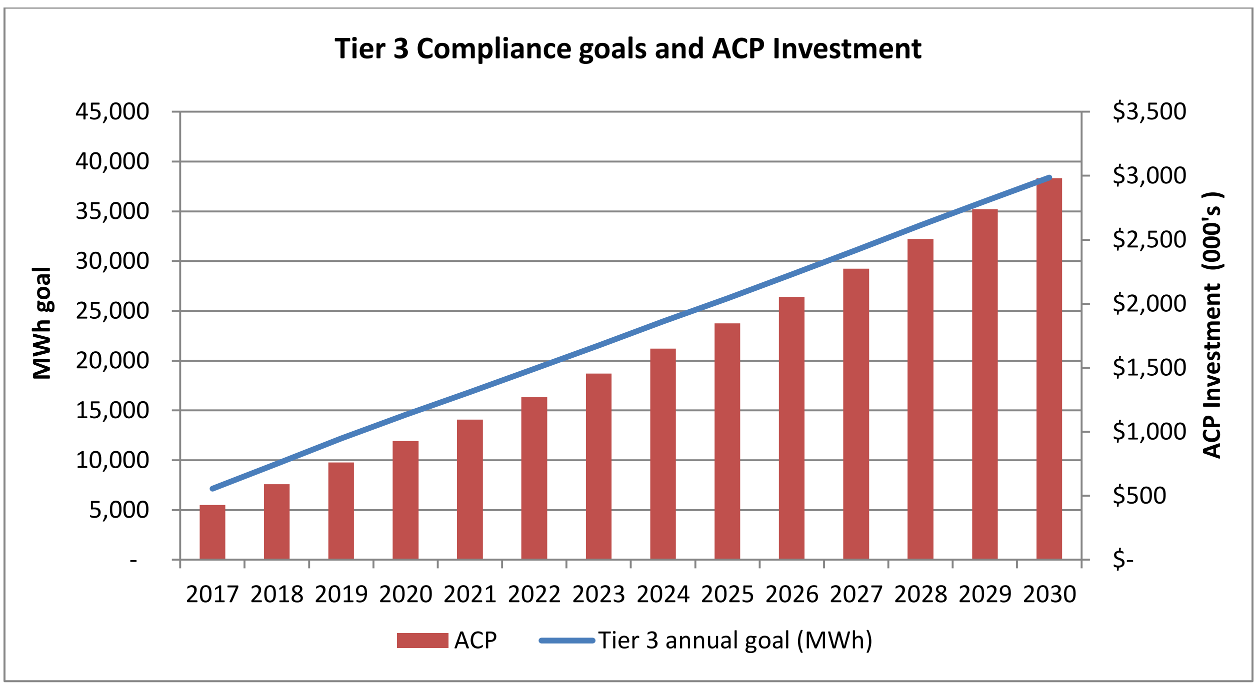
2018 Tier III
Beneficial Electrification Plan of
Burlington Electric Department

Pursuant to Vermont Public Utility Commission (Commission) Order in Docket 8550, the City of Burlington Electric Department (BED) submits the following informational filing. Consistent with the 2017 Tier III plan, the following sections highlight BED's:

- Tier III MWh_e goals and estimated alternative compliance payments;
- Updated project measures and program budgets; and,
- Proposed implementation strategies.

Tier III obligation

30 V.S.A §8005 (a)(3)(B) stipulates that distribution utilities serving more than 6,000 customers shall achieve Tier III credits equal to or greater than 2.0 percent of their annual retail electric load in 2017. Thereafter, a distribution utility's annual Tier III MWh_e credit goal shall increase by two-thirds of a percent until having reached 12 percent of its retail electric sales on or after January 1, 2032. Annual spending for Tier III eligible projects shall be capped at the alternative compliance payment (ACP). In 2017, the ACP was equal to $60 per MWh. After 2017, the ACP shall increase annually by the rate of inflation using the consumer price index. For BED, the forecasted long term, unadjusted, aggregate annual MWh_e goals and budgets are shown in the graph below:



The 2018 expected Tier III goal is 9,658 MWh e; the total aggregate ACP approximates $591,000. The 2018 ACP assumption was based on a total cost of $61.20 per MWh_e, which is two percent over the 2017 ACP rate to account for inflation.

It is worth noting that some stakeholders appear to interpret the above referenced statute to mean that although the percentage of the Tier III requirement increases annually by two – thirds of a percent, the percentage would be applied against 2017 sales; not against the utility's forecasted MWh sales in the year of program implementation. Under this interpretation, the 2020 requirement would amount to the 2017 sales, multiplied by the applicable Tier III percentage for 2020 – or 4.0 percent. Such a product would mean that BED's 2020 MWh e would be 14,297; not 14,564 as is currently estimated by BED in this three year plan. While BED does not believe this alternative interpretation is correct, BED would nonetheless appreciate the Commission's guidance as to which MWh_e goal is correct.

To encourage customers to reduce their fossil fuel consumption, many of the programs described below offer a financial incentive to improve the cost competitiveness of the measures promoted. The amount of the customer incentive varies depending on the type of measure. However, the total cost of the measures–on average – range from $40.15 per MWh_e in 2018 to $29.53 per MWh_e in 2020, inclusive of overhead, marketing, technical assistance and other sundry expenses. Declining average costs are primarily a function of reducing incentives for EV's and PHEV over time, as well as reducing overhead expenses as programs mature.

BED's Tier III goal and budget for the three years ending 2020 are as follows[1]:

Tier III Measure	2018 No. of Units	2018 Lifetime MWh e Credits	2018 Total Budget	2019 No. of Units	2019 Lifetime MWh e Credits	2019 Total Budget	2020 No. of Units	2020 Lifetime MWh e Credits	2020 Total Budget
Electric Buses	2	2,428	$ 148,030	2	2,428	$ 144,100	2	2,428	$ 137,550
All Electric Vehicles	150	4,932	$ 207,000	300	9,864	$ 345,000	600	19,728	552,000
PHEV	100	1,848	$ 69,000	100	1,848	$ 46,000	100	1,848	$ 46,000
VWHi Cap Public EVSE		-	$ -	2	160	$ -	4	481	$ -
BED owned Public EVSE	6	37	$ -	-	44	$ -	-	53	$ -
At Work EVSE	20	2,361	$ 29,300	20	2,361	$ 29,300	20	2,361	$ 29,300
E bikes	150	780	$ 41,250	150	780	$ 41,250	150	780	$ 41,250
PassivHaus(custom only)	1	624	$ 32,800	1	624	$ 32,800	1	624	$ 32,800
ccHP (non NG customers)	5	188	$ 2,475	5	188	$ 2,475	5	188	$ 2,475
Totals		13,197	$ 529,855		18,297	$ 640,925		28,490	$ 841,375
Max MWh e & Budget		9,658	$ 591,041		12,182	$ 760,448		14,564	$ 927,302
Over(under)		3,540	(61,186)		6,115	(119,523)		13,926	(85,927)
MWh Yield achieved			$ 40.15			$ 35.03			$ 29.53
MWh Yield Cap			$ 61.20			$ 62.42			$ 63.67

[1] The MWhe requirements do not yet include the carry over balances, if any, from 2017 nor is the use of any credits from Tier 2 resources contemplated herein. The results of the Reverse Auction program could also add to the MWhe goal but have not been included in the above table.

Project measures

For the three year period ending December, 2020, BED intends to promote the following energy transformation projects:

- Electric Buses
- Electric Vehicles and Plug in Electric Vehicles
- Electric Vehicle Supply Equipment
- Electric Bikes
- Passive House
- High Performance cold climate Heat pumps (non- natural gas customers)
- Reverse auction program

Electric Buses

a.) Introduction

More than any other single project proposed by BED thus far, the replacement of diesel powered buses with all electric ones has the most potential to substantially reduce diesel fuel consumption in the City and surrounding towns. And, since most diesel buses achieve an efficiency of approximately 4.25 miles per gallon, retiring high mileage public transit buses will lead to fewer NOx emissions. Thus, promoting the deployment of electric buses, as well as increasing overall transit bus ridership, remains a focal point of BED's tier III plan[2].

Program Update

Since the summer of 2016, BED, Green Mountain Transit Authority (GMTA), Vermont Department of Transportation (VTRANs) and others have been working together to encourage the adoption of electric buses in the State. Much has been accomplished since then but more work is necessary. Based on its conversations with the above stakeholders, as well as with two leading national electric bus manufacturers (Proterra and BYD), BED anticipates that 2-4 electric buses may be in operation by late 2018, or possibly early 2019. Four additional electric buses could be in service by 2020.

As noted in the table below, BED intends to claim up to 1,214 Tier III credits per electric bus that travels 30,000 miles annually, and offer up to $65,500 to GMTA as a means to offset the higher incremental cost of an electric bus. The credits and incentive are based on the following key assumptions:

2018 Electric bus Assumptions	
Total MWh e Credits/bus	1,214
Ann. Vehicle miles driven	30,000
MPG - replaced Bus	4.25
Est. Diesel Gallons reduced/yr	7,000
Incremental Cost (approx.)	$ 215,000
Est Electric consumption (Mwh)/yr	53
Total ACP	$ 74,000
Measure Life (yrs)	12
Est Performance Incentive	$ 65,500

[2] For additional information and analysis on the electric bus program, see BED's original custom project proposal in Docket 8866; November, 2016.

While the total proposed credits – and incentive – are based on the operations of GMTA, it is important to note that the program's conceptual performance based design is equally applicable to other bus operators such as UVM, Champlain College or the Burlington School district. However, unlike GMTA, BED is currently unsure whether these other bus operators are in a position to move forward with integrating electric buses into their bus fleets. Time will tell. But, BED is committed to continue working with these entities to further promote electric buses.

Since the proposed design is based on actual performance, the final credits to be claimed, as well as the total incentive paid out to GMTA – or any other bus operator – will be governed by three critical factors: total annual vehicle miles driven, gallons of diesel fuel displaced and the miles per gallon of the substituted vehicle. Because these factors are unknown today, BED will need to make adjustments after 12 months of operations for each electric bus that is put into operation. It is also important to note that the 2020 Electric bus additions – if any – will be contingent on the successful performance of electric buses in Vermont, as well as in other jurisdictions. And, until such time as electric buses are closer in initial cost to the alternatives, finding alternative funding sources to BED's incentive program will also be critical to future goal attainment as the incentive only goes so far to close the cost gap between a diesel bus and an battery electric one. Such other sources may include but are not limited to Vermont's VW environmental mitigation trust[3], VLITE and federal grants.

To BED's knowledge, the electric buses that GMTA proposes to purchase in the near future will be the first of their kind to operate full time in Vermont. So, their actual performance will be critical to BED's ability to encourage future adoption of similar buses at GMTA or elsewhere. Electric buses have been operating in several other locations, including some cold weather states like Utah, Massachusetts and Minnesota.[4] And, the reports from these locations, thus far, appear to be promising. Of course, BED, GMTA and other stakeholders will continue to monitor the performance reports on these electric buses as a means to inform future decisions.

Although various parties, including BED, have been actively promoting the speedy adoption of electric buses in the region for some time now, the delay in getting one into operation has been primarily due to funding challenges, bus procurement processes and the leading manufacturers' production capabilities. In fact, the procurement process initially commenced with a series of informal discussions in 2016 between BED, GMTA, VTRANs and others. Even though the process has been lengthy, discussions continue unabated and a lot of

[3] In October, 2017, the Department of Environmental Conversation was assigned by U.S. Justice Department to be the VW Trust Beneficiary. As the beneficiary, DEC must develop a multi-prong plan to fund up to $18 million in projects that will mitigate NOx emissions.

[4] E-mail correspondence with industry representative.

progress toward procuring an electric bus has been made thus far. More importantly, the discussions have evolved over time from whether the technology would be suitable given Vermont's weather, topography and operating conditions to how many electric buses can be integrated in to the existing fleet without any diminution in GMTA's service quality, reliability and operating expenses. The conversation, today, is about when, not if, electric buses will become part of GMTA's fleet.

To further the transition to electric buses, GMTA was recently awarded a $480,000 federal grant to apply towards the purchase of two electric buses in 2018. In its grant proposal to the Federal Transit Administration, GMTA noted how important integrating electric buses into the fleet would be to its contribution toward Vermont's clean energy goals. The grant proposal also expressed confidence that adoption of electric buses overtime could result in operating and maintenance savings so long as the upfront, incremental capital costs could be lowered by pairing the federal grant with BED's financial incentive. These notable attestations were reported as being one of the primary reasons for the award, even though the grant monies have historically been awarded to transit authorities operating in non-containment states – which Vermont has never been.

Since the grant award, GMTA has begun the process of issuing a formal request for proposals to a limited number of manufacturers who had earlier submitted to VTRANs and GMAT their qualifications in response to a formal request. After the issuance of the RFP, a thorough selection process will commence. Once the finalist has been selected, it could be another 8-12 months before GMTA could take delivery of a vehicle or vehicles based on the representations of a manufacturers' representative about delivery times. In short, capital budgeting decisions by a quasi-governmental authority such as GMTA take time. Nevertheless, BED is hopeful that the program will prove successful in the longer term, and that six electric buses will be in operation by calendar year end 2020.

b.) 2018 – 2020 program budgets

Over the next three year planning period, BED anticipates investing up to $430,000 in the custom Electric Bus program, of which $393,000 will be earmarked for incentives to further encourage clean bus technologies. On average, 8.5 percent of the total expected budget will be used to pay for overhead costs. After accounting for expected net revenues, BED anticipates incurring MWh_e costs of between $42 and $55. BED anticipates that after the first year of program implementation less staff time will be needed to manage the program and thus fewer administrative costs will be incurred. Net revenues have been included in this analysis for demonstrative purposes. By including such revenues, the analysis demonstrates that while BED is expending funds up to the ACP cap to motivate GMTA to integrate electric buses into its fleet, it also shows that BED's customers could benefit since revenues will also increase.

Arguably, BED could have included the present value of 12 years of revenues (the measure life of an electric bus) which would have made the analysis appear even better.

In exchange for financial incentives, the electric bus(es) will be required – per agreement – to charge in Burlington and to take service under the current LG Time of use tariff. For the purposes of this calculation, BED assumes first year net revenues will approximate $13,989 per year for two buses.[5] As more buses are added to the fleet, net revenues increase as shown in the budget table below. Thus, the three year average net cost to BED is $48.86 per MWh e.

Electric Bus Custom Prg Budget	2018	2019	2020	Total
Number of Units	2	2	2	6
Total MWh e Credits	2,428	2,428	2,428	7,284
Incentive (estimate)	$ 131,000	$ 131,000	$ 131,000	$ 393,000
Other expenses (estimate)	$ 17,030	$ 13,100	$ 6,550	$ 36,680
Total Budget	**$ 148,030**	**$ 144,100**	**$ 137,550**	**$ 429,680**
Net ann. Revenue	$ 13,989	$ 24,589	$ 35,189	$ 73,766
Cost per MWh e, Net of 1st yr Est. revenue	**$ 55.21**	**$ 49.22**	**$ 42.16**	**$ 48.86**
ACP cost per MWh e	$ 60.97	$ 59.35	$ 56.65	$ 58.99

Excluding net revenues, program costs are expected to be slightly less than the ACP cap of $61.20 in 2018, and decline thereafter as administrative costs decrease.

c.) Market potential

According to GMTA, between four and seven diesel buses are reaching the end of their useful lives and could be replaced with electric buses. Such a transition will however take time; possibly three to four years. UVM, Champlain College and the Burlington School district also operate a limited number of buses. But it is unclear at this time whether they will be able to move forward with an electric bus purchase anytime soon – as noted above. Thus, the potential to switch diesel buses to all electric ones is fairly limited during the period of time covered by this plan.

[5] Derived by 53,000 kWh annually times off peak energy ($0.10/kWh) times 2 buses or $10,600; plus, LG TOU demand charges equal to $ 3,388(80kW*$3.53)*12 months. Each bus has an 80 kW battery pack on board but none will be charging simultaneously, as software allows for the cycling of charges into the bus overnight.

d.) Customer Economics

Based on GMTA's information and data from industry sources, the economics of converting to electric buses from GMTA's perspective appear to be positive.[6] The primary factors influencing electric bus operations include: third party grants to reduce the incremental capital costs, total miles driven, fuel prices and maintenance costs. The table below compares the total lifetime cost of ownership of an electric bus ($1.68 per mile) to that of a diesel bus at various per gallon diesel prices; i.e. $1.35(low), $1.70 (mid) and $2.40 (high).

