Application for the FY 2016 TIGER Program

GREEN
Fleet Procurement
Benefit Cost Analysis

Submitted by the Regional Transportation Commission of Southern Nevada

DEPARTMENT OF TRANSPORTATION
UNITED STATES OF AMERICA

USDOT
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NEW FLYER

RTC

EXECUTIVE SUMMARY

Table 1: Benefits and Description by Evaluation Criteria

Long-Term Outcomes	Benefit Categories	Types of Societal Benefits
Quality of Life	***Not Quantified*:** Increased Accessibility	***Not Quantified:*** Enhanced transit attractiveness increases ridership and reduces household transportation expenditures.
	***Not Quantified*:** Health and Wellness Savings	***Not Quantified:*** Reduced emissions from transit diesel engines, particularly of harmful Particulate Matter, will result in societal health benefits.
Economic Competiveness	Travel Time Savings	Replacing old, unreliable diesel buses that are prone to in-service break-downs reduce transit travel times by increasing transit fleet reliability.
	Transit Fleet Operating Cost Savings	Reductions in transit operating costs due to lower priced compressed natural gas as compared to diesel fuel.
	Energy Security Benefits	Reductions in the economic cost of oil imports.
Safety	***Not Quantified*:** Crash severity reduction	***Not Quantified*:** Safety benefits due to a decrease in the risk of fatalities and injuries resulting from increased transit vehicle safety standards over time.
State of Good Repair	Maintenance and Repair Savings	Reductions in maintenance expenditures due to the replacement of diesel buses with high repair costs. This results in a reduced life cycle cost.
	Deferral of Complete Replacement	Reductions in future expenditures for transit procurement.
Environmental Sustainability	Emissions Reductions	Measurable reductions in Air Quality Criteria Pollutant emissions and a reduction in the Social Cost of Carbon emissions.
	Not Quantified: Noise reduction	***Not Quantified*:** Noise reductions benefit both transit passengers and the general public during transit operations. Reductions in noise emissions are the result of the use of quieter CNG engines, and general technology improvements that make new CNG buses quieter.

Table 2: Project Matrix

Current Baseline & Problem to be Addressed	Change to Baseline/Alternatives	Type of Impacts	Population Affected by Impacts	Economic Benefit	Summary of Results	Page Reference in BCA
Baseline: 28 old, unreliable diesel buses currently operating on RTC transit routes. Buses are currently beyond their design life, have high maintenance costs, consume relatively expensive diesel fuel, decrease energy security, increase travel times due to in-service break-downs, and emit harmful pollutants. *Problems Addressed:* Transit accessibility, transit reliability, reduced travel times, reduced fuel expenditures, reduced life-cycle costs and increased sustainability.	Retire 28 existing diesel fueled transit vehicles and replace with 28 compressed natural gas (CNG) buses for immediate placement in revenue service.	Enhanced transit accessibility. Increased economic competitiveness. Reduced maintenance related life cycle costs. Reduced emissions for increased sustainability.	This transit investment will benefit the approximate 62 million passengers RTC carried in 2015. The average ridership directly affected by these new buses averages 32 persons per service hour.	Monetized value of improved transit travel times, increased energy security, reduced operating costs, reduced maintenance costs, and reduced air pollution emissions.	A summary table of the estimated dollar value of project costs and benefits can be found below in Table 3.	Economic Competitiveness Benefits: page 7 State of Good Repair Benefits: page 10 Sustainability Benefits: page 11

