Attachments

Attachment A	Liberty Total Resource Cost Model MODIFIED by CoL
Attachment B	Lebanon Community Power Update #1
Attachment C	Excerpts from: *Evaluation of Permanent Load Shift (PLS) Technologies and Development of Energy Savings Tool,* EPRI, Palo Alto, CA: 2018. 3002011344. (Technical Update, Jan. 2018)
Attachment D	5/1 Draft, City of Lebanon, Request for Information (RFI) from Potential Vendors

Liberty Utilities (Granite State Electric) d/b/a Liberty Utilities

Total Resource Cost Model - MODIFIED by CoL with Lower Assumed Avoided Costs (Avoided FCM Capacity Charges) and Lower Estimated Customer Savings

Option 2 - Cellular Based Metering - From Staff Tech 3-1 Data Response (4/16/18)

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	
1	Year	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	
2	Units Installed	1,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3	#Units with Upfront Contribution	100															
4	#Units with Monthly Contribution	900	900	900	900	900	900	900	900	900	900						
	Benefits																**Total**
5	Regional Network System (RNS) Charges	$640,000	$645,050	$644,517	$631,433	$612,490	$594,115	$576,292	$559,003	$542,233	$525,966	$505,210	$484,455	$463,699	$442,944	$422,188	**$8,289,594**
6	Local Network System (LNS) Charges	$126,284	$131,082	$130,851	$128,171	$124,323	$120,615	$116,991	$113,480	$110,082	$106,767	$102,554	$98,340	$94,127	$89,913	$85,700	**$1,679,280**
7	Distribution Circuit Upgrades (Rev Req)	$0	$96,101	$92,889	$89,797	$86,815	$83,934	$81,148	$78,450	$75,831	$73,226	$70,622	$68,017	$65,412	$62,807	$60,202	**$1,085,251**
8	Avoided FCM Capacity Charges	$0	$102,118	$297,136	$250,753	$243,231	$235,934	$228,856	$221,990	$215,330	$208,870	$200,628	$192,386	$184,143	$175,901	$167,659	**$2,924,935**
9	Customer Savings	($9,511)	$87,774	$85,141	$82,587	$80,109	$77,706	$75,375	$73,113	$70,920	$68,792	$66,078	$63,363	$60,648	$57,934	$55,219	**$995,247**
10	Customer Contribution	$208,000	$108,000	$108,000	$108,000	$108,000	$108,000	$108,000	$108,000	$108,000	$108,000	$0	$0	$0	$0	$0	**$1,180,000**
11	Total Benefits	$964,772	$1,170,125	$1,358,534	$1,290,741	$1,254,967	$1,220,304	$1,186,662	$1,154,036	$1,122,396	$1,091,622	$945,091	$906,560	$868,030	$829,499	$790,968	**$16,154,308**
	Costs																
12	Revenue Requirement - Batteries	($1,522,041)	($1,396,114)	($1,287,404)	($1,190,992)	($1,103,335)	($1,015,704)	($928,047)	($851,385)	($785,693)	($720,000)	$0	$0	$0	$0	$0	**($10,800,715)**
13	Revenue Requirement - Cell Based Meters	($43,873)	($42,023)	($40,220)	($38,461)	($36,743)	($35,062)	($33,415)	($31,801)	($30,191)	($28,582)	($26,973)	($25,364)	($23,755)	($22,145)	($20,536)	**($479,144)**
14	Monthly Cellular Reading Cost	($36,000)	($36,000)	($36,000)	($36,000)	($36,000)	($36,000)	($36,000)	($36,000)	($36,000)	($36,000)	($36,000)	($36,000)	($36,000)	($36,000)	($36,000)	**($540,000)**
15	Cogsdale Programming Costs	($92,290)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	**($92,290)**
16	Meter MV-90 Programming Costs	($80,000)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	**($80,000)**
17	Total Costs	($1,774,204)	($1,474,137)	($1,363,624)	($1,265,453)	($1,176,078)	($1,086,765)	($997,463)	($919,186)	($851,884)	($784,582)	($62,973)	($61,364)	($59,755)	($58,145)	($56,536)	($11,992,149)
18	Net Benefit to All Customers	($809,431)	($304,012)	($5,090)	$25,288	$78,889	$133,539	$189,199	$234,850	$270,512	$307,040	$882,118	$845,197	$808,275	$771,353	$734,432	**$4,162,158**
	Net Present Value Calculation																
19	Required Rate of Return	9.40%															
20	Net Present Value	$886,488															

1 Year of installation
2 Total units in pilot
3 Based on Green Mountain Power's experience of 10% paying upfront
4 (2) - (3)
5 Calculation as described in testimony; Includes 3% degradation per year
6 Calculation as described in testimony
7 Page 7
8 Calculated using the most recent Avoided Energy Supply Components in New England: 2018 Report
9 Savings Calc TRC 2
10 Customer contribution of $1000 upfront (100) plus $10 per month (900)
11 Sum of lines 5-8
12 Page 3
13 Page 5
14 Verizon monthly cell data charges
15 Estimated programming costs associated with billing TOU rates
16 Estimated programming costs associated with reading cellular meters
17 Sum of lines 10-14
18 Sum of lines 9+15
19 Page 3
20 Net Present Value calculation of net benefits

Liberty Utilities (Granite State Electric) d/b/a Liberty Utilities

Total Resource Cost Model - MODIFIED by CoL with Lower Assumed Avoided Costs (Avoided FCM Capacity Charges) and NO Estimated Customer Savings (to show effect on non-participant ratepayers as a group)

Option 2 - Cellular Based Metering - From Staff Tech 3-1 Data Response (4/16/18)

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	
1	Year	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	
2	Units Installed	1,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3	#Units with Upfront Contribution	100															
4	#Units with Monthly Contribution	900	900	900	900	900	900	900	900	900	900						
	Benefits																**Total**
5	Regional Network System (RNS) Charges	$640,000	$645,050	$644,517	$631,433	$612,490	$594,115	$576,292	$559,003	$542,233	$525,966	$505,210	$484,455	$463,699	$442,944	$422,188	**$8,289,594**
6	Local Network System (LNS) Charges	$126,284	$131,082	$130,851	$128,171	$124,323	$120,615	$116,991	$113,480	$110,082	$106,767	$102,554	$98,340	$94,127	$89,913	$85,700	**$1,679,280**
7	Distribution Circuit Upgrades (Rev Req)	$0	$96,101	$92,889	$89,797	$86,815	$83,934	$81,148	$78,450	$75,831	$73,226	$70,622	$68,017	$65,412	$62,807	$60,202	**$1,085,251**
8	Avoided FCM Capacity Charges	$0	$102,118	$297,136	$250,753	$243,231	$235,934	$228,856	$221,990	$215,330	$208,870	$200,628	$192,386	$184,143	$175,901	$167,659	**$2,924,935**
9	Customer Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	**$0**
10	Customer Contribution	$208,000	$108,000	$108,000	$108,000	$108,000	$108,000	$108,000	$108,000	$108,000	$108,000	$0	$0	$0	$0	$0	**$1,180,000**
11	Total Benefits	$974,284	$1,082,351	$1,273,393	$1,208,154	$1,174,858	$1,142,598	$1,111,287	$1,080,923	$1,051,476	$1,022,830	$879,014	$843,197	$807,381	$771,565	$735,749	**$15,159,060**
	Costs																
12	Revenue Requirement - Batteries	($1,522,041)	($1,396,114)	($1,287,404)	($1,190,992)	($1,103,335)	($1,015,704)	($928,047)	($851,385)	($785,693)	($720,000)	$0	$0	$0	$0	$0	**($10,800,715)**
13	Revenue Requirement - Cell Based Meters	($43,873)	($42,023)	($40,220)	($38,461)	($36,743)	($35,062)	($33,415)	($31,801)	($30,191)	($28,582)	($26,973)	($25,364)	($23,755)	($22,145)	($20,536)	**($479,144)**
14	Monthly Cellular Reading Cost	($36,000)	($36,000)	($36,000)	($36,000)	($36,000)	($36,000)	($36,000)	($36,000)	($36,000)	($36,000)	($36,000)	($36,000)	($36,000)	($36,000)	($36,000)	**($540,000)**
15	Cogsdale Programming Costs	($92,290)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	**($92,290)**
16	Meter MV-90 Programming Costs	($80,000)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	**($80,000)**
17	Total Costs	($1,774,204)	($1,474,137)	($1,363,624)	($1,265,453)	($1,176,078)	($1,086,765)	($997,463)	($919,186)	($851,884)	($784,582)	($62,973)	($61,364)	($59,755)	($58,145)	($56,536)	($11,992,149)
18	Net Benefit to All Customers	($799,920)	($391,786)	($90,231)	($57,299)	($1,220)	$55,833	$113,825	$161,737	$199,592	$238,247	$816,041	$781,834	$747,627	$713,420	$679,213	**$3,166,911**
	Net Present Value Calculation																
19	Required Rate of Return	9.40%															
20	Net Present Value	$371,438															

