City of Burlington Electric Department's
2017 Annual Energy Transformation program plan

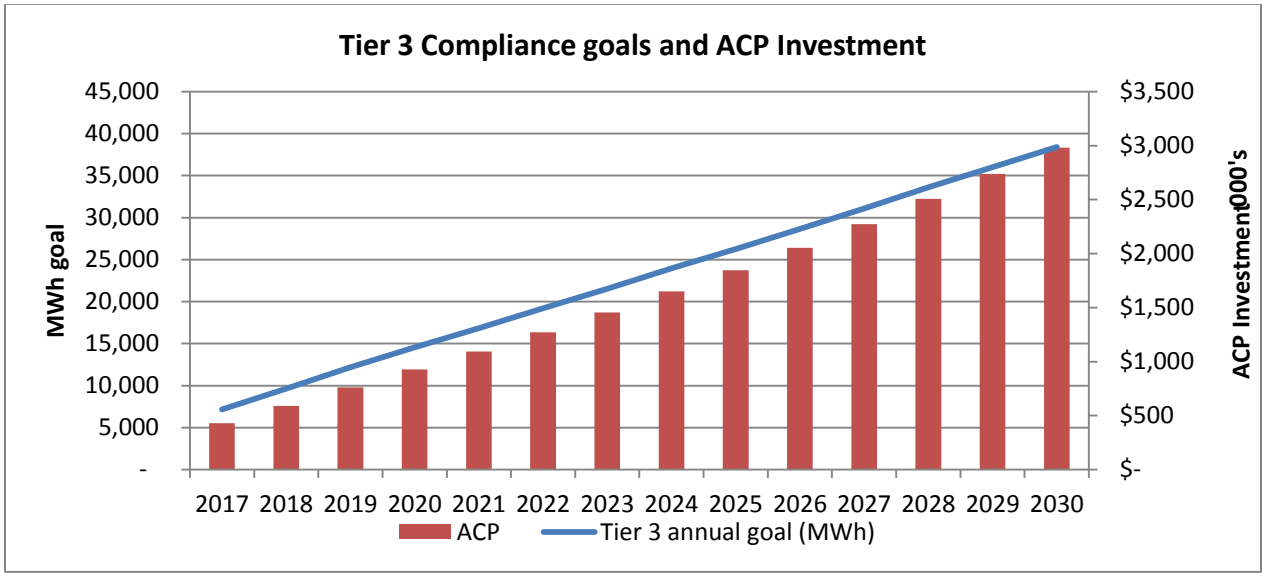
Introduction

Pursuant to Board order in Docket 8550[1], the City of Burlington Electric Department (BED) submits the following informational filing for the Public Service Board's (Board) review. In this filing, BED outlines its current 2017 Tier III plan. Consistent with the Board's directive, this tier III annual plan identifies BED's:

- Tier III obligation in terms of MWh credits and spending,
- Initial project measures; and,
- Proposed implementation strategy

Tier III obligation

30 V.S.A §8005 (a)(3)(B) stipulates that each distribution utility 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 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). For 2017, the ACP has been set at $60 per MWh. After 2017, the ACP shall increase annually by the rate of inflation using the consumer price index. For BED, the unadjusted, aggregate annual MWh goals and budgets are shown in the graph below:



[1] See; Investigation re: establishment of the Renewable Energy Standard program, Docket 8550, June 28, 2016 at pg. 52- 56.

For planning purposes, BED is currently operating under the assumption that the above-captioned goals and budgets would apply at least through 2020 – the year in which the Board will conduct a review of all Tier III programs in Vermont. In table format, BED's unadjusted Tier III annual goals and budgets through calendar year end 2020 are as follows:[2]

	2017			2018		
Tier III Measure	No. of Units	MWh Credits	Total Budget	No. of Units	MWh Credits	Total Budget
Electric Bus	2	2,428	$ 145,680	3	3,642	$ 222,890
Electric Vehicle	40	1,518	$ 91,080	50	1,898	$ 116,158
Electric Vehicle Supply Equipment	12	414	$ 24,840	19	656	$ 40,147
High Performance Heat Pumps	40	2,830	$ 169,800	49	3,467	$ 212,180
PassivHouse	0	-	$ -	0		$ -
Total		**7,190**	**$ 431,400**		**9,663**	**$ 591,376**
	2019			**2020**		
Tier III Measure	No. of Units	MWh Credits	Total Budget	No. of Units	MWh Credits	Total Budget
Electric Bus	2	3,642	$ 227,348	4	4,856	$ 309,194
Electric Vehicle	72	2,733	$ 170,605	80	3,037	$ 193,373
Electric Vehicle Supply Equipment	25	863	$ 53,872	15	518	$ 32,982
High Performance Heat Pumps	70	4,952	$ 309,124	76	5,377	$ 342,367
PassivHouse			$ -	2	755	$ 48,073
Total		**12,190**	**$ 760,949**		**14,543**	**$ 925,989**