Table 3: Summary of Benefit-Cost Analysis

Calendar Year	Project Year	Cost – Planning & Procurement	Cost – CNG Facility Operation	Benefit – CNG Bus Maintenance	Benefit – CNG Fuel Cost Savings	Benefit – Reduction in Oil Imports	Benefit – Transit Travel Time Savings	Benefit – Reduced Emissions	Benefit – Replacement Deferral	Total Benefit – Not Discounted	Total 3% Discount Rate - 2016 $	Total 7% Discount Rate - 2016 $
2016	-1	-$150,000	$0	$0	$0	$0	$0	$0	$0	-$150,000	-$150,000	-$150,000
2017	0	-$20,510,000	$0	$0	$0	$0	$0	$0	$0	-$20,510,000	-$19,894,700	-$19,074,300
Full Year Project Open												
2018 (opening)	1	$0	-$97,552	$205,070	$292,857	$196,933	$400,681	$243,767	$0	$1,241,756	$1,168,368	$802,739
2019	2	$0	-$100,235	$220,367	$298,632	$202,349	$409,544	$250,784	$0	$1,281,441	$1,169,537	$770,985
2020	3	$0	-$102,991	$226,427	$298,632	$207,913	$418,603	$257,974	$0	$1,306,559	$1,156,687	$729,488
2021	4	$0	-$105,823	$232,654	$286,012	$213,631	$491,044	$264,886	$0	$1,382,403	$1,187,116	$723,023
2022	5	$0	-$108,733	$239,052	$306,546	$219,506	$501,905	$271,532	$0	$1,429,807	$1,190,989	$696,935
2023	6	$0	-$111,724	$245,626	$314,887	$225,542	$513,008	$279,256	$0	$1,466,595	$1,184,983	$664,413
2024	7	$0	-$114,796	$225,195	$268,687	$231,744	$524,355	$286,720	$186,357	$1,608,263	$1,260,465	$687,746
2025	8	$0	-$117,953	$259,321	$273,393	$238,117	$464,494	$294,372	$26,808,797	$28,220,541	$21,454,132	$13,515,772
2026	9	$0	-$121,197	$266,452	$283,873	$244,666	$547,809	$302,228	$0	$1,523,832	$1,123,710	$549,848
2027	10	$0	-$124,529	$273,780	$306,973	$251,394	$559,927	$310,287	$0	$1,577,831	$1,128,625	$530,589
2028	11	$0	-$127,954	$281,309	$317,454	$258,307	$648,621	$318,998	$0	$1,696,735	$1,177,266	$536,345
2029	12	$0	-$131,473	$289,045	$332,640	$265,411	$584,972	$327,482	$0	$1,668,076	$1,122,660	$485,354
End of Transit Vehicle Design Life												
2030	13	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2031	14	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2032	15	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2033	16	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2034	17	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2035	18	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2036	19	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
2037	20	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0
TOTAL		**-$22,024,959 undiscounted**								**$23,743,838 undiscounted**	**$14,279,840 costs included**	**$1,468,937 costs included**

Note: Social Cost of Carbon not included in 7% (2016 $) discount rate analysis

Total Net Present Value of Benefits (7%)(2016 $): $20,693,237

Total Net Present Value of Costs (7%)(2016 $): -$19,224,300

Benefit-Cost Ratio (7%)(2016 $) = 1.07

Total Net Present Value of Benefits (3%)(2016 $): $34,324,540

Total Net Present Value of Costs (3%)(2016 $): -$20,044,700

Benefit-Cost Ratio (3%)(2016 $) = 1.71

Project Description

The RTC Transit Green Fleet Procurement project will dramatically improve regional economic competiveness by replacing 28 old diesel transit buses that have reached the end of their designed service life and purchasing 28 new clean-running compressed natural gas (CNG) transit vehicles.

Increasing economic competitiveness is a primary rationale for this TIGER project. Economic competiveness will be increased by decreasing transit travel times throughout the system and reducing transit operating costs. Travel times will be reduced by increasing transit service reliability with the replacement of older vehicles prone to in-service break-downs. Operational costs will be reduced by continuing RTC's fleet-wide conversion of rolling stock from diesel fuel to CNG. CNG is currently $2.19/gge (gasoline gallon equivalent) in Las Vegas compared to $3.08/gallon for diesel. These operational cost saving can then be directly passed on to the over 2 million residents and nearly 42 million annual visitors to Southern Nevada annually with potential future increases in transit service hours.