1 Year of installation
2 Total units in pilot
3 Based on Green Mountain Power's experience of 10% paying upfront
4 (2) - (3)
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Liberty Utilities (Granite State Electric) d/b/a Liberty Utilities

Total Resource Cost Model - MODIFIED by CoL with Lower Assumed Avoided Costs (Avoided FCM Capacity Charges) and NO Estimated Customer Savings (to show effect on non-participant ratepayers as a group) AND Assumes Monthly Cellular Reading Cost Might be Eliminated

Option 2 - Cellular Based Metering - From Staff Tech 3-1 Data Response (4/16/18)

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	
1	Year	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	
2	Units Installed	1,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3	#Units with Upfront Contribution	100															
4	#Units with Monthly Contribution	900	900	900	900	900	900	900	900	900	900						
	Benefits																**Total**
5	Regional Network System (RNS) Charges	$640,000	$645,050	$644,517	$631,433	$612,490	$594,115	$576,292	$559,003	$542,233	$525,966	$505,210	$484,455	$463,699	$442,944	$422,188	**$8,289,594**
6	Local Network System (LNS) Charges	$126,284	$131,082	$130,851	$128,171	$124,323	$120,615	$116,991	$113,480	$110,082	$106,767	$102,554	$98,340	$94,127	$89,913	$85,700	**$1,679,280**
7	Distribution Circuit Upgrades (Rev Req)	$0	$96,101	$92,889	$89,797	$86,815	$83,934	$81,148	$78,450	$75,831	$73,226	$70,622	$68,017	$65,412	$62,807	$60,202	**$1,085,251**
8	Avoided FCM Capacity Charges	$0	$102,118	$297,136	$250,753	$243,231	$235,934	$228,856	$221,990	$215,330	$208,870	$200,628	$192,386	$184,143	$175,901	$167,659	**$2,924,935**
9	Customer Savings	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	**$0**
10	Customer Contribution	$208,000	$108,000	$108,000	$108,000	$108,000	$108,000	$108,000	$108,000	$108,000	$108,000	$0	$0	$0	$0	$0	**$1,180,000**
11	Total Benefits	$974,284	$1,082,351	$1,273,393	$1,208,154	$1,174,858	$1,142,598	$1,111,287	$1,080,923	$1,051,476	$1,022,830	$879,014	$843,197	$807,381	$771,565	$735,749	**$15,159,060**
	Costs																
12	Revenue Requirement - Batteries	($1,522,041)	($1,396,114)	($1,287,404)	($1,190,992)	($1,103,335)	($1,015,704)	($928,047)	($851,385)	($785,693)	($720,000)	$0	$0	$0	$0	$0	**($10,800,715)**
13	Revenue Requirement - Cell Based Meters	($43,873)	($42,023)	($40,220)	($38,461)	($36,743)	($35,062)	($33,415)	($31,801)	($30,191)	($28,582)	($26,973)	($25,364)	($23,755)	($22,145)	($20,536)	**($479,144)**
14	Monthly Cellular Reading Cost	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	**$0**
15	Cogsdale Programming Costs	($92,290)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	**($92,290)**
16	Meter MV-90 Programming Costs	($80,000)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	**($80,000)**
17	Total Costs	($1,738,204)	($1,438,137)	($1,327,624)	($1,229,453)	($1,140,078)	($1,050,765)	($961,463)	($883,186)	($815,884)	($748,582)	($26,973)	($25,364)	($23,755)	($22,145)	($20,536)	($11,452,149)
18	Net Benefit to All Customers	($763,920)	($355,786)	($54,231)	($21,299)	$34,780	$91,833	$149,825	$197,737	$235,592	$274,247	$852,041	$817,834	$783,627	$749,420	$715,213	**$3,706,911**
	Net Present Value Calculation																
19	Required Rate of Return	9.40%															
20	Net Present Value	$654,901															

1 Year of installation
2 Total units in pilot
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LEBANON COMMUNITY POWER UPDATE #1

April 5, 2018

The Lebanon Energy Advisory Committee (LEAC),[1] and its two sub-committees, Municipal Aggregation and Street Lighting, are pursuing projects to reduce the City's power costs and environmental footprint. A combination of state legislation, regulatory support from the NH Public Utilities Commission, utility ambitions, and rapidly changing technologies make this an exciting time to initiate new approaches and projects regarding energy and climate action for the City and its residents. While no one of these projects is ready for final review or approval, we would like to take this opportunity to let interested residents and businesses know what is in the works. This update simply aims to introduce, at a high level, the different possibilities and their relationships one to another.

The Players:

The City of Lebanon's Master Plan, official policy adopted by the Planning Board and City Council, has an overall goal regarding energy that: "Lebanon is a leader in energy efficiency, renewable energy reliance, and innovation across municipal, commercial, institutional, and residential sectors." In pursuit of that goal the City has participated in several recent NH Public Utilities Commission (PUC) proceedings using the volunteer services and expertise of City Councilor Clifton Below, a former NH PUC Commissioner for 6 years who also worked previously on energy policy in the NH legislature for 12 years. The proceedings have included:

1) a Grid Modernization investigation that examined how the distribution grid needs to evolve to support greater efficiency, resiliency, and increased integration of distributed renewable electric generation like solar photovoltaics (PV);
2) a Liberty Utilities electric distribution rate case where the City negotiated and secured options in April 2017 to convert to energy saving LED street lighting, with either Liberty-owned fixtures or City-installed and owned fixtures (which may allow for greater savings than the Liberty option); and
3) a proceeding to develop new net metering tariffs (rate terms and conditions) for renewable energy, including City-installed renewable electric generation such as solar PV. In that net metering proceeding the City proposed to pilot the use of hourly real-time pricing for both net metering and electric loads in general. Real-

[1] LEAC is advisory to the City Council and administration. See: https://lebanonnh.gov/519/Lebanon-Energy-Advisory-Committee.

time pricing (or RTP) is a price that changes each hour for electricity generated and sold in the regional wholesale power market run by the grid administrator ISO New England. RTP, based on supply and demand, is on average much lower in cost than the rates most consumers pay.[2]

The Town of Hanover switched from fixed price electric rates to real time pricing a few years ago. This process of buying its electricity supply directly from the wholesale market has saved the town about $50,000 to $100,000 a year. If Lebanon had paid the average RTP that Hanover paid for the 12 months ending 2/17, the City would have saved over $160,000 and over $60,000 for the 12 months ending 2/18.[3] While this approach could be an option for Lebanon, the alternatives described below may provide even greater savings and price stability over the long term while helping the City achieve its energy and environmental goals. Hanover and Lebanon may collaborate to implement some of these goals and projects.

