United States General Accounting Office

GAO

Report to the Honorable Arlen Specter, U.S. Senate

August 1987

# MILITARY FACILITIES

# Conversion to District Heat in Germany





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GAO

**United States**
**General Accounting Office**
**Washington, D.C. 20548**

**Information Management and**
**Technology Division**

B-227312

August 31, 1987

The Honorable Arlen Specter
United States Senate

Dear Senator Specter:

This report responds to your October 29, 1986, request that we evaluate the Department of Defense's (DOD's) district heat conversion program in West Germany and provide information on the program's life-cycle cost-effectiveness. Under this program, DOD buys heat for U.S. facilities from public utility heat plants in local German communities—usually large co-generation facilities that burn several types of fuel and are equipped with state-of-the-art emission control equipment. Before conversion, U.S. facilities generated their own heat, usually by burning coal shipped from the United States.

We agreed to examine implementation of the district heat program by reviewing the economic analyses the Army and Air Force had prepared for nine projects which had led to a decision to convert to district heat, and to determine whether these analyses had identified reasonable costs. We identified six projects—five Army and one Air Force—and your representative selected three additional Army projects.

We made our selection of Army analyses from a list of all of the Army's district heat projects as of February 1987. We selected them to ensure that we reviewed analyses of large and small projects, which both V and VII Corps prepared, and which were performed by the Army at different times. Although selected to be roughly representative, the nine projects we reviewed do not provide a basis to generalize the results of our work to all Army or Air Force heating decisions.

We also agreed to obtain information on the number of projects completed and the locations planned for conversion to district heat in Germany, and on the environmental and security issues associated with converting from coal-fired plants to district heat. We did not separately examine specific environmental or security circumstances of the nine projects we reviewed. We also did not evaluate the economic impact of conversion to district heat on the American coal or shipping industries or labor.

## Review of Economic Analyses

For the nine analyses we reviewed, we found the following:

- Five of the Army analyses and their supporting documentation provided justifiable bases for converting to district heat. Although we noted some errors, they did not materially affect the results of the analyses, which showed district heat to be less costly than the other types of heating considered.
- The three other Army analyses had insufficient supporting documentation. Consequently, we could not determine if the economic analyses justified the decision to convert to district heat.
- The Air Force analysis was not a full life-cycle cost analysis, as DOD regulations require. However, our review indicated that a life-cycle cost analysis would have shown that the local heating alternative chosen was less costly than the then-current operations.

The Army has actively pursued district heat in Germany to reduce costs and to implement the U.S. requirement to abide by German environmental standards. As of February 1987, the U.S. Army, Europe (USAREUR) had signed 56 district heat contracts involving 124 installations throughout the Federal Republic of Germany and all major installations in Berlin, and was evaluating the possibility of signing additional contracts covering 115 installations. According to USAREUR officials, the Army had 737 installations in Germany as of March 1987. They explained that district heat is not feasible at many installations because (1) the installation is too far from a district heat facility, (2) the population of the installation is too small to justify consideration of district heat, or (3) the local utility company lacks the capacity to support the installation's needs. Based on information covering the 51 signed contracts for which complete cost estimates were available, the estimated total annual cost of district heat purchased for those contracts is 246,452,000 deutsche marks (DM).

The location of air bases away from cities limits the U.S. Air Force, Europe (USAFE) from obtaining heat from public utilities. However, USAFE has signed three heating contracts. At one base, the Air Force turned over its existing heating system to a private contractor who modified the plant to make it more efficient and extended its distribution lines to other locations. The second contract is with a local brewery that supplies heat generated from its brewing process to a nearby air base. The third contract, which we examined, was for a new heating system financed by a third party. Under this arrangement, a private contractor built the heating system for the Air Force and operates and maintains it, recouping costs through the rate structure. USAFE officials are currently

evaluating third-party financing of heating plants at six additional Air Force locations in Germany.