The project will also reduce maintenance costs of older transit vehicles and greatly improve air quality – as the Southern Nevada region strives to maintain air quality attainment and continue implementing binding commitments contained in the Particulate Matter (PM10), Ozone, and Carbon Monoxide (CO) Maintenance Plans.

Baseline Assumption

This benefit cost analysis compares the RTC Transit Green Fleet Procurement project build alternative to the "no build" scenario; which is the baseline assumption. Without the awarding of TIGER funds the project will not move forward. The baseline assumes that the 28 existing, old diesel transit vehicles would continue to operate in revenue service and continue to accumulate approximately 66,000 miles annually. Existing operating characteristics including transit headways, speeds, annual mileage accumulated, and service routes would be maintained.

To ensure a comparative analysis period between the baseline assumption and the build alternative, all benefits and costs of both alternatives are extended through the anticipated design life of the build alternative. This means that the analysis period extends 12-years beyond the anticipated year of the build project opening. Modern transit vehicles are designed to operate for 12-years or 500,000 miles of continuous service.

Costs related to the maintenance of the existing 28 diesel buses would continue through the analysis period. Specific maintenance costs include:

- Scheduled Maintenance;
- Unscheduled Maintenance;
- Propulsion Maintenance;
- Brake Maintenance;
- Transmission Rebuild/Replacement;
- Internal Combustion Engine Rebuild/Replacement; and
- Air Conditioning Compressor Replacement

These maintenance costs are assumed to increase 2.75% annually before discounting to present values. This annual rate of inflation was selected because it represents the historical average inflation rate from the preceding 20 years; 1994-2015.

Costs related to the maintenance and operation of diesel refueling and storage and maintenance yards are included with a 2.75% annual rate increase.

Operational costs related to refueling diesel vehicles in the baseline assumption incorporate findings from 12 studies that predict future oil prices (http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_rpt_132.pdf). This data source then used factors to convert wholesale crude oil prices into untaxed refined diesel prices. Existing federal, state and local diesel taxes were then added to these diesel cost estimates. No gas tax increases beyond those currently authorized were incorporated throughout the analysis period.

The current fuel economy of diesel buses was not projected to change throughout the analysis period. Therefore, current emission levels were also projected to remain consistent.

Economic competitiveness costs related to the unreliable operation of the current diesel fleet have been provided from the RTC's Fleet Management Services and are based on actual observed operating characteristics. These costs are anticipated to get marginally higher every year throughout the analysis period as the current diesel fleet operates well beyond its designed service life.

Total Project Costs

The total cost for the RTC Transit Green Fleet Procurement project is $22,024,959. This total project cost reflects the undiscounted lifetime project cost.

The total lifetime project cost is the sum of initial procurement costs, and the long-term maintenance and operation costs of utilizing CNG facilities for transit vehicle maintenance and refueling needs.

Other cost categories of the build alternative are outweighed by benefits of those same categories (i.e. the category of "CNG Fuel Cost Savings" is an overall project benefit, but the benefit amount is the difference between diesel costs and CNG fuel costs).

Planning and Transit Procurement Costs

Since this project is a purchase of transit rolling stock, there are no right-of-way costs. Additionally, since diesel buses will be retired and replaced with new CNG vehicles as they are delivered from Minnesota, there will be no construction delay impacts.

Procurement costs include the $20,360,000 purchase price for 28 vehicles at an approximate cost of $860,000 for each 60-foot and $550,000 for each 40-foot CNG transit vehicle. The RTC will purchase New Flyer Xcelsior® vehicles by exercising an owner-controlled option for additional transit vehicles under an existing rolling stock contract. The existing contract was awarded under a competitive procurement with all federal conditions observed.

Total procurement costs also include the soft cost of RTC staff time to administer the New Flyer procurement, contract award, exercising of options, contract administration, and subsequent grant award administration with FTA and the USDOT OST. These soft costs are anticipated to occur in 2016 and total $150,000.

