The Burlington Electric Story: One Utility Approach to the Future

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ABSTRACT

Burlington Electric Department (BED), a Vermont municipal utility, began efficiency programs decades ago, with Burlington being the first city in the United States to be 100% powered by renewables. This paper discusses the context within which the utility operates, the strategies deployed to achieve various efficiency and renewable goals, and the Strategic Direction that primes the utility to help make Burlington a Net Zero Energy City by 2030. The program design, metrics, results and lessons learned from a variety of initiatives will be presented and analyzed while also highlighting ongoing challenges. There are many entities working to address climate change and utility business model challenges; this paper provides an in-depth overview and analysis of one smaller utilities' path.

Introduction

The traditional utility business model is undergoing dramatic shifts in the provision and consumption of electricity services. The "Utility of the Future" must continue meeting the demands of the traditional utility - safety, reliability and affordability – in a far nimbler manner. It will have to embrace decarbonization of energy and distributed energy resources (efficiency, renewables, storage), augment their old revenue stream (as more customers install solar and storage), prioritize and implement strategic grid improvements to allow for bi-directional, variable power, strategically electrify the thermal and transportation sectors, and rethink their engagement with customers. Essentially, utilities must transform from one-way delivery of electrons to a comprehensive energy services company. If a utility cannot achieve this then they stand to continue to lose revenue as other market actors engage.

This paper explains the landscape in which the 113-year-old municipal Burlington Electric Department (BED) operates, and reviews six BED strategies to transition to the future: Use Less, Shift Towards Renewables, Control Load, Embrace AMI, Address the Thermal Sector and Strategically Electrify the Transportation Sector. Critically, BED is meeting or exceeding all of the usual requirements for a utility such as safety, reliability, affordability and customer satisfaction (BED 2017). Notably, the achievements highlighted below were accomplished without a rate increase since 2009 *and* BED has a Moody's rating of A3/Stable (Moody's 2017). This paper explores where BED is succeeding, where challenges remain, and various roadblocks in transitioning to an efficient, decarbonized, decentralized energy future.

Vermont Utility Landscape

Vermont has 17 electric utilities ranging from municipal electric departments with several hundred customers to Green Mountain Power, an investor-owned utility, with over 250,000 customers. Electric utilities are monopolies fully-regulated by the Vermont Public Utility Commission (PUC) and all are vertically-integrated—generating (or purchasing), distributing, and serving electricity directly to customers in defined service territories (DPS, 2018)[1]. Efficiency Vermont is the statewide electric energy efficiency utility (EEU) for all service territories except for Burlington, where BED has managed its own EEU since 1990 (PUC 2018).

In addition to traditional rate regulation, Vermont has several policies in place to support the state goal of "90% renewable across all sectors by 2050" (DPS 2016). These include: net metering; Standard Offer; and the Renewable Energy Standard (RES), which is similar to a renewable portfolio standard but which contains a unique "Tier III" for energy transformation projects to reduce fossil fuel consumption and promote strategic electrification (PUC 2018).

Burlington: Fertile Ground for Progressive Energy Planning

The city of Burlington has approximately 42,000 residents in its 15.48 sq/mi footprint (Census Bureau 2017). Burlington is Vermont's largest city and is considered one of the state's cultural hubs and economic anchor for the surrounding "Greater Burlington" area. The city hosts several large employers such as universities and hospitals, boasts a robust entrepreneurial community and has gigabit-speed fiber-to-the-premises for more than 90% of its residents and businesses (BTVIGNITE 2017).

Burlington has a history of progressive-left political leadership dating back to the 1970s: Bernie Sanders served as Mayor from 1981-1989 (McCarthy 1989). It was one of the first United States communities to sign on to the "Cities for Climate Protection" campaign in 1996, and in 2000 the City adopted its first Climate Action Plan (City of Burlington 2018).

BED's History of Energy Innovation

Established in 1905, BED currently services 20,000 meters consuming 345,000 MWh annually (Williams 2005, 4; BED 2015). In response to fuel shortages in the 1970s, BED converted its coal-fired generating station, located on the Lake Champlain waterfront, to wood chips, which were more affordable, renewable, and could be locally-sourced. BEDs initial foray into renewable power was triggered in the 1970s by fuel shortages and the oil embargo (Williams 2005, 24)[2]. Following this successful conversion, voters approved a bond to allow BED to build a 50MW wood chip electric generator, which would become the Joseph C. McNeil Station, commissioned in 1984 (Williams 2005, 24-25). The McNeil Station still runs today, burning as much as 400,000 tons of sustainably-harvested biomass sourced from northern Vermont and New York (BED 2018).