## Environmental and Security Concerns

In response to environmental concerns and air pollution control laws, German national and local governments have brought increasing pressure on the United States to stop burning coal at U.S. heating plants in Germany and to use district heat or such other sources of heat as natural gas. German government and USAREUR officials believe that district heat is environmentally preferable and a more efficient use of energy. To meet German pollution emission standards, many current U.S. coal-fired heating plants would have to undergo modifications costing millions of dollars. Under district or contract heat, the public utility or contractor is responsible for meeting pollution control laws.

Critics of district heat conversion suggest that district heat is less secure than U.S.-operated heating plants in part because supplies of fuel could be interrupted. However, U.S. Army officials disagree. They explained that all district heat plants can be fired by two or more types of fuel. Moreover, U.S.-operated coal-fired heating plants cannot operate without German-provided electricity, water, and sewer services. These utilities would be subject to risks similar to those faced by district heat. According to the German Minister of Finance, Germany has taken steps to ensure the uninterrupted supply of coal, oil, and natural gas. USAFE officials told us that security is one of the significant factors they consider before entering into a third-party-financed heating plant.

## Additional Congressional Concerns

As we were completing the draft of this report for issuance for agency comment, the Chairman of the House Armed Services Committee, in a letter to the Secretary of the Army, asked the Army to delay converting more installations to district heat until we issued our report and the Committee could further review the Army's record on conversions already approved. In particular, the Chairman expressed concern about whether the Army had (1) used outdated coal-pricing data in conversion evaluations, (2) considered modern coal-heating equipment for U.S. installations, which could burn smaller sizes of anthracite coal, and (3) adequately analyzed the planned conversion for installations at Vilseck.

While we were unable to conduct a comprehensive review of these issues because they arose late in our review, we did discuss them with USAREUR officials. They told us that the Army based the coal costs used in the economic analyses on prices that the United States was actually

paying at the location, or prices experienced in the geographic area, at the time of the analysis. For the period 1982-1985, prices paid for U.S. coal in Europe did not fall as rapidly as did prices of coal purchased at U.S. mines because shipping costs were included. For the analyses we reviewed, these prices were usually inflated for the future at a rate of 5 percent. Since these analyses were performed, the guidance has been revised to require that future energy prices be based on standard energy price factors that the U.S. Department of Commerce, National Bureau of Standards (NBS), issues each year for the Department of Energy. After adjusting the NBS forecasts for inflation, new analyses should project coal price increases at a rate slightly greater than 5 percent. USAREUR officials stated that heating options considered in their analyses did not include construction or modification of heating plants to burn smaller sizes of anthracite coal because such plants or modifications are more expensive than other coal-fired alternatives, such as those using bituminous coal. The economic analysis for the planned expansion of heating facilities at Vilseck had not been completed at the time we met with USAREUR officials.

## Current Status

The 1987 National Defense Authorization Act (P.L. 99-661) provides that conversion of a heating facility at a U.S. military installation in Europe to district heat or other fuel sources may be made if it is cost-effective and after notification of the Congress, followed by a waiting period of 30 days. On June 1, 1987, immediately after issuance of our draft report for comment, the Army notified the Chairman of the Senate and House Armed Services Committees that it was planning to sign contracts for district heat at 46 locations. The 30-day waiting period expired on June 30, 1987, and the Army is currently proceeding with the proposed district heat conversions.

Appendix I provides further information on the results of our review. Appendix II provides detailed information on district heat contracts signed and pending for each service, and the actual and pending effect of the Army contracts on coal consumption within USAREUR. Appendix III discusses the environmental and security issues associated with district heat in Germany. Appendix IV describes our objectives, scope, and methodology.

We requested and received official agency comments on a draft of this report. DOD agreed with our findings, and its final comments are included in appendix V.

As arranged with your office, unless you publicly announce its contents earlier, we plan no further distribution of this report until 15 days from the date of its issue. At that time, we will send copies to the Chairmen, Senate and House Committee on Armed Services, Senate Committee on Governmental Affairs, House Committee on Government Operations, and the House and Senate Committees on Appropriations; the Secretary of Defense; the Secretaries of the Army and Air Force; and the Director, Office of Management and Budget. Copies will also be made available to other interested parties upon request.