Total Cost of Ownership (Lifetime)		40 Ft (Elec)		Diesel Low		Diesel Mid		Diesel High
Capital Costs	$	694,000	$	454,000	$	454,000	$	454,000
Fuel Expense	$	88,751	$	102,925	$	129,609	$	182,977
Maintenance	$	128,559	$	189,625	$	189,625	$	189,625
Total Cost of Ownership	**$**	**911,310**	**$**	**746,549**	**$**	**773,233**	**$**	**826,602**
TCO/ miles	$	2.53	$	2.07	$	2.15	$	2.30
E-Bus lifetime Savings (**costs**)	$	-		**($164,761)**		**($138,077)**		**($84,709)**
Additional Infrastructure	$	-						
Adj for Tier 3 incentive	$	(65,500)						
Other Grants, including Fed		(240,000)		-		-		-
Total Cost of Ownership	**$**	**605,810**	**$**	**746,549**	**$**	**773,233**	**$**	**826,602**
Adj savings **(costs)**				**$140,739**		$167,423		$220,791
Adj TCO/mile	**$**	**1.68**	**$**	**2.07**	**$**	**2.15**	**$**	**2.30**
Lifetime Fuel cost/mile		0.25		0.29		0.36		0.51
Lifetime Fuel cost/Maint		0.36		0.53		0.53		0.53

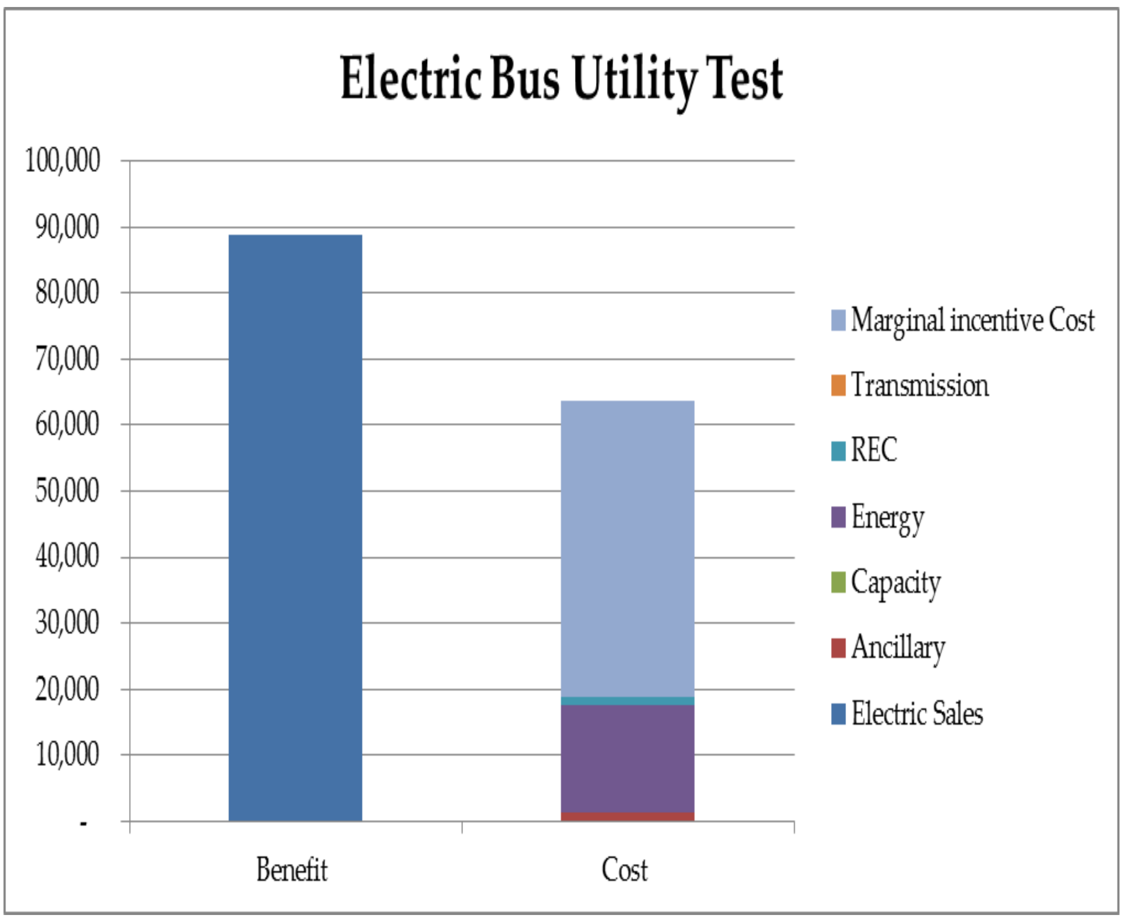
As the table highlights, the $240,000 federal grant coupled with BED's incentive, reduces the total cost of ownership of an electric bus relative to a diesel bus, even at today's historically low gas prices. As gas prices increase over time, operating an electric bus would result in even greater savings. While the grant award was announced well after BED's original incentive offer, BED still asserts that the incentive is necessary to overcome the initial cost barriers and to encourage GMTA to adopt this relatively new technology and begin to gain experience operating it. It is only after such experience that GMTA and other organizations would continue to consider purchasing additional electric buses in the near future. Also, as more electric buses are put into service, manufacturers can begin to make strides in improving their economies of scale which, in theory, will help to reduce the current premium on electric buses.

[6] See; *Opportunity Assessment: Feasibility of transitioning CCTA's Bus Fleet to Operation on Compressed Natural Gas*, Yborra & Assoc., report prepared for CCTA and VGS December, 2015.

e.) Utility Cost Test

Under the utility cost test, the program should result in a net utility benefit of $25,076 over the 12 year life of a bus. Benefits flow primarily from increased electric revenues ($88,751) due to the sale of 53 MWhs annually at the LG time of use rate.

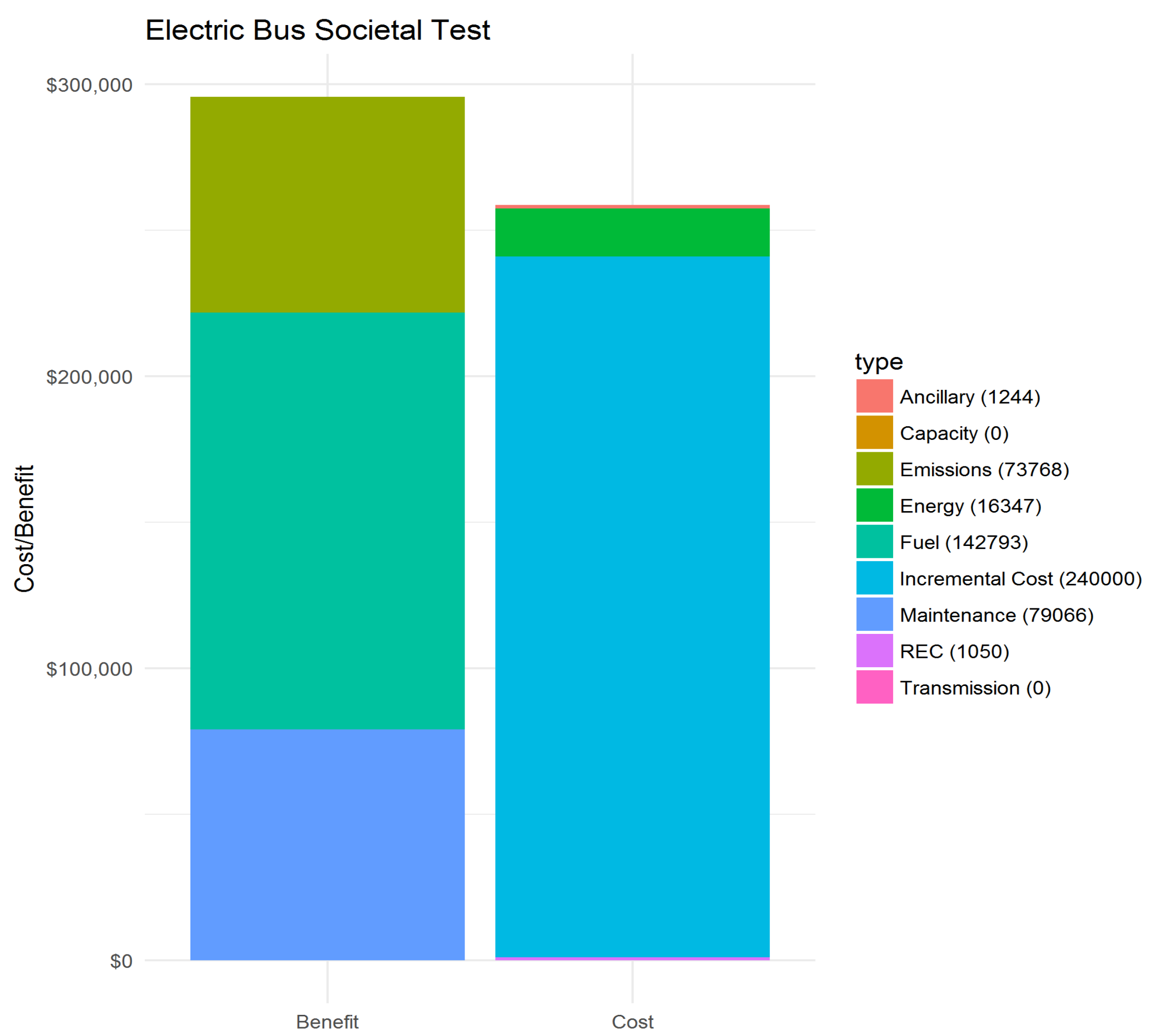
The primary program cost reflects the difference between BED's incentive and administrative expenses ($75,325 per bus) and the estimated cost of an alternative path to satisfy BED's Tier III obligation. That alternative may include the option of purchasing current day RECs at $25 each. Thus, for purposes of this analysis, BED's incremental cost to implement this program is $44,975.[7] Additional utility costs to serve a new electric bus will arise from additional wholesale energy purchases ($16,400), ancillary costs ($1,250) and REC purchases ($1,050). No incremental impacts on capacity, transmission, or utility distribution costs are assumed. When the project moves forward, BED and GMTA will make arrangements to ensure that the electric buses would be charged at nighttime when energy, capacity and t&d costs are the lowest through the use of BED's time-of-use rate structures.



[7] $75,325, less (1214 MWh e *$25) or $30,350.

f.) Societal Cost Test

To evaluate the societal costs and benefits, BED modelled the following benefit variables: Net avoided fuel costs ($142,793), lower maintenance costs ($79,066) and avoided emissions ($73,767). For emissions, the cost of carbon was set at $95 per ton. As for the incremental costs, BED modelled: incremental cost of the electric bus ($240,000), wholesale energy (16,400), additional REC purchases ($1050) and ancillary cost ($1250). From a societal perspective, the total net benefit of an electric bus amounts to approximately $36,926, as shown in the graph below.



Electric Vehicles and Plug in Electric Vehicles

a.) Introduction

As with the other Tier III programs, BED's overarching objective is to encourage the adoption of commercially available technologies that reduce the consumption of fossil fuels, and the emission of greenhouse gases associated with such consumption. That objective remains to be a driving force behind this program in 2018 and beyond. Moreover, financial incentives, as described further below, have been designed to help increase the cost competitiveness of these relatively new technologies, as well as to ease the financial burden of leasing EVs for income qualifying customers. This program objective is no different than the program objectives of Vermont's Energy Efficiency Utilities. Similarly to the EEU's lighting program, for example, the incentives highlighted herein will be reduced over time.

Program Update

In June, 2017, BED launched an all-electric vehicle program and started to provide customers a $1,200 financial incentive per vehicle that cost less than $50,000 (MSRP). Subsequent to the initial launch, PHEVs with a range of no less than 20 miles on their electric battery were added to the program. For these customers, BED is providing a $600 incentive. In the fall of 2017, the incentive on all electric vehicles for income qualifying customers was increased to $1,800.[8] These incentives will continue to be offered in 2018.

Over the summer, BED's incentives were augmented by Nissan. As part of an effort to clear out the existing inventory of older all-electric Leafs, Nissan began offering a $10,000 incentive for as long as supplies last. That offer continues today, and the local Nissan dealer is reportedly importing all electric Leafs from other Northeastern dealerships to satisfy demand. Soon after Nissan's program was announced, the number of the incentives processed by BED increased substantially in the month of August, as shown in the table below. BED has also begun to work with a local Chevrolet dealership to provide additional discounts off the MSRP of the Chevy Bolt.

[8] For more details, see: https://www.burlingtonelectric.com/EV

All electric				
	June	July	August	September
Nissan Leaf		5	5	5
Chevy Bolt		2	4	2
Ford Energi			1	
Ford Focus Electric			1	
				PHEV
	June	July	August	September
Ford c-max Energi		1	1	
Monthly Totals	**0**	**8**	**12**	**7**
Grand total				**27**

Although it is unclear how long the Nissan incentive will remain in effect, it certainly captured a lot of media attention and helped customers to make the switch to electric. BED hopes to take advantage of the momentum that Nissan created in the local market, and intends to aggressively market EV's and PHEVs through social media and normal customer interactions.

Because EVs and PHEVs have been approved on a prescriptive basis through the TAG process, BED intends to continue claiming 4.11 first year credits per EV and 2.31 first year credits per PHEV in 2018. The credit amounts are slightly more than what other utilities can claim because BED is a 100 percent renewable provider. Consequently, BED can also offer higher incentives to its customers if it chooses. Accordingly, BED intends to continue offering the aforementioned incentives in 2018, but will then begin to reduce them over time as conditions warrant. In support of the credits to be claimed per vehicle in 2018, BED has relied on the TAG-approved assumptions, as highlighted in the table below:

2018 AEV and PHEV assumptions		
Input	AEV	PHEV
Ann. Miles	9642	5427
kWh Consumption	3085	1791
Efficiency (kWh/mile)	0.32	0.33
Lifetime	8	8
MPG of ICE	25.3	25.3
Tier III credits (lifetime)	32.8	18.4

Incentives are not a mandatory form of encouragement under the RES. Nevertheless, BED believes that offering an aggressive incentive during the initial years of program implementation is essential to the overall long term success of the technology in Vermont. By offering a notable incentive, Burlingtonians will, in BED's opinion, begin to take notice of the value EVs have to offer, especially after they carefully assess their own driving needs. And, helping customers assess their daily driving needs will be an important component of BED's marketing efforts. Such efforts will point out that because of the City's compactness – only 13 square miles – residents could easily depend on EVs for nearly all of their local transportation needs such as running errands, shopping and dropping kids off at school. Indeed, if residents recognized that on most days the typical Vermonter drives just 31 miles[9], which is well within the range of an all – electric vehicle, range anxiety might be alleviated and many more EV's would be on the road.

b.) 2018 program budget

For all - electric vehicles (AEV's), BED anticipates investing $1.1 million, cumulatively, to implement an electric vehicle program that is designed to increase the number of AEV's registered in Burlington to about 1050 by calendar year end 2020. Nearly 87 percent of the total budget will be earmarked for customer incentives. As shown below, the amount of the incentive is scheduled to decrease by $200 annually as AEVs become more cost competitive with ICE vehicles. After accounting for 2018 first year net revenues, the cost of managing this component of the program should not exceed $33 per MWh_e in 2018. As more AEV hit the roads in Burlington, net revenues are expected to increase, as shown in the budget table below. Excluding net revenues, BED expects to expend – on average – no more than $32/$MWh_e$ to achieve its goals for this program.

[9] See VTRANs transportation 2016 studies.

AEV		2018		2019		2020		Total
Number of AEV		150		300		600		1,050
Total MWh e Credits		4,932		9,864		19,728		34,524
Incentive /vehicle	$	1,200	$	1,000	$	800		
Incentive (estimate)	$	180,000	$	300,000	$	480,000		960,000
Other expenses (estimat	$	27,000	$	45,000	$	72,000		144,000
Total Budget	**$**	**207,000**	**$**	**345,000**	**$**	**552,000**		**1,104,000**
Net ann. Revenue (energy only)	$	46,282	$	138,845	$	323,971	$	509,098
Cost per MWh e, Net of est revenue	**$**	**33**	**$**	**21**	**$**	**12**	**$**	**17**
ACP Cost per MWh e	**$**	**42**	**$**	**35**	**$**	**28**	**$**	**32**

The total PHEV program budget is as follows:

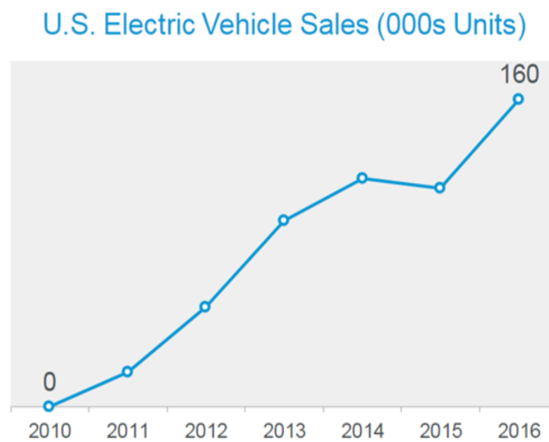
PHEV		2018		2019		2020		Total
Number of PHEV		100		100		100		300
Total MWh e Credits		1,848		1,848		1,848		5,544
Incentive /vehicle		600		400		400		1400
Incentive (estimate)	$	60,000	$	40,000	$	40,000	$	140,000
Other expenses (estimat	$	9,000	$	6,000	$	6,000	$	21,000
Total Budget	**$**	**69,000**	**$**	**46,000**	**$**	**46,000**	**$**	**161,000**
Net ann. Revenue (energy only)	$	17,909	$	35,818	$	53,727	$	107,455
Cost per MWh e, Net of est revenue	**$**	**28**	**$**	**6**	**$**	**(4)**	**$**	**10**
ACP cost per MWh e	$	37	$	25	$	25	$	29

Because PHEV are more widely accepted, BED does not anticipate investing as much in this program. Over the next three year period, the budget will likely be capped at a total of $161,000, cumulatively. But such a decision will be based on actual uptake in PHEVs, and whether market conditions warrant a decrease to the incentive. Similar to the AEV program, BED will likely decrease incentives overtime as PHEV become more cost competitive.

c.) Market potential

Since BED's program launch, a number of countries including China[10], Norway[11] and France[12] have announced major policy initiatives to increase the use of EVs and PHEVs as part of a comprehensive strategy to address global climate related challenges. Some countries have even threatened to cease the manufacturing of light-duty vehicles running on traditional internal combustion engines in the future. In response to these announcements, automobile manufacturers are ramping up battery research and accelerating efforts to gain manufacturing economies of scale. The result of these collective efforts has been a decline in EV costs and an increase in the number of EVs on the road; trends that are expected to continue well into the future.