Liberty Utilities was directed last year by the NH Public Utilities Commission to work with the City to develop its proposed RTP pilot to help inform the Commission about the value of real-time electricity rates. Liberty has also proposed a seperate pilot program to offer residential customers home-scale batteries for electricity storage along with time-of-use rates for distribution and transmission costs. Time-of-use rates are fixed rates that vary over different periods of the day and week, and these will enable additional customers savings in conjunction with use of the battery during times of peak electric demand and rates. For this Liberty Utilities needs new metering technology, as does the City for its RTP pilot. In its battery pilot program proposal to the PUC Liberty states:

[2] Energy suppliers purchase wholesale electricity at prices that reflect RTP but usually sell it to retail consumers at a price that is fixed for a specified period. An example is the utility's default service, which shows up on the monthly bill as an "energy service" charge (distinct from distribution and transmission charges that pay for the wires and systems that deliver the electricity). Suppliers set their forward fixed prices based, in part, on projections of RTPs, to which they add an insurance cost to hedge the uncertainty of future RTPs and future load (the amount of electricity supplied). The vast majority of retail customers would save money if they could pay the varying RTP and not pay the additional hedging costs built into fixed prices. They could save even more by shifting flexible loads (electricity usage) to lower cost hours to avoid expensive peak use hours. They could, for instance, time their use of a storage hot water heater or clothes dryer, or when an electric vehicle charges. The City could choose when to pump water to hilltop reservoirs or when to operate portions of the wastewater treatment process, both of which are big electric loads. Real-time pricing will provide a signal to consumers to adjust flexible loads. This is called "demand response," which is a key to economically integrating large amounts of local or distributed renewable power production and energy storage into the smart grid of the future.

[3] The latest period ending 2/28/18 included the coldest weather and largest spike in RTPs (in late December and early January) that the region has experienced in the past 4 years. Even with that spike in RTPs Hanover's RTP averaged 6.62¢/kWh for those 12 months compared with the City's 8.28¢/kWh. For the 12 months ending 2/17 Hanover's RTP averaged 4.42¢/kWh while the City's forward fixed price for energy service was 8.52¢/kWh. Hanover consumes about 2.6 to 3.2 million kWh/year, while the City consumes about 4 to 5 million kWh/year.

> Electric utilities should move beyond simply selling customers more electricity. Instead electric utilities must understand and support their customers' goals of reducing electricity use, managing costs, and obtaining electricity from an array of environmentally friendly sources. . . . Today's electric customer wants more than to simply have safe and reliable electricity service to their home or business. They have a better understanding how the electricity they use is produced and are interested in environmentally beneficial products and services that reduce their carbon footprint and increase efficiency. They are cognizant of their behavior and its effect on the environment. Electric utilities need to recognize that customers not only want to reduce their environmental footprint, but also have the technological capacities to achieve their goal.[4]

The Projects:

Lebanon Community Power is the proposed name for Lebanon's pilot RTP program that will incentivize users to shift some of their consumption of electricity from higher priced periods during the day to lower ones at night, on weekends, and sometimes in the middle of the day when solar power is especially abundant. Lebanon Community Power will also enable residents and businesses, as well as the City itself, to choose local sources of renewable generation to meet some or all of their power needs.

NH law enables communities to combine electricity loads, including those of any electric customers within the community who choose to participate, under what is known as municipal or community aggregation. They can then collectively arrange for the supply of electricity and potentially other services such as allowing for automated demand response.

NH law requires municipal aggregation to operate in such a way that it is not subsidized by taxpayers. At this stage LEAC is focused on fleshing out the aggregation plan and finding the best technologies and service providers to meet our project needs in collaboration with Liberty Utilities. A next step will be to issue a formal Request for Information to identify potential vendors, the most appropriate technologies, and to better learn what our options are. A final aggregation plan will have to be approved by the City Council and PUC before it is launched.

Landfill Gas to Energy: This project was recommended by LEAC and is moving ahead under the auspices of the Department of Public Works. The vision is to build a system to generate electricity from methane gas captured from our capped landfill that

[4] "Direct Testimony of Heather M. Tebbetts" for Liberty Utilities, November 30, 2017, p.3, found at: www.puc.nh.gov/Regulatory/Docketbk/2017/17-189/INITIAL%20FILING%20-%20PETITION/17-189_2017-12-01_GSEC_DTESTIMONY_TEBBETTS.PDF.

is presently being flared (burned off). The biologically derived methane comes from the breakdown of organic wastes, such as food, paper, and wood and thus is considered renewable. The City has hired an engineering firm that is undertaking a feasibility study, reviewing various options such as also capturing and using thermal (heat) energy from the project, and doing preliminary design work. Our initial estimate is that this project might produce enough green electricity to meet all of the City's municipal electricity needs and have excess to sell locally through Lebanon Community Power, resulting in net savings and new revenue for the City without the need to invest any general fund tax dollars into the project.

LED Street Lighting: this LEAC subcommittee is studying options for replacing current outdoor City-owned or paid for lighting with high-efficiency LED lights. The technology and vendors also exist to provide "smart" or adaptive street lighting, where lighting could be dimmed during times when there is little or no traffic on the streets, when there is a full moon, or for other considerations. Outdoor lighting levels could also be increased for special events, emergencies, and during times such as dusk when automobile accidents are statistically most likely to occur. Adaptive street lighting also extends the life of LED fixtures by many years and enables substantial additional energy and cost savings over time. A smart municipal street lighting network could also support many other applications, such as better traffic controls and the reading of electric meters in near real-time. This last feature will be needed for the Lebanon Community Power aggregation project with RTP and Liberty Utility's battery pilot. However, such adaptive streetlights, require a wireless communication system that would add to the initial cost, and LEAC must weigh all these factors in making a recommendation to the City Council and administration.

Community Scale Solar and other Distributed Generation on both City- and privately-owned locations within the City will be able to sell excess green power to Lebanon homes and businesses through Lebanon Community Power, potentially at a savings compared to other options. Virtual net metering, where a customer owns offsite solar PV or a share of the output from a community solar or other renewable project, will also be enabled through Lebanon Community Power.

For more information please contact City Councilor & LEAC Chair Clifton Below, clifton.below@gmail.com (Office: 603 448-5899) or City of Lebanon Energy & Facilities Manager Tad Montgomery, Tad.Montgomery@lebcity.com (Office: 603 442-6140). Additional background information can be found through select agenda items (4.C-F and 5.A) found here: https://lebanonnh.gov/AgendaCenter/ViewFile/Agenda/_01182018-1646?html=true.

Evaluation of Permanent Load Shift (PLS) Technologies and Development of Energy Savings Tool

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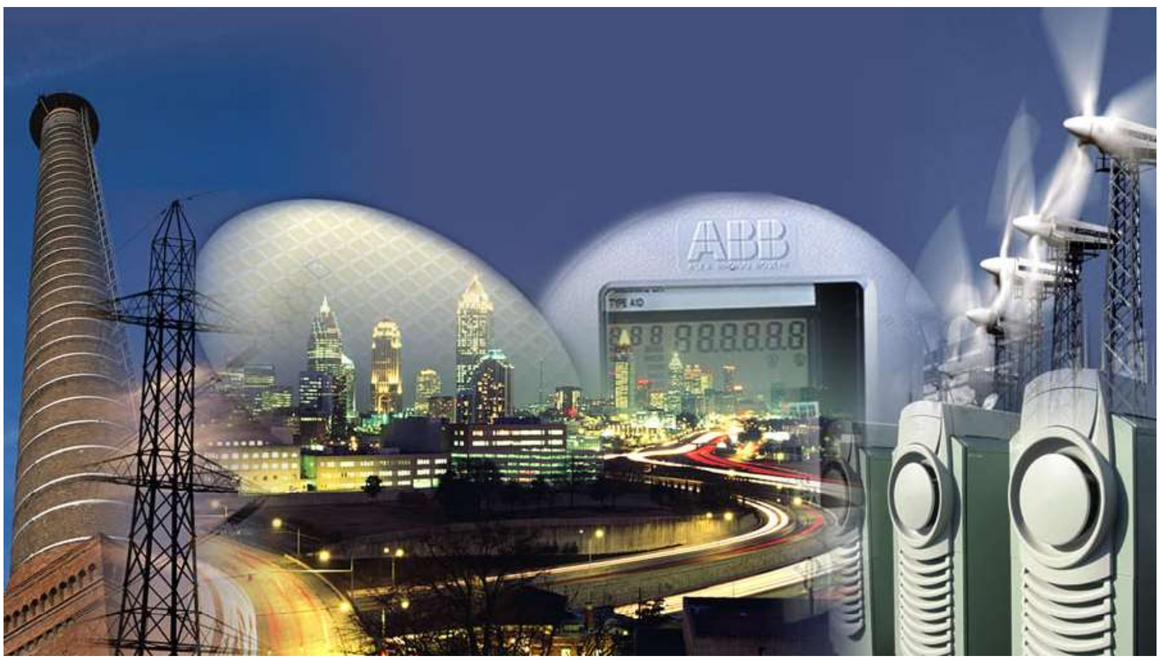