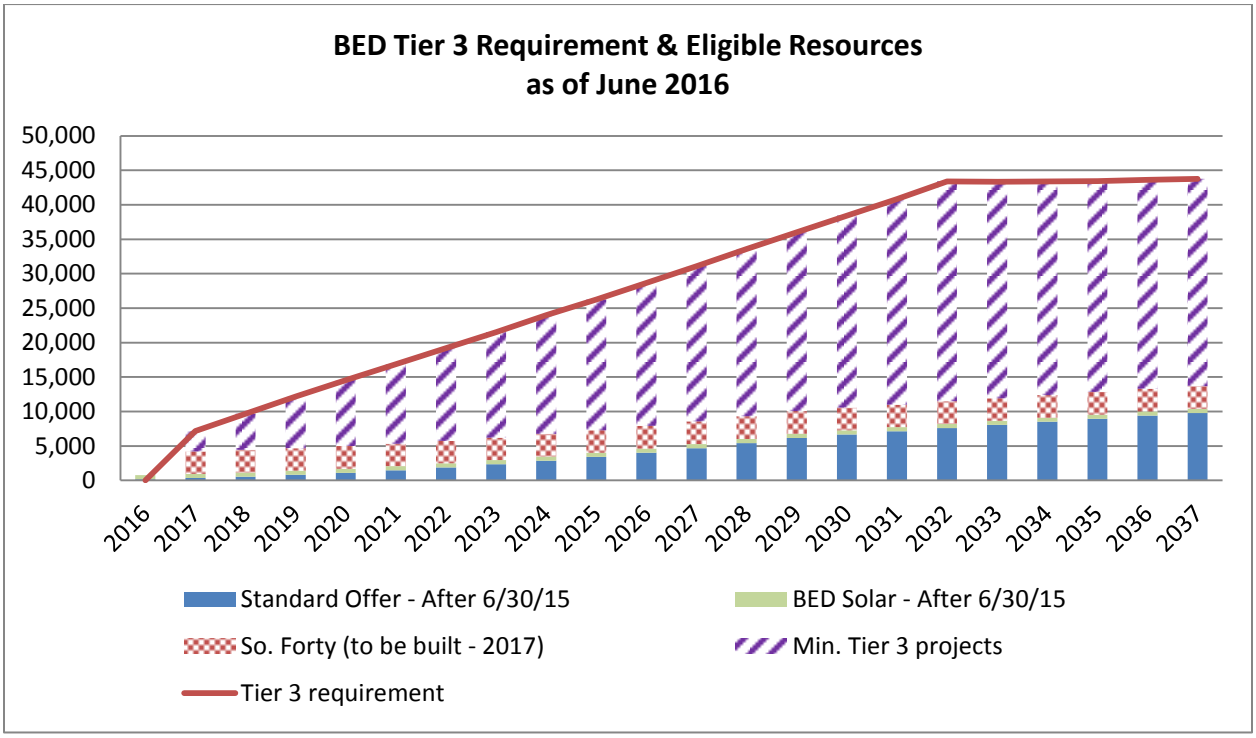
However, BED's obligations under the renewable energy standard (RES) may be modified. As a 100 percent renewable provider, BED is afforded an alternative pathway to RES Tier III compliance[3]. This pathway provides BED with an opportunity to request a reduction in its Tier III requirement that would have otherwise applied if the achievable Tier III potential in Burlington is less than the targets discussed above. This section of the statute was intended to address challenges specific to Burlington (such as the near universal access to natural gas). BED remains concerned that there could be substantial limits to the cost effective Tier III potential within City limits. It bears noting that despite these concerns, BED is nevertheless pursing a number of aggressive strategic initiatives to bolster sustainability. Consequently, BED has chosen to proceed with implementing Tier III measures that would achieve the full statutory targets. After the passage of time, and with experience, BED may still seek to modify its Tier III requirement in the future.

Since 2017 is the first year of the RES, the only potential for using "banked" credits toward a distribution utility's Tier III obligation would be from eligible projects installed between January 1, 2015, and December 31, 2016. BED does expect to claim some of these types

[2] Tier III credits and budgets are not cumulative in 2020, but are instead incremental.