As shown in the graph, the sale of all-electric vehicles in the U.S. has increased from a few dozen in 2010 to 160,000 in 2016.[13] A similar rate of growth has been occurring around the globe. Increased EV sales can be attributed mostly to the decline in battery costs and an increase in their range. Seven years ago, EV batteries cost between $400 and $600 per kilowatt – hour. By 2020, 30 – 60 kWh batteries are forecasted to cost as little as $100 per kWh.[14] Similarly, EVs travelled a distance of about 80 miles on a single charge in 2014. Today, the Chevy Bolt exceeds 230 miles. These advancements, coupled with increased availability, will undoubtedly lead to increased EV sales world-wide, and even in VT.



Indeed, there is plenty of market potential throughout Vermont and Burlington. As shown in the table below, there are roughly 18,700 light-duty passenger vehicles registered in Burlington.[15] Of these vehicles, 9,000 have been on the road since 2009, and are reaching the end of their useful lives. Consequently, there are a number of opportunities for BED to encourage customers to upgrade their next car purchase to an EV. If BED is able to convert 12 percent of Burlington's older vehicles (about 1,050) over the next three years, Burlingtonians would save

[10] See; *China's electric car push lures Global Auto giants, despite risks*, NY Times, September 10, 2017.
[11] See; *Norway to completely ban petrol power cars by 2025*, The Independent, June 4, 2017.
[12] See; *France to ban sales of petrol and diesel cars by2040*, The Guardian, July 6, 2017.
[13] Per conversations with manufacturer's representatives, power pt last accessed 10/15/2017:
[14] Based on conversations with industry experts and representatives.
[15] VT DMV registration in Burlington, July/August, 2017.

about $0.579 million[16] annually on automobile fuel expenses, and avoid consuming approximately 415,385 gallons of gasoline.

BTV Registrations	Hybrid	Diesel	AEV	Gas	Other	Propane	Total
Auto	**992**	**222**	**32**	**18,702**	**1**		**19,949**
PU Truck	**2**	**236**		**1,966**		**1**	**2,205**
Totals	**994**	**458**	**32**	**20,668**	**1**	**1**	
Source - DMV, Aug. 2017							

No. of older models (2009 or older)		9,000	Convert 12% to EV		1,080
Average MPG		26	Average MPG		26
Average Annual Miles		10,000	Average Annual Miles		10,000
Average gallons consumed/annually		385	Average gallons consumed/ar		385
Average gas costs/annually	$	962	Average gas costs/annually	$	962
Total Gallons/yr		3,461,538	Total Gallons/yr		415,385
Total Gas expenditures	$	8,653,846	Total Gas expenditures	$	1,038,462
Gallons cost	$	2.50	Gallons cost	$	2.50

d.) Customer economics (EV only)

From the customer's perspective, owning an all-electric vehicle could result in savings, if the owner is able to effectively manage their daily driving needs–meaning; EV owners have an alternative form of transportation on those occasions when they need to travel a longer distance than the average 30 to 31 miles per day. Alternative transportation could include access to a car share membership, another ICE vehicle, bus or a train. Based on the analysis below, leasing a Chevy Bolt could potentially cost $1,875 less relative to a comparable ICE vehicle, after consideration of the federal income tax credit and BED incentive. Much of the savings are generated from lower maintenance costs and fuel costs – which for purposes of this analysis were assumed to cost $2.59 per gallon for regular unleaded gasoline.[17]

Notably, the estimated savings are based on current approved tariffs (i.e. $0.17). However, BED intends to propose time differentiated, end use rates in the near future for EVs and other strategic electric measures, where appropriate, as a means to further improve customer economics.

[16] $1,038M less $0.459M electric costs. Typically Chevy Bolt driving 9642 miles per year will consume approximately 2,500 kWh, at $0.17/kWh (times 1080 EVs).

[17] See: Gasbuddy.com, accessed last on October 19, 2017.

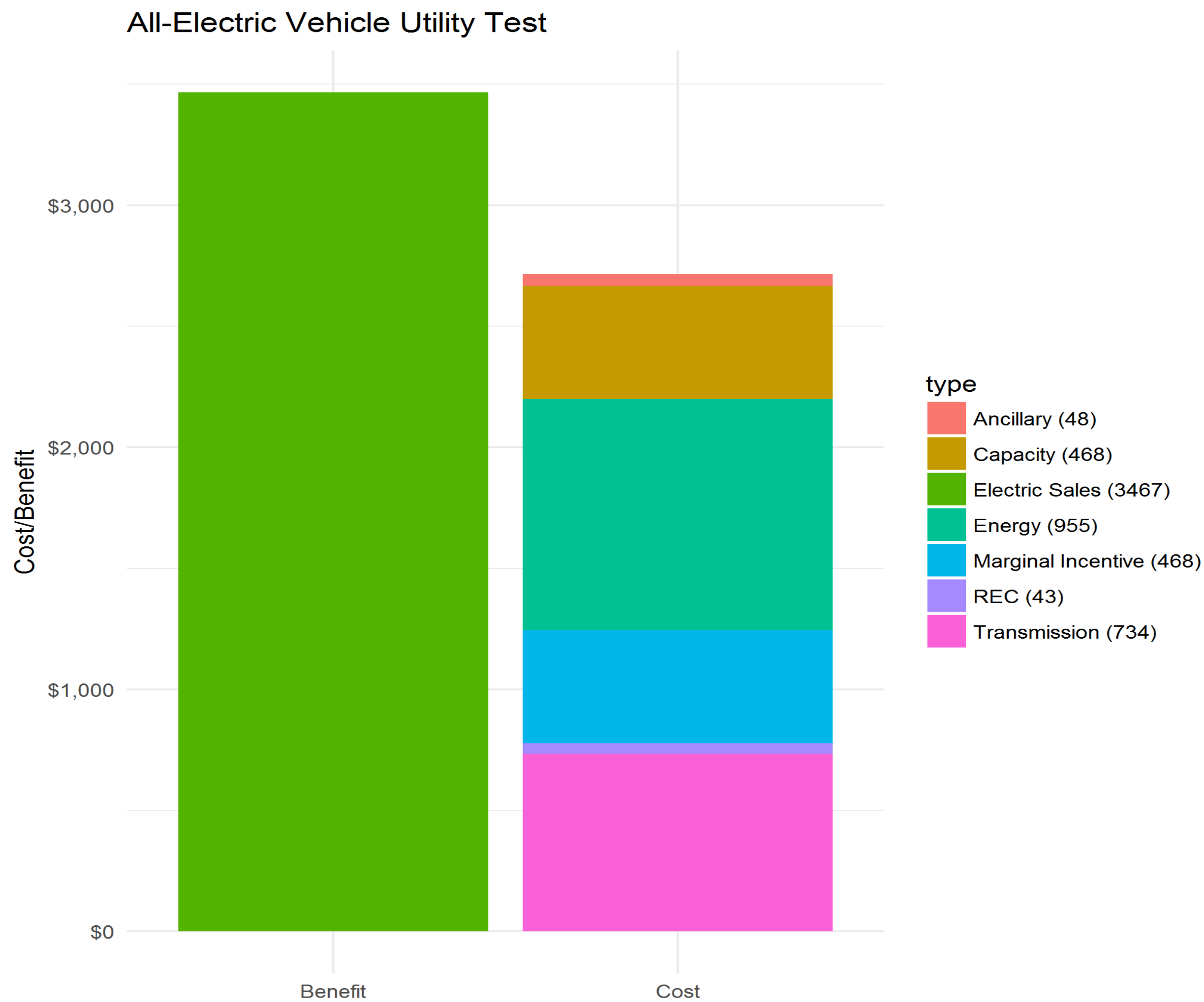
		Chevy Bolt		ICE
MSRP	$	37,500	$	32,500
FTC		($7,500)		$0
Tier 3 Incent		($1,200)		$0
Lease Downpayment		$4,000		$4,000
Net Cost	$	28,800	$	28,500
Lease Payment3Yr	$	8,741		$7,699
Ann Fuel&Maint(NPV)	$	1,567		$3,285
Total Cost of Ownership		$13,109		$14,984
TCO per mile		$1.36		$1.55
Savings (3 yr lease)		**($1,875)**		

e.) Utility Cost Test

In accordance with the UCT protocol, the program is expected to result in positive net benefits to the utility of approximately $662 per AEV over 8 years. Benefits flow from increased retail revenues ($3,466) from the sale of between 2,500 to 3,300 kWh annually, depending on the type of EV and vehicle miles travelled. As noted above, the recently available Chevy Bolt is far more efficient than earlier EV's and achieves nearly 3.9 miles per KWh compared to the 3.1 miles per KWh of other AEVs. So revenues may range considerably depending on the mix of EV products sold in 2018. Utility costs are related to ancillary services ($48), capacity ($468), energy ($954), transmission ($733) and additional REC purchases ($43). As with the E – bus, BED incorporated the marginal cost of implementing this program compared to buying additional RECs at $25 each to comply with its Tier III obligation. That incremental cost is assumed to approximate $558. [18]

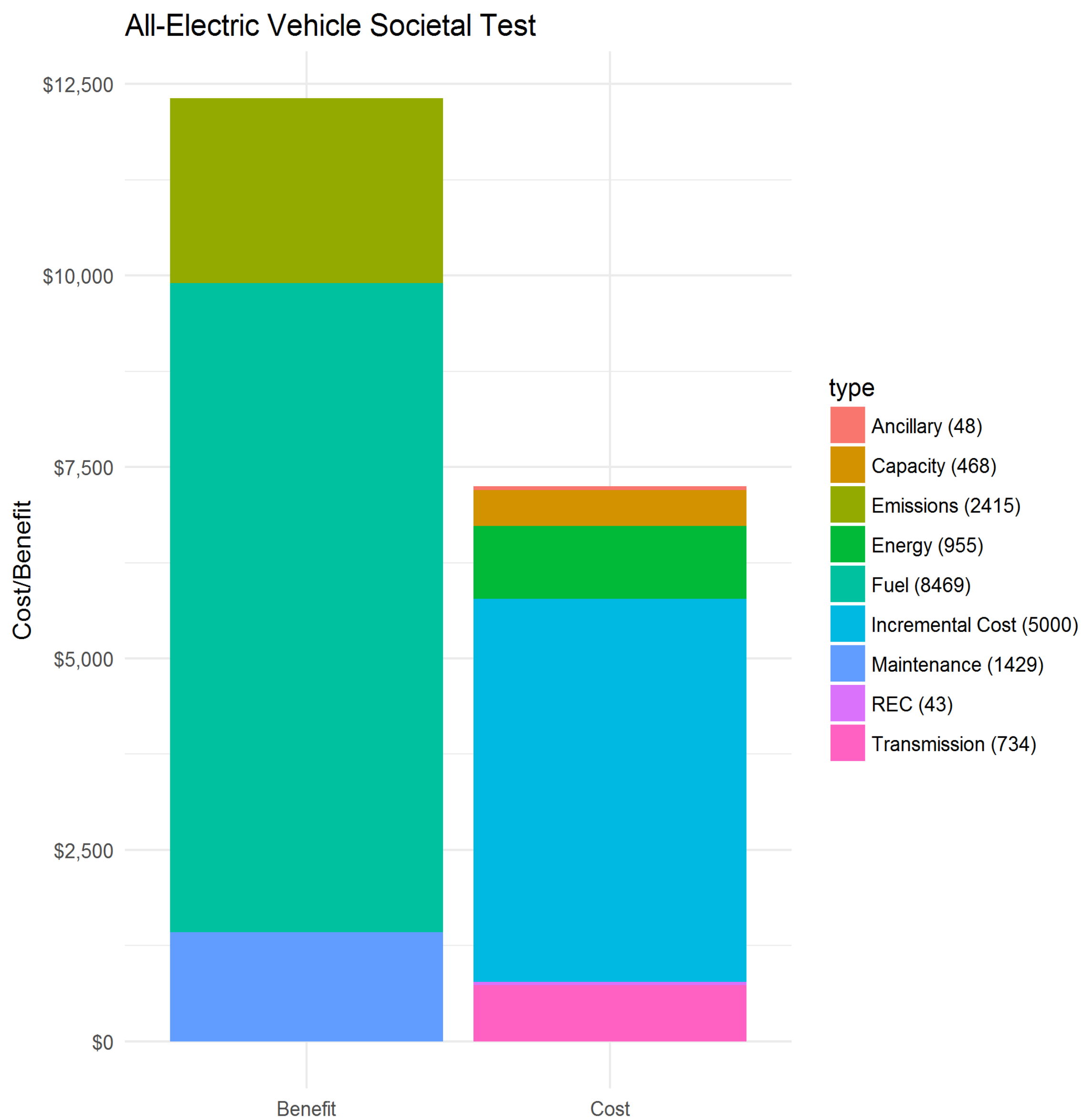
To contain utility costs, BED will strongly encourage EV and PHEV owners to adopt a time of use rate and install controls that allow for nighttime charging. This may lead to lower revenues, but also substantially lower costs as transmission and capacity related charges would be minimized.

[18] $558 = $25 per REC * 33 MWhe, less $1380 per AEV (incentive & administrative costs)



f.) Societal Cost Test

Under the SCT, net benefits amounted to approximately $5,065 over the 8 year life of the EV. Benefits include emissions reductions ($2,414), avoided fuel costs ($8,469) and lower maintenance costs ($1,428). Societal costs include the incremental cost of EV's ($5,000), ancillary services ($48), capacity ($468), energy ($954), transmission ($733) and additional RECs ($43).



All-Electric Vehicle Societal Test
$12,500
$10,000
$7,500
$5,000
$2,500
$0
Cost/Benefit
Benefit
Cost
type
Ancillary (48)
Capacity (468)
Emissions (2415)
Energy (955)
Fuel (8469)
Incremental Cost (5000)
Maintenance (1429)
REC (43)
Transmission (734)

Electric Vehicle Supply Equipment (EVSE, or charger)

a.) Introduction

Traditional car owners are accustomed to travelling hundreds of miles on a single tank of gas. Moreover, petrol stations are nearly ubiquitous so running out of gas in a typical car is uncommon–at least for non-college age drivers. Indeed, range anxiety does not affect most traditional car owners. This is not the case, however, for consumers who are considering the purchase of an EV. For them, range anxiety is an affliction in need of a remedy.

EV industry advocates, auto companies and electric utilities from across the country are seeking to lower anxiety levels in at least four basic ways.

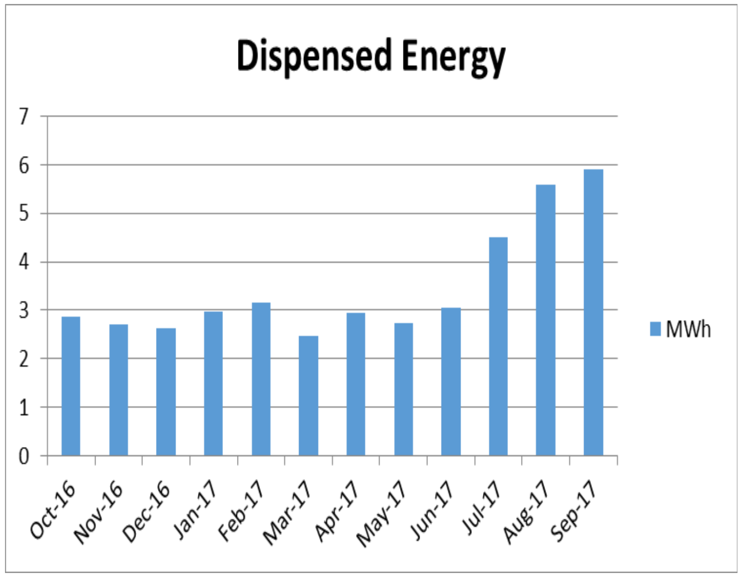
First, auto manufacturers are improving car technologies. The Chevy Bolt is a prime example. Whereas, a little over a year ago, the most widely used EV travelled 80-90 miles on a single charge; the Bolt has been officially clocked at 238 miles per charge. This is a remarkable achievement and will go a long way toward addressing the range concerns of consumers. But longer range is not enough to quell the current level of anxiety – as unjustified as it may be at the moment for EV newbies.

Second, the industry has been working for several years to increase customer awareness and education. Entities like Drive Vermont, VTRANs and the U.S. Department of Energy provide information to customers about how to assess their personal driving needs. Once consumers acknowledge the fact that they average about 31 miles per day, more people will make the switch–and save on fuel and maintenance.