In 1989, voters approved BED's proposal to establish an energy efficiency program through an $11.3 million energy conservation bond (Williams 2005, 26). Roughly a decade later, BED embarked upon the goal to have 100% of its power sourced from renewable sources. This was achieved through multiple steps, for example by signing new power purchase agreements (PPAs) to replace expiring fossil fuel-based sources of power, and through the 2014 acquisition of a 7.4MW hydroelectric facility located adjacent to the city in the Winooski River (Strand 2015). When this acquisition was completed, BED officially sourced 100% of its electricity from

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[1] In Vermont, most activities of a municipal utility are subject to oversight by the PUC (rate increases/decreases, rate design changes, net metering, construction, etc.) in addition to local and regional oversight; this presents various challenges and constraints in what BED can do.

[2] The authors recognize the long-standing discussion regarding the "renewability" of various energy sources (for example wood, landfill gas and hydropower). For the purposes of this paper, the authors utilize the definitions of renewable as defined in Vermont state law, 30 V.S.A. §8002. Section 2 (2).

renewable generation, making Burlington the first U.S. city to do so (Woodard 2016; McCullum 2014).

Following the 100% renewable milestone, BED and its Electric Commission set their eyes on a 2030 goal to "Make Burlington a 'net zero energy city' across electric, thermal, and ground transportation sectors by managing demand, realizing efficiency gains, and expanding local renewable generation, while increasing system resilience" (BED 2016). Burlington defines net zero as generating or sourcing enough renewable energy to cover its requirements in each of the key sectors. To achieve this will require ongoing creativity in a plan-do-check-act process, harnessing BEDs leadership position in the community to advance energy innovation programs to drive residential and commercial customers toward becoming net zero.

The remainder of this paper details strategies, lessons-learned, and upcoming challenges for this $60 million "retail cost-of-service" utility as it transitions into the future.

Strategy #1: Use Less

Since the 1989 voter-approved $11.3 million energy conservation bond, BED has invested over $31 million in efficiency, leveraging more than $32 million in customer investment. Figure 1 shows that Burlington's overall electricity use was about 4.0% less in 2017 than in 1989[3]. Juxtapose this to the State of Vermont for which usage increased 10.5%, and United States electric usage which increased 27.9% during the same time frame (BED 2017). Additionally, BED saves an estimated $4.1 million annually in direct costs ($2.2 million energy, $0.5 million capacity and $1.4 million transmission) – even at today's low energy prices. Customers save a total of $11 million annually on bills, with BED's efficiency program total utility cost delivered at 3.7 cents per kilowatt-hour (BED 2017).

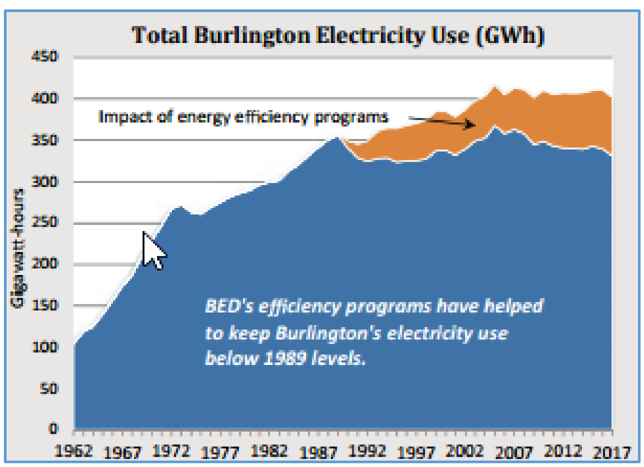


Figure 1. The Impact of Energy Efficiency in Reducing Burlington Electricity Use. 1962-2017. *Source:* BED 2018.

As is common in the efficiency industry, there are five core programs that shape the BED efficiency portfolio: Business New Construction, Business Existing Facilities[4], Residential New

[3] For comparison, City data shows that finished building square footage has increased 25% from 1990 – 2018.

[4] This includes industrial customers.