The RTC will also contract with a 3rd party to ensure transit vehicles are manufactured and delivered in conformance with the required specifications. These funds are anticipated to be awarded through a competitive RFP after award of TIGER funds. The total cost associated with the services provided by this construction management firm is $150,000 and is scheduled to occur in 2016.

CNG Transit Facility Maintenance and Operation Costs

This project continues RTC's aggressive initiative to transition both the entire fixed route and paratransit fleet from diesel to CNG propulsion. Because of this transition, sunk costs to retrofit and retool the RTC's two maintenance bases to support high-capacity CNG refueling and maintenance needs have already occurred; or are scheduled to occur regardless of this project receiving TIGER funds. This includes additional costs associated with compressors, dryers, refueling equipment, storage facilities, methane detection, electrical upgrades and ventilation modifications. Therefore, costs associated with installing hard CNG infrastructure and facilities are not included in the total cost of this RTC Transit Green Fleet Procurement project.

However, this project will contribute an additional 28 CNG transit vehicles utilizing these infrastructure investments. This analysis does include the marginal cost associated with each additional transit vehicle's CNG refueling and maintenance needs at these facilities.

CNG transit vehicles demand a higher facility cost due to increased electricity consumption to operate the CNG fueling compressors and any applicable rebuild cost. CNG facility operational costs are approximately $0.23/mile (2009 $) compared to $0.18/miles (2009 $) for comparable diesel facility operations.

Benefits – Quality of Life (Livability)

Livability Benefits Not Included in Analysis

Health and Wellness Savings – This project will produce a quantifiable reduction in emissions from transit diesel engines; particularly of harmful Particulate Matter. However, this cost benefit analysis does not quantify the monetized societal benefits of reduced healthcare costs from these emissions reductions. The primary consideration for not including these benefits is the difficulty in monetizing the existing healthcare costs to the current receptors of diesel exhaust from the 28 diesel transit vehicles in operation that will be replaced.

Increased Transit Accessibility – The RTC Transit Green Fleet Procurement project is a 1-to-1 replacement of old diesel buses with new, more efficient and sustainable CNG buses. There is no planned transit service increase associated with this project, and therefore there is only minor livability benefits associated with this project.

However, it should be noted that any reduction in transit operational costs by the RTC can in turn be utilized by the RTC to fund increases in transit service hours. This project results in operational cost savings. But, because these increases in service hours would be funded under a separate operational project with a different funding source, they are not included in this analysis of the RTC Transit Green Fleet Procurement project.

No livability benefits have been quantified and monetized for this analysis.

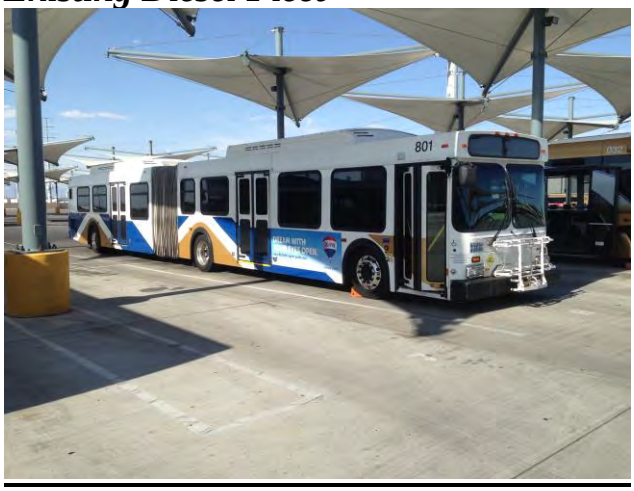
However, there is a subtle livability benefit associated with this project that could potentially increase transit ridership. Increasing the attractiveness of transit can induce more people to try transit and continue utilizing it – therefore contributing to a reduction in household transportation expenditures.