Third, utilities are building out the infrastructure necessary to serve EVSE, and several state utility commissions and state energy offices are encouraging them to do so. California, for example, has been evaluating the EVSE plans of its investor-owned utilities for several years now.[19] One purpose of these proceeding(s) is to review the policy and rate implications of the IOU's plans to roll out EVSE in their respective service areas in the most cost-effective manner. Many other states are doing the same type of reviews. However, there does not appear to be a consistently applied policy framework across the nation that would help guide investments in EVSE infrastructure. For its part, BED has deployed 14 publically available EVSE over the last several years, as further explained below. Most of the EVSE installed by utilities thus far have been low capacity type, or level 2, chargers. These chargers provide up to 7 kW of power per pedestal (at 240 volts), and typically take 6 -9 hours to completely charge a battery, depending on the battery size and power acceptance rate. EV owners can add up to 25 miles of additional range in one hour of charge time. Level 2 chargers are appropriate for EVs owners who are planning to park their car for longer periods of time, e.g. at home and at or near work locations.

[19] See California PUC Docket A 1701020 ,

Fourth, and finally, the availability of high capacity, 150+ kW chargers are needed along heavily travelled corridors. High capacity chargers allow for fast charging times so EV owners can reach their ultimate destination in a timely manner. A high capacity charger takes 30 minutes per 230+ miles of travel. Volkswagen, Tesla and other organizations are the main proponents of this initiative.



Program update

BED has increased publically available EVSE from 8 pedestals on December 31, 2015[20] to 14 in September, 2017. Over this time frame, MWh sales from all EVSE units have typically averaged between 2.0 to 3.0 MWh per month. Over this past summer, MWh sales have begun to increase. In August and September, aggregate MWh sales across all EV chargers increased to 6 MWhs. Of the 14 chargers in place today, two are 25 kW chargers, one is a so-called level 1 charger, and eleven are level 2 chargers. In total, the chargers can accommodate 25 EVs charging at the same time, but it is a rare event when two vehicles are actually charging at the same time and location.[21]

Going forward, BED has no definitive plans to significantly add to its fleet of publicly available EVSE. Instead, BED is pursuing a multi-prong approach to augment its existing public chargers. Approach one involves Volkswagen's affiliate Electrify America. Approach two is to increase usage at each of the existing BED owned public chargers. Approach three includes promoting EVSE at work (and other) locations throughout the City where vehicles remain for long durations.

<u>Electrify America</u>

As a part of its settlement with the U.S. government, Volkswagen Group of America created in 2017 an affiliate known as Electrify America (EA). This affiliate, based in Reston, Virginia, is responsible for investing $1.2 billion over the next 10 years in zero emission vehicle (ZEV) infrastructure, education, and EVSE access outside California to support the increased adoption of EV technology in the United States. The proposed investment represents the largest

[20] No new EVSE were installed in 2015. All new installations occurred in 2016 and 2017.

[21] Level 2 chargers have two ports capable of serving two cars simultaneously; the others have only one.

commitment of its kind to date.[22] According to EA, its investments will make it easier for millions of Americans to charge their electric vehicles in downtown city centers, residential neighborhoods and along major travel corridors. In addition, Electrify America will broadly promote the benefits of EVs–in a brand neutral manner–to consumers through education campaigns.

Since early spring 2017, BED and other interested parties have been engaged in discussions with EA about potentially investing in EVSE infrastructure throughout Vermont. During those discussions, BED highlighted the sources of its generation capacity, emphasized its net zero energy vision, and made a point of characterizing the City's *progressive-leaning* ideals. EA representatives were intrigued, and visited with various community representatives, including Mayor Weinberger, in September.

Since the visit, the pace of discussions has continued – albeit slower than we would like. Nevertheless, BED is undaunted and looks forward to further deepening its business relationship with EA. On September 28th, BED submitted for EA's consideration a concept proposal that identified three locations to site 2 - high capacity (e.g. 150 kW) chargers at each location. BED believes that two of the three locations will be accepted. A mock-up of what the charging "pods" would look like is shown in the graph above. Based on a preliminary engineering analysis, the total EA investment in the City's infrastructure could amount to approximately $240,000 (exclusive of the chargers, educations and annual maintenance expense). If the EA projects move forward, BED anticipates a number of benefits would ensue. For starters, approximately 48,000 gallons of gasoline would not be consumed over a three year period. Carbon emissions would be reduced by 468 tons. And, BED could increase sales by over 300 MWh per year starting in 2020. This stream of benefits is expected to increase over time, as more EVs hit the road and more EV owners visit Burlington from afar. In addition, the aforementioned proposal includes a provision that would make use of energy storage facilities so that inexpensive power could be used for daytime consumption. The table below provides an overview of some of the salient benefits of BED's proposal to Electrify America.

[22] See; National ZEV Investment Plan: *Cycle 1*, April, 2017, VW Group of America

VW Data proto types	2018	2019 MWh Dispensed	2020
Cherry Street		0	150
Echo Center		100	150
Total	0	100	300
E miles	-	315,000	945,000
Gas consumption avoided (gal)	-	12,115	36,346
MMBTUs avoided	-	1,490	4,471
Tier III credits		160	481
CO_2 avoided (tons)	**-**	**117**	**351**
ann EV miles	9,642	9,642	9,642
No of cars/ annually	0	33	98
cars per week	-	0.63	1.88

Increase MWh sales at existing BED EVSE

As shown in the table below, the six publically available chargers that BED has owned and operated since January 1, 2015 (through September 30, 2017) have dispensed 18.5 MWh; or about 23 MWh on an annualized basis.[23]

BED Publically Available EVSE			
Street location	2016	2017 (9 Months)	Total
1127 North Ave		1.083	1.083
146 University Place	1.365	3.935	5.3
210 Colchester Ave	0.673	2.796	3.469
617 Main St	1.413	1.777	3.19
81 Carrigan Drive	2.352	2.165	4.517
95 Summit St	0.124	0.894	1.018
Total	**5.927**	**12.65**	**18.577**
Annualized Basis	***5.927***	***16.87***	***22.79***

For 2018 and beyond, BED believes that MWh sales at each of its locations will increase by 20 percent annually. Much of the expected increase will be due to organic growth–meaning; that as the number of EV's registered in Burlington and neighboring towns increase so too will

[23] 8 of the 14 EVSE in service today were installed prior to January 1, 2015, and therefore are not included in this discussion.

MWh sales. Accordingly, BED does not anticipate offering additional incentives or having to increase marketing activities around the promotion of these stations. As such, no additional funds are currently anticipated to be spent on this portion of the program. Captured in the table below is a summary of the expected MWh sales and associated reductions in fossil fuel consumption. Assuming that each of the stations achieves the MWh goals, BED anticipates claiming up to 134 Tier III credits, cumulatively, by December 31, 2020.

BED Publically Available EVSE	2018	2019	2020
No. of units since 1/1/2016	6	0	0
MWh dispensed	23	27	33
E miles travelled	71,800	86,160	103,392
Gallons displaced	2,762	3,314	3,977
MMBTUs displaced	340	408	489
Tier III Credits	**37**	**44**	**53**

At-Work EVSE

To the best of BED's knowledge, there are relatively few chargers that employers have installed for their internal use or use by their employees. This will change as businesses adopt more sustainable practices and their employees begin to request using EVSE facilities at work. In fact, BED has been fielding numerous inquiries over the last several months about offers of financial assistance to install level 2 chargers at a variety of establishments.

In 2018, BED intends to begin addressing these inquiries. In the absence of a Tier III TAG approved EVSE related credit assignment; BED proposes to provide incentives directly to businesses that can demonstrate a need for assistance. BED will support these efforts by providing businesses and their employees with educational materials and technical assistance regarding EVSE locations, charge times, battery ranges, potential power curtailments and total cost of EV ownership. Some of this outreach may also be in partnership with local dealerships, Drive Electric Vermont and other regional organizations.

BED anticipates encouraging the installation of up to 60 chargers over the next 3 years. While it is difficult to forecast the amount of claimable credits in advance, BED is proposing to sub-meter each incentivized charging unit and monitor kWh usage. With this data BED would be able to determine whether the program design should be modified in the future. But in the meantime, BED proposes to claim upfront a certain amount of Tier III credits per EVSE. The exact level of credits will be finalized over the next several weeks either through the Tier III TAG process or in a custom EVSE program filing with the Commission.

Determining the level of financial incentives upfront is challenging. Nevertheless, BED believes that providing an upfront incentive would be appropriate and help to further encourage adoption of all electric vehicles. As noted, the actual incentives would be contingent on the installation of EVSE control devices that allow for energy use curtailment during peak events and the number of EV owners that would charge at the EVSE location.

Pending determination through the TAG process of the amount of claimable credits or a custom program filing, BED assumes each EV charger will dispense from 5 MWh to 20 MWh annually.[24] Weighted average BED costs (incentives, plus administrative costs) are forecasted to

[24] To accommodate this level of charging frequency per site, BED would need to think of alternatives to the typical 2 port 7 kW charging stations that have become customary in the field. Instead, lower cost, multi-port systems would need to be sourced and installed.

approximate $1,465 per EVSE device. By way of comparison, the installation cost of a level 2 business - grade charger ranges from $800 and $5,000 per pedestal, depending on the infrastructure needed to serve the charger. The average cost of an EVSE is about $2,200.[25] The annual weighted average Tier III credit is estimated at 118 MWh $_{e}$, assuming a 10 year life of the equipment. If 20 business locations participate in the program with between 10 and 40 EV owners each, the total cost of the program would amount to approximately $29,300 per year, and BED would claim up to 2,361 MWh $_{e}$ Tier III credits.[26] The table below provides a summary of "at work" program assumptions.

Per Business per L 2 (all EV only) - minimum sign ups ---->	10	20	30	40
Tier III credits per site type	7.16	14.31	21.47	28.62
ACP Max per site type	$ 313	$ 627	$ 940	$ 1,253
ACP Less Admin cost	$ 235	$ 470	$ 705	$ 940
Electric Sales (kWh)	4,967	9,934	14,901	19,868
Elec Revenues (.17/kWh)	$ 844	$ 1,689	$ 2,533	$ 3,378
Net ACP + additional 1st yr revenue	$ 1,079	$ 2,159	$ 3,238	$ 4,318
Total incentive, no controls	$ 235	$ 470	$ 705	$ 940
Total incentitve with controls	$ 810	$ 1,619	$ 2,429	$ 3,238
Total Cost, including admin (max)	$ 888	$ 1,776	$ 2,664	$ 3,552
Total Weighted Avg Cost (Max)		$1,465		
Weighted Avg Tier III credit		11.81		
Measure life		10		
Total Weighted Avg Tier 3 credit (Wavg)		118		
Number of Businesses sign up (2018)		20		
Total Claimed Tier III each yr		2,361		
Total Cost (max)		$ 29,300		
Total $/MWh e		$ 12		

It is important to note that the program design described above is contingent on whether BED can claim upfront the total lifetime (10 years) credits associated with EVSE, rather than claim after-the-fact credits based on 12 months of metered data. BED has structured the program design in this manner for two reasons: first, providing an upfront incentive helps to offset the capital cost of installing EVSE (which is believed to be the primary barrier to charging station installation at this time). Second, processing incentive checks annually based in sub-metered data is administratively burdensome and costly.

[25] See 2016 DOE study

[26] Tier III credits and ACP take into account a 13.6 % AC to DC conversion loss from the charger to the EV Battery. In addition, credits are based on the expected kWh of EVs that have not already been claimed as part of the EV purchase (roughly 17% of the total).

As an alternative to the above noted program incentive, BED may also consider offering customers the option to receive incentives in the form of lower electric rates for charging and/or interest rate buy down if customers choose to finance the installation. The intent of this alternative program design would be to provide customers with options to lower the cost of EV driving for their employees or customers even further.

b.) 2018 EVSE program budget

For 2018, BED anticipates investing approximately $29,300 in the at-work EVSE program element. On a per unit basis, the program should cost less than $12.40 per MWh $_e$, well below the maximum ACP.

As noted, EA intends to install 2 high capacity, 150 kW EVSE pods (maybe more), with each pod containing at least 2 chargers. Due to construction timelines around the selected sites, it is unlikely that these systems would be operational in 2018. One pod may be available in early 2019; the other in 2020. Since EA will be incurring the costs of installing these high capacity chargers in the city, including the necessary infrastructure to serve them, BED is not planning to incur any additional costs to implement this aspect of its EVSE program. Also, BED has no current plans to add significantly more publicly available chargers. Therefore, the 2018 EVSE budget includes investment only in the "at work" EVSE program as shown in the table below:

	2018		
	BED EVSE	VW EVSE	At Work
Total MWh e Credits	37	-	2,361
Total Budget	$ -	$ -	$ 29,300
$/MWh e	$ -	$ -	$ 12

c.) Market potential

BED has capped its "market" potential to the first 60 takers over the next three years for "at-work" EVSE incentives to limit the budgetary impacts.[27] Once the budget is depleted, BED will assess its budgetary situation and then determine whether to continue the program. In addition to monetary concerns, BED may or may not extend the program based on saturation levels. If residents and EV owners have numerous options to charge their vehicles, BED will consider if it needs to continue program operations.

Table 11. Total EVs Registered by Forecast Scenario

Year	Low	Medium	High
2015	1,113	1,113	1,113
2020	4,080	4,655	5,935
2025	14,457	18,873	30,506
2030	45,731	67,835	131,420
2035	107,012	170,371	318,979
2040	158,676	247,399	395,489
2045	175,852	266,687	404,233
2050	179,283	269,559	404,940

Table 12. EV Forecast as a % of Total Light Duty Vehicles

Year	Low	Medium	High
2015	0.2%	0.2%	0.2%
2020	0.9%	1.0%	1.3%
2025	3.2%	4.2%	6.8%
2030	10.2%	15.1%	29.2%
2035	23.8%	37.9%	70.9%
2040	35.3%	55.0%	87.9%
2045	39.1%	59.3%	89.8%
2050	39.8%	59.9%	90.0%

Although BED's market potential is currently limited on purpose, there is arguably a significantly larger economically achievable potential to be tapped. Based on VTRANs research into EV adoption, there could be between 14,000 and 30,000 EVs registered in Vermont by 2025.[28] A significant percentage of the future EVs could be registered in Burlington or nearby towns. Also, an increasing number of out of state EV travelers are coming into the city to visit. All these new EVs (and PHEV's) will need to plug in and charge up. As more EVs hit the road, BED is planning to be ready to provide a much needed service by making more EVSE available for residents, businesses and visitors to the region.

d.) Customer economics

For charging equipment alone, the economics are poor, especially for businesses. Most businesses are motivated to install EVSE to provide a benefit to their employees, customers and/or visitors. Businesses also install chargers for internal business purposes. Most of all, these type of businesses are interested in further promoting sustainability. In short, EVSE buyers are motivated by other factors other than purely economic ones and the primary barrier to charger installation is the up-front capital cost.

[27] Although this program has been characterized as an employer based program, the concept is equally applicable to condominium associations and large apartment complexes. Additionally, the program may also include other small businesses that want to include EVSE as an amenity to their customers.