[3] See; 30 V.S.A. §8005(b) Reduced Amounts, 100 percent providers. On July **, 2016, BED filed with the Board a notice that BED was entitled, either through contracts or owned generation, to amount of renewable energy equal to or more than 100 percent of its anticipated total retail electric sales in 2017.

of credits but the quantities are not expected to be large and they have not been quantified at this time. Additionally, as a result of its 100% renewable status, BED expects to apply Tier II credits from a number of solar generators to its Tier III requirement. As the graph below highlights, the aforementioned resources may reduce BED's Tier III requirement by as much as 50 percent in 2017 and 30 percent in 2020. BED may also apply those Tier II credits to Tier III compliance to cover shortfalls, if any, between actual Tier III credits achieved and its obligations.



Initial Tier III measures

For the four year period ending December 31, 2020, BED currently plans to implement at least the following energy transformation projects:

- Electric buses,
- Electric vehicles,
- Electric vehicle supply equipment, including public and at-work chargers,
- Electric bikes
- High-performance heat pumps, including cold climate heat pumps; and,
- PassivHouse design build training

Electric Bus

In terms of their size, length and seating capacity, battery-electric buses are similar in nearly all respects to their diesel-powered counterparts. But, unlike diesel-powered buses, they are much cleaner and quieter to operate. Moreover, fuel and maintenance costs are reported to be substantially less. On the other hand, battery electric buses are a new technology. Consequently, they cost more upfront.

All electric buses are powered by a battery in the undercarriage. Some batteries are of the lithium ion variety; others are comprised of iron phosphate. Both battery types can hold up to 250 kWh's of energy and travel between 125 and 150 miles on single charge. Charging times for these batteries can be as short as 10 minutes or take up to five hours.[4] Battery technologies however are rapidly advancing and prices are coming down. One manufacturer recently announced that its product can store up to 660 kWh and travel up to 350 miles on a single charge. The same manufacturer also lowered the price of some of its products by $80,000. For purposes of Tier III planning, BED intends to enforce a program design that promotes the use of longer range buses and to restrict charging to evening hours under time-of-use rates (existing or new).

Currently there are two well-known battery-electric bus manufacturers: Proterra and BYD. Green Mtn Transit, UVM, VTrans and other community stakeholders are familiar with both. In fact, Green Mtn Transit and UVM have been in discussions with them (and other bus companies) over the past several months. This past summer, battery electric buses from both manufacturers were in Vermont for inspection and a test ride.

Since battery-electric buses are viewed as a new, cutting-edge but commercially available technology that has the potential to substantially lower greenhouse gas emissions, BED believes that providing a financial incentive toward the purchase of a battery-electric bus would be an excellent investment of rate payer funds. A significant incentive would help to lower Green Mtn Transit's incremental upfront costs as well as reduce its total cost of ownership over the 12 year lifetime of each battery - electric bus. Also, BED's active involvement in this nascent market would contribute towards the industry's efforts to transform the public transit marketplace so that battery-electric technologies become more cost competitive over the next several years.

For more details on this proposed program, see BED's draft custom project plan filed with the Department on October 7, 2016.

[4] Short charge times require an additional investment in so-called Fast Charger infrastructure. These systems can cost an additional $500,000 to install and require up to 500 kW of power. BED is not proposing to include Fast Chargers in its Tier 3 program, at this time.

Electric Vehicles

Because Burlington is the largest city in Vermont, a regional employment hub and tourist destination, BED is uniquely positioned to promote the use of all-electric vehicles (EVs) as a means to reduce greenhouse gas emissions. At 13 square miles, the city is relatively compact. City residents could easily depend on EVs for most of their local transportation needs such as running errands, shopping and dropping kids off at school. Indeed, most Vermonter's drive approximately 31 miles per day,[5] which is well within the range of an EV. Moreover, Vermonters residing in neighboring towns could also rely on an EV's to commute into the City for work.

But adoption of EVs will take time, effort and additional incentives to effectively address a number of barriers to EV ownership.

Electric vehicles are a relatively new technology that is rapidly improving. Currently, two basic EV types are commercially available: all electric vehicles and plug-in hybrid electric vehicles. All electric vehicles are powered solely by a rechargeable lithium-ion battery pack capable of storing up to 25 to 30 kWHs of energy. The range of a fully charged, all-electric vehicle is between 60 and 80 miles, depending on temperature, driving patterns and topography (etc.). The MSRP of EV's ranges from $30,000 to $45,000, although actual prices can vary substantially among dealers and EV buyers can earn a $7,500 federal income tax credit. Additionally, General Motors recently announced that its new EV product, the Chevy Bolt, will be delivered to participating dealers in 2017. The Chevy Bolt is reported to have a driving range of 238 miles per charge and cost about $30,000 (after the federal income tax credit).[6]

Plug-in hybrid electric vehicles (or PHEVs) include both a battery pack and a gas tank to power an internal combustion engine. A PHEV's battery range is fairly limited compared to the all-electric vehicle but its total range is comparable to traditional vehicles.