This project will enhance the attractiveness of transit by simply replacing older buses at the end of their service life with clean new buses. But, the project will also benefit from the vehicle manufacturer, New Flyer, incorporating a more updated exterior design and a more ergonomically friendly interior with enhanced seating positions, better storage, better HVAC systems, and better lighting. A brochure of the vehicles to be procured with enhanced, modern designs can be found here:

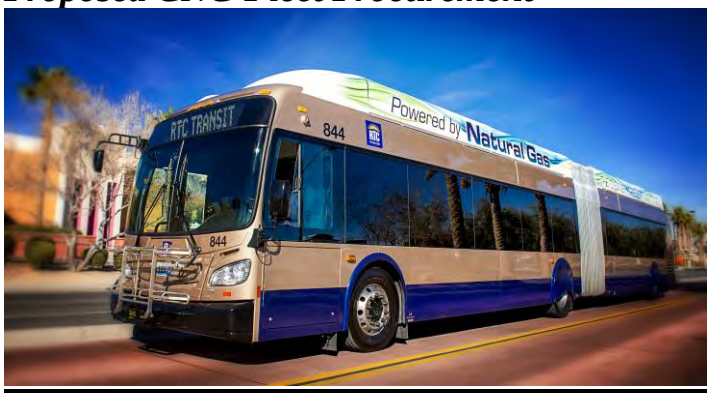
http://www.newflyer.com/index/cms-filesystem-action/buses/xcelsior/xcelsior%20brochure_032315_revised_forprint.pdf

A visual comparison of the RTC's existing diesel fleet and the CNG vehicles to be purchased with TIGER funds can illustrate this project livability benefit that is often difficult to monetize:

Existing Diesel Fleet



Proposed CNG Fleet Procurement



Benefits – Economic Competiveness

The economy of Southern Nevada is dominated by the gaming-based tourist industry located on the Strip. This industry is an important element of the national economy, with the tourist industry and supporting businesses employing over 382,800 people, 47% of the total regional workforce, and contributing $43 billion in economic output, which is over a third of the State of Nevada's GDP.

However, some aspects of the RTC's current fixed route fleet currently operate with inefficient aspects of economic competiveness.

CNG Transit Travel Time Savings from Increased Reliability

In light of the severe recent economic downturn in Las Vegas, a key component of any major infrastructure project is long-term economic competiveness. Ensuring travel times are minimized, especially for transit modes, can increase regional economic competiveness.

Approximately half of the vehicles targeted for replacement by this project are highly unreliable and diminish regional economic competitiveness. Based on observed field operating characteristics from RTC's Fleet Management Services, the current 40-foot diesel vehicles are reliable (0.92 in-service break-downs per vehicle/year), while the 60-foot diesel vehicles are highly unreliable (12.15 in-service break-down per vehicle/year). Taking the mean average for both vehicle classes to be replaced equates to 6.5 in-service break-downs per vehicle/year.

These non-recurring delays slow discretionary travel by visitors, and add to the monetary cost of commuting and reduce the efficiency and productivity of the workforce.

While CNG vehicles to be procured by this project are not anticipated to suffer in-service breakdowns and have proven highly reliable for the RTC, a nominal number of breakdowns for new CNG vehicles has been included to ensure a conservative analysis. In-service break-downs are projected to increase as buses reach the end of their design life.

Because the project is specifically designed to increase multi-modal travel options, travel time savings benefits were calculated for transit users only.

The first step in calculating the economic impacts of travel time savings is to determine the value of time for transit users. Consistent with the values contained in the *TIGER Benefit-Cost Analysis (BCA) Resource Guide* (www.dot.gov/sites/dot.gov/files/docs/Tiger_Benefit-Cost_Analysis_%28BCA%29_Resource_Guide_1.pdf), this analysis utilized the $13.00/hour value of Intercity Travel All Purposes travel for all transit users. CPI method to convert from nominal into real (constant) dollars: 2016 base year is $13.10. 1.20% annual growth rate.