Construction, Existing Homes and Efficient Retail Products. A summary of savings and investments for each program is provided in Table 1 below[5].

TABLE 1. Summary of Energy Efficiency Program Results. 1992 – 2016.[6]

Program	Time Frame	BED $ Invested	Annualized MWh Saved	Yield Rate	Peak Savings
Business New Construction	1994-2016	$4.1 million	17,706 MWh	$232/MWh	1,700 kW (winter); 2,400 kW (summer)
Business Existing Facilities	1993-2016	$14 million	65,000 MWh	$215/MWh	8,900 kW (winter); 8,000 kW (summer)
Residential New Construction	1994-2016	$1.8 million	1,641 MWh	$1,090/MWh	336 kW (winter); 285 kW (summer)
Existing Homes	1992-2016	$4.9 million	21,205 MWh	$231/MWh	5,870 kW (winter); 1,000 kW (summer)
Efficient Retail Products	2000-2016	$3.6 million	26,750 MWh	$135/MWh	5,631 kW(winter); 3,500 kW (summer)

Source: BED 2016.

BED updates programs ongoing and as needed. For example, BED has recently revised its Business New Construction (BNC) program to ensure that investments deliver results by using an "energy model/tiered incentive" approach, whereby 50% of the incentive is paid at project completion and 50% is paid after comparing at least one year of actual usage data to the modelled building data. BED has not yet compared this approach to the historic prescriptive approach, but plans to as more data is collected.

The 2030 net zero energy city goal likewise motivates BED innovation in energy efficiency programs in the thermal sector (Seyler 2017). BED partnered with Vermont Gas Systems (VGS), to encourage more customers to participate in available efficiency programs. The energyChamp program offers customers a one-stop option to help them comprehensively assess their total energy picture (thermal shell, heating, ventilation, air conditioning, lighting, appliances, and comfort and moisture issues) (energyChamp 2018). Thus far, 165 out of 247 apartment buildings (representing roughly 295 apartments) have received energy audits, with 84 completions to date resulting in 2,845 Mcf in natural gas savings and roughly 2,000 kWh in electric savings (C. Burns, Director of Energy Services, BED, pers. comm., April 15, 2018).

BED has also assisted commercial and industrial customers (which use 75% of total annual electric sales) to comprehensively assess their electric, thermal and transportation opportunities[7]. In 2016, BED partnered with private sector partners to establish Burlington as a 2030 District member (2030 Districts 2018). Overseen by Architecture 2030, 2030 Districts are unique private/public partnerships in designated urban areas across North America committed to reducing energy use, water use and transportation emissions. The program is still in the early

[5] Detailed energy efficiency program information is available in the Burlington Electric Department 2016 Energy Efficiency Annual Report.

[6] BED does not "drop out" measures that have reached the estimated end of their lifetimes due to results from "measure decay" studies that suggest it likely has a small-to-neutral impact from an overall load impact perspective.

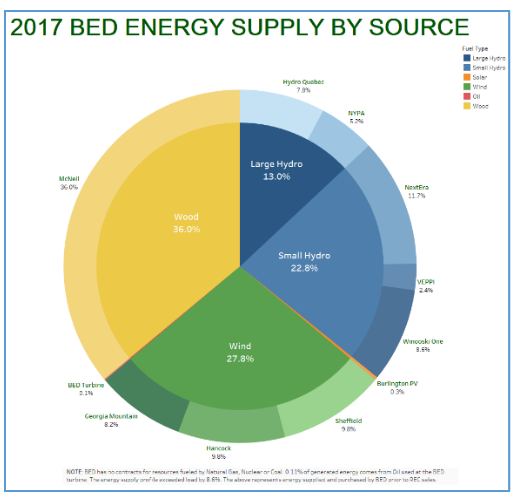
[7] "Industrial" customers are defined in Vermont as an account over 1,000 KW and includes commercial and industrial customers such as hospitals and universities; "large manufacturing" represents less than 5% of total sales.

stages, however over six million square feet of Burlington building space is committed with several energy efficiency projects underway.

A universal challenge for all efficiency programs remains the "split incentive" between tenant and landlord (McKibbin 2013). Sixty percent of Burlington's residential customers are renters, 95% of which use gas for space heating and domestic hot water with nearly all tenants (90%) responsible for all of their energy costs (thermal and electric)[8]. Given the minimal motivation for rental property owners to increase efficiency, Burlington enacted the Time of Sale Energy Ordinance (TOS) which mandates that cost-effective minimum energy efficiency standards are enforced when buildings are sold (BED 2018). However, these properties change ownership infrequently and it is likely that another approach is needed to address this issue.

