costs of $1.2MM.

1.3 Utility On-Bill Investment for Battery Electric Buses

Tariffed on-bill investment programs have been implemented both domestically and internationally, primarily to finance building energy efficiency improvements, and many have been based on the Pay As You Save® (PAYS®) system. While most PAYS programs have focused on residential customers, some

OFFICIAL COPY

Jul 22 2019

have financed projects for municipal and other public entities such as lighting improvements and other energy efficient technologies. In a tariffed on-bill program, a utility will invest in customer-sited energy improvements, and recover the costs of this investment from that customer site over time through a dedicated tariffed charge.

Assessing the potential value of a tariffed on-bill investment program for GoTriangle, Cadmus found the following for a 2020 installation:

- Based on expected annual fuel and operational savings, GoTriangle could pay the utility a monthly cost recovery charge of up to $2,792 through a tariffed on-bill investment program, while retaining 15% of the value of operational savings as net savings (positive cash flow).
- Assuming the utility's investment is recovered within the warranty period for the on-board battery purchases (12 years) and assuming Duke Energy's previously published net-of-tax rate of return of 6.75% would apply, these payments would be sufficient to recover $270,000 of upfront investment per electric bus through a tariffed on-bill program.
- This upfront investment would reduce the incremental cost of a 2020 BEB compared from $375,000 to roughly $105,000 (with the full incremental cost being 3.6 times the remaining incremental cost following financing). It is expected that the financeable share of up-front costs would increase over time as BEB technology improves and achieves cost reductions.

Table 2 presents data from the same set of calculations in the financial analysis for three additional years, 2021, 2022, and 2023. It shows that the incremental upfront cost of a battery electric bus and a depot charging station is expected to decline in the future, yet the incremental upfront cost barrier is expected to persist. This indicates that a financing solution could allow the transit agency to meet the upfront cost requirements of a greater number of battery electric buses in the near term.

Table 2: Estimated cost per bus for electrification of planned procurements (2020-2023)

	2020	2021	2022	2023
Incremental upfront cost per bus	$375,000	$361,000	$350,000	$339,000
Incremental upfront cost per that meets PAYS financing threshold	$270,000	$273,000	$276,000	$279,000
Copayment needed per bus (likely sought as federal or state grant)	$105,000	$88,000	$74,000	$60,000
Ratio of full incremental cost to copayment	3.6:1	4.1:1	4.7:1	5.6:1

Figure 2 illustrates the impact of the multiplier effect of a tariffed on-bill investment using the results presented in Table 2. With a potential utility on-bill investment offer from the utility, the incremental

OFFICIAL COPY

Jul 22 2019

upfront cost to the transit agency would drop by 72% in 2020, enabling it to more than triple the number of electric buses that could be purchased with the same grant funds. (This analysis assumes that additional grant funds would be needed only to fund the incremental cost of a battery electric bus over the cost of a standard diesel bus.) This ratio of copayment to incremental upfront cost is projected to increase in the coming years. This analysis projects that, by 2023, GoTriangle would be able to use a tariffed on-bill program to meet the incremental costs of 5.6 battery electric buses for the same cost as paying the full incremental cost of a single battery electric bus.

Figure 2: Sources of funds for the incremental upfront cost of a single battery electric bus and charger