Sincerely yours,

Frank C. Conahan
Assistant Comptroller General

# Contents

## Figures



### Abbreviations

| | |
|---|---|
| DEH | Directorate of Engineering and Housing (Army) |
| DOD | Department of Defense |
| DM | deutsche marks |
| GAO | General Accounting Office |
| NATO | North Atlantic Treaty Organization |
| NBS | National Bureau of Standards |
| OMB | Office of Management and Budget |
| USAFE | U.S. Air Force, Europe |
| USAREUR | U.S. Army, Europe |

# Results of GAO Review of Nine District Heat Economic Analyses

We reviewed nine economic analyses used to support decisions to convert to district heat at eight Army locations in Germany (Darmstadt and Kirchgoens-Ayers Kaserne [V Corps]; Ansbach, Augsburg, Fuerth, Bad Kissingen, Bad Toelz, and Neckarsulm [VII Corps]); and one Air Force installation (Sembach Air Base).

The Army analyses were prepared by comparing the costs of district heat with current operations, or construction and operation of a new or expanded coal-fired central heat plant, or both. All the analyses showed district heat to be less costly. Consistent with Army regulations, the analyses did not consider alternatives other than those considered to be executable—that is, those which can be reasonably expected to be implemented. Accordingly, the analyses we reviewed did not consider constructing a gas-fired plant since that option was prohibited at the time the analyses were performed. Similarly, the Army analyses did not include consideration of heat provided by third-party financing because no viable privately financed sources of heat other than the local utility were known at the time of the analyses. According to a recent Army briefing, local German municipalities would block third-party contracting if they were able to supply district heat.

In five of the Army analyses we reviewed, cost documentation and the analysis methodology adequately supported the decision to convert to district heat, although we noted errors in all of them. (See table I.1.)

**Table I.1: Army Estimates of Project Costs** (Discounted in Dollars for a 25-Year Life Cycle)

| Military community | Current operations[a] | Central heating plant | District heat | District heat cost savings |
|---|---|---|---|---|
| Ayers Kaserne | [b] | $18,972,964 | $16,401,423 | $2,571,541 |
| Revised[c] | [b] | 17,009,533 | 15,858,548 | 1,150,985 |
| Bad Kissingen | [b] | 21,481,607 | 12,443,265 | 9,038,342 |
| Bad Toelz | [b] | 20,314,832 | 18,520,797 | 1,794,035 |
| Darmstadt | [b] | 25,734,476 | 25,224,320 | 510,156 |
| Revised[c] | [b] | 24,222,444 | 19,337,404 | 4,885,040 |
| Neckarsulm | 8,322,601 | [b] | 5,755,864 | 2,566,737 |

Notes: The total costs reported are the results of the Army's economic analyses. We verified most of the significant cost elements in these analyses, but we did not verify all costs and cannot attest to the accuracy of all the figures. Analyses were prepared using a 10-percent discount rate in accordance with Office of Management and Budget instructions. See p. 13 for further comment on the methodology.

[a]Current operations included coal-fired plants, using anthracite or bituminous coal, or oil-fired heating plants, or both, depending on location. A new coal-fired central heating plant was considered as an option when replacement or expansion of heating facilities was required. (Costs of these alternatives are shown in the column "Central heating plant.")

[b]This alternative was not included in the analysis. (See p. 14 for further discussion of analysis alternatives.)

[c]We identified errors in the Army's analyses, some of which could have had a material impact on the results. In two cases, we asked the Army to rerun the computer analysis model with those errors corrected. This line shows the results of those revised analyses.

In the three other Army analyses, we could not determine if the decision was justified because sufficient supporting documentation was unavailable. (See table I.2.)

**Table I.2: Army Estimates of Project Costs** (Supporting Documentation Insufficient to Verify Costs)

| Military community | Current operations | Central heating plant | District heat | District heat cost savings[a] |
|---|---|---|---|---|
| Ansbach | $65,010,744 | $60,266,871 | $56,241,867 | $4,025,004 |
| Augsburg | 103,390,912 | [b] | 97,217,431 | 6,173,481 |
| Fuerth | 120,254,074 | [b] | 111,764,359 | 8,489,715 |

Notes: The total costs reported are shown in economic analyses provided by the Army. However, we were unable to trace costs from these analyses to supporting documentation.

