DEVELOPMENT OF AN AREA-WIDE DISTRICT HEATING SYSTEM BURLINGTON, VERMONT

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ABSTRACT

The University of Vermont, the City of Burlington, and the Fletcher Allen Healthcare group have teamed together to develop an area-wide district heating system using steam from a 50 MW local wood-fired cogeneration plant. This paper discusses technical issues, and the institutional and community issues associated with project development.

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INTRODUCTION

The City of Burlington, Vermont, located on the Eastern Shore of Lake Champlain, is Vermont's largest city with approximately 39,000 inhabitants. The City was chartered in 1763 and is noted for its historic district, the University of Vermont, and as a regional center for health care and financial services.

Since the early 1900's, city government has been actively involved in determining Burlington's energy future. In 1905, Burlington formed a municipal utility to reduce electric costs for city residents. Beginning with a modest start, the Burlington Electric Department has grown to be Vermont's largest municipally owned electric utility, serving almost 20,000 customers. The City's desire for reliable and environmentally friendly energy led to construction of the McNeil generating plant which was the world's largest wood burning plant when it was launched in 1984. Despite numerous challenges from investor-held electric utilities and the uncertainties of providing economical electricity supply from available resources in the Northeast, BED remains a strong and reliable electric energy supplier.

Burlington is an ideal candidate for a community energy system. Burlington's average winter temperature is approximately 29.4° F with approximately 8,300 heating degree days annually. The central business district is relatively compact within a twelve by eight block area, and major heat loads such as the University of Vermont and Fletcher Allen Healthcare Center are close by. A principal heat supply - the McNeil electric generating station - is located approximately 1.5 miles from the central business district. In addition to favorable technical characteristics, the Vermont community's interest in the environment and energy efficiency support consideration of district heating and cooling.

PROJECT HISTORY

Burlington's interest in community energy predates construction of the McNeil Station power plant in 1984. When McNeil Station was designed, a steam turbine with the capability of supplying community energy was specified and purchased. The interest in community energy has grown over the years and resulted in formal evaluations by the City and community during the past seven years. The studies included community energy evaluations prepared by Joseph Technology in 1994 and 1998, and a feasibility study prepared by Kattner/FVB Engineering in May of 1996. A validation study prepared by RDA Engineering was completed in December of 1998.

Throughout its history, McNeil Station has taken advantage of local wood resources to produce electricity for Burlington and the New England area. The economics of McNeil have been affected by alternative energy sources and the regional demand for electricity. The location of a major power

plant in close proximity to the City of Burlington and the neighboring Winooski community has also brought challenges. One concern of neighbors adjacent to McNeil has been fugitive dust emissions from the handling and storage of wood, as well as emissions from the wood-fired boilers. In the year 2000, the McNeil Partners addressed these issues by installing a new enclosure over the wood loading area and through aggressive management of the wood handling systems.

PROPOSED SYSTEM

Numerous technical options have been explored for interconnection of the UVM campus with McNeil Station. A steam line connection was chosen to provide the initial community energy leg which will take advantage of wood fuel and require the fewest modifications of the University of Vermont. (Figure 1) The system will consist of a high pressure steam main, condensate return piping, necessary thermal expansion devices and connections at the McNeil power station and University of Vermont central boiler plant. Steam will be delivered at a pressure of approximately 220 psig with condensate returned to McNeil Station. The majority of steam used by the University will be supplied from McNeil Station, however, stand-by and peaking steam will continue to be provided by the University of Vermont central energy plant.

In practical terms, steam will be purchased from McNeil Station and transferred to the University of Vermont through the system which will be developed and operated by the Burlington Electric Department. All required system upgrades, metering, and maintenance activities will be provided through the BED managed interconnection and amortized in the project financing. The initial cost of the project, interconnection of McNeil Station and UVM, is anticipated to be in the range of $7.5 million to $10 million. A large portion of this project will be financed with public funds since many of the environmental and economic benefits accrue to the greater Burlington community and society as a whole.

UVM supports the project given the following benefits are realized: that annual operating cost savings are achieved, future capital costs can be avoided and that the system is considered reliable.

PLANNED EXPANSIONS

Expansion to the Burlington community will initially include customers in close proximity to the University of Vermont. This will include the Fletcher Allen Healthcare system and their new facilities being constructed contiguous to UVM, nearby UVM buildings such as Waterman Hall, University Healthcare Building, Jeanne Mance Hall, and Dewey Hall, and the former Trinity College site. Longer-term development will extend west into the downtown and can include some of the Champlain College campus.

Another potential customer area is the redevelopment of the Winooski downtown. This development would include a thermal energy connection from McNeil Station to Winooski in conjunction with private development activities.