BED's is considering limiting electric vehicle program support to electric passenger vehicles that cost $50,000 or less (save for mass transit options discussed above).

Widespread deployment of EV's has the potential to significantly reduce fossil fuels and emissions of GHG. However, without a federal income tax credit and other incentives, most consumers would not select an EV over a traditional internal combustion engine. Today, the more persistent barriers to EV adoption are upfront costs and range anxiety. To address these market barriers, BED's EV program will provide an incentive to Burlingtonians who buy an eligible all-electric vehicle that is consistent with the incentives developed through the Tier III TAG process. BED anticipates that this investment could amount to as much as $2,000 per vehicle.

---

[5] Vermont Transportation Studies

[6] See; http://www.chevrolet.com/bolt-ev-electric-vehicle.html

After applying the tax credit and applicable incentives, the cost of EV ownership for customers driving approximately 11,500 annually will be lower than the cost of conventional passenger vehicles, even at today's extraordinary low gasoline prices. As the table below demonstrates, EV owners could save as much as $5,000 over the 8 year life of the vehicle.

	Chevy Bolt	ICE
MSRP	$ 37,500	$ 30,000
Federal Tax Credit	($7,500)	$0
Tier 3 Incent	($2,000)	$0
Other Rebates	$0	$0
Net Cost	$ 28,000	$ 30,000
Car Payment/5Yr	$27,605	$29,576
Ann Fuel&Maint(NPV)	$5,108	$8,234
Total Cost of Ownership	$32,713	$37,810
TCO per mile	$2.73	$3.15
Lifetime Savings	$5,097	

**Does not include Taxes, registration, delivery fees, etc.

Given that EV technologies are expected to improve over the coming years, and that EV's have the potential to significantly reduce GHG emissions, actively supporting and encouraging EV adoption appears to be a cost effective, strategic electrification opportunity. Accordingly, BED shall begin implementing an EV program that is similar to and consistent with statewide EV programs, as adopted by the Tier III TAG.

Electric Vehicle Supply Equipment (EVSE)

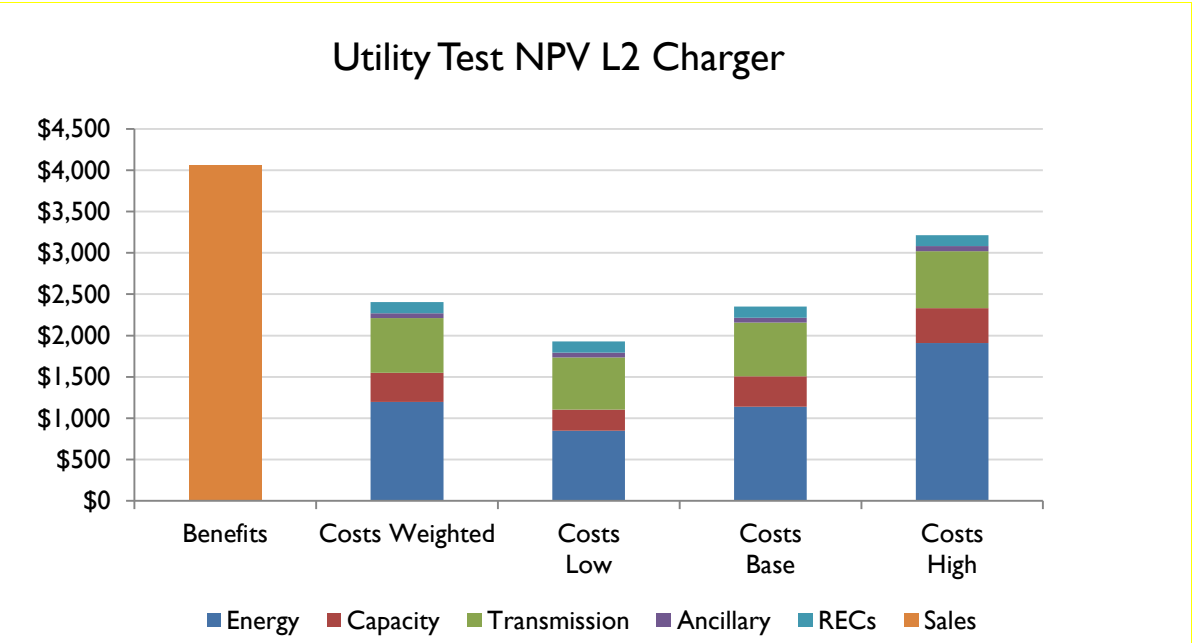
Since 2010, BED has installed 10 publically available EVSE stations in public parking garages, on UVM's campus and other locations such as Main Street and at BED's Pine street office. Two to three additional Level 2 EVSE stations are scheduled to be installed at a Hannaford's store located off of North Avenue and the Burlington Airport in late 2016 or early 2017. For the 12 month period ending on August 31, 2016, Burlington's publically available EVSE stations dispensed 26 MWhs of energy to 337 unique drivers; most of whom had travelled from nearby towns into Burlington. However, making EVSE available in public spaces does not go far enough to fully address one of the more persistent market barriers to EV adoption: range anxiety. Indeed, most EVSE stations have been installed at retail outlets, hotels, restaurants, public parking areas, some park and ride locations and educational facilities.[7] But very few stations have been located at places of employment or condominium associations and large apartment complexes. This needs to change if Vermont wants to transform the transportation

