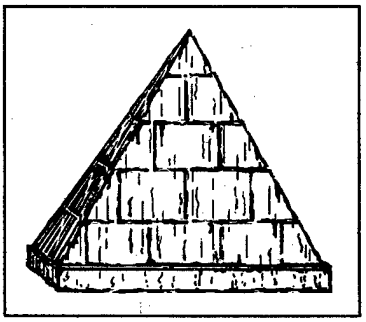

EEAP in Europe
USMCA
Karlsruhe

Contract DACA-90-C-0083

Volume I
Executive Summary

prepared by
Sverdrup & Parcel and Associates, Inc.
and
Gehrmann Consult, GmbH

DEPARTMENT OF THE ARMY
CONSTRUCTION ENGINEERING RESEARCH LABORATORIES, CORPS OF ENGINEERS
P.O. BOX 9005
CHAMPAIGN, ILLINOIS 61826-9005

REPLY TO
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Marie Wakefield,
Librarian Engineering

Letter 7243-P87
9 May 1983

Mr. Dale Bickenbach
EUDED-SE
U.S. Army Engineer Division, Europe
APO New York 09757

Dear Mr. Bickenbach:

We are happy to submit this Prefinal Report for the Energy Engineering Analysis Program for USMCA Karlsruhe. Volume IV, Survey Data, has already been forwarded to you.

This submittal makes use of the covers and text already in your possession. Please discard the entire contents of Volume I, Executive Summary, and substitute the new Executive Summary pages. Please discard the entire contents of Volume II, Energy Engineering Analysis Report, and substitute the new Volume II pages.

Please discard the following pages of Volume III and replace them with the noted substitutes.

Discard	Substitute
Title Page	Title Page
Table of Contents i and ii	Table of Contents i and ii
45-46	45-46
85-86	85-86
91-94	91-94
153-154	153-154
165-178	165-178
197-200	197-200
269-270	269-270
283-348	283-348
371-372	371-372
409-410	409-410
415-416	415-416
503-510	503-510
531-532	531-532
553-end	553-end

A new Volume V, Recommended Community Energy Management Plan, has been included in this submittal.

EUDED-SE 28 Feb 83

MEMORANDUM FOR RECORD

SUBJECT: EEAP Meeting on 4 Feb 83, Package No. 1, Contract No. DACA90-80-C-0083 for Vicenza, Livorno, and Karlsruhe, Germany at Sverdrup & Parcel, St Louis, Missouri

Attendees	Organization	Phone
Phil Brown	Huntsville OCE	(205) 895-5530
W. E. Brewer	Huntsville OCE	(205) 895-5480
James O'Malley	EUD Technical Cooridinator	(0611) 151-8111
Dale Bickenbach	EUD Project Manager	(0611) 151-5421
Jim Schmalz	S&P, Project Manager	(314) 436-7600
Bryan Robb	S&P, Spec Project Manager	(314) 436-7600
Doug Fitts	S&P, Project Engineer	(314) 436-7600
Michael Mundy	S&P, Chief Engineer	(314) 436-7600
George Thomas	S&P, Int Proj Manager	(314) 436-7600
Dick Beumer	S&P, President	(314) 436-7600

1. The meeting on 4 Feb 83 was started at approximately 0830 in the morning. Mr. O'Malley discussed the Energy Engineering Analysis Program Study for Karlsruhe Military Community, Volume 3 Appendixes. Starting on page 86, Mr. O'Malley went through the Appendixes and noted problems. This memo is a brief summation of that discussion. It is considered to be rough notes and not a complete transcript of the meeting.

2. Page 86 - It was discussed that Sverdrup & Parcel should use the fuel factors given in the ECIP guidance.

3. Page 91 - Reguested that paragraph 2 be reworked.

4. Page 92 - Electrical cost analyses shoud be reworked.

5. Page 93 - Description should be given of the high and low electrical tariffs for the utilization rebate. A complete analysis should be provided.

6. Page 101 to 103 - Problems are created here by the lack of data documentation. Also, "U" values on page 101 were somewhat difficult to believe.

7. Page 143 - The table on the top of the page entitled, "A Zone No. 23" has a footnote (2) for the U value that needs clarification. It is not clear were that footnote is referred to in the report.

8. Pages 166 to 172 - The different scales used in the chart are somewhat confusing when they do not start at zero. There should be some way provided to notify the reader of this. Clarification of these charts to make them simpler and less confusing should be provided in the report.

9. Page 197 - This is Appendix C-7, Community Generated Energy Conservation Projects. There was discussion as to whether paragraph 2, Part A which states Gerszewski Barracks should be really Smiley Barracks or not. For paragraph 3 it is requested that more detail be given to describing the buildings used for the building survey.

10. Page 198 - A recommendation should be made here and that recommmedation should be moved to the front of the report.

11. Page 284 - Provide a more specific recommendation.

12. Page 285 - Some discussion should be provided as to what happens with the building zone values and how this relates to section appendix E-3, also leave out non-engineering judgements and provide more technical backup.

13. Page 289 - More analysis and less general discussion is needed; provide your judgements after the analytical discussion.

14. Page 291 - The comments on this is the same as the comments on the previous two Appendixes E-2 and E-3 that more technical material and analysis are needed.

15. Page 293 - A quotation of four hundred dollars is there; provide the source of that quotation. On the last part of that page a plan should be recommended.

16. Page 295 - Consider moving this appendix to Increment F. It is not clear how this relates to supporting technical material.

17. Appendix E-6 is considered to be a good example of technical supporting material.

18. Page 301 - Provide your source as to where the 6.9 miles per hour wind velocity came from.

19. Page 302 - The six persons per room seems rather high; clarifiy this number as to its validity.

20. Page 303 - It is a possiblity that the calculation here is wrong. 607 feet per minute does not equal .25 meters per minute, provide clarification.

21. Page 304 - There are no conclusions with this chart as it is presented alone. Some analysis, comments, and discussions are needed.

22. Page 307 - Appendix E-9, Building Envelope Changes, same problem as before. ECO's are judged before analysis is done based on poor operational procedures. This should be clarified and each ECO considered alone.

23. Page 311 - Clarify your discussion and provide more detail.

24. Page 313 - The calculation provided here was not clear and there is some question as to its accuracy. Check this calculation and explain the analysis.