The $13.10/hour value of travel time was projected to increase at 1.2% annually throughout the analysis period consistent with the *Revised Departmental Guidance on Valuation of Travel Time in Economic Analysis* (www.dot.gov/sites/dot.gov/files/docs/USDOT%20VOT%20Guidance%202014.pdf).
Additionally, research has shown that transit waiting time unit costs are two to five times higher than in-vehicle transit travel time. Because this project replaces buses prone to in-service breakdowns with highly reliable buses, and break-downs commonly occur along busy arterials in hot summer months, this analysis assumes the highest average delay premium and uses a 5 times factor (www.trb.org/TRBNet/ProjectDisplay.asp?ProjectID=1034 and http://www.nctr.usf.edu/jpt/pdf/JPT11-2Litman.pdf).

Transit Fleet Operating Cost Savings

A primary economic consideration of this project is the fuel cost savings benefits that will be realized by the RTC. Fuel costs are by far one of the largest expenses to operating transit services, and reducing them even slightly can have a profound impact on reducing costs.

This analysis compared the anticipated future fuel expenditures for the existing 28 diesel powered buses with the proposed 28 new CNG buses to be procured. The primary data source for the comparison of future fuel prices was the TCRP Report 132 (http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_rpt_132.pdf). Fuel prices are extremely volatile, and this report was selected because it calculated an average annual future price of diesel and CNG from 13 independent and peer-reviewed studies that predict the future prices. The CPI method was then used to convert from nominal 2007 dollars into real (constant) dollars using a 2016 base year.

In the first full year of project implementation, the RTC will save approximately $292,857 from having the 28 new buses powered by CNG as compared to continuing to operate the existing 28 diesel buses.

Part of this cost savings realized by the RTC is due to differences in the fuel tax between CNG and diesel. As demonstrated in the table below, diesel taxes are higher than CNG taxes (gasoline gallon equivalent) across the federal, state, and local level.

Table 4: Fuel Tax Differences Between Diesel and CNG (gasoline gallon equivalent)

Fuel Type	Federal Tax	State Tax	Clark County Tax
Diesel	$0.24	$0.27	$0.19
CNG	$0.18	$0.21	$0.10

While not considered in this benefit cost analysis, it should be noted that the RTC utilizes scarce local transit revenues to provide transit service hours. Any reduction in RTC operational costs can be directly transferred to the public through increased transit service (i.e. new routes or reduced transit headways).

Reduction in the Economic Cost of Oil Imports

Fuel consumption has a cost beyond the actual operating costs and environmental costs of the consumption, and this additional cost is expressed as the economic cost of oil imports. This concept reflects two ideas: a monopsony component and a price shock component.

The monopsony component derives from the following logic; because the U.S. is such a large consumer of oil, an increase in U.S. demand for oil would lead to higher fuel prices (based on supply and demand relationships). The price shock component comes from the fact that when there is a reduction in oil supplies, this leads to higher oil prices which in turn reduces the level of U.S. economic output. As a consequence, reducing oil imports by consuming less fuel reduces the impact of these costs on the U.S. economy.

The National Highway Traffic and Safety Administration discusses this concept, and estimates that each gallon of fuel saved reduces total U.S. imports of refined fuel or crude oil by 0.95 gallons.

The recommended value for NHTSA's estimate of the per-gallon cost of oil imports (both the monopsony and price shock components combined) is $0.295 per gallon (2006 $). CPI method to convert from nominal into real (constant) dollars: 2016 base year is $0.34/gallon with a 2.75% annual growth rate over the project's design life (http://www.nhtsa.gov/DOT/NHTSA/Rulemaking/Rules/Associated%20Files/CAFE_Final_Rule_MY2011_FRIA.pdf)

Benefits – Safety

Safety Benefits Not Included in Analysis

While improving user safety of the transportation system remains the RTC's top priority, it is not a primary consideration for implementing the RTC Transit Green Fleet Procurement project.

The safety benefits of this project are minor and would be difficult to quantify. As this project replaces old buses with new buses, any reduction in the severity of crashes that result in property damage, injuries, or fatalities would be the result of improved crash worthiness of the buses themselves.