[a]This column represents the cost savings of district heat compared with the lowest cost alternative reported.

[b]This alternative was not included in the analysis.

USAFE officials did not prepare a 25-year life-cycle cost estimate for the analysis of alternative heating sources at Sembach Air Base. They compared the costs of current operations with cost estimates for a new third-party-financed heating plant for 1 year and found the new plant to

be approximately $600,000 less costly. This methodology was inconsistent with DOD regulations that require life-cycle cost analyses. However, our review indicated that, in this case, a life-cycle cost analysis would also have shown the third-party-financed heating plant to be less costly.

## How Economic Analyses Were Prepared

The Army Directorate of Engineering and Housing (DEH) officials at the V Corps and VII Corps prepared the Army economic analyses we reviewed. Officials entered cost information into a computer program that calculated the discounted cost of the project over a 25-year period. The computer program used a 10-percent discount factor and a 5-percent factor for fuel cost inflation. To improve their analyses, USAEUR officials have prepared and are using a new computer program that uses different inflation factors for different types of fuel.

In most of the analyses we reviewed, district heat would be provided from new plants or a self-contained expansion system located on Army installations. Officials at the Corps level evaluated district heat against one or both of the following alternatives: (1) continuation of current operations with allowances for boiler replacement or (2) a coal-fired central heating plant to replace the current heating system. (In some cases, this latter alternative would involve consolidating several smaller heating plants.) Starting in fiscal year 1987, gas-fired central heating plants are another alternative that may be considered. The fiscal year 1987 National Defense Authorization Act (P.L. 99-661) allows for such conversions which, according to DOD, were previously prohibited by the Congress. Prior heating studies for a community and the age of the existing heating system influenced the alternatives which were evaluated in comparison to district heat.

USAFE Directorate of Engineering officials prepared the analysis for the one Air Force project we reviewed. The USAFE analyses compared the costs of current operations for 1 year with the annual cost of a proposal for construction of a new third-party-financed central heating plant.

## Army Methodology for Calculating Costs

In accordance with Army Regulation 11-28, "Economic Analysis and Program Evaluation for Resource Management," and USAREUR's district heat economic analysis guidance, economic analyses must be based on the identification and development of appropriate costs for each alternative evaluated.

The following sections describe the costs usually associated with each alternative and the general method for developing these costs.

## Continuation of Current Operations

To analyze current operations, the following costs were usually considered, as appropriate, depending on current fuel used:

- fuel,
- labor,
- coal handling,
- ash disposal,
- utility,
- chimney sweeping,
- emission inspection,
- maintenance and boiler replacement, and
- pollution control equipment costs.

Costs for current operations were calculated on the basis of historical operating records, engineering judgments, and reference guides and publications.

## Consolidated Heating Plant

To analyze the expected costs of the use of a new central coal-fired heating plant to replace smaller decentralized or aging boiler systems, the same costs as those above were generally included, but were modified based on available data and engineering judgment to reflect expected results from consolidated operations. For example, a coal-fired central heating plant may be more efficient than a number of older, hand-stoked coal boilers, and could burn less coal and require fewer staff to operate and maintain. Also included in the economic analyses for this alternative were the costs for constructing the central heating plant and any necessary new or replacement distribution lines.

## District Heat

For the district heat alternative, the following costs were considered:

- connection charges for tying into the district heat system;
- price of the heat to be purchased, as proposed by the local utility;
- U.S. investment costs, such as new radiators and hot water lines, required to accept district heat; and
- anticipated labor costs to operate and maintain the U.S.-owned portion of the heating system (e.g., distribution lines within buildings).

District heat costs depend on the megawatts of energy to be produced and the number of megawatt hours. These energy requirements were estimated based on an analysis of the existing heating system and the amount of heat that would be needed once district heat was in place.