25. Page 314 - Table E 9.7, recheck your fuel cost although it appears to be right.

26. Page 329 - Engines on the last third of the page is apparently misspelled.

27. Page 330 - The savings listed in Table E-11.1, please check these as they may be off by a factor of a ten.

28. Page 357 - The profiles of fuel and electricity should be reevaluated and then justified with complete data and analyses.

29. Page 321 - For EMCS a document must be provided that clearly analyizes whether a feasibility study is practical. Give a price, lay out a plan with a diagram and provide a cost analysis with referenced sources. Use backup documentation from BLAST for this analysis. Only use the surveyed buildings for your analysis, no backup or user controls will be changed, no Government lines or equipment will be used in the cost analysis. The savings/costs and control functions will be extrapolated to the entire community.

30. Concluding the review of the Karlsruhe submittal it was pointed out that these general comments on Karlsruhe pertain to all the communities. In the period left review was given to the Vicenza and Livorno reports. Concerning Vicenza, more documentation and justification for the analysis is required. Sverdrup & Parcel should list the projects and energy savings of those projects that are known to be in place. The report must be based on accurate

EUDED-SE
SUBJECT: EEAP Meeting on 4 Feb 83, Package No. 1, Contract No. DACA90-80-C-0083 for Vicenza, Livorno, and Karlsruhe, Germany at Sverdrup & Parcel, St Louis, Missouri

and adequate documentation. It is not the responsibilty of the contractor to worry about the political ramifications of the their analysis. Also for Livorno, the same comments apply as to Karlsruhe and Vicenza.

31. All pages should be numbered, and all review comments should be answered even if only to say the answer will be provided based on the discussions of the 3 and 4 Feb at Sverdrup & Parcel. Submit all three communities as a prefinal with front page 1391 documentation. At conclusion of these discussions it is agreed that EUD will modifiy Increment B at no cost to the Government to take out a portion which says, "all buildings" and to replace this to include only the surveyed buildings as specified by the Schedule of Services. The contract will possibily be modified to comply with the latest ECIP guidance.

Dale N. BICKENBACH
Project Manager

CF:
Sverdrup & Parcel, 801 N. Eleventh, St. Louis, Missouri 63101
OCE, ATTN: DAEN-MPE-E (Mr. Joe McCarty), Washington, DC 20314
Huntsville, ATTN: HNDED-PM (Mr. Phil Brown), PO Box 1600, Huntsville, Alabama 35807
EUDED-SF (Files)
EUDED-TM (O'Malley)

Enclosure 2

Responses to EUDED-SE Memorandum for Record of 28 February 1983

Comment 2: Fuel factors given in the ECIP guidance have been used.

Comments 3, 4, and 5: Appendix B-5, Electrical Billing Procedures, has been clarified.

Comment 6: Backup data has been submitted as Volume IV, Survey Data; a more comprehensive explanation of method has been inserted in Volume II. The "U" values in question are those calculated by BLAST for the constructions involved; BLAST does not report the normally-included film coefficients as part of the construction since it calculates them hour-by-hour during the LOADS run.

Comment 7: Footnotes are on page 149, at the end of the special zones.

Comment 8: A note calling attention to the truncated vertical scale has been added where appropriate. Explanatory texts have been added on pages 165 and 173.

Comments 9 and 10: Appendix C-7, Community-Generated Energy Conservation Projects, has been redone.

Comment 11: A more specific recommendation has been made in Volume II, Analysis, and Volume V, Recommended Community Energy Management Plan.

Comment 12: Appendix E-2, Building Zone Valves, has been deleted. Still-relevant information has been inserted in Volume II and Volume V.

Comment 13: Appendix E-3, Thermostatically Controlled Individual Radiator Valves, has been deleted. Still-relevant information has been inserted in Volume II and Volume V.

Comments 14 and 15: Appendix E-4, Boiler Plant Modernization, has been deleted. Still relevant information has been incorporated into Volume II and Volume V.

Comments 16 and 17: Appendix E-5, Conservation Ramifications of Electrical ECOs, has been deleted. Still-relevant information has been incorporated into Volume II and Volume V.

Comment 18: Appendix E-7, Analysis of Weatherstripping, has been redesignated E-3 and now occurs on page 289. The citation "per TM5-785" has been made for the wind velocity, which is given more comprehensive treatment in Appendix B-1, Weather Data.

Comment 19: Six persons per room is not uncommon for administrative offices or work spaces.

Comment 20: Appendix E-8, Vestibules, has been deleted.

Comment 21: The chart in question found no application for the Karlsruhe community; it has been deleted.

Comments 22, 23, and 24: Appendix E-9, Building Envelope Changes, has been redesignated E-8 and now starts on page 317. The conditions assumed and the calculations required have been more clearly explained.

Comment 25: The fuel cost figures given in Table E-9.7 (now E-8.8) agree with those given in the C appendices and were those in effect during the Phase I work in January 1981.

Comments 26 and 27: This discussion has been moved to Volume II.

Comment 28: The source and intended function of these fuel and electricity profiles has been more fully explained in Chapter III of Volume II. We believe they are valid as they stand.

Comment 29: An EMCS analysis in accordance with the criteria in TM5-815-2 and the cost estimating guidelines in HNDSP 83-049-ED-ME has been prepared and has been included as Appendix E-6 starting on page 299 of Volume III.

Comment 30: Vicenza and Livorno specific responses have been included in the letters of compliance for those communities.

Comment 31: All pages have been numbered and headed "Final Report" for this Prefinal Submittal.

April 6, 1983

EUMED-SE

Sverdrup & Parcel
ATTN: Mr. James A. Schmalz
801 North 11th Street
St. Louis, Missouri 63101

Dear Mr. Schmalz:

As requested by your letter of 10 March 83 your submittal has been reviewed by our Technical Branch. The review comments are enclosed having been discussed by our phone conversation of 1 April. As stated during the 1 April call, we expect a pre-final submittal for the Karlsruhe, Vicenza, and Livorno military communities to be submitted by 29 April 1983. Tentatively a presentation will be scheduled for the second week in June.

It is expected that your pre-final submittal will incorporate the review comments discussed during our meeting of 3-4 February 1983. Notes of the meetings have been sent by seperate letter. As previously stated the notes are not to be considered a complete transcript of those meetings. Your submittal will be technically reviewed upon receipt. If you have further question please contact me at 0611-151-5421.