The Federal Motor Vehicle Safety Standards (FMVSS) are U.S. federal regulations specifying design, construction, performance, and durability requirements for motor vehicles and regulated Automobile safety-related components, systems, and design features. FMVSS are currently codified at 49 C.F.R. 571 and are developed and enforced by the National Highway Traffic Safety Administration (NHTSA).

FMVSS are divided into three categories: crash avoidance (100-series), crashworthiness (200-series), and post-crash survivability (300-series). The first regulation, FMVSS No. 209, was adopted on 1 March 1967 and remains in force to date though its requirements have been periodically updated and made more stringent.

This periodic updating of the FMVSS provides the rationale for why the buses to be procured by this project are safer than the buses to be replaced. The average age of buses to be replaced are high mileage models dating back to 2005. Many of the FMVSS applicable to transit buses have been updated since 2005, with many of them pertaining to safety standards for CNG vehicles.

Quantifying and monetizing these safety benefits would be both difficult and provide only small benefits; as an analysis would require collecting existing transit crash rates and combining them with the marginal safety benefits of new buses. This analysis simply notes that a measurable safety benefit is present for this project, even though it is not measured, monetized, and included in this benefit cost analysis.

Benefits – State of Good Repair

CNG Vehicle Maintenance and Repair Savings

Maintaining a state of good repair for RTC's fixed route transit fleet is a primary consideration of this project. The buses to be retired currently have extremely high maintenance costs, while the new CNG vehicles to be procured have proved highly reliable to the RTC with low maintenance costs.

This cost benefit analysis of the monetary benefits of keeping the transit system in a state of good repair utilized information from the RTC's Fleet Management Services Department, which is charged with maintaining the fixed route fleet, and TCRP Report 132 (http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_rpt_132.pdf).

TCRP Report 132 outlines the customary and routine maintenance costs for transit vehicles powered by different propulsion technologies. As Table 5 below illustrates, the maintenance costs between CNG and diesel vehicles are approximately equal, with diesel maintaining a slight cost advantage.

Table 5: Vehicle Maintenance Cost Differences between Diesel and CNG Per/Mile

Fuel Type	Scheduled Maintenance	Unscheduled Maintenance	Brake Maintenance	Transmission Replacement (Fixed Cost)	Propulsion Maintenance
Diesel	$0.23	$0.42	$0.08	$12,856.00	$0.18
CNG	$0.31	$0.44	$0.08	$12,856.00	$0.20

However, this typical and small cost advantage for diesel vehicle maintenance erodes when costs for maintaining the RTC's existing diesel fleet are examined.

RTC's diesel engine rebuild or replacement costs are much higher than the national average. Typically, engine replacement costs are identical for both diesel and CNG transit vehicles, at an approximate fixed cost of $12,856 annually (http://onlinepubs.trb.org/onlinepubs/tcrp/tcrp_rpt_132.pdf); CPI method to convert to 2016 dollars. However, RTC's diesel vehicles to be replaced require two engine replacements annually, as each replacement only last 6 months. This is twice the national average for the frequency of diesel engine replacement. Additionally, RTC's Fleet Management Services Department has tracked the cost of these replacements at approximately $40,000 each; or $80,000 annually for each transit vehicle.

The RTC's diesel fleet to be replaced also have high maintenance costs associated with air conditioning compressors that are prone to failure. The old buses are not well suited to coping with the extremely high temperatures common in

Southern Nevada. Replacement costs for each compressor are approximately $6,000 for each bus, with two replacements per year required.

These specialty repairs demanded by the current diesel fleet not only cost the RTC in additional maintenance expenditures, but also a large portion of the fleet is continually unavailable to operate in productive revenue transit service. Almost half of the 31 total 60 foot diesel vehicles to be replaced are perpetually out-of-service due to necessary repairs. For example, diesel engine repair or replacement requires the bus to be taken out of active service for up to 1-month.

The CNG buses to be procured by this project have been designed to manage the high temperatures and do not have similar problems with engine replacements and air conditioning compressors. If TIGER funds are awarded, the RTC will be able to retire this high cost diesel fleet and realize $205,070 in savings annually in the first year of implementation just in avoided diesel maintenance costs.

