Boston Properties

September 8, 2016

SENT VIA EMAIL

Ms. Liza Paden
Cambridge Community Development Department (CDD)
344 Broadway
Cambridge, MA 02139

RE: MXD Infill Development Concept Plan – Supplementary Information for Steam Utilization Feasibility Review

Dear Ms. Paden,

As requested by CDD Staff, the attached Steam Utilization Feasibility Review Prepared by AHA Consulting Engineers is attached for inclusion with MXD Infill Development Concept Plan.

Please contact me if you have any questions about this information.

Thank you,

Michael B. Tilford
Project Manager - Development

Enclosure

cc: Jeff Roberts – CDD
Suzannah Bigolin – CDD
Susanne Rasmussen - CDD

MEMORANDUM

To: Michael Tilford at Boston Properties

From: Robert Andrews, PE

Date: September 7, 2016

Subject: Kendall Square Urban Renewal Project
Steam Utilization Feasibility Review

As required by Article 14.74(a), the feasibility of connecting to the existing district steam system was evaluated. This study was conducting using the Department of Energy Resource's (DOER) "Guidance for the Application of the MEPA GHG Policy and Protocol to the Use of the Dalkia Cambridge CHP District Steam" document. This guidance allows for the quantification of stationary source fuel consumption using a source energy compliance path based on the results of site energy path modeling performed in compliance with the Stretch Energy Code and converted using the site to source fuel conversion factors (SSFCF).[1] The site path energy modeling for the new buildings and the steps indicated in the guidance were used to evaluate the electricity generated and to calculate the source energy savings. While the initial review of the Dalkia steam approach indicates reductions in Greenhouse Gas (GHG) emissions due to the shared steam/electric generation, the costs are unclear and future flexibility is a concern. Further, the Project would be able to capture only the stationary source GHG reductions for electricity that corresponds to amount of steam purchased; it cannot be assumed that all electricity used on-site is generated by Dalkia locally, especially in the summer when local demand for steam is greatly reduced.

The potential connection to the local Dalkia plant in Kendall Square was investigated based on the site path energy modeling for two scenarios/building systems: (1) heating energy only; and (2) both heating and cooling using absorption chillers. The detailed calculations that support the following findings are attached.

Scenario 1 (Steam for Heating Only)

Assuming an installation of absorption chillers with COP (coefficient of performance) of approximately 0.7, meaning that it takes 17,140 Btu of steam to produce one ton-hour of cooling, and following the MEPA/DOER guidance the calculations, the analysis shows that if steam is used to offset natural gas used for heating, the total source energy associated with the proposed buildings would be reduced by an estimated 71 percent; thereby, significantly reducing stationary source GHG emissions.

[1] Guidance for the Application of the MEPA GHG Policy and Protocol to the Use of the Dalkia Cambridge CHP District Steam as a Fuel Source, Draft from March 11, 2014.

Scenario 2 (Steam for Heating and Cooling)

Assuming an installation of absorption chillers with COP of approximately 0.7, meaning that it takes 17,140 Btu of steam to produce one ton-hour of cooling, and following the MEPA/DOER guidance the calculations, the analysis shows that if steam is used to both heat and cool the building, the total source energy associated with the proposed buildings would be reduced by an estimated 87.8 percent; thereby, significantly reducing stationary source GHG emissions. The generated electricity exceeds the Project's need and it is equivalent to 990 home's energy use for one year. +

Challenges with Connecting to District Steam

While utilizing district steam may result in reduced GHG emission, significant hurdles exist, including routing, capacity, condensate disposal and long-term pricing. The several challenges to using the central plant steam approach include:

1. Locating the steam supply piping underground in relation to the buildings and findings connection route that avoids existing obstacles (e.g. other utilities, MBTA, Red Line, etc.)
2. Ensuring adequate capacity in the utility steam system to support buildings' needs and potential future modifications.
3. Utility steam condensate is dumped to the sanitary waste system in Kendall Square. Therefore, the condensate must be quenched with potable water to be less than 140° F before being dumped to drain. There may be an opportunity to capture quenched condensate and use it as reclaimed water for toilet flushing or irrigation. But thus also adds more equipment and infrastructure to the buildings.
4. Long-term steam pricing is contract negotiated; it is not a regulated utility, like gas and electricity. Therefore, long-term pricing is an inherent risk.
5. The steam supplier is a private entity and is subject to being sold to other companies, with the inherent policy and procedure change, which also considered a risk.

If there are any questions, please feel free to contact us.

Combined Heat & Power Energy Impact Analysis

The potential connection to the local Kendall combined heat and power plant (Dalkia) was investigated following the site path energy modeling for cooling and heating energy. Detailed results are presented in the following table based on formula furnished by DOER "Guidance for the Application of the MEPA GHG Policy and Protocol to the use of the Dalkia CHP District Steam". The calculations show that if steam is used to offset natural gas used for heating, the total source energy associated with 3 buildings would be reduced by approximately 71% and the greenhouse gas emissions would be reduced significantly, again based on DOER formulas.