[7] See; Wagner, F et al, *Drive Electric Vermont Case Study,* Idaho National Laboratory for the US DOE, March, 2016, at pg. iii.

sector. As a means to address this shortcoming, BED's EVSE program will focus primarily on helping private businesses to install level 2 EVSE for use by their employees and customers as well as housing complexes in the City (although targeted deployment of public charging stations will likely continue).

For the most part, EVSE station ownership by a business for use by their employees and customers is not seen as a typical investment in which the owner expects a financial return. Rather, EVSE ownership is viewed by some businesses as an employee perk, as well as a marketing opportunity. This view also holds for some housing complexes that install EVSE for their residents and guests. Consequently, BED has not considered the economics of ownership from the customer's perspective as part of its analysis for this program. Nevertheless, investing rate payer funds (i.e. incentives) is a worthy investment under the utility cost test and the Tier 3 screening tool.

Under the utility cost test, every level 2 EVSE station yields $1700 in net benefits over 12 years, as shown in the graph below. Net benefits flow from additional MWh sales that exceed the incremental cost of wholesale energy, capacity and transmission.



Under the Tier III cost test, BED's financial investment would be limited by statute to $60 MWh equivalent, inclusive of overhead charges. Accordingly, BED's expenditures would be capped at approximately $2,000 per Level 2 charger, or about 17 percent of the installed cost of networked level 2 ChargePoint charger.

As noted above, encouraging adoption of EVs has the potential to significantly reduce GHG emissions if consumers begin to trade in their traditional vehicles. However, many consumers remain concerned that they may be stranded in their EV due to insufficient EVSE

stations. To effectively address this concern, BED intends to implement an EVSE program targeting Burlington businesses, condominium associations, large apartment complexes and other businesses. BED's EVSE program will, for the most part, be similar to and consistent with the statewide EVSE program, as adopted by the Tier III TAG. Where BED's program may differ from the statewide program is when a customer presents a unique set of circumstances that would not be appropriately addressed by the statewide program. If such circumstances arise, BED will file with the Department a custom program for consideration if BED deems it to be an appropriate opportunity.

Lastly, BED's current rate design project includes proposed rates for both public and private charging of electric vehicles in its scope of work. By offering rates specific to charging equipment, BED hopes to increase the cost-effectiveness of electric vehicles by reducing charging costs to consumers. Such reductions, however, depend on whether the timing of charging can be controlled and limited to off peak times.

Electric Bikes

To complement its local transportation initiatives, BED also intends to actively promote electric bikes to encourage residents to use their cars less often for daily commutes to work. In many European countries and select U.S. cities (i.e. Portland, Ore.), increased use of bicycles is considered to be an effective strategy to reduce traffic congestion, lower GHG emissions and improve health. [8]

While BED has not fully completed its analysis of E-bikes, BED is interested in encouraging the increased use of e-bikes in the City as a means to reduce fossil fuel consumption and the emissions of greenhouse gases. In fact, BED has initiated meetings with VNikesolutions, Localmotion, and the Old Spokes Home in Burlington discuss how an e-bike program may be accepted in the City. Based on preliminary analyses, an e-bike as the potential to annually:

- Displace 65 gallons of fuel[9]; and,
- Reduce 1300 lbs of CO2

If BED moves forward with promoting e-Bikes as a part of its Tier III program, BED anticipates that each e-bike would result in 7.1 MWh of Tier III credits, assuming an 8 year measure life. Each bike could also be eligible for up to $400 in incentives, inclusive of administrative expenses. However, because BED has not completed its analysis, this Tier III plan does not include an estimate of total MWh credits that could be generated from the implementation of an e-bike program. When such analysis is complete, BED will supplement

[8] Blondel, B et al, *Cycle more often to cool down the Plant – Quantifying CO2 savings of Cycling,* European Cyclists Federation, November, 2011.