Strategy #2: Shift towards Renewables

The shift towards renewables began in the 1970s and has involved (and continues to involve) deliberate acquisitions of renewable plants and the execution of multiple renewable power purchase agreements. To achieve this shift while maintaining stable rates, Burlington has made many modifications, for example, in how it participates in the regional power market and in managing peak demand. As of 2017, BED received energy in excess of its needs from renewable resources. Figure 2 presents BEDs energy supply acquisition by source for Calendar Year 2017 while Figure 3 presents the shift in fuel sources from 1992 – 2017 [9] [10].



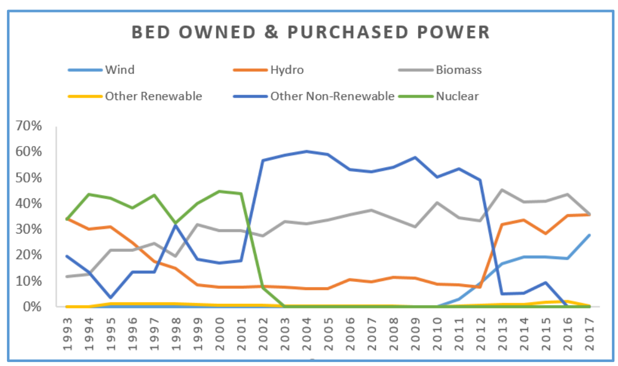


Figure 2. Owned and Purchased Supply. 2017[11]. Figure 3. Owned and Purchased Supply Over 24 Years. 1993 – 2017[12]. *Source:* BED 2018 (both figures).

[8] Most multi-family buildings in Burlington are three-plex's that were single-family homes - not large, multi-rise buildings; owners prefer the tenants pay heating costs directly.

[9] Note that, after the sale of renewable energy credits, the energy BED customers receive is predominately hydro.

[10] Regarding capacity, during 2017, BED's owned and contracted resources provided 76% of BED's 84.7 MW of market capacity obligation. Capacity primarily comes from McNeil (~26 MW), BED Turbine (~18 MW), and Independent System Operator of New England (20~30 MW). All other resources provide <5MW of capacity per unit.

[11] The 0.1% BED Turbine is available for use during a peaking event but otherwise is unused.

[12] The distribution is roughly 50% owned (McNeil ~40%, Winooski Hydro ~10%) and 50% purchased.

One significant benefit to changing the resource mix was to "break" the link between volatile fossil fuel prices and BED's wholesale cost of power. As a result, BED is largely immune to swings in wholesale prices due to changes in natural gas prices (Figure 4 shows the relationship between natural gas and wholesale prices), allowing BED to keep rates constant since 2009[13]. Additionally, BED has been able to predict its cost of wholesale power since 2009 with greater accuracy due to the minimizing of fossil fuel effects.

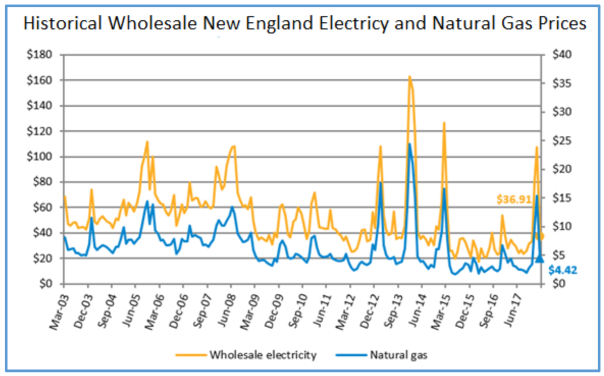


Figure 4. Wholesale Electricity and Natural Gas Prices for New England. 2003 – 2017. *Source:* ISO Newswire 2018.

BED coupled the move to renewable resources with a strategy of "arbitraging" the value of its renewability where possible. BED reviews whether to sell higher-priced Renewable Energy Credits ("RECs") – for example, RECs from new, large-scale wind – to other utilities and substitute them with lower-valued RECs, such as those associated with older, existing hydro facilities. As a result, BED's largest budgetary risk is not natural gas, but the value of RECs. BED has been able to sell some portion of its RECs for future periods at times of higher prevailing prices to minimize short-term volatility, but the current extended downturn in New England REC markets is becoming increasingly challenging and will likely lead to rate impacts, after nearly a decade of constant rates[14].

