

APPLICATION OF THERMAL ENERGY STORAGE TO PROCESS HEAT  
RECOVERY IN THE ALUMINUM INDUSTRY

John McCabe  
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PROJECT OUTLINE

Project Title: Aluminum Waste Heat for Bellingham District Heating

Principal Investigator: John McCabe

Organization: Rocket Research Company  
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Redmond, WA 98052  
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Project Goals: Assess the economic viability and public acceptance of a district heating system in Bellingham, Washington

Conduct a review of the technological impact on the Itarco aluminum plant.

Evaluate other thermal energy sources for back-up.

Evaluate institutional considerations.

Perform a detailed system cost analysis.

Project Status: All tasks are proceeding on schedule with no significant results to date.

Contract Number: 86Y-4253C

Contract Period: April, 1979 to September, 1980

Funding Level: \$1,000,000

Funding Source: ORNL

## PROJECT SUMMARY

ORGANIZATION: Rocket Research Company - Prime Contract  
Subcontractors to RRC:

Trans Energy Systems - District Heating  
System Installation  
Ekono Oy - District Heating System Design  
Martin-Simonds Associates - Community  
Relations Consultants  
Bechtel Corporation - A & E Consultant for  
Intalco Plant

ADDRESS: York Center  
Redmond, Washington 98052

PROJECT TITLE: Application of Thermal Energy Storage to Process  
Heat and Waste Heat Recovery in the Aluminum  
Industry

PROJECT MANAGER: J. E. McCabe TELEPHONE NO.: (206) 885-5000

CONTRACT NO.: 86Y4253C CONTRACT PERIOD: 4/1/79 - 9/30/80

CONTRACT AMOUNT: \$1,014,653

### PROJECT GOALS:

The goals of this project are to assess the economic viability and the institutional compatability of a district heating system in the city of Bellingham, Washington, and to determine the technical and economic advantages of using thermal energy storage methods.

### PROJECT STATUS:

The project is currently in the ninth month of an eighteen month program. The waste heat streams at the aluminum plant that will provide the energy for the district heating system have been characterized and the energy demand of the district heating system service area has been defined. A comparative evaluation of the technical and economic features of three thermal energy storage methods will be initiated this month. Energy storage, in the form of hot water, will allow greater use of the constant energy supply by the variable energy demand. The thermal storage methods to be evaluated include: 1) a confined aquifer, 2) an abandoned coal mine located beneath the city of Bellingham, and 3) an above ground, insulated metallic tank.

## I. PURPOSE

This project is directed toward determining the economic viability and institutional compatibility of a district heating system that uses waste heat from an aluminum plant as the source of thermal energy. The project has been designed to show how existing energy storage techniques can enhance the utility of low temperature waste streams. This project will provide technical and economic comparisons of energy storage in confined aquifers, in an abandoned coal mine, and in above-ground, insulated, metallic storage tanks.

## II. BACKGROUND

Under a Department of Energy (DOE) Contract, Rocket Research Company has investigated the use of aluminum process reject heat as a source of energy for large scale district heating. During Phase I of a multi-phased program, RRC conducted a preliminary evaluation of a district heating network for the City of Bellingham, Washington, with reject heat recovered from the Intalco Aluminum Corporation plant located in Ferndale, Washington. The baseline District Heating System is a network of closed-loop hot water pipes that recover energy at approximately 250°F from the fume hood ducts at Intalco and transmits the energy to a relatively high density commercial/residential population center for space and hot water heating. Results of the tradeoff studies conducted during Phase I show that the District Heating System concept is both technically and economically attractive because the system design concept is based on existing technology and implementation of the concept will be economically competitive with existing systems using conventional fossil fuels.

RRC estimates that approximately 40 percent of the low quality heat generated at Intalco which is presently unuseable, could be effectively applied to space and hot water heating in the city of Bellingham by means of a district heating system to serve as many as 20,000 residences and commercial buildings. If this energy recovery was realized from all of the nations' aluminum plants, a savings equivalent to six to eleven million barrels of oil could be realized annually. By the year 2000, the cost of this energy is projected to be about one quarter that of conventional energy sources.