Sincerely,

Dale N. Eichenbach
Project Manager
Engineering Systems Planning Section

PROJECT

REVIEWING ELEMENT EUDED-TX

REVIEWER Wiggleton DATE April 83

REFERENCE	CMT NO	COMMENT	ACTION
GEN.	1.	What has been submitted looks like they are "heading" in the right direction. This does not Mean an 'approval' as a submittal.	
	2.	Table of Contents FOR Vol II. SECTION VI LIST WHAT WAS EVALUATED - THEN why rejected or accepted.	
	3.	Example B For the Prefinal it is all right to include references to paragraphs IN the SOS - but remove them from the final.	
	4.	page 7 - last paragraph "Having reduced the proable diversity to presumably minor deviations from 14 standard building types," Should this be "average"? - Explain	

* indicates Value Engineering Comment

DESIGN REVIEW CO...

PROJECT
EEPP NO. 1

REFERENCE	ITEM NO	COMMENT	ACTION

5. page 11 - next to last paragraph last sentence.

Will this be rewritten for the Italian sites?

"This time saving step had no effect on loads calculated by BLAST for the average buildings, since winter time solar gain is so small in Germany."

Page 13

6. Middle of page "BLAST's software will not acknowledge summer conditions heating a building above its winter indoor temps."

What about the command HEATING OFF!?

7. page 17 - next to last paragraph What are you trying to say with the last sentence?

"This rescaling and adjusting is the primary reason why no valid conclusion can be drawn from the "average" building

REFERENCE | COMMENT NO. | COMMENT | ACTION

models on Fair design day result given in Appendix C-1.

8. page 22 Top paragraph
Can more information be provided for the statement in the first paragraph?
Info on the graphs/equations and where they obtained the data for the equations.

9. page 25
Expand on the adjustments incorporated into the program.
Be specific; How did you get the results to where you wanted them.

10. page 26 The TABLE
Explain the +17.9, -25.8, -31.9% mismatches.

See P.12

Indicates Value Engineer Comment

DESIGN REVIEW COMMENTS - CONT

PROJECT CEAP NO. 1

REFERENCE	COMT NO.	COMMENT	ACTION
	11.	Example C sheet 3 of 4 P B.1.a Show where: "the calculated plant efficiency and calculated yearly consumption" values are derived and it doesn't have to be in this section.	
	12.	Volume 5 - foot note 2 Section VII of Vol 2 is Energy Conservation Projects this is not consistant with the title.	

Indicates Value Engineer Comment

Enclosure 3

Responses to EUDED-TM (Mr. Hazelton) Comments on 10 March 1983 Submittal

Comment 1: The 10 March submittal has been incorporated into Volume II, Energy Engineering Analysis Report, with the revisions noted below. It serves to tie together many portions of the study whose relationship has heretofore been obscure. Taken as a whole, the EEAP studies should be much more usable documents.

Comment 2: The treatment of ECO's assessed has been revised.

Comment 3: Scope of work paragraph references have been removed in that part of the 10 March submittal incorporated into the Prefinal.

Comment 4: The word "standard" has been changed to "composite" per agreement during the telecon of 2 April 1983.

Comment 5: The submitted narrative will be site-specific for each community.

Comment 6: In all honesty, does the complexity of the remainder of the BLAST narrative leave the reviewer with the impression that we would have discovered such a problem and been kind enough to point it and its hard-won solution out if the simple, obvious, unresearched step would have sufficed?

Comment 7: The statement is misleading if inferred to mean the "average" buildings have no utility. Average building loads are used in several analyses, specifically the building envelope changes described in Appendix E-8, but is not possible to say "Because of such and such a feature, thus and so should be done to all type X buildings." Classification into and extrapolating from building types is a powerful tool for large-scale energy studies but is not a result in itself.

Comment 8: Graphs of part load vs. boiler efficiency have been incorporated into Sub-appendix F-4.4, Plant Type Models.

Comment 9: Specific adjustments were incorporated into the BLAST runs by modeling additional zones. This list of zones in the narrative represent all of those adjustments.

Comment 10: Reasons or justifications for mismatches between BLAST calculations and actual consumptions are found in the installation summaries in Chapter VI of Volume II.

Comment 11: The "calculated plant efficiency and the calculated yearly consumption" are BLAST program outputs. No hand calculation was involved.

Comment 12: The misunderstanding prompting this comment was cleared up during the 2 April telecon.

DEPARTMENT OF THE ARMY
CONSTRUCTION ENGINEERING RESEARCH LABORATORIES, CORPS OF ENGINEERS
P.O. BOX 9005
CHAMPAIGN, ILLINOIS 61826-9005

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Marie Wakefield,
Librarian Engineering

The contents of Volume II have been extensively revised, and two volumes, IV and V are new. We have tried to meet the general comments brought out in the past year of submittal and review. Enclosures 1, 2, and 3 describe the specific actions taken in response to your written comments from the 3-4 February 1983 meeting here in St. Louis and on Mr. Hazelton's review of our 10 March submittal.

We hope to have the Italian reports in your hands before too long. We also look forward to a review in Frankfurt in mid-June.

Sincerely,

SVERDRUP & PARCEL AND ASSOCIATES, Inc.

James A. Schmalz
Project Manager

Enclosures

cc: U.S. Army Engineer Division, Huntsville
P.O. Box 1600
Huntsville, Alabama 35807
Attn: Mr. Phil Brown

FINAL REPORT

Contract DACA90-80-C-0083
Energy Engineering Analysis Program in Europe
Karlsruhe Military Community

Volume I
Executive Summary

prepared by

SVERDRUP & PARCEL AND ASSOCIATES, Inc.
St. Louis, Missouri
and
Gehrmann Consult, GmbH
Wiesbaden, West Germany

29 April 1983

TABLE OF CONTENTS

Volume I - EXECUTIVE SUMMARY

TABLE OF CONTENTS (continued)