Evaluation of Permanent Load Shift (PLS) Technologies and Development of Energy Savings Tool

3002011344

Technical Update, January 2018

EPRI Project Manager

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ABSTRACT

This report provides an overview of permanent load shifting technologies including details about each performance characteristics, maturity, market status, cost-effectiveness and safety as well as environmental concerns, if any. The load shifting technologies reviewed here fall under these three categories a) traditional thermal energy storage systems b) Electric storage systems and finally controls based technologies.

The report also includes a review of existing EnergyPlus™ building simulation model which details the process of developing EnergyPlus™ models for baseline, as well as scenarios that incorporate Thermal Energy Storage (TES) systems. The research revealed some required fixes in the EnergyPlus™ related to the controls systems of storage systems; these were communicated to National Renewable Energy Lab (NREL) who have in turn incorporated the fixes back into EnergyPlus™. The review on EnergyPlus™also include details on ice tank modeling and chilled water coverage. The simulations from EnergyPlus™ allow for estimation of energy savings and implementation costs for thermal energy storage systems used in buildings.

Finally, this report provides details of a beta version of predictive tool, called Thermal Energy Storage System (TESS), which estimates energy savings and implementation costs for thermal energy storage systems used in the building. The tool can scale models to match building characteristics with multiple levels of scaling; first for building size, and then for annual energy use, and finally for monthly peak demand. The tool incorporates results from EnergyPlus™

Keywords

Demand response
Energy storage
Load shifting
Market characterization

2
TECHNOLOGY OVERVIEW

Three technology segments are considered in the analysis: active thermal storage, electrical storage, and building controls based storage. All three segments can provide varied levels of load management at varied cost level and operating characteristics. This section provides details on common operating characteristics of thermal and electrical storage.

Thermal Storage

Thermal energy storage has historically been lower cost, but can only provide load shifting (e.g. it cannot send energy back into the grid). The charging and discharging profiles depend on the actual technology. From a heat transfer/thermodynamics standpoint, the charging rate will fall off as ice is built due to the heat transfer barrier created by the ice. However, by optimizing heat exchanger design and using water circulation and other mechanisms most of the manufacturers have overcome the problem of creating a more linear charging profile. During the discharge phase, internal melt systems can provide a flatter profile while external melt systems will provide higher discharge rates. Some manufacturers combine internal and external melt to reduce complexity in design and application.

The charging curve for thermal storage has a characteristic shape of a constant charge rate early with a rapidly decreasing charge rate. The charge cut-off signal is either a glycol temperature or refrigerant pressure signal that indicates sufficient ice formation. The actual cut-off temperature or pressure depends on the individual manufacturers' design, and the higher the cut-off condition, the greater is the efficiency of charging, given that the charging cycle is the primary energy user for thermal storage system.

During discharge, most manufacturers have designed their systems to ensure a constant discharge rate. Discharging is usually complete when the ice or chilled water has lost its capacity, or when the time limit (end of peak period) is reached. The thermal cut-off is detected by a rapidly increasing glycol or refrigerant temperature which indicates insufficient cooling capacity.

Electrical Storage

Electrical energy storage systems have charging and discharging characteristics that vary based on the technology. On the customer side of the meter, batteries and flywheels are considered the most likely possibilities for storing energy for load management. Ultracapacitors have high charging and discharging rates, but can only store a fraction of the energy. Therefore, while they are good for regulating transient events, ultracapacitors cannot perform well within a load management program such as PLS.

3
THERMAL STORAGE TECHNOLOGIES

TST1

Technology: The TST1 is a packaged thermal storage unit that uses underutilized air conditioning capacity at night to create cold storage in the form of ice that is discharged during the day to avoid air conditioner operation during the peak hours. The system is unique in that it works with refrigerant-based air conditioing systems that are common in residential and small commercial buildings. It connects to both split system and rooftop air conditioners found in these building types. These systems are designed to be connected through a network and can be controlled as a bulk resource.

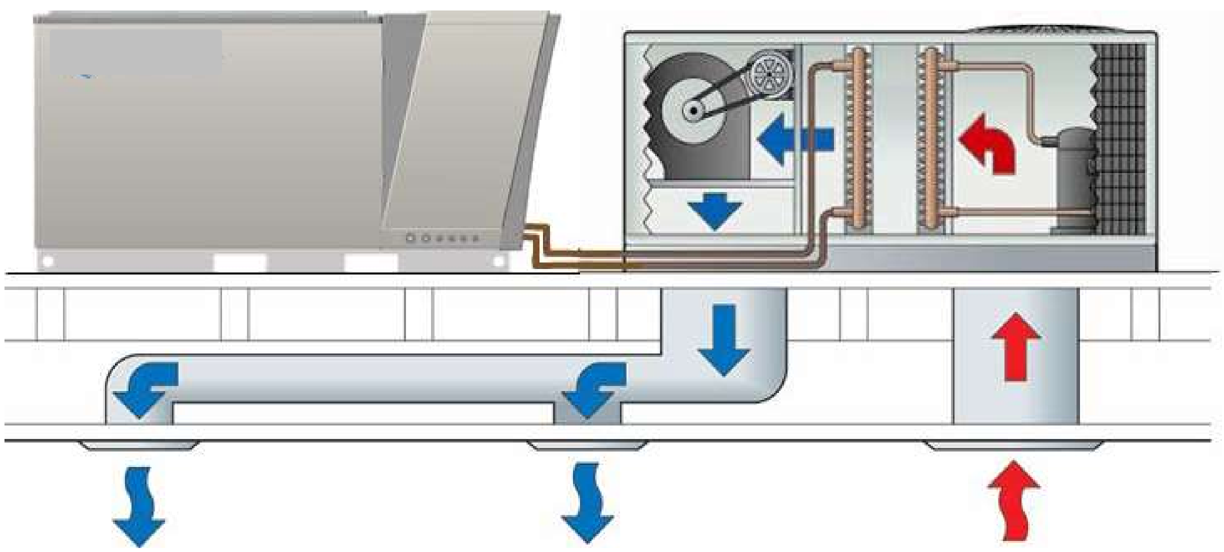

Figure 3-1
TST1

Performance Characteristics: TST1 is available as a 30 T-hr. system with its own ice making apparatus. A 30 T-hr. system will eliminate approximately 30 kW-hr of peak load, with a greater displacement when the air conditioning units are older. The round trip efficiency is a function of the outdoor temperatures during the charging and discharging periods, but is close to 100% when the difference between daytime highs and nighttime lows is approximately 22F. The charging of the system takes between 8 and 12 hours depending on the nighttime outdoor temperatures. The discharge rate is a function of the cooling system being displaced and can vary between 3 and 7.5 tons of cooling (4 to 10 hours of operation). The rated discharge rate is 5 tons designed to run through a 6-hour peak period.

Maturity and Market Status: The product has been commercially available since 2006 and a few thousand units have been deployed. Many utility evaluations have been conducted and results have demonstrated the capacity and performance of the system. The product is also available through commercial HVAC channels such as Carrier and Trane.

Cost-Effectiveness: The storage unit is available at an approximate cost of $150/kWh. Including the cost of installation which can vary depending on the site and the cost of connectivity, the total installed cost is approximately $300/kWh.