Because the viability of a District Heating System in Bellingham is largely dependant on cost and institutional considerations, Phase II of the program is presently addressing these areas so that the necessary level of confidence can be established prior to a major commitment of funds. As part of this Phase II effort, RRC is also conducting the following technical and economic evaluations:

- 1) seasonal storage of hot water in an abandoned coal mine below the city of Bellingham and in confined aquifers,
- 2) integration of waste energy streams from nine local facilities (oil refineries, wood and paper mill, cement plant, etc.) with the District Heating System,
- 3) determining the impact on the Intalco facility when it is integrated with the District Heating System, and,
- 4) assessment of the state of development of district heating system equipment.

### III. PROJECT DESCRIPTION

The project has been organized into five major tasks. These tasks are described in the following paragraphs.

Task I is a marketing analysis effort which is directed toward characterizing the potential market in terms of energy demand, peak loads, scope of system conversions required, etc., and an assessment of the rate at which subscribers will join the utility.

Task II is a technology review that is concerned with three specific areas: 1) the impact on the Intalco facility when it is integrated with the district heating system, 2) the technical and economic comparison of hot water storage in confined aquifers, in an abandoned coal mine and in metallic, insulated tanks, and 3) an assessment of the technological status of district heating system equipment.

Task III will evaluate the feasibility of utilizing energy waste streams from 9 facilities in the area (2 oil refineries, a paper mill, cement plant, etc.) to increase and/or supplement the energy capability of the district heating system.

Task IV is concerned with the legal, political and social constraints that collectively are referred to as institutional considerations. Included will be evaluation of the various public and private entities that can own, market, store, sell, distribute, and manage a district heating utility. Items to be considered in the evaluation include: financing, taxation, regulations and permits, rate making, environmental considerations, right of way acquisition, contracts with energy supplier and user, impact on existing utilities, and DHS liability.

Task V, the system cost analysis effort, will definitize the design of the district heating system to the level which will permit a

detailed cost estimate to be made for building and operating the system. Evaluations will then be made of the different ownership structures and the financing options available to each ownership structure. System design and operating information, construction schedules, ownership and financing options will all be included in computer programs that will permit the sensitivity evaluation of all technical and economic factors so that the program can be optimized for various criteria, i.e., minimum rate to consumer.

#### IV. RESULTS

The project is currently in the ninth month of an 18-month program. The Marketing Analysis Task is nearing completion with the energy demand surveys and conversion cost studies more than 90% complete. The Community Advisory Group will continue to meet every month to discuss issues of concern. For the Technology Review task the effort concerned with determining the impact on the Intalco facility when it is integrated with the district heating system has been completed. The part of the Technology Review Task associated with evaluating aquifer storage and the use of an abandoned coal mine as an aquifer versus the use of metallic tanks is now being initiated. An evaluation study has been conducted for the heat exchanger to be installed in the ducts at Intalco and testing of a simulated heat exchanger element to assess fouling rates has been initiated. The task to evaluate the use of waste streams from alternate energy sources is in the initial phase with the only activity being the coordination meetings held with each of the 9 candidates. The Institutional Considerations task is an active phase of the program. Meetings have been held with the Washington State Utilities and Transportation Commission concerning regulations that are applicable to a district heating system and there has been a series of meetings with bond underwriters, bond counsel and management consultants to discuss financing options. Additional activities involve the analysis of legal authority, discussions of environmental impact permits with city and county planners and with the State Department of Ecology, right-of-way acquisition and construction impacts. The System Cost Analysis task is in the initial stage. A preliminary system design phase has been completed as a basis for providing a preliminary cost of energy.

#### V. FUTURE ACTIVITIES

Effort will continue on each of the five tasks during the coming months. The marketing analysis task will be reduced considerably -- the effort remaining involves support of the Community Advisory Group in Bellingham and preparation of the Market Analysis Report.