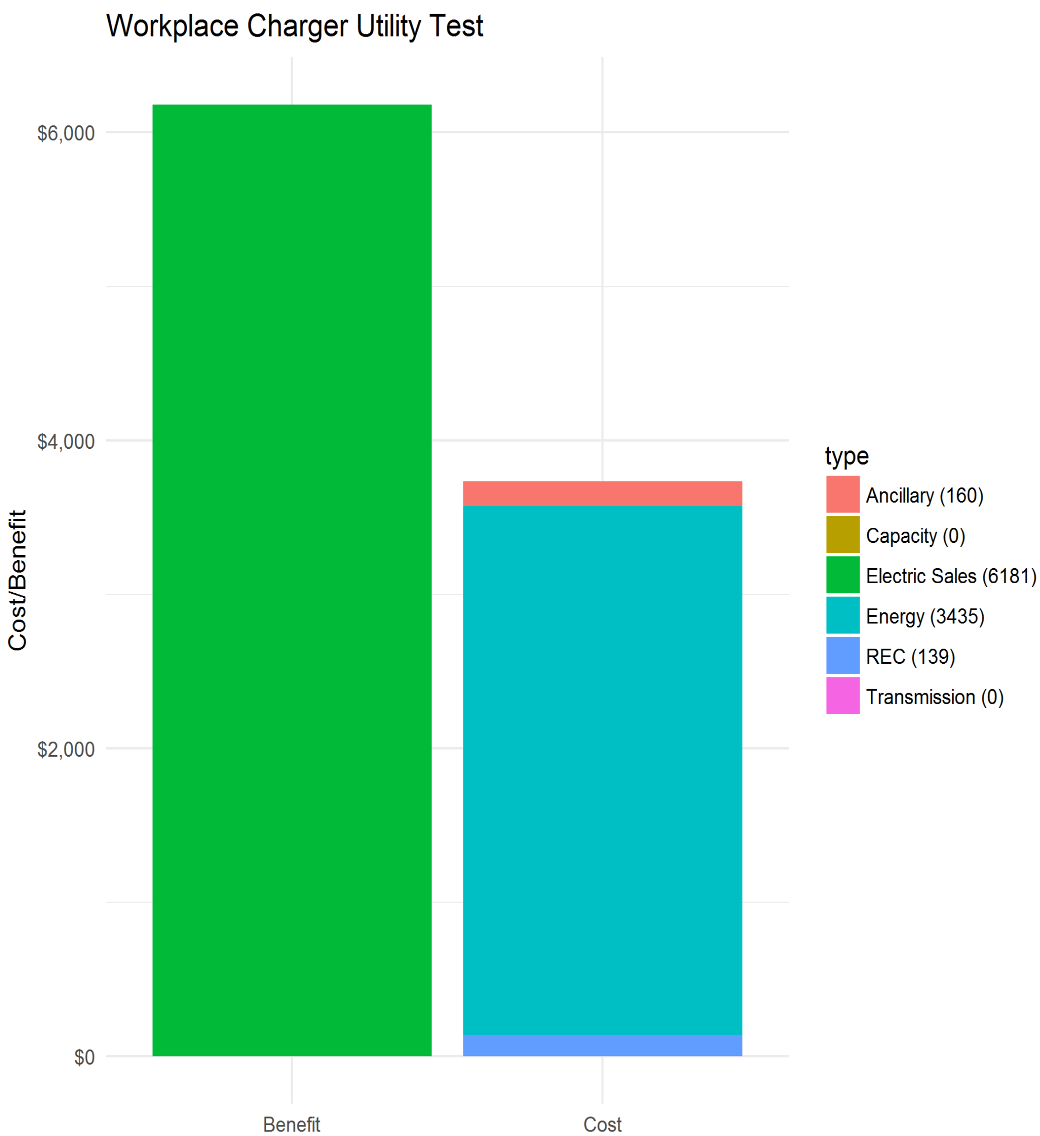
[28] See; *Section15. 2016 PHEV and EV registration fees,* Legislative report, December, 2016.

e.) Utility Cost Test

Under the UCT, the weighted average net utility benefit of the "at work" program amounts to approximately $2,400 per level 2 pedestal over ten years. Benefits flow from increased electric revenues of roughly $6,100 under rates that might be applicable for load controlled EV chargers. Incremental costs result from additional energy purchases ($3,400), ancillary services ($160) and new REC acquisitions ($139).

Under the proposed program design, EVSE are controllable so that power serving the chargers can be curtailed and/or shut down during critical peak demand periods. Accordingly, capacity costs were not included in this analysis. Also, forecasted revenues were developed by applying a marginal 8 to 10 cent per kWh rate to the weighted average EVSE usage by program participants. Lower retail end use rates (or credits in this case) have been modelled in this analysis to reflect a program that would motivate customers to dynamically modulate their consumption, when and if needed. The same rate structure could include an adjustment that would cover peak demand and transmission costs and, thus, hold the general body of ratepayers harmless in the event that charging does occur during on-peak demand time periods.

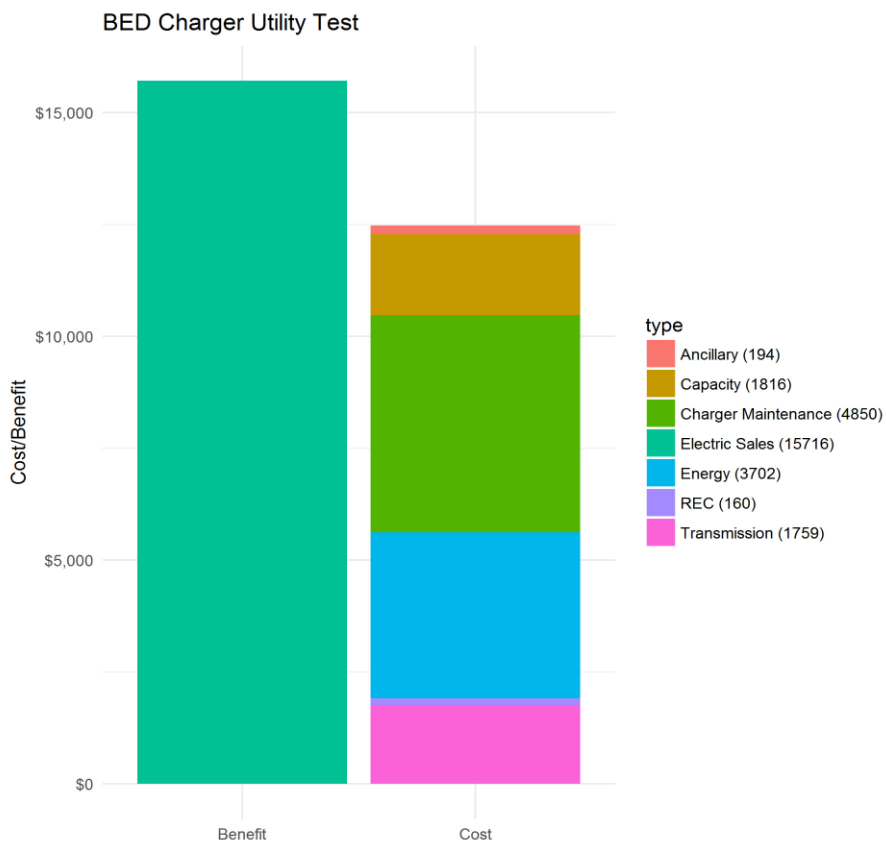
It is notable to call attention to an important assumption. BED anticipates that based on the above analyses, the marginal cost of implementing an "at work" EVSE program is less than the alternative path to Tier III compliance (i.e. buying $25 RECs). Accordingly, incentives have not been included as an incremental utility cost for the purpose of this test. BED will incur some kind of cost – either the ACP or a less expensive pathway. Thus, at $12 per MWh e BEDs at work EVSE program costs represent a sunk costs, not an incremental cost.



Workplace Charger Utility Test
$6,000
$4,000
$2,000
$0
Cost/Benefit
Benefit
Cost
type
Ancillary (160)
Capacity (0)
Electric Sales (6181)
Energy (3435)
REC (139)
Transmission (0)

Utility cost test for BED owned EVSE

For BED-owned EVSE, the net utility benefit per charger amounts to about $3,234 over ten years. Benefits flow from additional MWh sales at .17/kWh($15,715) . Incremental costs were associated with EVSE maintenance/service fees ($4,849), energy ($3,702), capacity ($1,815), transmission ($1,758), ancillary ($ 194) and REC purchases ($160). Capacity and transmission costs were included for this equipment as the ability to curtail street side commercial charging is uncertain. For purposes of this analysis, BED assumes that MWh sales will increase 20 percent annually as more EVs hit the road.

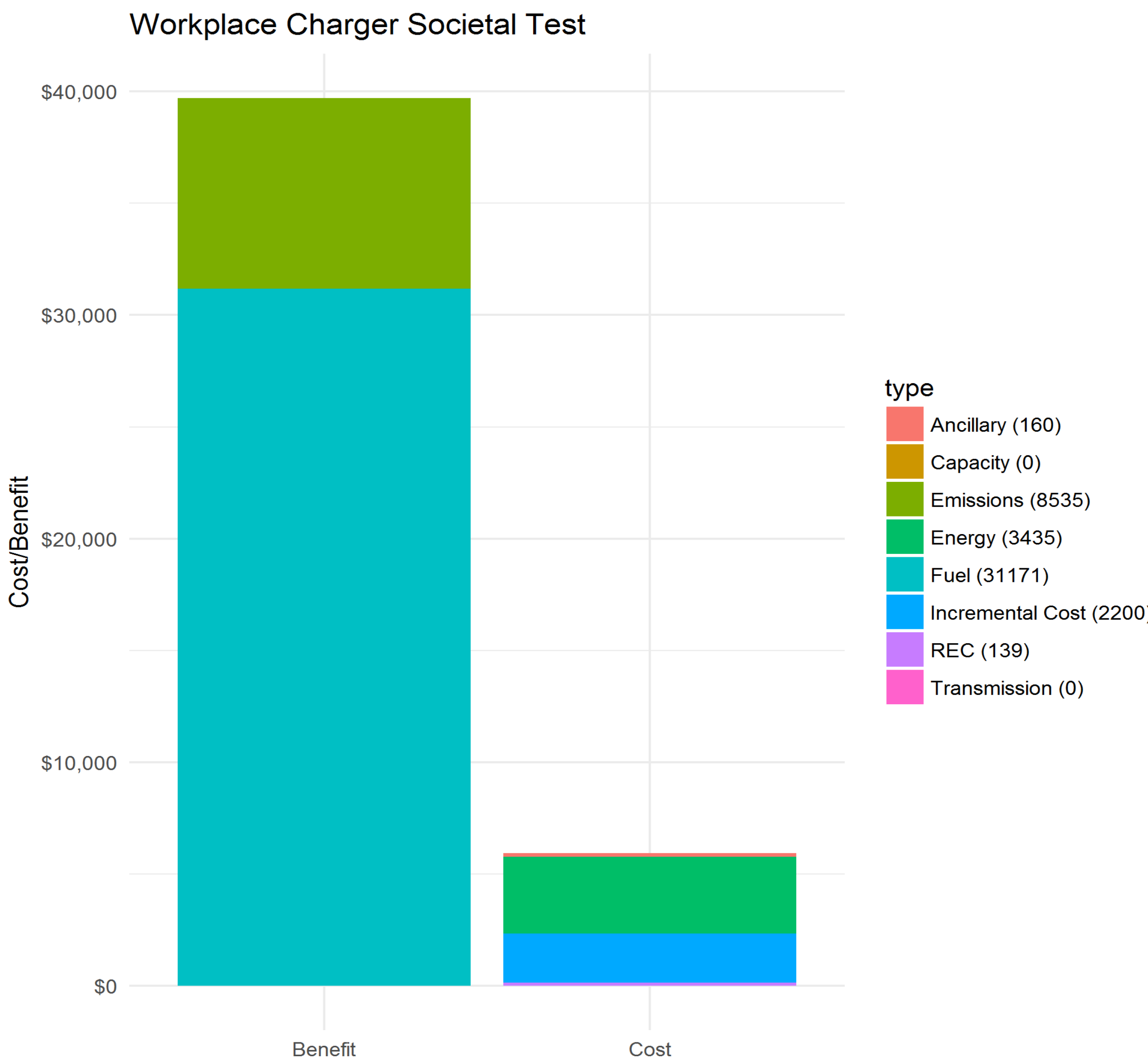


Utility cost test for EA owned EVSE

The utility cost test was not performed for the proposed EA chargers since EA will incur all the costs to install the units and pay for maintenance. Provided that rates from the utility to the charger owner are appropriate, any utility cost test for such chargers would be positive.

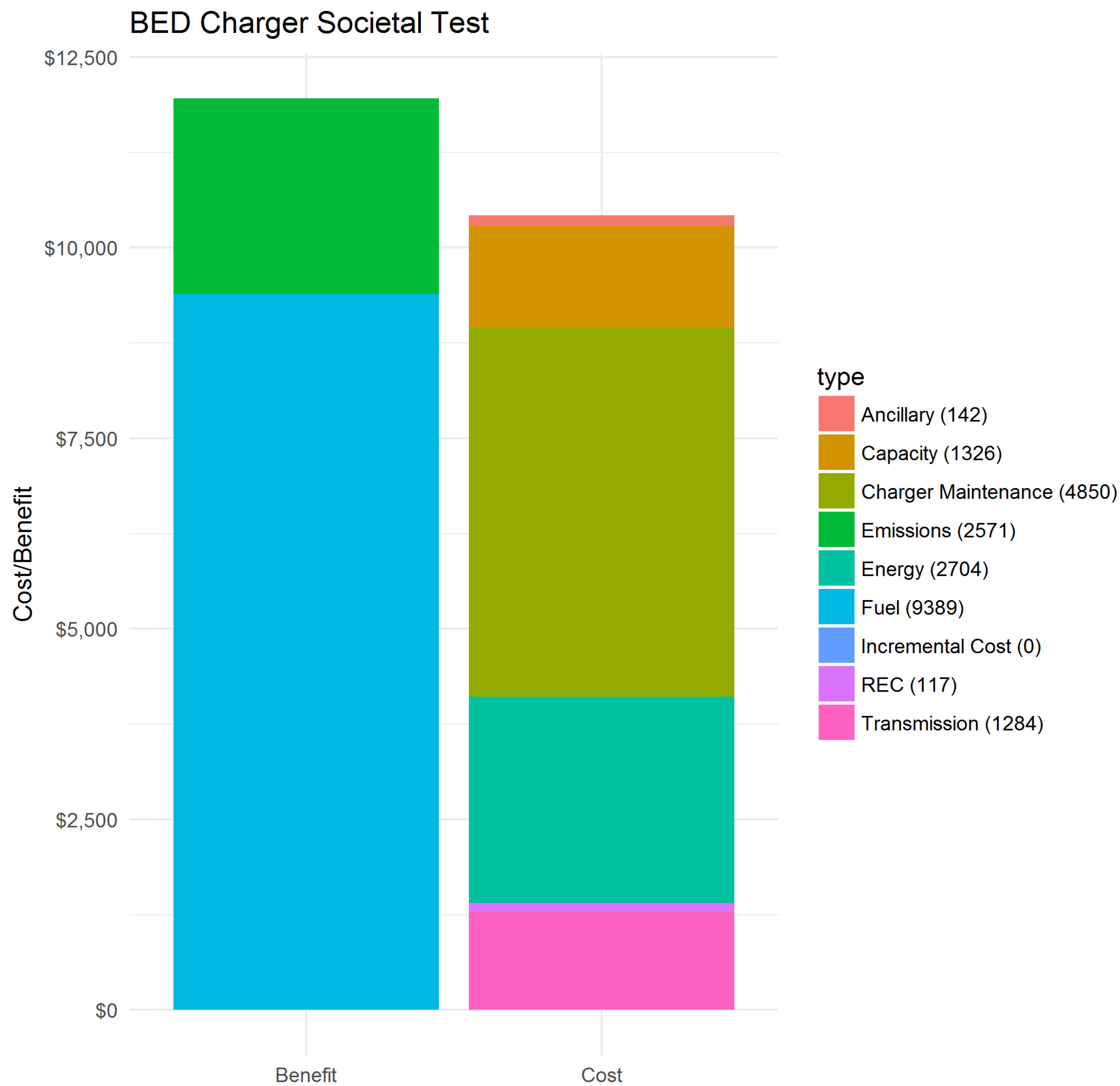
f. Societal cost test

The "at work" EVSE program has the potential to generate up to $33,772 in societal net benefits. Most benefits flow from reduced consumption of fossil fuels ($31, 170) and avoided emissions ($8,535). Additional costs include the estimated average cost of an EVSE pedestal ($2,200), additional purchases of energy ($3,435), ancillary services ($160) and RECs ($139). The societal value of avoided fuels was assumed to increase annually at the rate of the inflation (approximately 2.0%). Meanwhile, avoided emissions were based on a $95/ton cost of carbon.



Societal Cost test for BED owned EVSE

Under the SCT, BED owned EVSE could generate up to $1,536 in net benefits per EVSE. Again, benefits were generated from avoidance of fossil fuel consumption ($9,389) and emissions ($2,570). Similar to the "at work" EVSE program, the fossil fuels were modelled under the assumption that fuel prices would increase – on average – about 2.0 percent annually. The cost of emission was estimated to cost $95/ton of carbon. Additional costs stem from wholesale energy ($2,700), charger maintenance ($4,849), capacity ($1,326), transmission ($1,285) ancillary ($141) and REC purchases ($117).



Electric Bikes

a.) Introduction

The electric bicycle is technology from the 1800s, but with the advent of microcontrollers and lithium-ion batteries, it is rapidly improving. Electric bicycles are powered both by a rechargeable lithium-ion battery pack capable of storing hundreds of watt-hours of energy and a rider. The range, when fully charged, is between 10 and 100 electric-assisted miles, depending on temperature, terrain, bicycling habits and cargo weight. The electric bicycle continues to function, though poorly, as a regular bicycle even if the battery becomes depleted.

Program update

This is a new program to be fully launched in 2018. No update is available.

b.) 2018 program budget

BED, in conjunction with Local Motion and other local partners, will have launched an Electric Bicycle incentive program by the end of 2017. The program will involve three separate sub-programs:

- Direct Incentives of Electric Bicycles administered by Local Motion
- Creation of Lending Library: BED will purchase electric bicycles and Local Motion will lend those bicycles to Burlingtonians
- Incentivizing Electric Bicycles in the Burlington Bike Share program

Direct Incentive through Local Motion

Provide up to 400 rebates to City residents and businesses by the end of 2019. Rebates will be limited to electric bicycles and conversion kits with a MSRP of $5,000 or less and will be $200 per unit.

Year	Bikes	ACP	Tier 3 Credits	Total Incentive	Admin Costs	Total Budget
2018	125	$40,300	650	$25,000	$7,500	$32,250

Bicycle Share

Provide incentives to Burlington Bike Share program for Electric Bicycles. Rebates will be $200 per unit. Initial incentive will be limited to 25 bicycles.