ENVIRONMENTAL BENEFITS

The Burlington Community Energy System will provide substantial environmental benefits to the region. If harvested sustainably, Vermont forests can provide a significant portion of the City's energy needs indefinitely, while providing environmental and economic benefits. Over twenty years ago, the benefits of wood fuel as a local renewable energy source were recognized by the Burlington community - the McNeil Station was designed and built to capture those benefits. The Burlington Community Energy System will enhance the efficiency of the McNeil Station by generating heat as well as power.

The use of biomass will greatly reduce the region's greenhouse gas emissions. By substituting fossil fuels in the form of natural gas and oil with wood chips, a biomass fuel, emissions of several pollutants are drastically reduced. Fossil fuels remove carbon that is stored underground and transfer it to the atmosphere producing a net increase in carbon dioxide (CO_2) emissions. CO_2 is a "greenhouse gas" that traps heat in the atmosphere, thus contributing to global warming. In a combustion system, biomass releases carbon dioxide as it burns, but biomass also needs CO_2 to grow -- thus creating a closed carbon cycle and no net increase in CO_2 emissions. Some reductions are also achieved in SO_2 (sulfur dioxide), CO (carbon monoxide), particulates and NO_x (nitrogen oxides) emissions. The table below provides a summary of the environmental impact of the Burlington Community Energy System in each phase and in total.

Table I
Phased Environmental Impact

Burlington Community Energy System - Avoided Emissions (Tons/yr)	**Phase I UVM District Htg (1)**	**Phase II FAHC, MCHV Campus (2)**	**Phase III Downtown CBD (3)**	**Phase IV Winooski (4)**	**BCES, Total of all Phases**
Annual Community Energy (MMBtu)	357,604	170,658	116,019	50,000	**694,281**
Emission Type					
Nox	33.1	16.6	10.7	4.6	**65.0**
SO2	24.3	12.1	7.9	3.4	**47.7**
Particulates	3.3	1.7	1.1	0.5	**6.5**
CO	8.3	4.2	2.7	1.2	**16.3**
CO2	29,349	14,519	9,521.8	4,104	**57,493**
VOC	1.3	0.7	0.4	0.2	**2.6**
Total (Tons/yr)	29,419	14,554	9,545	4,113	**57,631**

(1) Includes Health Science Research, UHC, Waterman, Dewey
(2) MCHV campus with build out
(3) From Kattner/FVB Study, Case 4 - Emissions derived using 1998 JTC study.
(4) Winoosky Redevelopment Project, complete scope - Emissions derived using 1998 JTC study

The reductions in emissions have a desirable effect on the environment which extends beyond greater Burlington and benefits all of society. One widely accepted method to assign a value to environmental benefits is to apply externality costs to each emission type. Externalities are benefits or costs resulting as an unintended byproduct of an economic activity that accrue to someone other than the parties involved in the activity. Median externality costs were researched for each pollutant and applied over a twenty year time period. When all phases are complete the total economic benefit of these avoided externality costs is $1.7 million per year. The twenty year net present value of the emissions reduction is almost $21 million.

BARRIERS TO DEVELOPMENT

Despite the positive climate and interest in community energy development, several formidable barriers have presented themselves throughout the evaluation process. Probably the greatest barrier to implementation is the uncertainty of fuel prices. For the University of Vermont, oil is the benchmark for energy price with natural gas as substitute fuel. Over the past ten years oil prices have varied widely sending mixed signals as to future cost and availability. Wood price has remained relatively stable, however, the specter of oil and natural gas price dropping below the equivalent wood price for significant periods of time have prevented the University of Vermont from committing to a long-term energy supply contract with a large fixed capital component.

A second major barrier has been the desire of the University to remain independent of a community based energy system. The University staff does not trust outside energy suppliers to reliably provide heating for the campus and is reluctant to give up control of its central plant facilities.

Third, it has been extremely difficult to quantify direct benefits of a community energy system for each of the customers and the City as an energy system developer. From a monetary standpoint, the University receives reimbursement for energy use and capital expenses associated with its central plant and distribution system. Cost savings do not immediately accrue to the University utilities department, and the central utility is not run as a profit center. Thus, the risk associated with future fuel costs and savings associated with a stable energy supply are not reflected in an operating cost budget.