[9] Assumes average weekly bike travel of 32.6 miles that would have been by car with 26 MPG efficiency

this annual plan and provide notice to the Department and Board prior to initiating the program.

High-performance heat pumps

BED's high performance heat pump program will promote advanced 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. Unless and until, natural gas prices increase, or the performance of ccHPs improves significantly, the program will initially concentrate its marketing efforts primarily on non-natural gas customers, "green" customers who oppose the consumption of natural gas and the new construction/major renovation markets (residential & commercial).

The ccHP program will be designed and implemented in coordination with BED's energy efficiency division, and will incorporate all known best practices with respect to the operations of heat pumps. Furthermore, the program will seek to ensure that eligible heat pumps are installed in buildings that either meet or exceed minimum performance standards as defined by the Department in Docket 8311. It is important to note however that BED's assessment of ccHP's departs from the analyses conducted by VEIC for the TAG in several respects. The most significant difference is that because of BED's status as a 100% renewable provider, the total tier III credit is higher than those credits reported in the VEIC planning tool. Additional factors that have the effect of increasing the total Tier III credit include higher natural gas energy loads (90 MMBTU), higher BTU content (100,000/ccf) compared to propane etc., 0 .95 net to gross ratio, and use of controls. (BED's current program design envisions the imposition of conditions that require retrofit applications to include weatherization measures, if they have not already been installed, and controls).

Factors that have the effect of reducing Tier III credits (vis-à-vis VEIC's planning tool) include a 60 percent offset and 240 percent coefficient of performance. In BED's view, reliance on manufacturers' reported rated capacity under climate zone IV conditions is not supportable. Consequently, BED reduced the amount a fossil fuels (BTU's) that could potentially be offset with a ccHP to 60 percent from 85 percent.

As BED has noted on multiple occasions, the economics of ccHPs for customers connected to the natural gas system are highly sensitive to the unit's coefficient of performance, the retail price of fuels (natural gas and electric), and customer operations. Indeed, relatively small changes in any of these variables can have a material impact on whether customers actually save money by installing a ccHP in their home or business. For example, at today's low fossil fuel prices and assumed average COP (i.e. 240%); customers connected to the natural gas system should not expect to save money using a ccHP for space heating; even if the entire upfront cost of the ccHP is subsidized. But if the COP of a ccHP improves to 260%, then the cost of operating it relative to a NG boiler with an AFUE of 85 percent would be slightly lower

(however the payback for the capital cost of the ccHP would be excessive). Similarly, modest changes in fuel prices affect customer economics. At $1.70/ccf of natural gas, using a ccHP with a COP of 240 percent would cost less to operate than an NG boiler. But at $1.40/ccf, natural gas boilers with an 85% AFUE would be less expensive to own vis-à-vis ccHPs. As shown in the table below, only those customers heating with propane, kerosene and electric resistance baseboard (at today's prices) would achieve a reasonable return on their investment.

	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	26,377.49	900	651	983	659	26,377	5	4
COP/AFUE	2.4	0.85	0.85	0.8	0.8	1	0.8	0.6
Price per unit	$ 0.15	$ 1.41	$ 2.05	$ 2.17	$ 2.62	$ 0.15	$ 275.00	$ 227.00
cost per MMBTU	18.32	16.59	17.45	29.61	23.98	43.96	20.96	17.20
Total cost	$ 1,649	$ 1,493	$ 1,571	$ 2,665	$ 2,158	$ 3,957	$ 1,886	$ 1,548
If ccHP can displace:	0.6	54,000,000	54,000,000	54,000,000	54,000,000	54,000,000	54,000,000	54,000,000
Remaining BTU served by existing system	0.4	36,000,000	36,000,000	36,000,000	36,000,000	36,000,000	36,000,000	36,000,000
total ccHP cost		$ 989	$ 989	$ 989	$ 989	$ 989	$ 989	$ 989
Total FF cost		$ 597	$ 628	$ 1,066	$ 863	$ 1,583	$ 755	$ 619
Total heating cost		**$ 1,586**	**$ 1,617**	**$ 2,055**	**$ 1,852**	**$ 2,572**	**$ 1,744**	**$ 1,608**
Savings $ (costs)		**$ (93)**	**$ (47)**	**$ 610**	**$ 306**	**$ 1,385**	**$ 143**	**$ (61)**
Savings %		-6.3%	-3.0%	22.9%	14.2%	35.0%	7.6%	-3.9%
Plus GMP lease								
Total savings		$ (93)	$ (47)	$ 610	$ 306	$ 1,385	$ 143	$ (61)
Avg Install Cost		3500	3500	3500	3500	3500	3500	3500
Simple payback (yrs)		n/a	n/a	5.74	11.46	2.53	24.53	n/a