Year	Bikes	ACP	Tier 3 Credits	Total Incentive	Admin Costs	Total Budget
2018	25	$8,060	130	$5,000	$250	$5,250

Total budget

Year	Bikes	ACP	Tier 3 Credits	Total Incentive	Admin Costs	Total Budget
2018	150	$48,360	780	$30,000	$7,750	$37,750

c.) Market potential

The potential market for electric bikes in Burlington is very large as nearly everyone should be able to ride one. Electric bikes have recently begun to grow in popularity (especially internationally) as the cost of batteries has decreased and the performance has improved.

d.) Customer economics

The analysis is based on the draft measure that is currently before the TAG committee showing 1,286 driving miles displaced annually. Users would also gain benefits that are not directly monetizable such as improved health and an additional transportation option.

	Electric Bicycle	ICE (Miles Reduced)	ICE Replaced
MSRP			28,000
Incremental Cost	750		
Fuel	23	780	780
Maintenance	100	312	312
Tier 3 Incentive	-150		

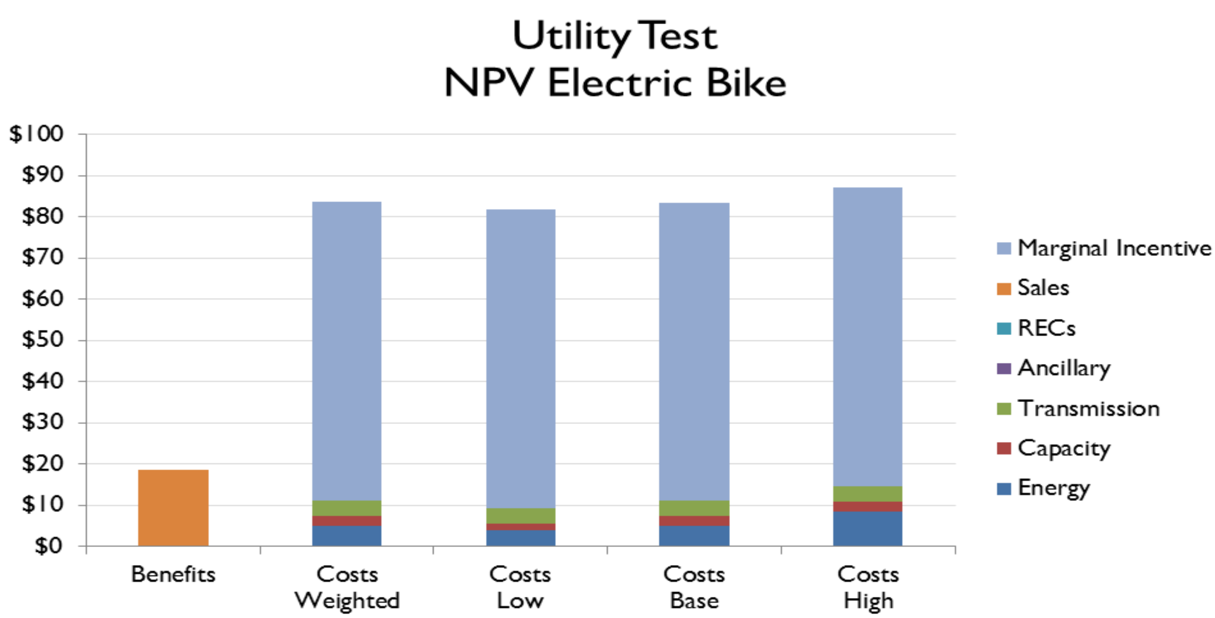
Net Cost	723	1,093	29,093
Increased Cost		370	28,370

e.) Utility Cost Test

Electric bikes–despite their name–are still mostly human powered, and do not use much electricity. Nevertheless, over the eight year expected lifetime of an electric bike BED expects to make about $10 on the marginal electric sales net of wholesale costs, however, the marginal incentive of $73 results in a negative overall impact to BED.

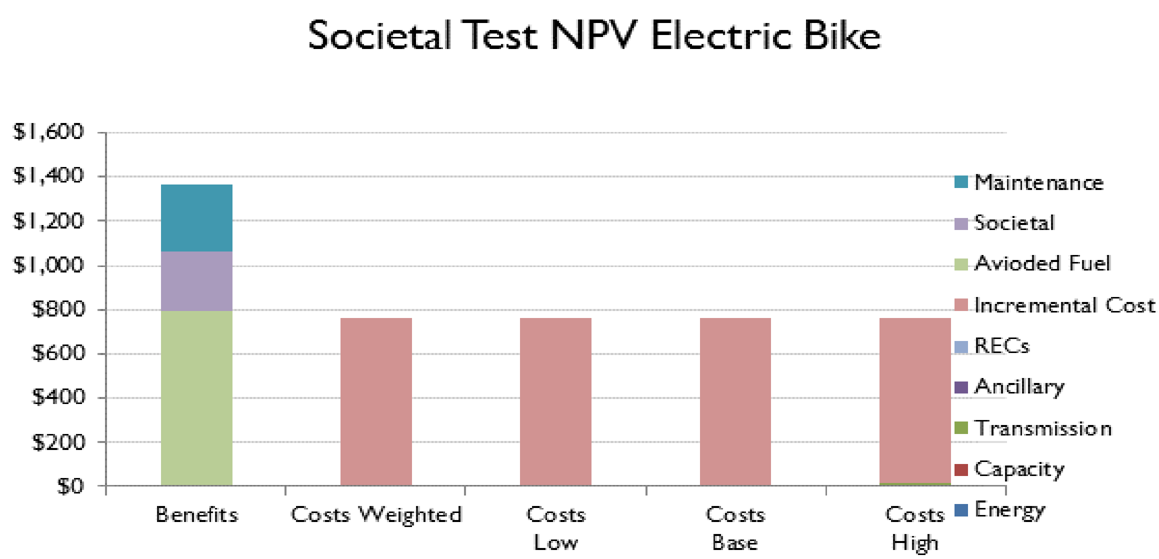
Under the base case scenario, net utility costs (lifetime) are expected to amount to $65 per electric bicycle. Benefits flow from increased electricity sales of 16.7 kWh annually. Electric sales depend on the electric bicycle type, battery size and total annual miles of use. Annual electricity sales are estimated as $2.

Utility costs (lifetime) are associated with the marginal incentive of $73, energy ($5), capacity ($2), transmission ($4) and additional REC purchases (less than $1) to ensure BED's 100 percent claim of renewability is maintained.



f.) Societal Cost Test

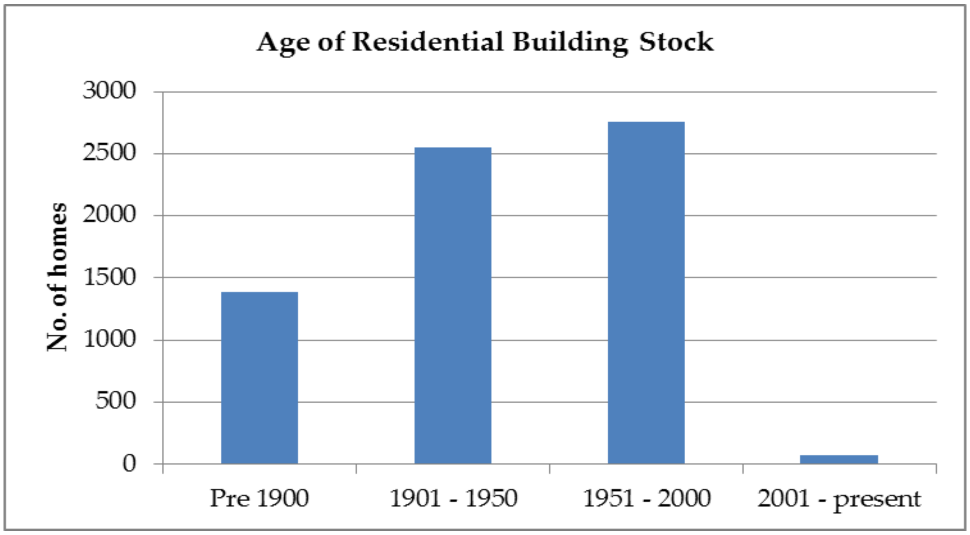
Net societal benefits (lifetime) under base case assumptions could amount to about $606 per electric bike. Benefits are primarily due to avoided fossil fuel consumption ($790), avoided GHG emissions ($275) and avoided maintenance costs ($300). Avoided emissions are a function of the miles driven annually, GHG content of displaced fuel per MMBTU and carbon costs ($95/ton). Societal costs (lifetime) are comprised of the incremental cost of an Electric Bike ($750), energy ($5), capacity ($2), transmission ($1) and additional REC purchases (less than $1) to ensure BED's 100 percent claim of renewability.



Passive House and/or Deep energy retrofit (DER) program

a.) Introduction

Like most of Vermont, much of the housing stock in Burlington is old. Indeed, the average age of residential buildings in Burlington is 79.5 years. And, 3,735 homes were built before 1950.[29]



As a consequence, achieving the State's 2050 energy goals will take a massive effort to upgrade and weatherize the existing housing stock. To help the state achieve its thermal energy policies, BED initiated a Passive House/Deep energy retrofit (DER) program in 2017. As noted in last year's Tier III plan, the program has, to date, been primarily focused on training. This effort will continue in 2018, and possibly into 2019. In addition to this effort, BED will continue to seek out partners to build and/or renovate buildings to the Passive house standard.

Passive House (or PassivHaus) is not a technology but rather a standard for new building construction and major renovations. Established in Germany during the 1980's, interest in the Passive House (PH) standard among U.S. based architects, developers, contractors and building owners has been steadily increasing since the mid-2000's. The intent of the PH standard is to dramatically improve building quality and occupancy comfort while also reducing total energy use intensity (i.e. BTU consumption per conditioned sq. foot). For BED, promoting Passive House construction is viewed as a means to address four imperatives of its 2016 strategic plan: carbon reduction, energy independence, economic development and greater building resiliency.

[29] See Socrata database; includes only 2 – 4 family homes, and single family homes, not condominiums.

Building to the PH standard is voluntary. Nevertheless, earning a PH certificate is rigorous. It requires a paradigm shift in building design and construction techniques. The first step toward certification is to develop a building design that minimizes heating and cooling loads through so-called "passive" measures. Examples of such measures include but are not limited to orientating the building to take advantage of solar heat gain in the winter and shading during the summer, insulating the building well above current codes, using heat recovery technics to make optimal use of waste heat, eliminating thermal bridges, and ejecting incidental internal heat sources to the outside environment during the summer. Because the building is airtight, a continuous supply of filtered fresh air is supplied to living/working spaces and stale air is exhausted; providing balanced and controlled ventilation with high-efficiency heat exchangers.

Any type of building can obtain a Passive House certification: single family homes, multi-family buildings, apartments, mixed-used buildings, office buildings, and even schools. Despite widespread and misleading descriptions, PH buildings still require heating systems in cold climate zones, like Vermont. Also, they are not necessarily net zero-energy buildings. However, because certified PH buildings consume 80 - 90 percent less energy per square foot than current code-compliant buildings, they allow contractors to "right-size" mechanical equipment to match the actual heating and cooling loads of buildings. Right sizing equipment reduces the upfront capital costs of boilers and air conditioners, as well as the annual operating costs of space conditioning buildings. And, in some cases, PH buildings can rely solely on alternative heating and cooling systems such as electric resistance baseboard, woodstoves or cold climate heat pumps. Passive Houses also employ day lighting strategies and task lighting techniques; both of which dramatically reduce the need for artificial lighting.

Building to the PH retrofit standard would have the effect of raising expectations about the quality and comfort of living and working spaces. In addition to using less energy, certified passive house buildings are known to be:

- Healthier than typical buildings as passive house standards rely on high-quality ventilation systems that pump fresh outside air that is free of mold and indoor air contaminants into the living space.
- More comfortable due to increased levels of insulation, elimination of thermal bridges and fewer air exchanges. As a result, the interior environment remains at a steady temperature level and there are no drafts.
- Affordable to own and maintain as higher initial construction costs for high performance building components are substantially offset by a reduction in system sizing and energy consumption.
- Resilient during inclement weather conditions as Passive house buildings are able to maintain habitable interior temperatures in freezing weather without power for longer periods of time than standard buildings; allowing people to shelter-in-place.

Program Update

Over the past two years, BED has sponsored 2 PH training sessions in Burlington. Each has been well attended and interest in Passive houses is growing among regional tradespeople. In early November, another five day session will be conducted at BED by Yestermorrow, an important strategic partner in this effort.[30] Yestermorrow specializes in advanced training for the next generation of builders, as well as for current practitioners who want to up their "game" in the construction field.

In addition to offering training sessions 2017, which has been supported with EEU funds, BED worked with a builder, and his architect, to determine what incentive BED could offer to renovate a residential building he owned in Burlington to the Passive House standard. Based on the results of our collective analyses on the project, BED offered to provide a $25,000 performance - based incentive, contingent upon a post-project energy assessment. In exchange for the incentive, the builder/owner also agreed to permanently disconnect the building from the natural gas system. At the time of writing this report, the project has been on hold. Nevertheless, BED intends to continue seeking out similar custom projects. If successful, and another project is advanced, BED proposes to claim up to 624 Tier III credits and invest about $33,000 to help an owner (and builder) lower the incremental cost of renovating to the Passive house standard. The table below includes a summary of the pertinent assumptions used for the 2017 project and which would be applicable to future similarly situated projects.

	Technology	Passive House - Retrofit
	Customer	312 So. Winooski
	Incremental Cost (PH Related only)	$ 80,000
Existing System	**Existing Fuel**	Natural Gas
	Fuel Consumption (ccf,gal)	1191
	Building MMBtu Load	119.1
	System Type	Boiler
	System Efficiency	0.85
	Btu per Unit Fuel	100000
	Efficient Adj Btu/Unit Fuel	85000
Fuel Displacemen	**% of Load Displaced / Reduced**	1
	MMBtu Displaced / Reduced	119.1
	Units of Fuel Saved	1,401
	Power Plant Heat Rate	9.541
	MWh Equivilant input	12.5
BED MWh goal and ACP cap	**1st Yr MWh (FF) Saved**	12.5
	Measure Life	50
	Lifetime MWh equivilant	624
	ACP cap (100% RE utilities)	$ 38,198

30 See: Yestmorrow's website located here.

b.) 2018 program budget

If a similar custom passive house project, as the one described above, moves forward in 2018, BED will offer the same performance based incentive. Accordingly, BED would expect to invest up to $32,800 in the program/project, and claim 624 Tier III credits. It is important to note that each Passive House project would be assessed on their individual merits. Thus, the incentive amount, as well as the proposed Tier III credit will be estimated on a case-by-case basis.

Passive House (renovations)	2018	2019	2020
No. of units	1	1	1
MWh e credits	624	624	624
Max. ACP	$ 38,189	$ 38,953	$ 39,732
BED program costs			
Incentive	$ 25,000	$ 25,000	$ 25,000
Admin costs	$ 7,800	$ 7,800	$ 7,800
Total BED program costs	$ 32,800	$ 32,800	$ 32,800
Net retail revenue	412.37	412.37	412.37
$/MWh e, net of first yr net revenue	**$ 51.90**	**$ 51.90**	**$ 51.90**
Max. ACP/MWh e	$ 61.20	$ 62.42	$ 63.67

b.) Market potential

The economic market potential for passive house renovations and new construction is quite limited under current conditions. Mostly, the limitations are due to the perceived high cost of building to the Passive house standard and lack of training.

Concerning the cost of building (and occupying) a Passive House, most owners have a short term perspective. Naturally owners would like to keep the first cost of building/renovating a building as low as possible in order to keep their monthly mortgage payment reasonable. This tendency however can lead builders to cut corners and construct (or renovate) homes only to the current - day code. If Vermont truly wants to successfully transform the marketplace, a longer term perspective will be necessary. This means that homeowners and policy makers need to consider the longer term differences in the operational and fuel costs as well as increased resale value of code – compliant homes and Passive Houses. Since homes are occupied for 75 to 100 years[31], the operational and fuel savings can more than

[31] For purposes of this analysis, BED used a 50 year measure life, despite literature suggesting longer life spans. BED used a shorter time frame in order to conservatively estimate fuel savings and to

offset the higher incremental cost of building to higher code standards, as shown in the customer economics section below. These savings however can be lost since many homeowners move on to new homes before they can reap the savings of a Passive House. Due to this split incentive dilemma, BED has limited its program budget to one passive house project per year, as shown in the budget table highlighted above.

d.) Customer economics

Using the 2017 project as an example, BED has found that a customer's incremental cost to renovate a residential building into a Passive House is high. According to information provided by the building owner, the incremental cost is approximately $80,000 before incentives. Energy related savings for heating loads, however, amount to only $1600 to $1900 annually over the next several years due to low natural gas prices; thus, the customer's simple payback ranges between 42 and 50 years. Similarly, the project would likely result in a negative net present value return on investment to the building owner of approximately $28,000 using a 3.0 percent discount rate. For the project to yield a positive net present value return, the incremental cost of construction would need to be reduced by no less than $30,000 or natural gas prices would need to increase faster than currently estimated (or some combination thereof).