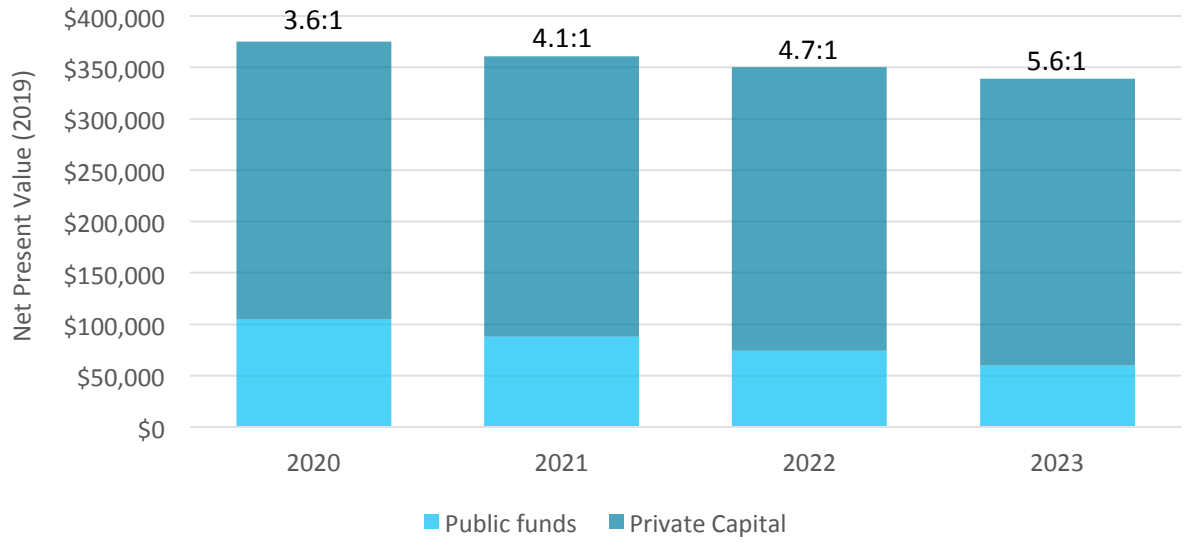


Table 3 shows the portion of the total annual incremental upfront cost that could be covered with a utility on-bill investment if GoTriangle were to solely purchase battery electric buses in the coming years. Of a total incremental cost of roughly $20.1 million, 76% (roughly $15.3 million) could be addressed through a tariffed on-bill program, leaving the agency with a remaining upfront copayment need of $4.7 million. The resulting ratio of total incremental upfront cost to post-financing copayment indicates how many more electric buses could be procured per grant dollar under a tariffed on-bill program.

Table 3: Estimated cost for fleet electrification with utility on-bill investment and copayment

	2020	2021	2022	2023	Total
Estimated number of buses to be procured	20	12	8	16	56
Total incremental upfront cost ($ million)	**$7.5M**	**$4.3M**	**$2.8M**	**$5.4M**	**$20.1M**
Total tariffed on-bill investment	**$5.4M**	**$3.3M**	**$2.2M**	**$4.5M**	**$15.3M**
Total copayment needed($ million)	**$2.1M**	**$1.1M**	**$.6M**	**$1.0M**	**$4.7M**
Ratio of copayments to full incremental cost	3.6:1	4.1:1	4.7:1	5.6:1	**4.2:1**

OFFICIAL COPY
Jul 22 2019

2 Value to the Utility and Ratepayers

Duke Energy provides electricity service to most members of the North Carolina Public Transit Association, including GoTriangle. After reviewing the results of the analysis in Section 1, Duke Energy representatives provided publicly available data to complete analysis of the cash flows related to the same tariffed on-bill investment as would be seen from the perspective of the utility and its ratepayers.

The analysis of cashflow components for a utility offering such a tariffed on-bill investment program for clean transit includes:

- Utility energy supply costs to serve new load from electric buses
- Utility capacity costs for new peak demand
- Utility revenues from new load
- Utility investments in battery electric buses
- Cost recovery payments through tariffed on-bill programs

This analysis does not include:

- Utility program administration costs
- Any utility grid infrastructure make-ready costs not recovered from the transit agency
- Any costs or benefits associated with financing the utility's upfront investment (this analysis assumed utility investments are sourced from available funds)

2.1 Data Inputs for the Utility

Table 4 summarizes additional inputs related to Duke Energy used in this analysis.

Table 4: Data inputs for Duke Energy analysis

Inputs	Assumptions and Source
Utility marginal energy and capacity costs	Provided by Duke Energy to reflect annual energy costs per kWh and capacity and T&D costs per annual kW (Duke Progress inputs used)
Utility retail tariff	Duke Progress Small General Service TOU Tariff used
Utility System Peak	Hour ending at 7am in winter months (provided by Duke staff)
Line loss	3.35% (derived from Duke progress NC EIA Form-861 report, 2017, Early Release Data)
Utility Discount Rate	6.75% (from prior Duke DSM plans)
Retail Rate and Utility Marginal Cost Escalation	Based on escalation forecast embedded in Duke avoided costs

OFFICIAL COPY
Jul 22 2019

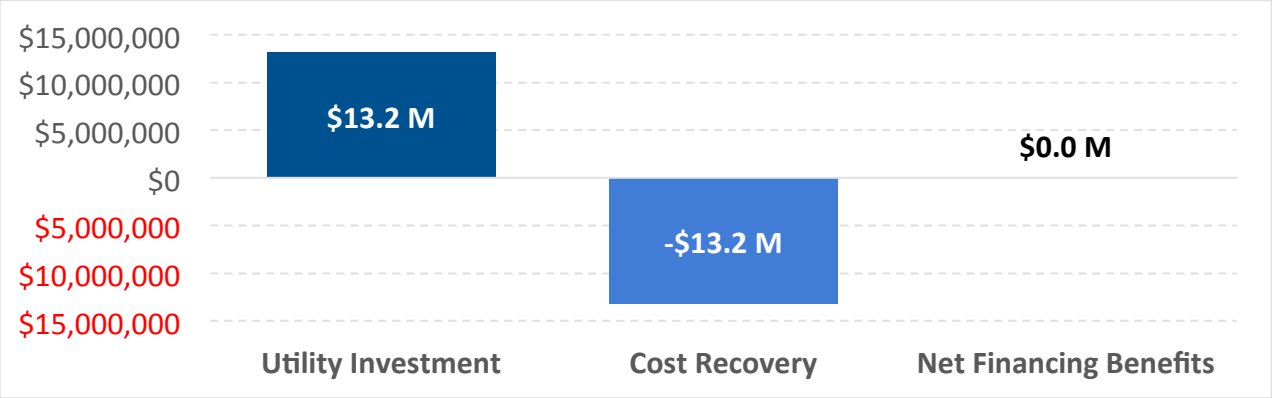
2.2 Results of Cash Flow Analysis for the Utility and Ratepayers