To improve the customer's economics of owning a ccHP, BED is considering the merits of implementing a bill credit or rate rider that provides for a kWh rate reduction during the winter heating season. Such a credit, if allowed to be implemented, would reduce the operating cost of heating a home with a ccHP during most times of the winter relative to a natural gas boiler, even at today's low prices. For example, a bill credit of $0.05/kWh improves the cost effectiveness of ccHP from the customer's perspective and reduces the investment payback by 15 years, roughly the measure life of a ccHP.[10] However, providing a bill credit based on a specific end-use technology, without having completed an in-depth cost of service analysis, has never been implemented before in Vermont. Similarly, it is not entirely clear whether the cost to serve ccHPs is lower than the cost of serving other end uses and thus deserving of a bill credit. Nevertheless, implementing a rate design based on achieving societal goals (as opposed to economics) would allow for greater opportunities to reduce the consumption of natural gas in the City.

[10] As noted in BED's draft 2016 Integrated Resource plan, ccHPs pass both the utility cost test and societal cost test as the additional benefits derived from ccHPS likely exceed the cost of wholesale energy, capacity, transmission and other ancillary services during most of hours of the year.

Presuming that BED is able to credit natural gas customers based on the usage of ccHP during most of the winter hours, BED anticipates that 40 – 50 or more units could be incented and installed in 2017. As with the transportation programs highlighted above, BED contends that its efforts to support the installation of ccHP and other heat pump technologies will help to transform the space heating market space and significantly contribute toward the State's 2050 renewability goal.

PassivHouse

During the initial years of Tier III implementation, BED's primary focus under this program will be on sponsoring PassivHouse (PH) training for local builders, architects and other building trades professionals. BED believes that it is only through such local training that the industry will begin to make the transition toward building hyper-efficient homes at a cost that most homeowners can afford. While PassiveHouse standards are obtainable today, the costs are still exorbitant vis-à-vis code complaint new construction homes. This is mainly due to the fact that many area contractors are unfamiliar with PassiveHouse practices. This will change overtime. With increased training and outreach, BED fully expects that in a matter of 5 -10 years PassiveHouse designs will become the standard for all newly constructed homes.

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 from services spaces; 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 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.

Once the building trade industry becomes more familiar with PH design and practices, BED assumes that building a new single family home to the PH standard will cost roughly 10 – 20 percent more ($16,200) than a code compliant house. Additional costs stem primarily from increased planning and design work, PH certification, profit mark-ups and more expensive materials (i.e. windows and doors, insulation). However, PH designs are known to be far more utilitarian than typical homes. Improved open floor concepts and better insulation around windows allow for greater use of the living space. Thus, PH homes are typically smaller than their counterparts but homeowners do not feel as if they're compromising on the size of their home. More importantly, PH buildings consume far less primary energy per year than code compliant homes – 18 MMBTUs vs 90 MMBTU's (i.e. space conditioning, domestic hot water, lighting and plug loads). And, such energy savings (approximately 80 percent) have the potential to reduce household energy bills by $1200 annually.

If BED's initial PH training program is successful and many of the area's construction professionals begin to appreciate the value of building a superior product, the number of new PH compliant buildings in the City will begin to increase. However, BED fully expects that this transition could take 3–4 years before a single PH is built. As such, BED is not expecting to claim Tier 3 credits in 2017. It may be possible to encourage 1-3 single family homes in 2018 or 2019. If and when such homes are completed, BED will begin to claim Tier III credits of up to 377 MWh per home, and potentially more if a 2–4 multifamily structure is built to the PH standard. Also, since any type of building can be built to the PH standard, there may be a few

opportunities in the next two–five years to encourage larger commercial structures to be built to the PH standard. These projects will be submitted as custom projects prior to BED's issuance of an incentive.