Deferral of Complete Replacement

The baseline assumes that the 28 existing, old diesel transit vehicles would continue to operate in revenue service and continue to accumulate approximately 66,000 miles annually. Existing operating characteristics including transit headways, speeds, annual mileage accumulated, and service routes would be maintained.

The build alternative to be implemented with the award of TIGER funds would have the additional benefit of deferred transit vehicle replacement costs at a future date. To ensure a conservative analysis that does not inflate the benefit of deferred replacemenet, the year 2024 was selected as the benefit year. All diesel vehicles to be replaced by this project are currently over the 500,000 mile FTA limit. By year 2024, the buses will have completely exceeded both the 12-year and 500,000 mile replacement thresholds; and their replacement would be necessary for safety concerns.

The benefit of these deferred costs utilize the same costs of the build alternative; Planning and procurement costs of $150,000 in 2016, and vehicle manufacture costs of $21,428,571 in 2016. Both costs are assumed to increase 2.75% annually through 2024.

Benefits – Sustainability

Sustainability Benefits Not Included in Analysis

Reductions in noise emissions are the result of this project's use of quieter CNG engines, and general technology improvements that make new CNG buses quieter than the older diesel models they replace. Noise reductions benefit both transit passengers inside the vehicle and the general public during transit operations. This project benefit was not included in this analysis because the monetary gains are likely small, and because of the difficulty in assigning a societal cost to the noise of both the existing and proposed 28 transit vehicles.

Emission Reduction Benefits

Sustainability benefits are derived from replacing old, diesel transit vehicles with new clean-running CNG models. Both the baseline and build assumptions include equivalent operating characteristics and transit ridership, therefore all emissions benefits are the result of more modern, cleaner engines running on a cleaner CNG fuel source.

Emission reduction estimates for this project were conducted using the Diesel Emissions Quantifier (DEQ) tool developed and maintained by the EPA. More information about the tool and the National Clean Diesel Campaign can be found at: http://www.epa.gov/cleandiesel/quantifier/.

Basic operating assumptions entered into the DEQ tool reflect both standard industry averages and observed RTC fleet operating characteristics. Twenty-eight buses were analyzed, with an assumed annual VMT of 66,000 and an annual 600 idling hours per bus replaced and procured. Table 6 below identifies the quantified emissions benefits of the project:

Table 6: Emissions Reductions of Project Implementation

Annual Estimates	NOx (short tons/year)	PM2.5 (short tons/year)	VOC (short tons/year)	CO2 (metric tons/year)
Baseline of Vehicles Retrofitted	20	1.3	1.86	1,771
Percent Reduced (%)	76%	21%	80%	25%
Amount Reduced Per Year	15.2	0.3	1.5	443

After emissions were calculated using the DEQ tool, the emission reductions were monetized according to the recommended values found in the *TIGER Benefit-Cost Analysis (BCA) Resource Guide* (www.dot.gov/sites/dot.gov/files/docs/Tiger_Benefit-Cost_Analysis_%28BCA%29_Resource_Guide_1.pdf). The CPI method was used to convert from nominal into real (constant) dollars with a 2016 base year and a 2.75% annual growth rate factored in over the life of the project.

The emission savings result in $243,767 annual savings in the first year of project implementation. These savings reflect the undiscounted total value of all pollutant reductions. In the final summary table of costs and benefits, the benefits were discounted at an annual rate of both 3% and 7% respectively.

However, there is no longer a fixed unit cost of CO2 emissions. Rather, the TIGER guidance recommends the use of the net value of carbon dioxide emissions, as calculated from the 3% Social Cost of Carbon (SCC). SCC guidance states that the value of carbon dioxide emissions changes over time and should be discounted at lower discount rates. While other benefits and costs (that exclude carbon dioxide) should continue to be discounted at both 7% and 3%, following NOFA guidance this analysis will discount carbon dioxide benefits to the 2016 base year at a discount rate of 3%.