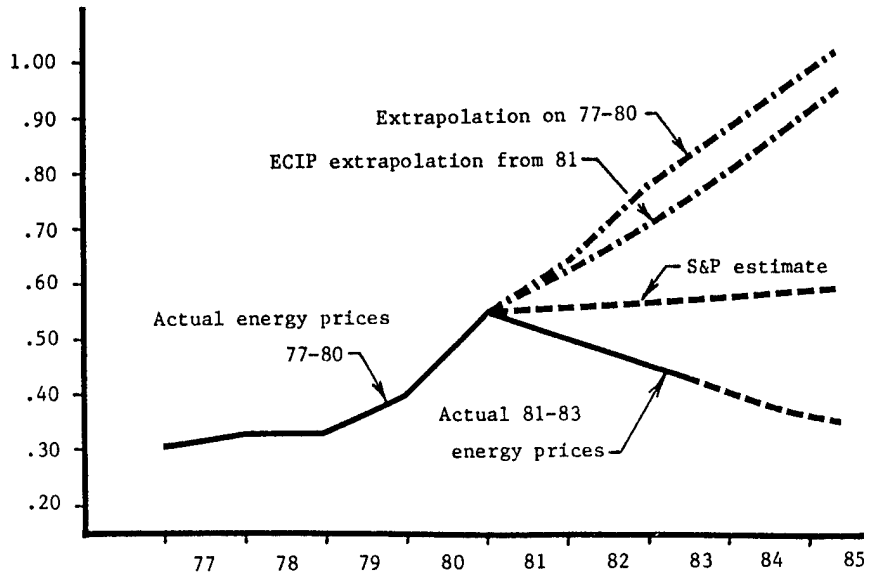
I. INTRODUCTION

A. Abstract

This Energy Engineering Analysis Program (EEAP) study analyzes the energy consumption on 11 USMCA Karlsruhe installations for calendar year 1980, identifies the areas of energy waste, and recommends several energy conserving actions and projects. The field work spanned from January to August of 1981. Techniques employed in the analysis and assessment include forecasting of European energy prices and of Karlsruhe's population growth, the BLAST computer program, a weather tape transcription program, and a mathematical model of equipment failure that assesses the risk inherent in retaining old equipment. The study identified no effective energy-saving measures affecting buildings (Increment A); significant waste was traced to boiler operations and to the lack of centralization. No non-essential electrical loads were identified. Nearly $8 million in funded projects have been recommended, and project documents have been prepared for $8.4 million more. When the recommended projects and non-funded maintenance and operation actions are implemented, energy consumption will fall by 23.7% of 1975 levels and expenditures by 20.4% of 1980 levels in real dollars. They will produce annual savings of 179.7×10^9 Btu and $1,678,400; recommended projects will pay off in 4.7 years.

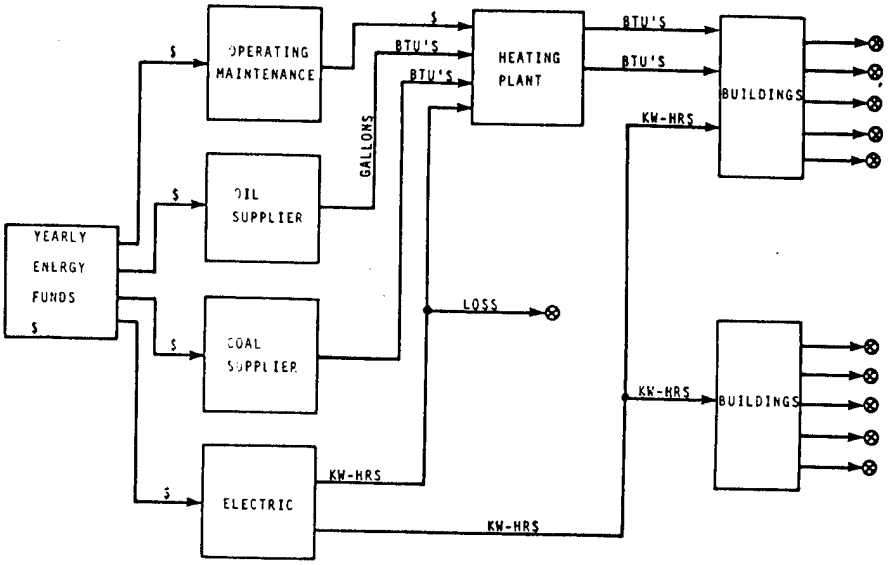
B. Results and Conclusions

- We foresaw in May of 1981 that neither an extrapolation of 1977-80 energy prices nor the ECIP escalators would properly forecast energy prices in the 80's but instead that the worldwide recession, growing conservation ethic, and integration of oil-producing countries into the global economy would hold energy prices to a 2% growth in real terms. As shown below, our predictions have matched events more closely than other methods. Falling energy prices mean funded projects cannot generate revenue, and our recommendations reflect this.



ENERGY PRICES EXTRAPOLATION

- Results of a BLAST analysis able to model the response of central heating plants have been presented on Input-Output diagrams for each installation. These diagrams show the flow of energy-related expenditures through their transformations from funds to fuel consumed to energy use to ultimate losses. Close study of these diagrams of energy use is recommended before possibly ill-considered projects are attempted.



- Community efforts had saved 1.0% of FY1975 energy use at the start of the study.
- Management of coal before it reaches Karlsruhe should be improved. Several recommendations are made.
- Boiler operating procedures and the supervision of boiler operators should be improved. Several recommendations are made.
- A planned maintenance program should be instituted for all utility and heating equipment.
- If one becomes available, as many buildings as possible should be connected to a district heating system. Connecting Paul Revere Village and parts of the Shopping Center and Smiley Barracks will cost $2.4 million for secondary distribution but save $3.1 million annually. Necessary capital expenditures could be regained in 3 years if purchased energy cost as much as $13 per million Btu, twice its forecast value. In all probability, purchased energy will cost less than $10 per million Btu, making district heating even more attractive.
- No effective energy-savings projects involving modifying, improving, or retrofitting existing buildings (Increment A) have been indentified. Mild temperatures, low wind velocities, and lack of mechanical ventilation work against weatherstripping. Only two of 94 building envelope changes investigated had B/C ratios great than 1.0 and these involved only eight of the 458 heated building.
- In accordance with discussions at the Preliminary Presentation, no new consoldiated heating plants (Increment E) have been recommended. Analysis of a consolidation plan for Gerszewski Kaserne confirms this early assessment.
- The BLAST models indicate 40% of the coal delivered to Paul Revere Village and 32% of the fuel oil delivered to Neureut Labor Service Kaserne are lost, even after all heating plant, distribution systems, and building losses are accounted for. Rectifying actions and projects have been recommended.