	As-Proposed Energy Model				Mitigated Without Optional Absorption Chillers Measure							Annual Savings	
Buildings	**A**	**B**	**C**		**D** B * 1.04	**E** D * 1.37	**F** A - E	**G** F * 3.01	**H** D * 1.59	**I** G + H			
	Site Electricity	**Site Gas**	**Total Source Energy**	**Source Energy EUI**	**Note 1**	**Elec. Cogenerated**	**Grid Electricity**	**SSFCF for Grid Elec.**	**SSFCF for CHP DS**	**Total Source Energy**	**Source Energy EUI**	**kWh of Electricity Savings**	**Annual CO2 Emissions Savings** (Note 3)
	MMBTU	*MMBTU*	*MMBTU*	*kBtu/ SF*	*MMBTU*	*MMBTU*	*MMBTU*	*MMBTU*	*MMBTU*	*MMBTU*	*kBtu/SF*	*kWh*	*tons per year*
135 Broadway - Residential	12,217	7,426	49,826	**109**	7,723	10,580	1,637	4,928	12,279	17,207	**38**	3,100,721	1,716
145 Broadway - 11 CC Office	11,222	4,589	97,649	**222**	4,773	6,539	4,683	14,096	7,589	21,685	**49**	1,916,378	1,061
250 Binney - 14 CC Office	12,967	4,589	84,514	**186**	4,773	6,539	6,428	19,350	7,589	26,939	**59**	1,916,378	1,061

Note (1): DS Losses = 12%; Assumed gas boiler efficiency = 93% therefore DS load = Site gas *.93* 1.12 = 1.04 Site gas.

Note (2): Annual non-baseload output emission rates for NPCC New England: 1,106.82 lb of CO2 per MWH reduction in electricity use; from eGrid 9th edition Version 1.0 Year 2010 GHG Annual Output Emission Rates

The analysis has been expanded so it considers the CHP for both heating and cooling, using absorption chillers. Assuming an installation of absorption chillers with COP of approximately 0.7, meaning that it takes 17,140 Btu of steam to produce one ton-hour of cooling, and following the MEPA guidance the calculations were performed for both cooling and heating. The analysis shows that if steam is used to both heat and cool the building, the total source energy associated with 3 buildings would be reduced by approximately 87.8%. The generated electricity exceeds the projects' need and it is equivalent to 800 homes' energy use for one year.

	As-Proposed Energy Model				Mitigated With Optional Absorption Chillers Measure											Annual Savings	
Buildings	**A**	**B**	**C**		**D** B * 1.04	**E**	**F**	G A - E	H F*12/1000+D	I H * 1.37	J	**K** J * 3.01	**L** H * 1.59	**I** G + H			
	Site Electricity	**Site Gas**	**Total Source Energy**	**Source Energy EUI**	**Note 1**	**Space Cooling**	**Steam for Space Cooling**	**Site Electricity w/O cooling**	**CHP DS (Note 2)**	**Elec. Cogenerated**	**Grid Electricity**	**SSFCF for Grid Elec.**	**SSFCF for CHP DS**	**Total Source Energy**	**Source Energy EUI**	**kWh of Electricity Savings**	**Annual CO2 Emissions Savings**
	MMBTU	*MMBTU*	*MMBTU*	*kBtu/ SF*	*MMBTU*	*ton-hrs*	*kBtu*	*MMBTU*	*MMBTU*	*MMBTU*	*MMBTU*	*MBTU*	*MBTU*	*MBTU*	*kBtu/SF*	*kWh*	*tons per year*
135 Broadway - Residential	12,217	7,426	49,826	**109**	7,723	189,567	3,249,171	9,942	11,362	15,566	-5,623	-16,926	18,065	1,139	**2**	4,561,829	2,525
145 Broadway - 11 CC Office	11,222	4,589	97,649	**222**	4,773	131,359	2,251,493	9,646	7,295	9,994	-348	-1,047	11,598	10,551	**24**	2,928,844	1,621
250 Binney - 14 CC Office	12,967	4,589	84,514	**186**	4,773	134,964	2,313,277	11,348	7,364	10,088	1,259	3,791	11,709	15,499	**34**	2,956,628	1,636
									J * 1000 * 0.29307								
Total	36,407	16,605	231,989								-4,712			27,190		10,447,301	5,782

Note (1): DS Losses = 12% Ds distribution system losses.

Note (2): Negative numbers show that the CHP District can provide the total Site Electricity demanded by the project; so it's 100% savings.

Note (3): Annual non-baseload output emission rates for NPCC New England: 1,106.82 lb of CO2 per MWH reduction in electricity use; from eGrid 9th edition Version 1.0 Year 2010 GHG Annual Output Emission Rates