Safety: The system has been rated to UL 1995 standard (similar to air conditioning equipment) and is qualified for application in residential, commercial and industrial buildings.

Environmental Considerations: The system uses water as its storage medium. The water is filled on-site and is not used during operation. The manufacturer recommends using fungicide tablets to avoid biological growth.

TST3

Technology: TST3 operates by using the air conditioning chillers in these buildings to form ice during the off-peak hours and then cooling the building in conjunction with the chillers during the peak hours (daytime). There is no refrigerant circulation to the ice tanks, only glycol is circulated. The ice forms on the outside of the tube when the glycol is circulated at temperatures of 25F or lower. During discharge, glycol is circulated inside the tubes and the ice melts, cooling the glycol. The evaporator temperature is lower, but so is the outdoor temperature during ice make, and the overal chiller COP is only marginally impacted. However, the chiller capacities might be reduced during ice making conditions.

The product is offered as a packaged tank high heat transfer surface area containing a spiral-wound, polyethylene-tube heat exchanger surrounded with water. TST3 units are available in a variety of sizes ranging from 45 to over 500 ton-hours.

There are other advantages to this system. Due to the lower glycol temperatures during the cooling period, the cooling coils can remove greater humidity and cool the air to a lower temperature. This allows the chillers to operate more efficiently. At the same time, the amount of air flow required for cooling is reduced resulting in benefits such as smaller ducts, which in turn increases the available building space for tenants. In operation, the product can operate in five modes:charging, charging with nighttime cooling, chiller cooling, ice storage, and cooling and chiller + ice storage cooling.

Figure 3-4
TST3

Performance Characteristics: The round trip energy efficiency of the system varies between 90 – 110% based on the location, chiller efficiency, and configuration. The charging and discharging rates can be varied as a function of the chiller size. The nominal hours of charge is 10 hours, but they can be charged in as few as 6 hours with little capacity impact. The charging rate is nearly constant because of the design of the heat exchanger. The discharge can be controlled through glycol mixing valves to vary the proportion of cooling provided by the chiller and ice storage system. From a modeling perspective, the system can be modeled as providing full-flexibility in discharge in line with building and grid needs.

Control Mode Definition

Mode	Chiller Pump	Chiller	Ice Valve	Blend Valve	Distribution Pump
Chiller Only	On	Enable CHWSP 42°F	55°F (0% Ice)	40°F (100% to load)	Modulate on remote ΔP
Ice Only	On	OFF	42°F	40°F (100% to load)	Modulate on remote ΔP
Chiller & Ice	On	Enable CHWSP 42°F RLA Limit 30-50%	42°F	40°F (100% to load)	Modulate on remote ΔP
Make Ice	On	Enable CHWSP 23°F	15°F (100% to ice)	80°F 0% to load)	Off
Make Ice & Cool	On	Enable CHWSP 23°F	15°F (100% to ice)	42°F	Modulate on remote ΔP
Off	Off	Off	-	-	Off

Figure 3-5
Ice Storage Control Mode Definition

Maturity and Market Status: TST3 systems have been installed in more than 4000 buildings in the last 30 years in medium and large commercial buildings and in industrial applications around US and in 37 other countries. 80% of their installations go with air cooled chillers.

Cost-Effectiveness: These systems have been installed without incentives in many buildings through first cost reduction in chiller size, duct size and better dehumidification. Because of the capability of these systems to be modular and to be located in many possible locations on the building premises, the incremental installation cost of these systems is in the order of $100/kWh if installed as an added system. However, for most new construction and chiller rehabs, the system can be installed at almost no additional first cost through reducing chiller capacities. The cost and channel partner are key reasons why these systems constitute the bulk of installed systems under the current PLS program.

Safety: Rated to UL standards as a heat exchanger.

Environmental Considerations: Address restrictions on use of propylene glycol in certain jurisdictions.

TST6

Technology: A new generation of water heaters have evolved that are grid connected and provide energy storage at the residential and small commercial level. These units operate similar to solar thermal systems in that they have the capability to raise the temperature of the water to 180F, and then use mixing valves to temper the water temperature to customer settings. The water heaters are larger water heaters in the 80 – 120 gallon range (normal water heaters are in the 40 – 50 gal range). The storage can be generated using either heat pump water heaters or from electric elements. This technology is very flexible with the capability of fast response to variability in renewable generation.

Performance Characteristics: The units are normally equipped with either a 4.5 or 9 KW electric element. If it is set up as a heat pump, then the normal operating kW is around 1.5 kW, but the auxiliary element is 4.5 kW. However, most of water heating occurs in the early morning hours and there is not substantial overlap with summer peak demand times. As California moves towards the 33% RPS, CAISO is increasingly concerned about the requirements for flexibility as expressed in their “duck” curve. Heat pump water heaters can be very well suited to fil the mid-morning valleys while still mitigating the steep afternoon ramps. EPRI is currently conducting research with Midwestern and Hawaiian utilities to assist with balancing wind.

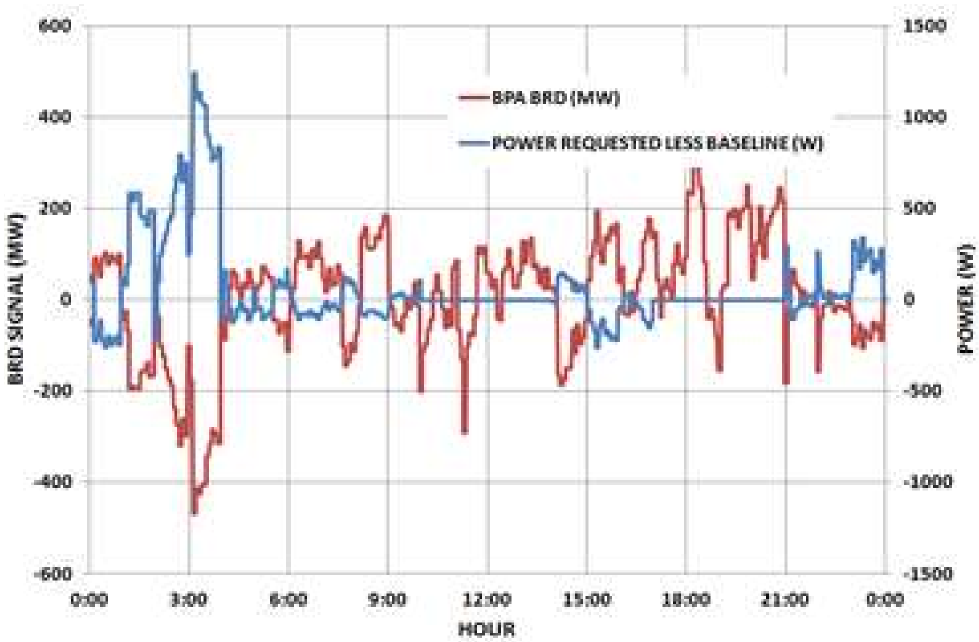

Figure 3-8
Energy Storage Water Heater

Maturity and Market Status: The product is commercially available. There are also other vendors that produce retrofit controllers for the same purpose.

Cost-Effectiveness: As a retrofit controller, the cost is in the order of $300 per controller, which converts to approximately $60/KW and approximately $20/kWh. This is highly cost-effective for utilities that have a high penetration of electric water heaters in their territory.

Safety: Rated to UL standards as a water heater.