2.2.1 Cash Flows for On-Bill Investment and Cost Recovery

Using the terms of a potential tariffed on-bill investment program described in Section 1.3, the cash flow analysis found that:

- Duke Energy could finance the procurement of 56 battery electric buses from 2020-2023 with a tariffed investment of NPV $13.17 million. This analysis assumed that the capital for this investment was sourced by Duke from available funds at its cost of capital.
- The cash flow from the on-bill cost recovery payments is also equal to NPV $13.17 million, as the cost recovery payments would include the program cost of capital, which is assumed to be equal to Duke's own cost of capital.
- As a result, there would be no net financing cost or benefit to the utility and ratepayers.

Figure 3: Lifetime discounted total cash flows (2020-2023 procurement of 56 BEBs)



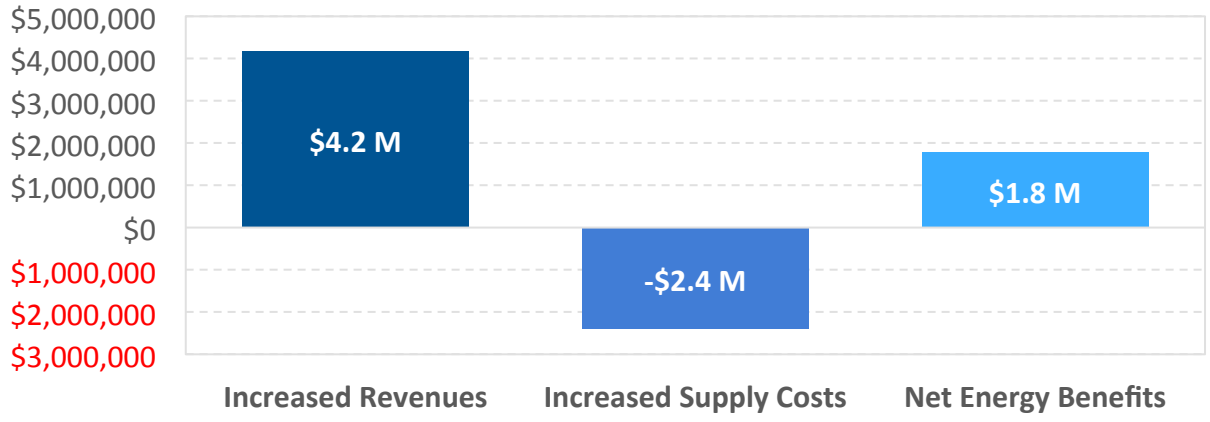
2.2.2 Cash Flows for Supply and New Sales

The analysis also considered the benefit of additional sales resulting from vehicle electrification on the part of GoTriangle. The ratepayer value of these additional sales would be partially offset by the additional utility energy and capacity costs required to serve this new load. The analysis found that:

- Increased sales of electricity to battery electric buses would increase utility revenues by NPV $4.17 million over the lifetime of the 56 buses planned for procurement from 2020 through 2023 by GoTriangle.
- Duke Energy would incur NPV $2.40 million in additional energy and capacity costs to serve this new load.
- Duke Energy would gain NPV $1.78 million in net energy revenue from procurement of 56 BEBs.

OFFICIAL COPY
Jul 22 2019

Figure 4: Lifetime discounted cash flows for new electricity sales (2020-2023 procurement of 56 BEBs)



2.2.3 Aggregate Utility Impacts

The aggregate impact to the utility and ratepayers of offering a tariffed on-bill investment program for battery electric buses can be determined by combining the cash flows related to on-bill investment and cost recovery with the cash flows of supplying electricity for additional sales. This yields the following conclusions:

- The estimated net present value of the benefits over the expected operating life of the batteries on-board the buses is NPV $17.3 million.
- The estimated net present value of the costs over the same period is NPV $15.6.
- These lifetime costs and benefits yield net ratepayer benefits of $1.78 million and a benefit-cost ratio of 1.11.
- This analysis does not account for potential program administration costs, which would be a reduction to ratepayer benefits, and must be less than NPV $1.78 million to retain ratepayer benefits.

OFFICIAL COPY
Jul 22 2019

Figure 5: Lifetime discounted total cash flows for the utility (2020-2023 procurement of 56 BEBs)