The poor customer economics of Passive houses (relative to code – compliant renovations) is the primary reason why most typical owners do not currently renovate their buildings to the PH standard. But with a $25,000 financial incentive, as proposed by BED, the customer's project economics can be improved, although the end result would still be a negative net present value to the building owner of $3,700 over the expected 50 year life of the building. The simple payback also would be marginally improved as shown in the table below.

Total incremental cost	$ 55,000	$ 55,000
Average Energy savings	$ 1,600	$ 1,900
Simple Payback (yrs)	34	29

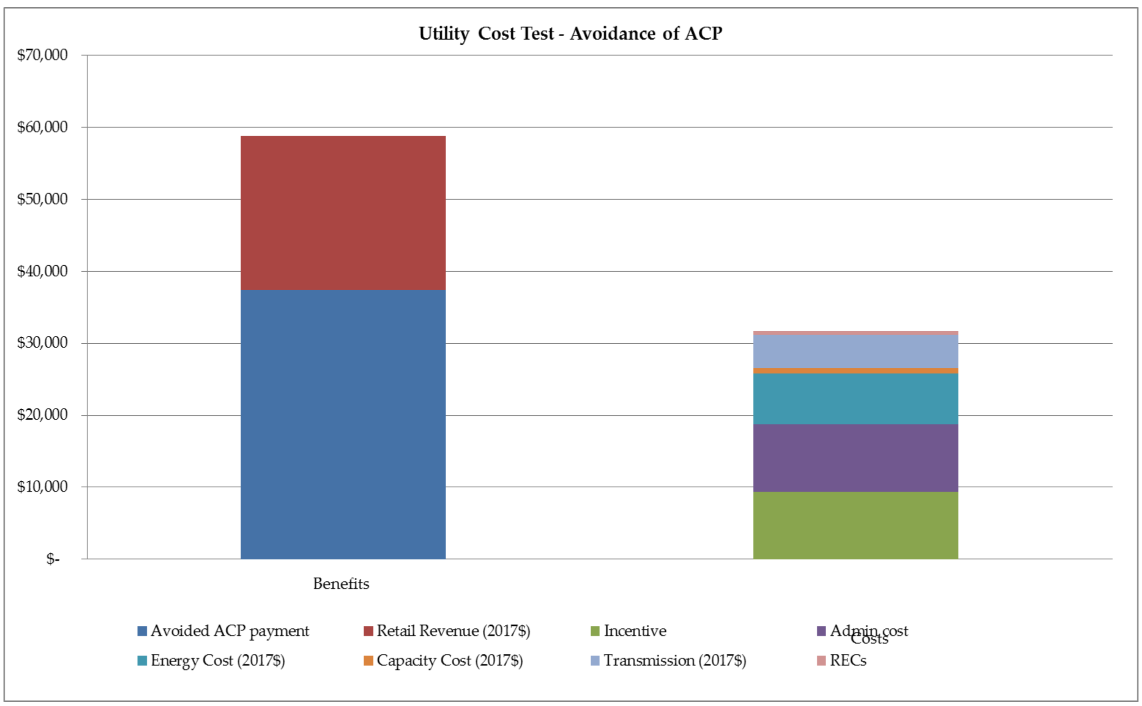
e.) Utility Cost Test

As noted in BED's 2016 Integrated Resource Plan (IRP), promoting and supporting an active program that results in the construction of PH certified homes in the City would result in net positive benefits for BED and its ratepayers, generally. The primary benefit flows from the avoidance of the marginal alternative compliance payment (ACP, less the cost of $25 RECs) that

account for the potential failure of some house systems such as windows, roof leakages, and unexpected thermal bridges caused by buildings settling over long periods of time.

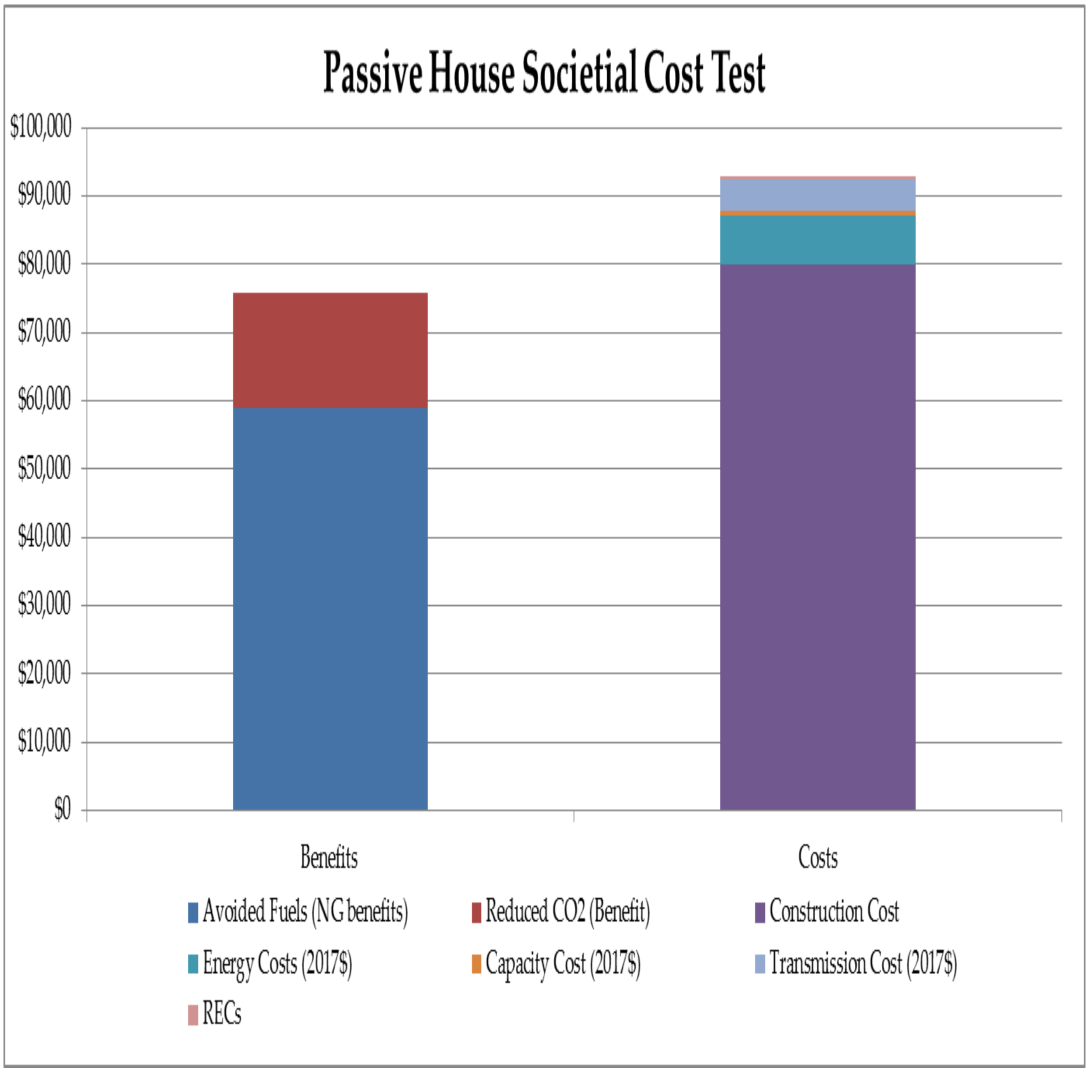
would otherwise be incurred in the absence of a program – and to a smaller extent, the sale of additional electricity.

As noted, failure to deploy such initiatives could result in penalties or alternative compliance payments (ACP) to the State's Clean Energy fund. For this analysis, the ACP was set at $38,189 , which approximates the 50 year lifetime MWh equivalent of the fossil fuels displaced by the project times the $61.20/MWh e. By encouraging this project to move forward, BED would avoid having to make such a payment in the first year of the Tier 3 program. Additional benefits will flow from the sale of additional electricity (approximately $21,328), as the house would be heated primarily with a cold-climate heat pump. Utility costs include the following: marginal incentive costs ($9400), admin ($9549), wholesale energy ($7011), capacity ($783), transmission ($4594), and additional RECS ($579). According to this analysis, BED could generate a positive net utility benefit of approximately $27,573 per project, as shown in the graph below.



f.) Societal Cost Test

Under the societal cost test, the project would result in net societal costs amounting to approximately $17,000 over the 50 year time horizon. Again, the net costs are due to the high incremental costs (which are borne by the owner, not society), historically low natural gas prices and the short planning horizon. With time, such as 75 years, and additional construction training to reduce incremental costs, the project could turn out to be societally cost effective. Benefits from this type of project flow from avoided fuel consumption ($58,871) and reductions CO_2 emissions ($17,017). Costs include the incremental cost of renovations ($80,000), wholesale energy to serve ccHPs ($7,011) in the building, capacity costs ($783), transmission ($4594) and additional REC purchases ($579).



High Performance Heat pumps (non- natural gas customers)

a.) Introduction

During 2018, BED's high performance heat pump program will continue to promote advanced thermal technologies including but not limited to cold climate heat pumps (ccHP), ground source heat pumps (gSHP) and other types of commercially-available, variable flow systems. As before, the program will concentrate its outreach efforts on non-natural gas customers, "green" customers who oppose the consumption of fossil fuels and the new construction/major renovation markets (residential & commercial). But, BED is scaling back its 2018 – 2020 projections of ccHPs installed in the City due to the results of a 2017 DPS evaluation report. That evaluation indicates that the forecasted ccHP- related savings based on Efficiency Vermont's analyses were roughly twice the actual savings that customers participating in the evaluation study experienced. These changes in expected savings have undermined the customer's economics even further. Now, a customer's simple payback on their investment will likely extend beyond the useful life of the equipment for customers heating with natural gas, oil and pellet boilers. Consequently, BED is now anticipating it will provide incentives for no more than 15 ccHPs over the next three years, as shown in the table below.

Program update

In 2017, BED developed a webpage for interested customers to self-assess their heating needs and determine whether purchasing a ccHP made sense for them. That website will be maintained going forward and may be enhanced with additional information. Customers visiting BED's ccHP website can also download a rebate form to receive an incentive. As additional technologies are added to the program, additional downloadable rebate forms will also be added. During the next implementation period, BED does not intend to actively market ccHPs in its territory. Rather, it will focus on providing unbiased information and analytical assistance so customers can evaluate their heating and cooling requirements. Depending on the customer's situation, they could be advised to invest in additional weatherization measures instead of a ccHP and/or directed to VGS for assistance with a high efficiency boiler – if on natural gas. If a customer uses propane, oil or kerosene, additional assessments by BED energy services staff may be performed to help customers determine whether a ccHP would provide for sufficient and cost effective heating and cooling. If a ccHP is determined be cost ineffective then customers may still qualify for an incentive, provided under the TEPF program, to upgrade their aging boiler/furnace.

During the first year of the Tier planning period, BED processed one Tier III ccHP rebate form.

b.) 2018 program budget

Based on the evaluation results, which resulted in dramatically lower, tier III credits, BED anticipates investing no more than $2,500 annually in the ccHP program.

CCHP		2018		2019		2020
Per unit BED costs						
First Yr Credit		2.5		2.5		2.5
Meas Life		15		15		15
Life time Credits		37.5		37.5		37.5
Weighted Avg Total incentive	$	413	$	413	$	413
Admin cost	$	83	$	83	$	83
Total BED cost	$	495	$	495	$	495
Progam costs						
No. of Units		5		5		5
Total Lifetime credits		187.5		187.5		187.5
Total program costs	$	2,475	$	2,475	$	2,475
$/MWh e	$	13.20	$	13.20	$	13.20

c.) Market potential

Because most customers are served by VGS and natural gas prices are so low, the market potential for retrofitting homes and businesses with a ccHP is extremely low.[32] Consequently, BED is projecting limited program expenditures. As events unfold over the next few years, BED will re-evaluate the market potential to determine whether additional investments are warranted. Potential events leading to increased future investment could include a rise in natural gas prices, improved efficiency of ccHP or new technologies such as lower cost, modular geothermal heat pumps.

d.) Customer economics

As reported in the 2017 Tier III plan, the customer's economics of ccHPs are poor. Since that report was filed in December, 2016, the economics have not improved even though fossil fuel prices (except natural gas) are slightly higher from a year ago. Indeed, customers installing ccHP should not expect to save money unless they heat with propane, kerosene or electric resistance heaters. The table below provides an overview of the customer's economics at current

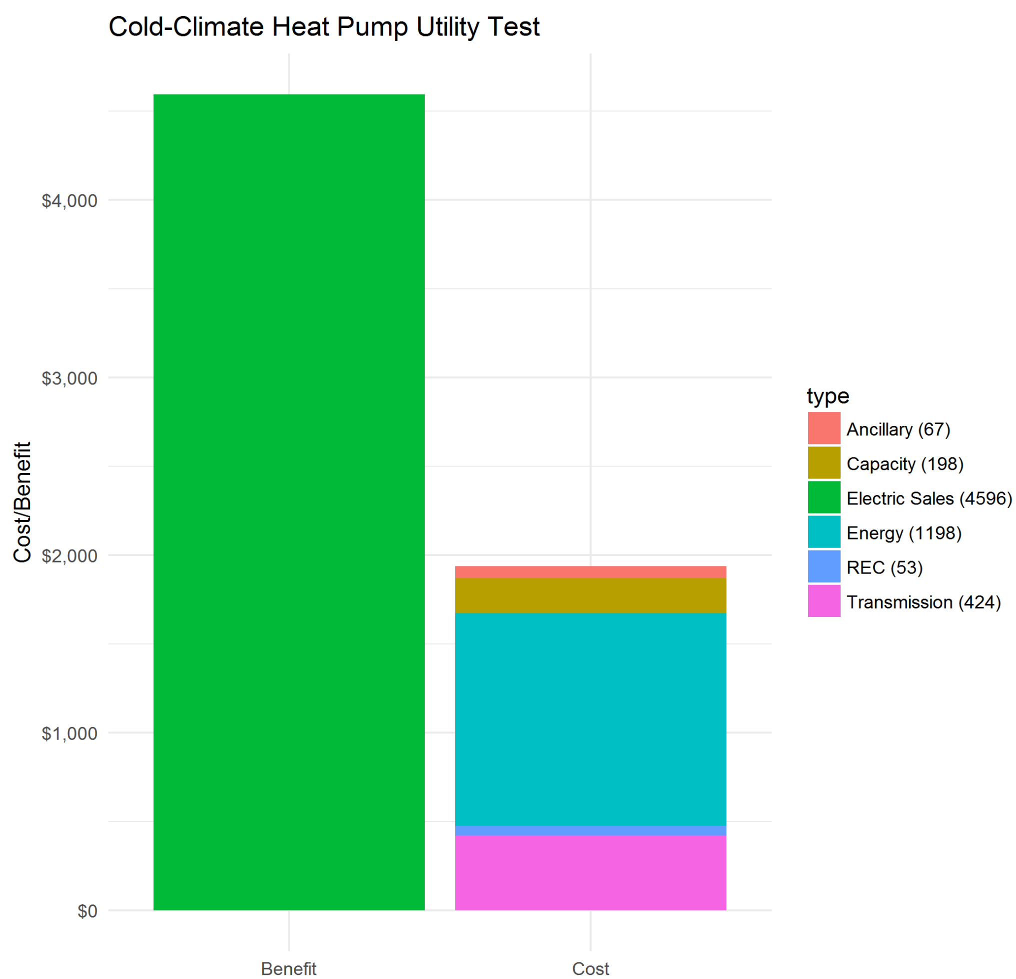
[32] Despite the poor economics, BED will continue to provide incentives under the EEU upstream program. Most EEU funded incentives are applied to systems that are installed in new construction or major renovations where lower first costs (relative to a new boiler/furnace) and cooling are important motivators for customers.

fuel prices (October, 2017). Unlike last year's analysis, the table below assumes that a ccHP can only displace 40 percent of the expected heat load of building, whereas last year's analyses assumed 60 percent displacement. This reduction in heating load capacity is roughly consistent with the DPS's evaluation findings. The table below does not include impacts (positive or negative) on a customer's cooling costs.