City of Lebanon, New Hampshire

Request for Information (RFI) from Potential Vendors

May 1, 2018

For the Provision of Services to Support 3 Related Projects:

1) Smart LED Street Lighting Conversion (with potential conversion of some highway style cobra heads to decorative lamp posts with LED),

2) Interval Metering for the City's Electric Pilot (in collaboration with Liberty Utilities, the local electric utility), and

3) Services to Support Lebanon Community Power, a Proposed Municipal Aggregation Involving the Use of Real-Time Hourly Pricing

The City of Lebanon NH is seeking a show of interest and information about capabilities from potential vendors, along with some indicative budgeting information, for three related projects: 1) Smart LED Street Lighting Conversion Project, with potential conversion of some highway style metal posts with cobra heads to decorative lamp posts with LED, 2) Interval Electric Metering for the City's Electric Pilot with advanced functionality (in collaboration with Liberty Utilities), and 3) Services to Support Lebanon Community Power (LCP). LCP is a proposed municipal aggregation under NH RSA 53-E that will pilot the use of real time hourly pricing for net metering and retail energy supply in conjunction with the development and operation (indefinitely into the future) of a transactional platform that supports direct retail purchases and sales of power from distributed generation and storage, including net metered customer-generators, and potential support of demand response services. The responses to this RFI will help to inform the parameters of formal RFPs (Request for Proposals) for services that may be issued by the City within the next year. In the case of Interval Electric Metering for the City's Electric Pilot, responses to this RFI could lead to potential approval of a proposed metering solution by Liberty Utilities and the NH Public Utilities Commission, paid for primarily by LCP (or its customers) and implemented by Liberty.

The City is looking for potential vendors to provide individual services itemized below or various packages or combinations thereof. Potential vendors are asked to mail and email in PDF format a letter of interest to Tad Montgomery, Energy & Facilities Manager, City of Lebanon, City Hall, 41 N. Park St, Lebanon, NH 03766; tad.montgomery@lebcity.com, with a copy to clifton.below@gmail.com and with regard to Interval Electric Metering only, a copy to Heather.Tebbetts@libertyutilities.com. Questions about this RFI may also be addressed to Mr. Montgomery. The letter of interest shall be one to two pages long and specify which elements of this RFI, by outline number, the vendor is potentially interested in serving, such just 1.c or all of 2. The letter should briefly indicate relevant vendor capabilities and experience and may include hyperlinks to or attachments of supporting information and shall include contact information for follow-up inquires. The City may follow-up with potential vendors to request indicative budget numbers for possible solutions, particularly for its Smart LED Street Lighting Project as the City has an internal deadline of May 25, 2018 for a Capital Improvement Program (CIP) initial proposal with initial budget numbers for potential adoption and inclusion in the City's 2019 capital budget. The deadline for responses to this RFI is June 20, 2018.

Particularly regarding services to support Lebanon Community Power, potential vendors that might provide partial services, but that want to be considered to join a team to provide a more complete package of services, may identify that interest and willingness to be identified to other potential vendors. Proprietary or confidential information should not be included in responses to this RFI at this time as responses may be subject to public disclosure under NH's Right to Know law, RSA 91-A. Following the outline below of potential services sought is additional information and hyperlinks about each project.

1. **Smart LED Street Lighting Conversion Project.** The City seeks to convert approximately 900 street and outdoor lights to energy efficient LED's before the end of 2019. There is some possibility that the Town of Hanover may join in a final RFP with an additional smaller number of total street lights. Most of these lights are currently owned by Liberty Utilities, but the City is considering the option to purchase replacement LED fixtures and install them with a contractor, subject to approval of the utility, and then own and maintain all such fixtures. Although the City is particularly interested in exploring the business case and financial model for adaptive (networked and dimmable) street lighting, a conventional installation of fixed wattage and lumen output LED street lights will also be considered. The City has nearly completed an updated inventory of all outdoor lighting, most of which is currently high-pressure sodium (HPS), including mapping of each fixture that is being considered for conversion or possible discontinuance in the City's GIS. Examples of this mapping are attached. The City is also working to draft a street lighting policy that will guide selection of locations for removal or addition of street lights, including consideration of potential better linear coverage with each new LED fixture.

   The City's additional criteria and needs include:

   a. Night sky and abutter friendly fixtures: Sharp horizontal cut-off, cut-off of light trespass onto private property where appropriate, and glare minimization are highly desirable. The City is considering limiting most or all new LED street lighting to color temperatures of 3000 K CCT or warmer (such as 2700 K).

   b. Dimming capability is highly desirable. An expected fixture life of 20 years or more that maintains a minimum specified lumen output is highly desirable. If a conventional fixed-lumen output LED conversion is determined to be the preferable alternative, then LED dimming capability with a standard NEMA 7-pin socket to allow for future upgrade to smart networked control of fixtures is a desirable option.

c. A communication system for the dimmable street lighting could be provided as an integral part of or separate element of an overall smart LED street lighting conversion project. The City is interested in exploring the pros and cons of various communication systems, including the relevant business cases and financial models. Such a communication system should offer the potential to support other applications, including providing communication with AMI water and electric meters located anywhere within the City. The City has a central hilltop antenna location, with potential back haul to central IT through the City's own fiber optic network, that may be available to support this project.

d. Dimmable street lighting located where it would not be behind an existing or retail meter or readily installed group utility meter, will likely need to have integrated revenue grade metering (complying with ANSI C12.1-2008 and/or ANSI C12.20-2010 standards) that is capable of reporting aggregated loads, with hourly interval data, daily to Liberty Utilities' Meter Data Management System (via polling) for load settlement purposes. The City also desires near real time direct access to such interval meter data and will need it for accounting and billing purposes to the extent included in the Lebanon Community Power municipal aggregation.

e. Smart Street Lighting control application software, including support services.

f. Potential conversion of some highway style cobra heads to decorative lamp posts with LED (first group) and potential replacement of a mix of HPS and LED luminaires in a mix of acorn globes with new uniform globes and lamps with designed in dimmable LED (2nd group). The first group is 27 to 44 highway style metal pole mounted cobra head LED and HPS lamps located in the historic Colburn Park area in downtown Lebanon, mostly supplied through underground conduit and currently owned by Liberty Utilities. The City is considering acquiring some or all of this group so it can replace some or all of these with historic style decorative lamp posts with networked LED lamps with characteristics described above. This first group of highway style cobra heads are items 4 and 9 in the attached inventory table (p. 9 of this RFI). The existing 27 LED luminaires (item 9) were installed by Liberty as part of an initial pilot of LED luminaires with a color temperature of 4000 K and would be returned to Liberty for reuse if the City decides to proceed with conversion to warmer color temperature networked luminaires with or without decorative post conversions. A critical consideration of possible pole and luminaire conversions along downtown streets to more decorative and historic style poles and fixtures will be the ability to maintain appropriate lighting levels on road surfaces. The second group of possible decorative lighting conversions is a set of 30 historic style street light posts with a variety of similar acorn globes that the City owns, identified as items 13 and 14 in the attached schedule. Most of these are located on and near the downtown pedestrian Mall. The original set of decorative posts were 12'-7" "NY" style fluted posts from Antique Street Lamps and, more recently, include similar "Old Town" posts from Spring City Lighting, one of which has their newest Crossfire Gen 2 optical system for LED. The other 8 LED luminaires are simple conversions of 150 watt screw-in HPS lamps to screw-in "corn cob" style LED retrofit lamps, with the old HPS ballast bypassed or removed. These may consist of a variety of wattages and color temperatures (e.g. 2700K, 3000K, 3500K and 4000K). The plastic acorn globes, for both LED and HPS are generally similar but with different ages and details (some are opaque and some clear, some have black bands or finials, and some have gold bands or finials). The City is interested in setting a new uniform standard for the globe and luminaire and will consider both incremental replacement and conversion of the whole group in one project. In general, the criteria set forth in subparagraphs 1 a-e above should apply to the potential conversions in this subparagraph.