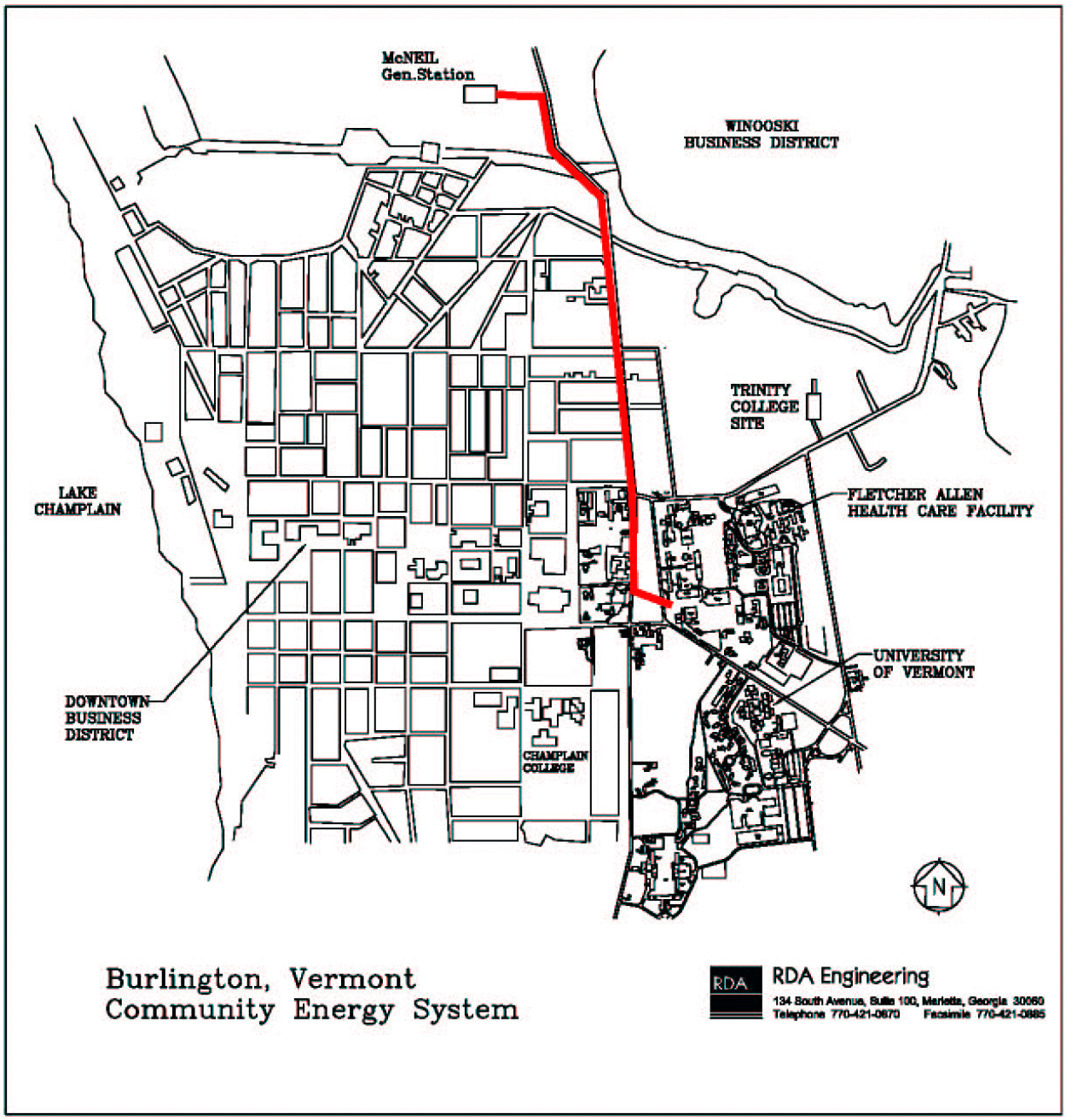
One of the major benefits of the community energy system is environmental. Unfortunately, there is almost no way to quantify bottomline dollar benefits to the University, Fletcher Allen and even the community due to reduced emissions and support of the local wood economy. For that reason, grant funding is being sought since the entire community benefits from the project.

A fourth barrier could be considered a lack of urgency to implement the project. At this time, fuel is available and there are no overriding financial or regulatory concerns which make implementation of the project an immediate need. Thus, each major customer and the City can continue on their current development and operating paths without the need to integrate their energy planning. Without a national policy directive supporting reduction of greenhouse emissions, the benefits of a renewable source community energy system envisioned in Burlington are not given high priority.

IMPLEMENTATION

Subsequent meetings between the UVM staff and Burlington Electric Department have resulted in general agreement as to how the project should proceed. On October 19, 2001 the UVM Board of Trustee's passed the Community Energy Support Resolution supporting the project and joint efforts to seek federal and other funding.

Figure 1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Gen.Station
WINOOSKI
BUSINESS DISTRICT
TRINITY
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