- The most plausible and cost-effective EMCS for Karlsruhe costs $7.6 million to install, $210,000 annually to maintain, and saves $82,000 net per year. Its cost/benefit ratio is .1 and its simple payback is 92 years. EMCS is not recommended.
- A load shedding system for Smiley Barracks, the installation with the highest demand charge penalty ($3,442) in 1980, costs $370,000 to purchase and install and $6,800 annually to maintain. Unless the existing billing structure can be changed, load shedding runs at a net loss of $3,300 per year. Renegotiation might result in annual savings of $3,400, where the projects B/C ratio would be .09 and its simple payback 111 years. Load shedding is not recommended.
- Energy-efficient electric motors are recommended as replacement equipment in accordance with a schedule of operating times based on motor size and Karlsruhe's marginal electrical energy cost.
- Proposed new buildings through 1986 will have no impact on energy conservation. No recommendations are made concerning them.
- Future construction should be in accordance with the ASHRAE Standard for Energy Conservation in New Building Design with minor changes recommended herein.

II. ENERGY CONSUMPTION

A. FY75 Energy Consumption

- Energy consumed on each of the 11 study installations is compared with FY80 consumption below. The degree of conservation achieved is also shown.

FY75 AND FY80 ENERGY CONSUMPTION

USMCA KARLSRUHE

(10^9 Btu)

Installation	FY75	FY80	% Change (Conservation is Negative)
Gerszewski	130.1	159.5	+ 22.6
Neureut U.S.	187.5	188.3	+ .4
Thomas Nast	6.3	6.3	---
Pforzheim M.S.	3.7	3.7	---
Germersheim	158.6	151.6	- 4.4
Paul Revere Village	363.4	337.6	- 7.1
Rheinland	82.6	89.7	+ 8.6
Shopping Center	56.9	46.7	- 17.9
Smiley	50.5	50.5	---
Neureut L.S. *	---	---	---
Pforzheim F.H.	21.9	17.0	- 18.7
Totals	1061.5	1050.9	- 1.0

* included in Neureut U.S.

- The data show significant savings on family housing areas and the service-oriented shopping center, the results of conservation effots there.
- The simultaneous increases on Gerszewski and Rheinland must have resulted from population or mission changes that predate the study, since no conditions were discovered to account for this discrepancy.

B. Energy Consumption by Energy Source

- Calendar year 1980 (CY1980) energy consumption by source is shown below.

ENERGY CONSUMPTION BY SOURCE, CY1980

USMCA KARLSRUHE

Source	Amount	Energy	Cost
Electric Energy	32.7 x 10^6 kWhr	111.8 x 10^9 Btu	$1,542,600
Electric Demand	-----	-----	549,200
#2 Fuel Oil	1,874,000 gal.	254.6 x 10^9 Btu	1,687,300
#6 Fuel Oil	1,816,850 gal.	273.8 x 10^9 Btu	1,212,900
Coal	14,044 Metric Tons	410.4 x 10^9 Btu	1,394,300
Totals		1050.6 x 10^9 Btu	$6,386,300

C. Energy Consumption by Installation

- Calendar year 1980 (CY1980) energy consumption by installation is shown below.
- Area, Cost, Unit Energy Use, and Unit Energy Cost is also shown below.

ENERGY CONSUMPTION BY INSTALLATION, CY1980

USMCA KARLSRUHE

Location	Area (ft^2)	Energy (10^9 Btu)	Unit Use (Btu/ft^2)	Cost ($)	Unit Cost ($/$ft^2$)
Gerszewski	749,300	159.5	213,000	1,311,000	1.75
Neureut U.S.	386,000	151.6	393,000	1,032,000	2.67
Thomas Nast	15,920	6.3	396,000	74,500	4.68 **
Pforzheim M.S.	17,900	3.7	204,000	53,900	3.01 **
Germersheim	903,300	151.3	167,500	1,310,000	1.45
Paul Revere	1,189,000	337.6	284,000	2,431,000	2.04
Rheinland	349,000	89.7	257,000	534,000	1.53
Shopping Center	243,500	46.7	192,000	451,000	1.85
Smiley	258,800	50.5	195,000	521,000	2.01
Neureut L.S.	87,700	36.7	418,500	334,700	3.82
Pforzheim F.H.	105,500	17.0	126,000	161,000	1.19
Totals		1050.6		$8,214,100*	

* includes $1,827,800 in operating and maintenance costs

** housing area only

- o Continued use of Camp Thomas Nast is a mission requirement, although housing battery personnel on Germersheim Depot would save energy and dollars. This relocation suggestion was rejected during discussions in January 1982.
- o Major energy conservation and cost saving projects have been recommended for Rheinland, Paul Revere Village, and Neureut U.S.

D. Distribution of Energy on Installations

- o A complete picture of the energy flow on each installation is shown on Input-Output diagrams in Volume II.

E. Typical Building Energy Consumption

- o All buildings on the 11 study installations were assigned to one of 14 building types. Descriptions, energy parameters, and input data for BLAST ZONE models for each of these types can be found in Volume III.
- o "Average" buildings of each type were constructed from audit data using hand calculating techniques. The year-round energy consumption characteristics of each "average" building was ascertained using annual BLAST runs and a weather tape.
- o The energy consumption characteristics of the 13 "average" building types, and for "special" types which have no average type, are given below.

ENERGY CONSUMPTION CHARACTERISTICS OF BUILDING TYPES

USMCA KARLSRUHE

Bldg. Type	Description	Annual (10^9 Btu/yr)	Unit Annual (10^3 Btu/ft^2-yr)	Peak (10^6 Btu/hr)	Unit Peak (Btu/ft^2- hr)
A	Admin, Billets	3.13	84	1.80	48
B	Admin, Service	.65	124	.30	58
C	Family Apartments	1.43	78	1.35	74
D	2-story Barracks	.43	118	.13	36
E	Metal Bldgs.	1.18	68	.68	39

Bldg. Type	Description	Annual (10^9 Btu/yr)	Unit Annual (10^3 Btu/ft^2-yr)	Peak (10^6 Btu/hr)	Unit Peak (Btu/ft^2- hr)
F	Repair Shops	.38	43	.45	51
G	Wood Bldgs.	.16	83	.08	40
K	Meeting Halls	.49	119	.28	68
M	L.S. Barracks	.14	82	.06	37
P	Family Dwellings	.30	84	.24	68
Q	Heating Plants	--	--	--	--
S	Specials	*	*	*	58
U	Unheated	0	0	0	0
W	Controlled-humidity	--	--	--	--

*averages not applicable to unique "special" buildings

- o These consumption characteristics reflect the uses, load profiles, and temperature standards identified for each "average" building type during the audit.

- o The distribution of building heat loss for 10 "average" building types is shown below.