2. **Interval Metering for City's Electric Pilot:** The City, in collaboration with Liberty Utilities, is interested in finding an interval metering solution with advanced meter functionality to support its Lebanon Community Power pilot and that can also work in conjunction with Liberty's proposed residential battery storage pilot for customers that might participate in both pilots, which are expected to have durations of approximately 10 to 20 years (or more). Such a metering solution might be called AMI (advanced metering infrastructure) except for the limited interest in two-way communication to the meter as described in subparagraph h below. This project will likely involve on the order of one thousand or more residential and commercial electric meters in Lebanon (and possibly Hanover) with the capability of communicating in near real time with as many of the following features as are feasible, affordable, and advantageous to the City:

   a. Digital Meters that are revenue grade certified to ANSI C12.1-2008 and/or ANSI C12.20-2010 standards (required).

   b. Measure or compute and report the following metrics:
      i. Accumulating registers:
         1. Total kWh in each direction (bi-directional metering)
         2. kWh in each direction for each line or phase
         3. Total kVARh (Reactive Total kWh)
      ii. Instantaneous measurements:
         1. Watts for each line or phase, forward (and reverse for bi-directional meters)
         2. Volts for each line
         3. Amps for each line
         4. Power Factor for each line
         5. VARs (Reactive Power) for each line
         6. VARs total
         7. Frequency
      iii. Interval Demand measurements:
         1. kW demand
         2. kVA demand

c. For Liberty's battery pilot purposes, the capability to program at least 3 TOU registers (bidirectional, meaning the ability to record or calculate net imports and exports within each TOU period), initially for the following three periods (adjustable with a field update if needed): i) Off-peak: all days from 7pm to 8 am, plus all hours of Saturdays, Sundays and ten federal holidays (detailed under "Additional Information" below); ii) On-peak: Monday-Friday excluding holidays, 8am to 2pm; and iii) Critical peak: Monday-Friday, excluding holidays, 2pm to 7pm.

d. Sufficient cybersecurity and protocols to comply with the "Privacy Policies for Individual Customer Data" of NH RSA 363:37-38 and to satisfy Liberty Utilities' and the City's cybersecurity concerns.

e. For Liberty Utilities' purposes the meter should be capable of being securely polled on a once-daily basis to report hourly interval data, including TOU periods, to Liberty's meter data management system (using Itron's MV-90 xi software) with sufficiently accurate time and date stamps suitable for use in Liberty's load settlement system. Liberty does not have interest in two-way communication for the purposes of this RFI.

f. For the City's purposes the metering system should be capable of broadcasting, reporting, or transmitting either directly or through a communication device to a central server (City or Utility) or secure cloud storage on the internet with a frequency of access of at least once per minute (or maybe once per 5 minutes). Also highly desired is some reasonable period of local storage of critical meter data in the event of a communication failure from the meter for at least basic hourly interval data (e.g. 2.b.i.1).

g. Inclusion of secure cloud-based storage of meter data at 1-minute intervals for a short duration (such as for at least the most recent 1,000 reads) and at 5-minute or hourly intervals on a long-term basis, e.g. life of the meter, with secure API access for authorized parties. An alternative to inclusion of cloud based meter data storage might be the ability to allow secure access to meter data on a near real time basis to LIINES (Laboratory for Intelligent Integrated Networks of Engineering Systems) at the Dartmouth College Thayer School of Engineering, that is planning to collect, anonymize, and store 1-minute interval data for research and program/service development purposes.

h. The City would strongly prefer that the proposed meter not be capable of having software or firmware downloaded or modified via the internet or incoming RF communication for cybersecurity reasons. However, the City is strongly interested in facilitating demand response programs, so would consider integration of an optional Home Area Network with communicating meters (see also items 3.e and 3.f below). The alternative to two-way meter communication for this functionality would be to use a separate internet-based channel for DR communications.

i. The City is particularly interested in a reasonably low-cost method for securely obtaining meter data such as through existing internet connections or through a shared smart street lighting communication system in which some contribution to the cost of such a system might be made, as opposed to more expensive subscriptions to wireless carrier cell service data plans.

3. **<u>Services to Support Lebanon Community Power:</u>** a proposed municipal aggregation of retail electric load using hourly Real Time Pricing (RTP) for load settlement and net metering of local renewable distributed generation. For these services the City will consider potential vendors, including particularly competitive electric power suppliers (CEPS) that are registered with the NHPUC, that can provide or manage the provision of the entire package of services, as well as vendors who might provide only some of the desired products or services. Potential vendors who might provide only one or some of these services can also indicate their interest in being identified to other potential vendors with whom they might subcontract with or collaborate with in a final proposal. The ideal vendor will capitalize (fund) all the development costs for these services and recover them as part of a fixed price mark-up on kWh sales. The transactional municipal aggregation model using NH RSA 53-E that the City seeks to pilot and pioneer is intended to be a replicable and durable model that other NH communities could join in on or adopt on their own. Desired services include:

   a. Support for the City becoming a Load Serving Entity (LSE) by becoming a wholesale market participant in the ISO New England energy markets to allow the City to self-supply at real time hourly prices even in advance of LCP launch (enabling testing of billing software). This may be desirable even if the City does not proceed with the municipal aggregation plan. The City as LSE could be the supplier for all LCP participants or a NH CEPS could serve as the LSE.

   b. **Transaction and Billing System:** development and implementation of a basic transactive platform to support exchanges of electric power using hourly real time pricing between retail electric customers and local distributed generation, such as net metered PV and City landfill gas to energy generation, as well as wholesale supply. Desired features may include:

      i. The billing system will match hourly meter data for both consumption and production with hourly real time prices for energy (NH Locational Marginal Price or LMP) and ancillary services from ISO New England and generate an electronic or web-based bill on a daily, twice weekly, or monthly basis that transparently shows all billing determinants for each hour of the period.

      ii. An overlay of the RTP exchange that enables bilateral fixed price contracts between consumers and generators (such as Purchased Power Agreements or PPAs), including for community or virtual net metered projects. Energy exchanged in the same hour of both consumption and production would pay and be paid the stipulated fixed price (with the retail adder for transaction costs). Like a contract for differences,[1] to the extent electricity is consumed in different hours than the contracted generation supply the buyer might pay a bit more or less than the stipulated rate depending on whether the consumption occurred during hours that were on average more or less in value in RTP than the hours of generation.

iii. Initialization of ACH (automated clearing house or bank) payments from 2X weekly billed customers to LSE account that pays ISO-NE 2X weekly.

iv. Summary electronic or paper billing of monthly billed and payment customers, showing average cost per kWh for the billing period and a presentation style to the bill that makes it easy for customers to understand at a glance, and easy to get additional information on the hourly details, which may only be available on-line or in electronic files.

v. Payments or credits to participant generators. This may include retrospective payment or credit for avoided transmission charges and capacity charges for net metered distributed generation (DG) that have net exports of electricity during hours when transmission charges are incurred (monthly regional coincident peak hour) and when FCM capacity charges are incurred (hour of annual New England peak demand).

vi. Tracking of customer deposits (payment, application, refunds, interest).

vii. Hedging or budget payment plan options for customers who want to limit their exposure to market volatility such as having to pay short-term RTP spikes from winter (or summer) peak demands. Besides conventional products such as a winter sleeve, one innovative idea is to offer a retained shared savings plan for customers who pay monthly. For each monthly bill the difference between RTP and the applicable default service rate would be calculated. Assuming savings initially, half of such savings would be retained by LCP and held in a reserve for the customer (like an additional security deposit, but more readily cashed out by the customer). Those retained saving could then be used to pay half (or more) of the difference between RTP and default service rates during those few months that RTP might typically be more expensive than default service, such as from winter price spikes.

c. **Working capital** and debt collection services. This will be needed mainly for customers who pay monthly (as opposed to those, such as the City, who automatically pay on the same day, twice per week, as ISO New England is paid).