Initial Tier III implementation strategy

In general, one set of proposed programs is intended to address the transportation sector; the other set addresses space heating. 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 above noted measure 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. BED, GMTA, UVM and other stakeholders, including bus manufacturers have been in discussions focused on providing financial and technical support to begin the process of converting the existing bus fleet to battery electric buses.
Estimated No. of Participants (equitable opportunity)	2 customers (GMTA and UVM), 2 buses. Because GMTA and UVM serve a wide spectrum of customers, many of whom are also BED customers, this proposed program will allow for an equitable opportunity for all customers, including low income customer, to participate in and benefit from the implementation of a battery-electric bus program.
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 and VEIC
Impact on Energy	Depending on battery type, range and miles driven, energy consumption is approximated to be 50 to 55 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 72,000 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 vehicles costing $50,000 or less (except for mass transit options). Program will target market both the retail consumer market and commercial/institutional (C/I) fleet owners. Point of purchase rebates shall be provided to area auto dealers who sell eligible products to Burlington residents. 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, carShare and taxi services
Estimated No. of Participants (equitable opportunity)	40 EVs. 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.	368 gallons, 45 MMBTU
Carbon Emissions Avoided	3.5 tons per EV per year
Lifetime MWh Tier 3 Credit	38 MWh per EV
Collaboration Partners	Drive Electric
Impact on Energy	3.6 to 3.8 MWh per EV
Impact on Peak	1–3 kW per charge. Include TOU metering or special rates to promote night time charging.
Budget/ACP	$Up to 2,000 per EV, 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
Objective/Implementation strategy	Reduce range anxiety car owners may have about electric vehicle transportation. Program will target businesses, apartments and condominium complexes to install Level 2 EVSE stations for use by employees, residents and customers.
Estimated No. of Participants (equitable opportunity)	10 - Level 2 stations
FF displaced/MMBTU equiv.	315 gallons of fuel per station, 38.7 MMBTU
Carbon Emissions Avoided	3 tons
Lifetime MWh Tier 3 Credit	34.5 MWh (inclusive of AC/DC conversion penalty of 15%)
Collaboration Partners	Larger customers, City of Burlington, Drive Electric
Impact on Energy	2,650 kWh sales per Level 2 station, increasing as EV penetration increases
Impact on Peak	7.2 kW
Budget/ACP	$Up to 2,071 per station
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, localMotion 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)	TBD
FF displaced/MMBTU equiv.	68 gallons, 8.4 MMBTU per e-bike
Carbon Emissions Avoided	1300 lbs per e-bike
Lifetime MWh Tier 3 Credit	7.1 MWh
Collaboration Partners	LocalMotion, 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	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)	40 - 50 units. This program would also be available to low income customers.
FF displaced/MMBTU equiv.	635 ccf, 54 MMBTUs (assumes a 85% AFUE NG boiler) per ccHP per year
Carbon Emissions Avoided	3.1 tons per ccHP/year
Lifetime MWh Tier 3 Credit	71 – 80 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	$4,000 per ccHP, inclusive of administrative expenses, or 50% of installed costs whichever is less. gSHP applications will be submitted on a custom basis.
Best Practices	Incentives will be conditioned on whether remote controls are installed with ccHP units; and will be capped at no more than 50% of the installation costs.
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.

Technology/Program	PassivHouse
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)	2-4 PH training sessions annually. BED does not expect to claim any Tier III credits in 2017. In 2018 or 2019, 3 PH buildings could be built with each SF structure worth up to 377 lifetime MWhs.
FF displaced/MMBTU equiv.	847 ccf of Natural gas, 72 MMBTU's
Carbon Emissions Avoided	4.2 Tons of CO2 per home/ per year
Lifetime MWh Tier 3 Credit	377 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, VEIC
Impact on Energy	Electric energy impacts will decreases
Impact on Peak	Demand for power will decrease
Budget/ACP	$Up to 16,200 per home, 100% of the incremental cost of PH assuming local design build professional become more familiar with the PH standard
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.

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 might not increase electric consumption in order to verify if whether options exist that could be more cost effective than those outlined above. A potential study that includes Tier III components is underway through the Department of Public Service. However, the timing of Tier III implementation (i.e. the obligation begins to be incurred in two months) is near. Accordingly, BED must begin to implement cost effective measures before it can conduct such an extensive analysis. BED will however 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 7,190 MWh of credits in 2017 and require no less than a $428,000 investment, inclusive of overhead costs. Each year after 2017, BED will need to acquire slightly more credits by installing ever more Tier III measures so that by YE 2020, BED will have achieved cumulative credits of 43,500 MWh and invested more than $2.7 million 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.