Another "lesson learned" is that wholesale market rule changes can have unexpected, material consequences on prior resource acquisition decisions. One such impact occurred when the regional transmission organization, Independent System Operator of New England (ISO-NE) recently changed rules such that: (1) Power resources may now bid negative prices to produce energy (i.e. they are willing to *pay* to put power onto the grid as opposed to *being paid* for delivering power to the grid), and; (2) Variable resources (such as wind) must submit bids at which they would allow themselves to be curtailed to relieve transmission constraints (Do Not Exceed Dispatch or "DNE"). These changes, resulting from one wind resource that provides roughly 8% of BED's annual energy needs, have resulted in annual costs to BED of roughly 1% of BEDs total cost of service. In this case, BED pays the wind plant a fixed contract rate while the wind plant then bids the lowest possible price to avoid curtailments. This bidding practice resulted in a collapse of energy prices in the congested northern Vermont transmission system;

[13] Burlington's rate structure is available here: https://www.burlingtonelectric.com/rates-fees

[14] The decrease in REC values is due to a variety of factors such as: (1) Market sensitivity to excess supply or shortages due to the general inability of REC sellers to store the product combined with a known penalty rate for buyers who end up "short" and (2) load growth being "soft" or non-existent, so growth in RPS requirements may be offset by load falling.

these prices are the basis for BED's market payment for the resource. BED has addressed future liability resulting from this market change by modifying PPAs, but the example provides a glimpse into just one of the challenges of the energy markets when making long term resource commitments and highlights the need for ongoing review and modifications (which also presents challenges). Clearly, the potential for adverse impacts on existing resources from unknown future market changes is very hard to avoid.

Other challenges remain as well, such as how to fund grid modernization to continue integrating renewable energy.

Strategy #3: Control Load

After energy costs, ISO-NE capacity and regional transmission costs are the next largest costs[15]. Figure 5 shows the volatility capacity prices and Figure 6 shows regional transmission cost increases. Load control can reduce these costs.

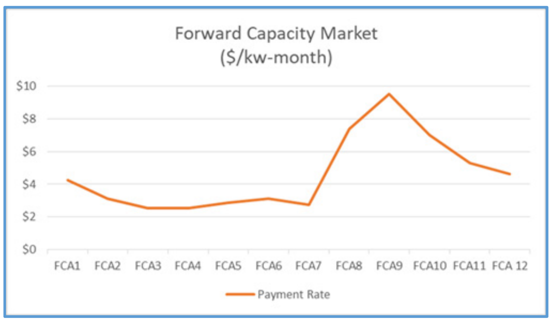


Figure 5. Volatility in forward capacity prices.
Source: BED 2018.

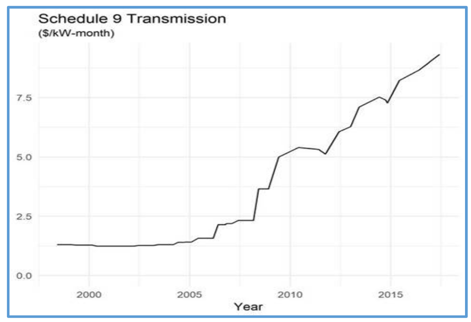


Figure 6. Regional transmission cost increases.
Source: BED 2018.

BED has deployed a number of relatively innovative programs to try to limit these costs, including demand response programs (active and passive) and load-reduction programs. As BED reduces its load relative to other entities in New England, BED can reduce its allocation of a variety of costs.

For example, from 2009-2013, BED contracted with Enernoc for load reduction services resulting in a program that paid customers to reduce load on demand. Two lessons emerged. First, subscribed load reductions did not always occur when a load curtailment event was declared. Second, the majority of the reductions came in the form of initiating emergency backup generation (rather than actual load reductions). While the program successfully reduced capacity and transmission costs, as shown in Table 2, the combination of Enernoc's departure from the New England market, changes in air quality rules, and BEDs desire to not incentivize generator usage resulted in BED exploring other alternatives.