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[1] There are many explanations of "contract for differences" or "CfD" regarding energy on the web. One of the better ones can be found at: https://www.emrsettlement.co.uk/about-emr/contracts-for-difference/ (except for the last part specific to the UK). A CfD allows for a physical hedge against RTP volatility in place of a financial hedge, better benefiting the development of renewable generation and long-term electricity price certainty for the consumer, while still allowing for the benefits and savings from demand response for flexible loads and the use of RTP on the margin.

d. **Customer Enrollment and Transfer Back to Default Service:** This will require the involvement of a NH CEPS that has established Electronic Data Interchange (EDI) services with Liberty Utilities. Timely transfer back to default service may be needed for LCP customers who default to limit bad debt exposure.

e. **Renewal Portfolio Standard (RPS) compliance**, including a system for compensating qualifying DG for RECs (renewable energy certificates) at some market based or negotiated rate, for use in LCP RPS compliance or for resale. Another desirable feature will be an option for customers to procure REC's in excess of RPS requirements for premium green-certified electricity.

f. **MOBILE APP:** Development of an application that allows customers, including customer-generators, to see their consumption and production in near real time, along with applicable ISO New England RTPs, from any interconnected device, with an option to set alerts when user-determined thresholds are approached.

g. **DEMAND RESPONSE:** Systems, platform, or applications that enable automated customer demand response (based on RTP and Day Ahead (DA) price signals, along with potential hours of coincident peak demands) for flexible loads (e.g. electric hot water storage heaters, electric clothes dryers, and EV charging).

h. **FOR THE FUTURE - Day-ahead Pricing Option**: integration of an option for customers, and possibly customer-generators (net metered DG), to select DA hourly pricing, where any difference in real time load (or production) from DA commitment is settled at RTP.

i. **FOR THE FUTURE - 5-minute RTP:** eventual integration of an option for 5-minute RTP and load settlement if and when Liberty's load settlement system is capable of such.

ADDITIONAL INFORMATION

1) Street Lighting:

a. The City was a party to a settlement agreement in DE 16-383 that was approved by the NHPUC in Order 26,005 on 4/12/17. The relevant provision of that settlement (pp. 12-13) is excerpted below and explains why the proposed approach to LED conversion set forth herein is likely possible. The reference to "the City" is to the City of Lebanon:

"L. LED Tariff Provision

"In addition to the LED provisions of Liberty's Rate M "Outdoor Lighting Service" as submitted in the Company's updated filing of November 21, 2016, and further updated in its filing made on January 5, 2017, Liberty, as part of its compliance filing made pursuant to an order in this case, shall file a tariff which provides that customers may elect to pay for the LED fixtures and installation, and that the Company shall include the cost of such fixtures and installation as plant on its books and records and customer payments for such as Contributions in Aid of Construction. The Company will work collaboratively with Staff and the City to develop an LED tariff that allows customers to install LED fixtures, subject to agreement by the Company with respect to third party contractors used by such customers. Municipal customers shall have the right to have maintenance performed by private line contractors and qualified public employees subject to agreement with the Company and other related conditions. The Company shall work with the City and any other municipalities who approach Liberty to explore alternative options with respect to offering LED street lighting service. If such discussions produce a mutually acceptable outcome, the Company shall file additional tariff pages to incorporate alternative LED street lighting options."

Responses to this RFI will help inform the collaborative negotiation of additional tariff provisions. Liberty's current tariff for outdoor lighting can be found on pp. 105-111 of their current tariff found at: https://new-hampshire.libertyutilities.com/uploads/Rates%20and%20Tariffs/Electric%202018/GSE_February_1_2018_Tariff_Full_2.pdf

b. An inventory of existing outdoor lights is shown in the table below. The counts for those fixtures owned by Liberty Utilities are based on their invoicing. While most of these are located within the City's GIS, there are some discrepancies to be resolved which may result in minor adjustments to the final counts. Sample maps, with pole IDs, are attached as Appendix A.

City of Lebanon, NH - INVENTORY OF STREET LIGHTS & OTHER OUTDOOR LIGHTS - 4/28/18							
Group ID #	**Existing Fixture Type**	**Lumen Output**	**Nominal Wattage**	**Existing Lamp**	**Actual Watts**	**Current Owner**	**Count**
1	Cobra Head on Wood utility pole	4,000	50	HPS RWY		Liberty Utilities	490
2	Cobra Head on Wood utility pole	9,600	100	HPS RWY		Liberty Utilities	137
3	Cobra Head on Wood utility pole	27,500	250	HPS RWY		Liberty Utilities	63
4	Cobra on metal pole w/fnd. (Rwy)	27,500	250	HPS RWY		Liberty Utilities	18
5	Cobra Head on Wood utility pole	50,000	400	HPS RWY		Liberty Utilities	1
6	Cobra Head on Wood utility pole	4,000	100	MV RWY		Liberty Utilities	26
7	Cobra Head on Wood utility pole	8,000	175	MV Rwy		Liberty Utilities	36
8	Cobra Head on Wood utility pole	22,000	400	MV RWY		Liberty Utilities	5
9	Cobra on metal pole w/fnd. (RWY)	16,000	130	LED RWY		Liberty Utilities	27
10	LumHPS **Post** (mostly cedar w/gooseneck; 4 decorative)**	9,600	100	HPS Post (Lum)		Liberty Utilities	12
11	Flood on Wood utility pole	27,500	250	HPS FLD		Liberty Utilities	12
12	Flood on Wood utility pole	50,000	400	HPS FLD		Liberty Utilities	8
	SUBTOTAL luminaires currently owned by Liberty Utilities and paid for by the City =						**835**
13	12'-7" decorative post w/acorn top	?	150	HPS in Acorn		City	21
14	12'-7" decorative post w/acorn top	?	~38-80	Asst LED post top		City	9
15	Sq. metal posts parking lot lights	30,000	320	Pulse Start MH	363	City	24
16	Sq. metal posts parking lot lights	4,978	66	LED RWY Elumen	69	City	2
17	Police Station parking lot lights		TBD	MH or HPS? RWY		City	10
18	Other outdoor lights to chg to LED		TBD	HPS??		City	?
19	School District SAU outdoor lights		TBD	HPS, FLD or RWY		Liberty Utilities	9
	Total Count, inc. 38 LEDs (that may change for uniformity of color & globe, coverage, and control)						**910**
	Total Count - non LED - fixtures with potential substantial energy & long-term cost savings						**872**
	** among these are 4 fiberglass direct embed poles and 1 stand alone wood pole paid for seperately						

c. The City's draft street lighting policy, which may contain criteria to evaluate whether some existing street lights may be eliminated, or new street lights added, will be forthcoming and may, if adopted, affect the fixture count for conversions, removals, and additions for a final RFP.

2) Interval Metering:

a. Liberty's holiday schedule is as follows, as excerpted from p. 19 of their tariff:

"30. Holidays

"The following New Hampshire legal holidays shall be recognized as holidays for purposes of billing service in off-peak periods:

Holiday	Day Celebrated
*New Year's Day	January 1st
Martin Luther King, Jr. / Civil	Third Monday in
Washington's Birthday	Third Monday in
Memorial Day	Last Monday in May
*Independence Day	July 4th
Labor Day	First Monday in
Columbus Day	Second Monday in
*Veterans Day	November 11th
Thanksgiving Day	When appointed
*Christmas	December 25th

* If these days fall on Sunday, the following day shall be considered the holiday."

b. More details on Liberty's battery pilot can be found at: https://www.puc.nh.gov/Regulatory/Docketbk/2017/17-189.html. At Tab 20, Supplemental Testimony of Heather M. Tebbetts, on pp. 20-21, Liberty describes it proposed metering solution for its battery pilot, costing about $426/meter installed, and at Tab 27, Statement, p.2, Liberty describes a revised estimate of $5/month/meter for meter data communication through a Verizon 4G cellular data service, down from a previous estimate of $7/mo./meter.

c. See also "Technology Opt-In to Support TVR for Competitive Supply of Generation and More" on pp. 19-23 of the Grid Modernization in NH report: https://www.puc.nh.gov/Electric/IR15-296/NH%20Grid%20Mod%20Final%20Report%203-20-2017.pdf

3) Lebanon Community Power

a. LCP Update # 1, a high-level summary, can be found at: https://lebanonnh.gov/DocumentCenter/View/6327

b. A summary of the regulatory background and context from DE 16-576, the NHPUC's proceeding to develop new net metering tariffs can be found at: https://lebanonnh.gov/DocumentCenter/Home/View/4261 with a link to the main PUC order that endorses the City's proposed pilot and summarizes the City's position and proposed pilot at pp. 16-17, pp. 41-43, and p. 63.

c. A Draft Municipal Aggregation Plan will soon be forthcoming.