DISTRIBUTION OF BUILDING HEAT LOSS
USMCA KARLSRUHE AVERAGE BUILDING TYPES
(energy loss shown as 10^6 Btu)

Bldg.	Ventilation		Roof		Walls		Windows		Floors		Doors	
Type	(Btu/yr)	(%)	(Btu/yr)	(%)	(Btu/yr)	(%)	(Btu/yr)	(%)	(Btu/yr)	(%)	(Btu/yr)	(%)
A	1887	60	381	12	245	8	289	9	313	10	6	0
B	338	52	135	21	59	9	49	7	63	10	4	1
C	766	54	141	10	237	16	205	14	80	6	1	0
D	225	52	68	16	67	16	27	6	41	10	2	0
E	851	72	189	16	56	5	3	0	15	1	66	6
F	218	57	59	16	25	7	22	6	32	8	23	6
G	52	33	50	32	20	13	12	8	20	13	2	1
K	280	57	46	9	78	16	28	6	56	11	2	1
M	42	30	13	10	28	20	17	12	38	27	2	1
P	200	67	27	9	37	12	18	6	18	6	1	0

- The building type of every building on the 11 study installations has been noted in the Lists of Buildings for each installation in Appendix D in Volume III.

F. Typical Heating Plant Consumption

- The 124 heating plants in the study installations have been assigned to one of 12 heating plant classes based on size, fuel, and distribution system fluid.
- Energy consumption characteristics of all plants were ascertained from the BLAST PLANT models. Those for typical members of each class were averaged using hand calculation to facilitate community-wide analysis of ECOs.
- Heating plant classes are summarized below.

HEATING PLANT CLASS CHARACTERISTICS

USMCA KARLSRUHE

Class	Size, Fuel, Fluid	Seasonal Efficiency*
1	large, #6 oil, steam	.325
2	medium, #6 oil, steam	.512
3	small, #6 oil, HW	.616
4	small, #2 oil, HW	.592
5	small, #2 oil, steam	.480
6	medium, #2 oil, steam	.536
7	small, #2 oil, air	.536
8	medium, coal, steam	.448
9	small, coal, steam	.472
10	large, coal, HW	.352
11	medium, coal, HW	.488
12	small, coal, HW	.208

* Seasonal Efficiency is defined as net energy delivered/gross energy consumed in CY1980.

- The 52 hand-stoked, coal-fired heating plants on Paul Revere Village constitute class 12, with a seasonal efficiency of .208. A major project, ECO GY463F15, is directed towards eliminating these inefficient heating plants.
- A complete listing of the members of each heating plant class can be found in Volume III.
- Actual consumption of heating plants for which this is known can be found in the Lists Lists of Heating Plants for each installation in Appendix D in Volume III.

III. ENERGY CONSERVATION OPPORTUNITIES (ECO'S) ASSESSED

A. Operational and Maintenance ECO's

OM-1 Control Infiltration

OM-2 Consolidate Servicesinto Permanent Buildings

OM-3 Reschedule Use of Facilities

OM-4	Reset Temperature Controls
OM-5	Reduce Heating and Cooling in Little-Used Areas
OM-6	Manage Domestic Hot Water More Efficiently
OM-7	Operate HVAC Systems More Efficiently
OM-8	Operate Heating Plants More Efficiently
OM-9	Manage Electrical and Lighting Systems More Efficiently
OM-10	Operate Waste Treatment Plants More Efficiently
OM-11	Operate Distribution Systems More Efficiently

B. Funded ECO's

F-1	Weatherstrip Doors and Windows
F-2	Add Vestibules
F-3	Insulate Building Structures
F-4	Install Double-Pane Insulating Glass
F-5	Upgrade Domestic Hot Water Systems
F-6	Upgrade HVAC Systems
F-7	Upgrade Heating Plants
F-8	Upgrade Electrical and Lighting Systems
F-9	Upgrade Waste Treatment Systems
F-10	Upgrade Distribution Systems
F-11	Add Heat-Recovery Systems
F-12	Install EMCS
F-13	Add Temperature Control Systems
F-14	Change Steam Systems to Hot Water
F-15	Interconnect Existing Power Plants
F-16	Connect to Commercial Heating Systems
F-17	Sell Steam to Local Communities
F-18	Recover Energy from Waste
F-19	Install Solar Systems
F-20	Use Renewable Energy Sources
F-21	Exploit Passive Techniques

IV. RECOMMENDED COMMUNITY ENERGY MANAGEMENT PLAN

A. Present Actions that Should Continue

1. Emphasis on conservation ethic.
2. Heating system conversions from steam to hot water.
3. Negotiations to include parts of Karlsruhe on the district heating loop.

B. Recommendations to Higher Command

1. Modify coal procurement specifications to discourage amount of fines.
2. Rescreen coal to remove undersized particles.
3. Rewrite boiler operating contracts to include efficiency incentives.

C. Energy Conservation Modifications Made Since 1975

1. No funded modifications were found.

D. Planned Facility Modifications Indicated in the Community Master Plan

1. The Initial Capital Cost (ICC), energy saved, cost saved, B/C, E/C, and payback for the nine projects with impacts on energy conservation are listed below.

Project	ICC (10^3)	Energy Saved (Btu/yr)	Cost Saved (10^3/yr)	B/C	E/C	Payback
Gerszewski FMP I-IV	--	2.3×10^9	--	--	--	--
Rheinland 9709	$2,500	10×10^9	$34.1	.14	4.2	70
Local control systems	--	-47.8×10^9	--	--	--	--
Germ. Oper. Bldg.	--	$-.4 \times 10^9$	--	--	--	--
Germ. Child Care	--	$-.4 \times 10^9$	--	--	--	--
Bowling Center	--	$-.2 \times 10^9$	--	--	--	--
Dependent School PRV	--	-5.9×10^9	--	--	--	--
Germ. Battery shop	--	0	--	--	--	--

E. Operational and Maintenance Energy Conservation Opportunities

1. The energy and dollar savings from recommended operating and maintenance actions are listed below.

Action	Energy Saved (Btu/yr)	Dollars Saved
Preventive Maintenance Program	--	--
Enhanced Boiler Management	--	$122,500
Screen Combustibles from Ash	18.5×10^9	$ 62,730
Discontinue heating PRV 9200	--	--
Turn NATO warehouses off when doors are opened	--	--

F. Funded Energy Conservation Projects (Increments A, B, E, and G)

1. There are no recommended Increment A projects.

2. There is one recommended Increment B project, the heating plant interconnection for Paul Revere Village and Karlsruhe Shopping Center.