[15] BED's regional costs are allocated based on hourly load, hourly load at Vermont Monthly Peaks, hourly load at New England Annual Peaks, hourly load at BED Annual Peaks, and fees More information about ISO-NE's transmission cost structure is available here: https://www.iso-ne.com/system-planning/transmission-planning/transmission-cost-allocations/.

Table 2. Demand Response Results. 2009 – 2013.

Peak	Year	Date	HR	DR Impact (MW)	Value ($/MW)	Estimated Savings
ISO Annual	2013	19-Jul	5 pm	2.00	$ 46,196	$ 95,164
ISO Annual	2012	17-Jul	5 pm	1.46	$ 43,979	$ 66,135
ISO Annual	2011	22-Jul	3 pm	2.80	$ 46,446	$ 130,049
ISO Annual	2010	6-Jul	3 pm	1.52	$ 69,240	$ 105,245
ISO Annual	2009	18-Aug	3 pm	0.70	$ 69,240	$ 48,468

Source: BED 2018.

In 2017, BED launched a pilot customer engagement demand response program called "Defeat the Peak". BED's customer research indicated that customers were unlikely to curtail demand during critical peak periods for a small bill credit, but would do so if the action resulted in a greater community benefit. Therefore, BED rewarded different local non-profits with a $1,000 donation if the community was able to "Defeat the Peak" when BED called for a demand reduction. In the summer of 2017, BED called two critical peaks and asked its customers to curtail demand during certain periods with the selected charity also requesting their members to reduce demand[16]. Customers responded and met BEDs curtailment goals, and BED provided two non-profits with $1,000 each (BED 2017).

Another recent demand response pilot, Packetized Energy, provides customer transparent load control. Small devices (Packetized Energy Device Managers or PDMs), installed on the top of customers electric hot water tanks, allow BED to shift load to reduce wholesale electric costs in a way that is not disruptive to the customer. This pilot program enables BED to control devices in real time by raising and lowering the Virtual Power Plant (VPP) set point while not affecting customer quality of service. Figure 7 below highlights these capabilities. The orange bar shows the VPP signal controlled by BED and the blue lines represent the packets of energy used by the water heaters. The customer may opt out, as seen by the blue spike above the orange set point. This initial demonstration has the potential to scale and include a wide range of end-use devices such as electric vehicle charging, batteries, and pool pumps.

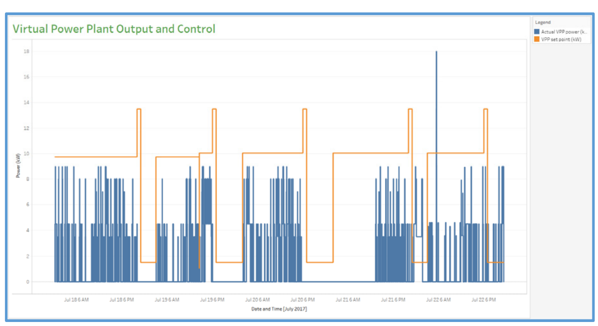


Figure 7. Packetize Energy Device Power Management. *Source:* BED 2018.

BED has approached solar and micro grid pilots as "load reducing resources" as well. Figure 8 below shows BEDs increasing, diverse mix of solar resources, including BED-owned

[16] For example, turning off air conditioners when heading to work, refraining from dish/clothes washing and turning off non-essential lights until after 7 pm.

plants, PPAs with merchant solar facilities inside the Burlington system (ranging from 7 kW to 2.5 MW AC) and net metered systems. Most recently, in 2017, BED initiated the Solar Shopper program, designed to help residential and small commercial customers install net-metered solar systems up to 15 kW (BED 2017). BED partners with local solar vendors and provides customers an easy-to-use, web-based comparison shopping tool to help them make better solar decisions by providing personalized, comparative pricing information within three business days.

The Solar Shopper program has two goals in mind: (1) speed adoption of in-city solar and (2) test alternative revenue pilots. Regarding the first goal: for a progressive city (and compared to Vermont), the number of net-metered systems is not substantial. In 2011, there were only 25 net-metered systems in Burlington. As of July 2017, 160 net-metered systems had been installed (BED 2018). Various reasons have been cited. Installers consider the city inspections to be more onerous than permitting requirements elsewhere in Vermont. Also, there are customers who question the need to invest in solar when their utility is 100% renewably sourced.