	CCHP	NG Boilers	Oil	Propane	Kerosene	Electric, kWh	Pellets	Wood, green
House BTU load - delivered	90,000,000	90,000,000	90,000,000	90,000,000	90,000,000	90,000,000	90,000,000	90,000,000
BTU per unit of fuel	3412	100,000	138,200	91,600	136,600	3,412	16,400,000	22,000,000
Total consumption	26,377	900	651	983	659	26,377	5	4
COP/AFUE	2.5	0.85	0.85	0.8	0.8	1	0.8	0.6
Price per unit	$ 0.15	$ 1.40	$ 2.41	$ 2.63	$ 2.93	$ 0.15	$ 294.00	$ 227.00
cost per MMBTU	17.58	16.47	20.52	35.89	26.81	43.96	22.41	17.20
Total cost	$ 1,583	$ 1,482	$ 1,846	$ 3,230	$ 2,413	$ 3,957	$ 2,017	$ 1,548
If ccHP can displace:	0.4	36,000,000	36,000,000	36,000,000	36,000,000	36,000,000	36,000,000	36,000,000
Remaining BTU served by existing system	0.6	54,000,000	54,000,000	54,000,000	54,000,000	54,000,000	54,000,000	54,000,000
total ccHP cost		$ 633	$ 633	$ 633	$ 633	$ 633	$ 633	$ 633
Total FF cost		$ 889	$ 1,108	$ 1,938	$ 1,448	$ 2,374	$ 1,210	$ 929
Total heating cost		**$ 1,522**	**$ 1,741**	**$ 2,571**	**$ 2,081**	**$ 3,007**	**$ 1,843**	**$ 1,562**
Savings $ (costs)		**$ (40)**	**$ 106**	**$ 659**	**$ 332**	**$ 950**	**$ 174**	**$ (14)**
Savings %		-2.7%	5.7%	20.4%	13.8%	24.0%	8.6%	-0.9%
Avg Install Cost		3500	3500	3500	3500	3500	3500	3500
Simple payback (yrs)		n/a	33.17	5.31	10.54	3.69	20.16	n/a

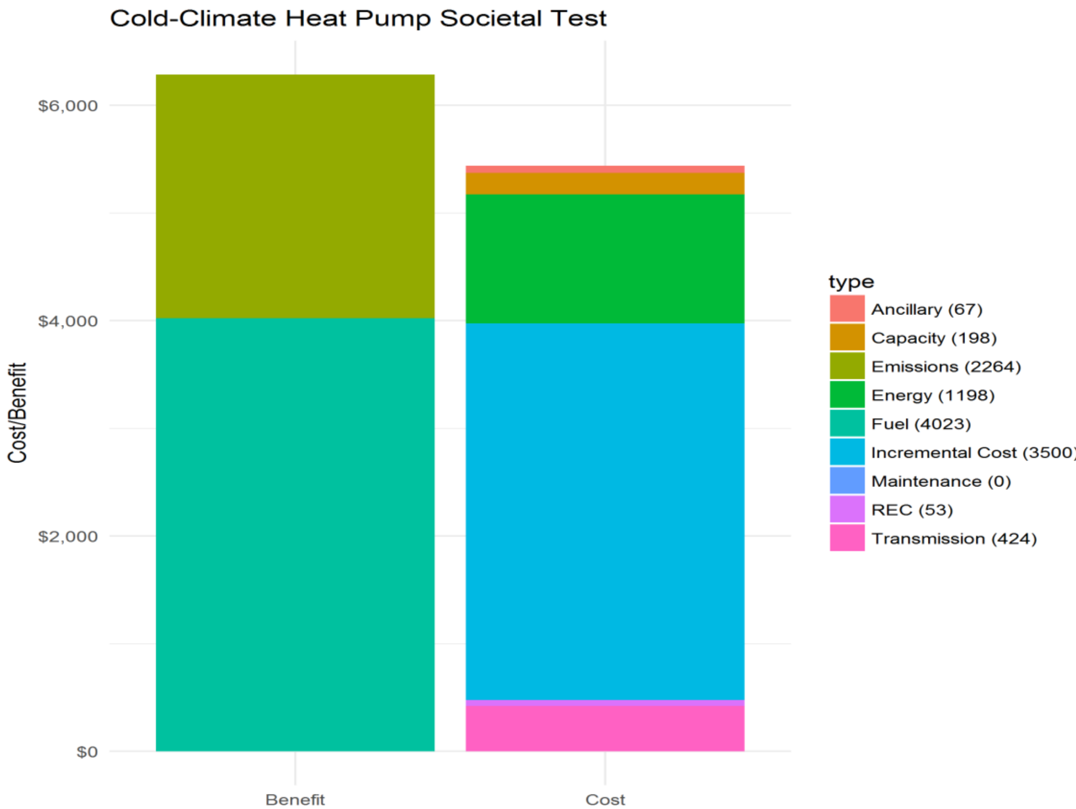
d.) Utility Cost Test

Despite the poor customer economic results, ccHPs may be beneficial under the utility cost test and result in net benefits of about $2,557 over the 15 year life of a unit. Utility benefits flow from increased electric sales ($4,500). Costs are driven by increased expenses for energy ($1200), capacity ($200), transmission ($423), ancillary ($67) and REC purchases ($53). Since the cost of managing this program is less than $25 per MWh $_{e,}$ incentives have not been included as a utility cost for purposes of this analysis for the reasons stated above.



f.) Societal Cost Test

Installing and maintaining a ccHP in one's building also may result in societal net benefits of about $850 over 15 years of continuous operation. Benefits flow from lower emissions ($2,263) and avoided fuel costs ($4,023). Costs stem from installing the units ($3,500), as well as for energy ($1,200), capacity ($200), transmission ($423), ancillary ($67) and REC purchases ($53).



<u>Ground-Source Heat Pumps</u>

To complement its heating initiatives, BED also intends to actively promote ground-source heat pumps (GSHPs). Ground-Source heat pumps can have greater efficiency than air-source heat pumps and also do not degrade in efficiency during extreme cold temperature events. Thus it should be possible to install significantly more heating and cooling capacity for the same amount of peak demand. GSHPs could also be installed to replace the entire heating and cooling load of a building rather than as a partial replacement as with an air-source heat pump.

While, as of this drafting, the TAG committee has not fully completed its analysis of GSHPs, BED is interested in encouraging their increased use as a means to reduce fossil fuel consumption and the emissions of greenhouse gases. BED has initiated meetings with CX Associates and others to discuss how a GSHP program may be deployed in the City. Through its EEU, BED has previously incentivized GSHPs in several local schools.

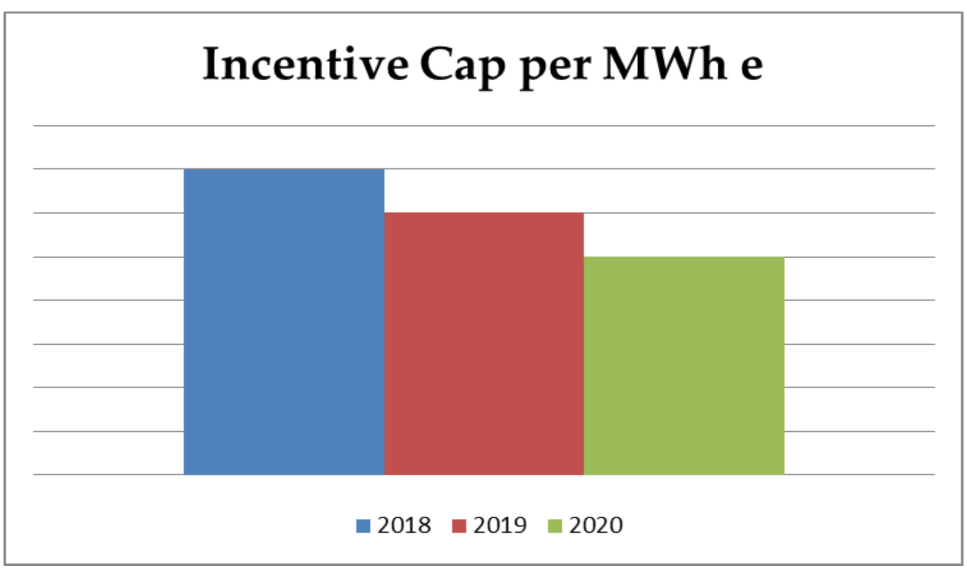
Because the TAG committee has not completed its analysis, this Tier 3 plan does not include an estimate of total MWh credits that could be generated from the implementation of a GSHP program. When such analysis is complete, BED will supplement this annual plan and provide notice to the Department and Commission prior to initiating the program.

Reverse Auction Program

BED intends to develop in 2018 a multiyear custom-based reverse auction program. Under this program design, BED will issue requests for project proposals designed to materially reduce fossil fuel consumption and greenhouse gas emissions. In all likelihood, the RFP would be preceded by a request for information and partner qualifications. The RFI would act as an idea generator, which BED could pre-screen against a set of parameters. In this manner, project developers would bring forward viable ideas that could be readily implemented. Although the details of the program have not been finalized, BED envisions establishing a set of parameters to ensure that potential bidders develop innovative projects that would result in long term benefits. Such parameters could include the following:

- 20 year minimum project life;
- 100 percent fossil fuel reductions; and/or,
- Beneficial electrification with load controls

While BED is constantly researching new, commercially available technologies that could be viable substitutes for traditional fuel burning engines, BED believes that a RFP process could help to identify novel projects that would have otherwise been undetected. Moreover, an auction process could drive down Tier III program costs as project developers would submit bids for the amount of an incentive that would be needed to move a project forward, rather than BED establishing a set amount that project developers would take irrespective of what they needed to actually implement the project. In addition, BED could select proposals based on their ability to meet RES goals in the most cost-effect manner possible. BED also envisions the potential for establishing a multi – year declining incentive cap per MWh $_e$ so that project developers would know in advance how much their projects could generate in funding. An example of such a declining pathway is highlighted below.



Implementation strategies

In general, one set of proposed programs is intended to address the transportation sector; the other set addresses the built environment. Aside from these generalities, each of the above noted programs will rely on very distinct implementation strategies. In the tables below, a short description of BED's program objectives and implementation strategy for each of above noted measures is provided. Also, the tables identify other program-specific parameters such as the estimated number of participants, fossil fuel displacements, Tier III MWh claims, ACP/program budgets, collaboration partners, potential impact on energy loads and peak demand, best practices and whether the technology is appropriate for Vermont.

Technology/Program	Electric Buses, Public transit and/or school buses
Objective/Implementation strategy	Replace diesel buses with battery-electric buses. BED has introduced a custom program for review that includes providing a performance- based incentive contingent on the miles driven annually.
Estimated No. of Participants (equitable opportunity)	1 customer - GMTA Potential customers include UVM, Champlain college and Burlington School district
FF displaced/MMBTU equiv.	7000+ gallons of Diesel fuel/965 MMBTUs per bus per year.
Carbon Emissions Avoided	77 tons annually
Lifetime MWh Tier 3 Credit	1204 MWh per bus
Collaboration Partners	GMTA, UVM, Champlain College
Impact on Energy	Depending on battery type, range and miles driven, energy consumption is approximated to be 51 to 53 MWh annually.
Impact on Peak	As much as 80 kW per bus if charging is not constrained. Program assumes long haul buses to allow night time charging under TOU or special rates. As such, BED is not anticipating that this program will materially impact system peak or the customer's demand charge.
Budget/ACP	Up to $73,000 per bus, inclusive of administrative overhead expenses
Best Practices	Ensure battery management system controls are installed such that multiple buses are not charging at maximum capacity at the same time.
Appropriate technology	Yes. Battery electric buses are in operation in multiple jurisdictions, including cold weather zones such as Worcester, MA, Quebec and Alberta. However, this technology is still relatively new as such buses have only just started to operate in these cold weather locations.
Min Building Standards	Not applicable.

Technology/Program	Electric Vehicles
Objective/Implementation strategy	Replace conventional internal combustion engine passenger vehicles with all-electric or PHEV vehicles costing $50,000 or less. Program will target market both the retail consumer market and commercial/institutional (C/I) fleet owners. Downloadable rebates are available from the Burlington Electric website. Energy services staff will engage C/I customers to promote transitioning existing fleets to all-electric vehicles. C/I customers will include be not be limited to city of Burlington, area colleges, UVMMC, car share and taxi services
Estimated No. of Participants (equitable opportunity)	150 EVs/100 PHEV's. All customers in the market for vehicles will have an equitable opportunity to participate in and benefit from the EV program as rebates will be available to all Burlingtonians through area dealers.
FF displaced/MMBTU equiv.	300 to 315 gallons, 38MBTU
Carbon Emissions Avoided	3.5 tons per EV per year
Lifetime MWh Tier 3 Credit	33 MWh per EV
Collaboration Partners	Drive Electric
Impact on Energy	2.5 to 3.3 MWh per EV
Impact on Peak	1–3 kW per charge. Include TOU metering or special rates to promote night time charging.
Budget/ACP	$276,0000, inclusive of administrative overhead
Best Practices	Industry standard best practices do not exist in this market
Appropriate technology	Yes
Min Building Standards	Not applicable.

Technology/Program	Electric Vehicle Charging Equipment - at work locations
Objective/Implementation strategy	Reduce range anxiety of consumers who are considering purchasing an EV. Program will target businesses, apartments and condominium complexes to install multi-port EVSE stations for use by employees, residents and customers.
Estimated No. of Participants (equitable opportunity)	20 per year
FF displaced/MMBTU equiv.	1000 gallons per pedestal, 125 MMBTU
Carbon Emissions Avoided	-
Lifetime MWh Tier 3 Credit	118 MWh per pedestal, lifetime credit (inclusive of AC/DC conversion penalty of 15%)
Collaboration Partners	Larger customers, City of Burlington, Drive Electric
Impact on Energy	8195 kWh weighted average sales per Level 2 station, increasing as EV penetration increases
Impact on Peak	7.2 kW each level 2 station
Budget/ACP	$29,000
Best Practices	n/a
Appropriate technology	Yes
Min Building Standards	n/a

Technology/Program	E - Bike
Objective/Implementation Strategy	In collaboration with area bike dealers, Local Motion and city officials, BED seeks to reduce vehicle miles driven in the city, traffic congestion and promote healthier lifestyles.
Estimated No. of Participants (equitable opportunity)	150 bikes
FF displaced/MMBTU equiv.	780 gallons, 8.4 MMBTU per e-bike
Carbon Emissions Avoided	
Lifetime MWh Tier 3 Credit	
Collaboration Partners	Local Motion, Area and state bike dealers, city officials
Impact on Energy	Minimal
Impact on Peak	Minimal
Budget/ACP	up to $420 per e-Bike
Best Practices	n/a
Appropriate technology	yes
Min Building Standards	n/a

Technology/Program	Passive House
Objective/Implementation strategy	Initially to provide PH training to local building professionals. Over time, training and outreach efforts will be pursued with the intent of transforming the market place such that PH buildings become the standard new construction home or building.
Estimated No. of Participants (equitable opportunity)	2 PH training sessions annually, 1 Passive house retrofit or new construction
FF displaced/MMBTU equiv.	1401 ccf of Natural gas, 119 MMBTU's
Carbon Emissions Avoided	7.0 Tons of CO2 per home/ per year
Lifetime MWh Tier 3 Credit	624 per SF structure; larger structures could be much more. Larger PH projects will be submitted on a custom basis as opportunities are presented.
Collaboration Partners	Building professionals
Impact on Energy	Electric energy impacts will decreases
Impact on Peak	Demand for power will decrease
Budget/ACP	Custom designed budget and incentive
Best Practices	USA and/or International Passive House standards shall apply
Appropriate technology	Yes
Min Building Standards	See USA/International Passive House standards, which exceed the Vermont stretch codes.

Technology/Program	High performance heat pumps
Objective/Implementation strategy	Transform the building space heating market. Pursue strategic electrification opportunities by targeting non-natural gas customers, "green" customers and new construction/major renovation projects. Consider instituting a winter bill credit to improve the natural gas customer's economics of ownership.
Estimated No. of Participants (equitable opportunity)	5 units. This program would also be available to low income customers.
FF displaced/MMBTU equiv.	424 ccf, 36 MMBTUs (assumes a 85% AFUE NG boiler) per ccHP per year
Carbon Emissions Avoided	--
Lifetime MWh Tier 3 Credit	37.5 MWh per ccHP
Collaboration Partners	None
Impact on Energy	6 to 7 MWh annually depending on outside temperatures, amount of fossil fuel offsets and buildings characteristics (i.e. room layout, Weatherization)
Impact on Peak	1–2 kW
Budget/ACP	$2500, inclusive of administrative expenses, gSHP applications will be submitted on a custom basis.
Best Practices	Customers will be advised to coordinate the ccHP operations with their existing heating system.
Appropriate technology	Yes
Min Building Standards	BED will encourage participants to weatherize homes before installation and provide EEU incentives to offset the cost of weatherization, if appropriate.

Tier III Alternatives that do not increase electric use

With the exception of the Passive House program, BED has not prepared a comprehensive review of all potential Tier III measures that could or could not increase electric consumption in order to verify whether options exist that could be more cost effective than those outlined above. However, BED will consider any potential programs that come to its attention that would not increase electric usage and could be more cost-effective than the programs outlined above. If BED becomes aware of such programs it will consider appropriate modifications to this plan, or will consider expanding its programs to meet targets earlier than required and "bank" the credits for future periods. Due to the aggressive goals set both in BED's strategic plan and in the RES, BED suspects that all cost-effective options will need to be leveraged, especially in Burlington, to meet the ongoing targets.

Conclusion

Assuming BED does not apply excess Tier II credits to its Tier III obligation, implementation of the above noted programs is expected to result in 13,197 MWh_e credits in 2018 and require no less than a $532,475 investment, inclusive of overhead costs. Each year after 2018, BED will need to acquire more credits by installing ever more Tier III measures so that by YE 2020, BED will have achieved cumulative credits of 59,984 MWh and invested more than $2.1 million (or less) in advanced, yet commercially available technologies that will reduce fossil fuel consumption. To accomplish this level of achievement, BED intends to implement a series of multifaceted programs targeting the transportation sector and building space heating markets. BED will also pursue a number of custom projects as they are presented. If BED is successful in achieving this level of implementation, BED will have attained its goals in accordance with the RES in 2020.