3. There are no recommended Increment E projects.

4. There are three recommended Increment G projects

5. The funded ECOs assessed for Karlsruhe are listed below.

Project	ICC (10^3)	Energy Saved (Btu/yr)	Cost Saved (10^3/yr)	B/C	E/C	Payback	Inc.	Rec
Insulate ceilings	$164	3.8×10^9	$36.3	2.0	23	4.5	G	Yes
Electric hot water heaters								
(replacing coal)	--	--	-$12	--	0	--	G	No
(replacing oil)	--	--	-$6.1	--	0	--	G	No
Gers. consolidation	$5,012	9.9×10^9	$953	1.6	2.0	5.2	E	No
TN7114 upgrade	$370	2.2×10^9	$14	.25	5.9	26	B	No
New street lights (per pole, in dollars)	($375)	3.2×10^6	($11.31)	.19	9	33	B	No

Project	ICC$_3$ ($10^3)	Energy Saved (Btu/yr)	Cost Saved ($10^3/yr)	B/C	E/C	Payback	Inc.	Rec
Load shedding								
(existing billing)	$370	--	-$3.3	--	0	--	B	No
(reduced billing)	$370	--	$3.4	.09	0	111	B	No
Neureut Dist. System Replacement	$2,950	30.4 x 10^9	$131	.29	10	23	G	Yes
Rheinland Dist. System Replacement	$392	2.1 x 10^9	$7	.12	5.2	56	G	Yes
EMCS	$7,567	72 x 10^9	$82.5	.10	9.5	92	B	No
Interconnect Heating Plants	$7,743	181 x 10^9	$2,098	2.3	31	2.8	B	Yes

6. The recommended projects listed in descending B/C ratio order:

Project	ICC$_3$ ($10^3)	Energy Saved (Btu/yr)	Cost Saved ($10^3/yr)	B/C	E/C	Payback	Inc.	Rec
Interconnect Heating Plants	$7,743	181 x 10^9	$2,098	2.3	31	2.8	B	
Insulate Ceilings	$164	3.8 x 10^9	$36.3	2.0	23	4.5	G	
Neureut Dist. System Replacement	$2,950	30.4 x 10^9	$131	.29	10	23	G	
Rheinland Dist. System Replacement	$ 392	2.1 x 10^9	$7	.12	5.2	56	G	

7. Increment G projects are listed in descending E/C ratio order:

Project	ICC$_3$ ($10^3)	Energy Saved (Btu/yr)	Cost Saved ($10^3/yr)	B/C	E/C	Payback
Insulate Ceilings	$164	3.8 x 10^9	$36.3	2.0	23	4.5
Neureut Dist. System Replacement	$2,950	30.4 x 10^9	$131	.29	10	23

Project	ICC (10^3)	Energy Saved (Btu/yr)	Cost Saved (10^3/yr)	B/C	E/C	Payback
Rheinland Dist. System Replacement	$392	2.1×10^9	$7	.12	5.2	56
Electric hot water heaters						
(replacing coal)	--	--	-12	--	0	--
(replacing oil)	--	--	-6.1	--	0	--

G. Forecast of Future Energy Consumption

- The forecasted energy consumption for USMCA Karlsruhe is shown below.

FORECASTED ENERGY CONSUMPTION

USMCA KARLSRUHE

Installation	Actual Consumption in 10^9 Btu		Estimated Consumption in 10^9 Btu				Change, 80 to 86
	75	80	83	84	85	86	
Gerszewski	130.1	159.5	159.5	140.3	140.3	138.0	-13.5%
Neureut U.S.	151.6	151.6	151.6	141.5	141.5	111.1	-26.7
Thomas Nast	6.3	6.3	6.3	6.3	6.3	6.3	----
Pforzheim M.S.	3.7	3.7	3.7	3.7	3.7		----
Germersheim	158.6	151.6	150.3	145.8	145.8	145.8	- 3.8
PRV	363.4	337.6	327.5	324.6	297.6	203.4	-39.8
Rheinland	82.6	89.7	85.3	75.3	73.2	73.2	-18.4
Shopping Center	56.9	46.7	45.3	45.3	45.3	36.5	-21.8
Smiley	50.5	50.5	50.3	50.3	50.3	50.3	-.4
Neureut L.S.	35.9	36.7	25.0	25.0	25.0	25.0	-31.9
Pforzheim F.H.	21.9	17.0	16.1	16.1	16.1	16.1	- 5.3
Totals	1061.5	1050.9	1020.3	974.2	945.1	809.4	
% Change, Base 80	----	----	-2.9	-7.3	-10.1	-23.0	
% Change, Base 75		-1.0	-3.9	-8.2	-11.0	-23.7	

V. OTHER STUDY RESULTS

A. Energy Price Forecasts

- Spring 1981 study correctly forecast real decline of energy prices evident in 1981 and 1982.
- Same sources and methods predict real decline will continue throughout decade of the 1980s.
- Economic analyses reflect this current prediction and to that extent contradict earlier studies which may have merely extrapolated steep relative inflation of energy prices seen in 1979 and 1980.
- For projections of future coal, heating oil, electricity, and maintenance costs see Appendix F-1 in Volume III. Projected unit energy costs are shown below.

PROJECTED UNIT ENERGY COSTS

	Unit Cost per 10^6 Btus in		
Source	Jan 81	Jan 85	Jan 91
Electricity	$13.82	$16.58	$20.08
#2 Fuel Oil	6.63	9.61	14.99
#6 Fuel Oil	4.31	6.25	9.75
Coal	3.40	4.62	6.54
Maintenance	1.00	1.19	1.44
	29.16		

B. Population and Occupancy Forecasts

- An analysis of variance (ANOVA) study of past USMCA Karlsruhe population data using Student's t indicated no significant historical trend.
- Study assumes population will remain stable essentially at present levels through the 1980s.
- Actual troop strength is classified and unavailable for this study.
- For estimates of day- and nighttime populations of the 11 installations studied, see Appendix F-2 in Volume III.

C. BLAST

- Each installation was analyzed with an innovative application of the BLAST program that enabled not only buildings but also the operation of heating plants to be modeled. This innovative analysis consists of six steps.