Regarding the second goal: one of the leading concerns utilities have regarding customer-sided distributed energy resources is the potential decrease in sales revenues. Therefore, a component of this pilot is that for each completed project generated through BED, the solar vendor pays BED an agreed-upon customer acquisition charge[17]. As is seen in other utilities, BED struggles with balancing conceptual support for customers to self-generate through net-metering while observing the very real price difference between net-metered systems ($0.19/kWh) and PPA or whole sale prices with capacity included (ranging from $0.06/kWh upwards). Certainly there are benefits to local generation in that it reduces various transmission and capacity costs, but there are disagreements between net-metering proponents and BED as to what this financial value is and how the costs and benefits are shared across all customers[18].

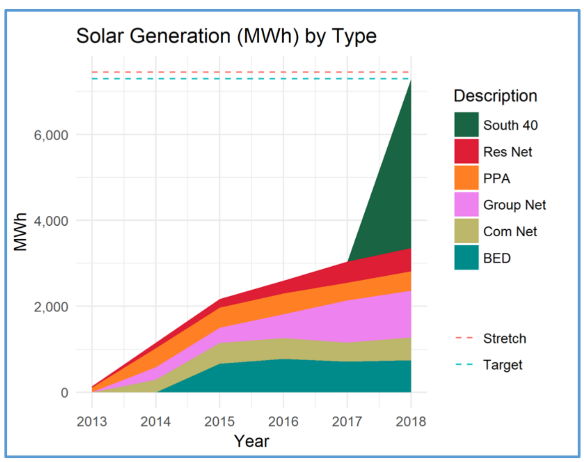


Figure 8. Solar Generation (MWh) by Type[19]. *Source:* BED 2018.

[17] Because customer acquisition costs are one of the largest "soft costs" for solar installers, they have been receptive to BED's customer acquisition charge. However, as this pilot is in its infancy, it is not yet known how helpful approaches such as this may be to providing a long-term viable business model for utilities.
[18] In an effort to show where in the grid solar may be more versus less helpful, BED developed this map: https://www.burlingtonelectric.com/distributed-generation
[19] "BED" refers to BED owned plants; "Com Net", "Group Net" and "Res Net" refer to commercial, group/shared, residential net-metered systems; "PPA" refers to power purchase agreements; "South 40" refers to a 2+ MW PPA.

Another load-reducing resource that BED is now initiating is the development of a microgrid at the Burlington International Airport. BED will be placing energy storage at the Airport, primarily to provide backup power in the case of an outage and reduce BED's net load during peak hours. Also, it will allow BED to purchase energy at low-priced hours and resell it at high-priced hours, and provide frequency regulation services to the grid. This project is scheduled to be completed by 2018, and it will be one of the first, if not the first, full airport energy storage-based microgrid.

Strategy #4: Embrace Advanced Metering Infrastructure (AMI)

The American Recovery and Reinvestment Act of 2009 allowed BED the opportunity to leverage Smart Grid Investment Grant dollars to replace its entire metering infrastructure with AMI (American Recovery and Reinvestment Act 2009; DPS 2018). This fundamental change in BEDs available data, data handling and data visualization capabilities is enabling some of the activities discussed in this paper, such as an electric vehicle rider tariff (mentioned below) and the Packetize Energy pilot (described above). AMI can also assist with outage management and power quality issues. However, technological advances can be more than humans are able to immediately harness (Platsis 2017). In a year, BED leap-frogged from one reading per customer per month to 12 data reads and additional status flags for each customer per hour. As one staffer stated: "This was in itself a bit of a painful lesson as we suddenly felt like we were drinking from a firehose" (BED staff, pers. comm., March 14, 2018).

As is true for most utilities, identifying how best to utilize data for pilot or other innovative programs while not adversely impacting the basic billing function is a continuing, iterative learning curve at BED. For example, BED was able to utilize AMI interval data in its Summer 2017 "Defeat the Peak" program to baseline customer usage and estimate results. However, new devices that contain some of the functionality of the AMI system are becoming available and may prove more viable in the long term. Ultimately, the role AMI may provide in enabling "Utility of the Future" endeavors remains an evolving process.

Strategy #5: Address the Thermal Sector

As mentioned above, the Renewable Energy Standard Tier Three Provision and the Net Zero Energy City by 2030 goal require BED to engage in reducing emissions from the thermal sector. Besides Time of Sale, energyChamp and District 2030, BED is comprehensively pursuing the viability of modifying the McNeil Biomass plant to provide heat via a new, district heating system. This is not a new initiative; it has been formally studied six times over the last several decades. Invariably, the estimated project costs did not justify moving forward (Freese 2016). However, three "lynchpin" properties representing 73% of the potential annual heating load (350,458 MMBtu/year) are supportive of the current, most comprehensive analysis. A recent feasibility study suggests potential greenhouse gas savings in the range of 405,914 – 502,187 tons over thirty years at a cost of $39.2 - $52.7 million (Corix 2017). Preliminary planning for the project is moving forward, with the City and its developer meeting with key potential customers to advance to the engineering phase of the project. While it is not yet certain that the project will come to fruition, this is the closest that BED and the City have come to seeing the project materialize in three decades. If it materializes, it presents the largest single opportunity for BED and the City to reduce thermal emissions and provides a platform for integrating additional thermal sources and customers in the future[20].

Strategy #6: Strategically Electrify the Transportation Sector

RES requirements and net zero energy city goals have also encouraged BED to implement mechanisms to reduce emissions resulting from the transportation sector. To achieve this, BED is working to increase the adoption and usage of electric buses, electric vehicles and plug-in hybrid vehicles, electric vehicle supply equipment, and electric bicycles[21].

Specifically, BED is partnering with local transportation providers to transition eight diesel buses to all-electric buses (Proterra and/or BYD) by 2020. Meanwhile, in June 2017, BED began offering customers $1,200 incentives ($1,800 for income qualifying customers) leveraged by a one-time $10,000 incentive from select manufacturers. In March of 2018, BED partnered with local credit unions to offer an electric vehicle financing product (Kanarick 2018). Finally, BED plans to propose an electric vehicle charging rate to the PUC during the second quarter of 2018 (BED 2018). By September of 2017, BED had overseen the installation of 14 publicly available electric vehicle supply equipment (EVSE), most of which are the low capacity, "Level 2" type. BED is now focusing on increasing usage of these, installing at least one high capacity charger if funds materialize[22], and discussing opportunities for EVSE at the Burlington International Airport. Later this year, BED will partner with Burlington's bicycle nonprofit Local Motion, creating a lending library and incentivizing electric bicycles in the Burlington Bike Share program.

Conclusions

Clearly, Vermont's BED has successfully undertaken programs and projects to advance its Net Zero Energy City vision. As a smaller municipal utility serving a climate- and rate-conscious public, BED continues to strive, in good faith, towards managing safe, reliable, affordable energy while also stepping into the forays of the new energy paradigm. BED's efforts in efficiency programs, transitioning towards 100% renewably sourced power, ongoing exploration of ways to use AMI data to better manage demand, and strategically electrifying the thermal and transportation sectors all attest to this.

Interestingly though, while BED has achieved some "Utility of the Future" indicators (such as achieving 100% renewably sourced power), it has accomplished this through the acquiring and contracting of power from large scale facilities which arguably is a more traditional approach. Additionally, BED finds itself struggling with issues outside of its immediate circle of influence. These include issues such as the "split incentive", the design of

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[20] BED supports and incentivizes cold climate air source heat pumps (ASHP), but with most Burlington homes heated by gas (and current gas prices), customer uptake is currently not substantial. This district heat project, focused on large industrial users and harnessing waste heat from an existing wood power plant, is an "and/both" approach to transitioning to renewable heat. Further, the business model for this project currently sets the financial risk on the project developer (not the City, BED or customers) and is also fuel agnostic, allowing for future incorporation of energy from sewage plants, geothermal or concentrated solar.

[21] More details regarding BED's electric transportation strategy is available in the BED 2018 Tier III Beneficial Electrification Plan. https://www.vpirg.org/wp-content/uploads/2017/12/2018-BED-Tier-III-Filing.pdf

[22] BED is applying for funding to Electrify America, Volkswagen Group of America's affiliate responsible for investing $1.2 million over the next ten years in zero emission vehicle efforts in the United States.

net-metering, changing power market structures, and how grid modernization, transmission and capacity costs are allocated.

BED can claim many significant successes, and the staff continue to work towards others. Ultimately, however, key policy, regulatory and market reform beyond the power of any one utility is needed to ensure the transition to our shared energy future is not only safe, reliable and affordable but also decarbonized.

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