  1. Assigning all energy-using buildings into one of 14 types. (See Appendix C-1 in Volume III for building classification.)
  2. Auditing a significant number of buildings in each type.
  3. Combining all audit data in each building type to produce an "average" building using hand calculation.
  4. Constructing a BLAST model for each "average" building as a ZONE.
  5. Grouping proper numbers of properly-sized ZONES using the "zone multiplier" parameter of a SYSTEM to model the buildings served by each distribution system.
  6. Applying heating system audit data to model all the heating plants on the 11 installations as PLANT models.

- The additions to the standard BLAST LIBRARY required to model USMCA Karlsruhe's installations can be found in Appendix F-4.1 in Volume III.
- ZONE input data for each building type can be found in Appendix F-4.2.
- SYSTEM input data for the three distribution system types prevalent on USMCA Karlsruhe can be found in Appendix F-4.3.
- Input data required to model the operation of the six boiler types on USMCA Karlsruhe can be found in Appendix F-4.4.
- Characteristics for the 71 different PLANT models necessary to analyze energy use on USMCA Karlsruhe can be found in Appendix F-4.5.
- These building types are widely represented on American facilities in West Germany, so the LIBRARY, ZONE, SYSTEM, and PLANT data can be used to model the majority of these installations.
- The accuracy of the resulting BLAST models are given below:

ACCURACY OF BLAST MODELING

USMCA KARLSRUHE

Installation	Calendar 1980 Consumption (10^9 Btu) Reported	Calculated	Mismatch (%)
Gerszewski	159.5	150.2	-5.8
Neureut U.S.	151.6	151.6	0
Thomas Nast	6.3	6.4	+1.6
Pforzheim M.S.	3.7	3.5	-5.4
Germersheim	127.9	150.8	+17.9
Paul Revere	337.6	337.8	0
Rheinland	89.7	90.1	+ .4
Shopping Center	46.7	46.4	- .6
Smiley	50.5	51.2	+1.4
Neureut L.S.	36.7	36.7	0
Pforzheim F.H.	17.0	17.0	0

- Standard input forms for the BLAST analysis used in this study can be found in Appendix F-4.6 in Volume III.

D. Weather

- EUDAP-S-supplied tapes of Heidelberg weather furnished for the study were inadequate. The first tape was empty but for record identifiers; the second showed obviously incorrect temperature entries on approximately 10 percent of the dates. No better tape could be provided.
- Sverdrup independently located a weather tape for Ramstein AFB in Landstuhl, which was used.
- A comparison of Heidelberg, Karlsruhe, and Ramstein weather is shown below.

COMPARISON OF HEIDELBERG, KARLSRUHE, AND RAMSTEIN WEATHER

Location	Lat.	Long.	Elev.	Wind	Vel.	99%	1%db	1%wb	Rng.
Heidelberg	49-23	8-39	359	N	5	12	88	72	24
Karlsruhe	49-01	8-22	410	NE	6	7	88	71	26
Ramstein	49-26	7-36	780	ENE	6	9	85	69	28

- o Table 11 indicates that Ramstein's weather is as good a model for Karlsruhe as is Heidelberg's.
- o Year-round daily weather summaries can be found in Appendix B-1.
- o Day-long hourly weather summaries of the winter and summer design days can be found in Appendix B-1.

E. ADJUST (Weather Tape Construction Program)

Because of early weather tape difficulties a program developed by the U.S. Bureau of Standards to construct weather tapes in an NBSLD format was modified to read and create 1440 format weather tapes. Discovery of the Ramstein tape relieved the necessity for its use on Karlsruhe, but it was required to construct a weather tape for Livorno in Italy. (See EEAP Livorno Final Report, Volume III, page 49 and pages 293-313 for the FORTRAN code of the modified program.)

F. Retention Risk

- o The expected lifetime of existing energy-consuming equipment in West Germany is critical in proper economic analysis of long-term projects.
- o A combined statistical/econometric model of the risk attendent upon retaining such equipment was developed for this study.
- o Based on actual lifetime data, the Weibull Distribution, and the Present Value Multiplier from the ECIP Guide, Retention Risk for various types of equipment can be calculated.
- o Retention Risks for coal-fired boilers; well-maintained oil-fired boilers; and ill-maintained oil-fired boilers of current ages 1 through 30 years can be found in Appendix F-8 in Volume III.

G. ECIP Analysis in West Germany

- Incremental Escalation Rates and Escalation Factors for Extending Costs and Benefits given in the 7 November 1977 ECIP Guidance through FY83 were extended through FY86 to include the construction period of all funded projects recommended by the study using the results of the Energy Price Forecasts summarized in VI.A above.
- A table of the resulting Yearly Incremental Escalation Rates based on these results can be found in Appendix F-12 in Volume III.
- A table of Escalation Factors for Extending Costs and Benefits based on those incremental escalation rates can be found in Appendix F-12.

H. Forms

- A form to calculate IBOP in accordance with USAREUR Suppl 1 to AR415-35 and detailed instructions for its use can be found in Appendix F-7 in Volume III.
- A form summarizing all project information and manipulating it into the form required by ECIP, and instructions for its use, can be found in Appendix F-14 in Volume III.
- A corrected ECIP Economic Analysis Form and instructions for its use can be found in Appendix F-15 in Volume III.
- A form to calculate the Life Cycle Cost of a funded project and instructions for its use can be found in Appendix F-16 in Volume III.
- Instructions for completing DD 1391 forms as envisioned for this program can be found in Appendix G-1 in Volume III.

J. District Heating

- A distribution system similar to that required to expoit the City of Karlsruhe's contemplated district heating system was developed for ECO GY463F15. October 1985 construction cost of this system is $2,401,000.

- Connecting Paul Revere Village and parts of the Shopping Center and Smiley Barracks will save $3,094,000 annually.
- 162.0×10^9 Btu would have to be purchased from the system.
- If Karlsruhe City funds the distribution system, the breakeven energy cost from district heat is $19.10 per million Btu, approximately 3.6 times the expected 1986 cost of coal energy.
- If the U.S. must fund the system, breakeven energy cost depends on desired payback period. Breakeven costs for several paybacks are shown below.

BREAKEVEN ENERGY COSTS FOR DISTRICT HEATING

Payback Period	Annual Payback	Net Annual Savings	Breakeven Energy Cost
3 yrs	$965,000	$2,129,000	$13.14 per million Btu
4	756,000	2,338,000	14.43
5	634,000	2,460,000	15.19
8	449,000	2,645,000	16.33
10	391,000	2,703,000	16.69

- Connection to the district heating loop is attractive for any contracted energy prices equal to or less than those shown.