The costs of constructing and maintaining a new district heat plant or distribution lines, or both, were included in the price charged by the utility for district heat if the specific circumstances involved a new plant. This circumstance applied in 4 of the 5 cases we reviewed where documentation was available. These costs were usually paid for in the rates charged for the heat over the first 10 years of the contract if the plant provided heat solely to the U.S. base. In the case where the existing system was expanded (Bad Kissingen), the investment costs of the expansion were similarly amortized and charged for the first 10 years and the rate charges reduced thereafter.

## Review of Army Analysis Methodology

In general, the Army analysis methodology included consideration of appropriate sources of cost for each alternative, and the computer analysis program appears to be analytically sound. However, errors occurred which are discussed in the following section. Although the errors in the analyses we reviewed did not change the conclusions that district heat was the least costly alternative, the kinds of errors noted could lead to incorrect conclusions under different circumstances.

This problem is especially notable in the conduct of sensitivity analyses. Although Army guidance clearly requires sensitivity analyses to be performed to determine the impact of currency rate fluctuations and the computer analysis program is designed to include such analyses, the analyses we reviewed did not accurately conduct these sensitivity analyses, or they were not performed. Since these analyses were prepared, currency rates have changed dramatically, highlighting the importance of appropriate consideration of exchange rate variation in reaching a conclusion about the costs of alternative heating options. For example, in one case, Ayers Kaserne, we asked the Army to rerun the computer analysis, correcting for several errors. The results of that reanalysis indicate that the decline in the exchange rate between dollars and DM could have altered the results. For this project, the Army chose the district heat alternative. Given the exchange rates in effect at the time of the decision (above 2.90 DM to the dollar in September 1985), this was the proper selection because district heat was the least costly alternative whenever the exchange rate was above 2.80 DM to the dollar. However, under current exchange rates (less than 2.0 DM to the dollar), coal-

fired central heating would have been the least costly alternative. In the other case for which we have a corrected analysis, the current exchange rate would still have made district heat the least costly alternative. However, the current currency rates, which resulted from the dollar falling against the DM, could have an impact on costs of conversion decisions which would be of concern in future analyses.

In its computer analysis program, the Army estimated the present value of the costs of its heating options by applying a discount rate of 10 percent to a stream of projected future costs. Approved Office of Management and Budget (OMB) policy at the time of these studies called for the use of a 10-percent discount rate applied to future costs after adjusting these costs for inflation. In June 1986, OMB issued a revised policy on discounting in evaluating leases of capital assets, which calls for the use of a discount rate that reflects the estimated cost of government borrowing. The new policy agrees with our long-standing recommendations on the calculation of discounted present values. OMB is still considering this change for its policy on other types of cost-benefit analyses.

If the cost of government borrowing at the time of the Army studies (approximately 12 percent) had been used instead of the 10-percent rate, the future savings estimated from the use of district heat would be reduced. A higher discount rate means that dollars saved in the future are reduced in value in the current year. For example, the present value of each $100 in savings one year in the future is about $91 using the 10-percent discount rate, but would be about $89 if the 12 percent rate is used. If current rates of government borrowing were used (approximately 8 percent), the calculated savings would be greater.

## Details of Our Review of Nine Analyses

The two V Corps analyses (Darmstadt and the Ayers Kaserne at Kirchgoens) and three of the six VII Corps analyses we reviewed (Bad Kissingen, Bad Toelz, and Neckarsulm) were adequately documented and provided a reasonable basis for converting to district heat. Our review of the backup documentation and discussions with officials who prepared the analyses showed that major costs were supported by engineering reference manuals, historical records, and proposed contract terms. For example, in the Neckarsulm project, officials compared the costs of current operations with district heat. Operations and maintenance costs over a 25-year period for current operations were based on the size of the boilers and cost estimates contained in an engineering analysis report. Fuel costs were based on actual fuel consumption over a 3-year period with a fuel cost inflation factor built in. District heat costs

were based on terms and conditions contained in a proposal from the public utility company and on estimates by local Army officials of the amount of district heat to be purchased to meet the heating needs of the installation.

For four of the five analyses that were adequately documented, the Army did not consider the continuation of current operations as one of the alternatives. In one case (that for Bad Kissingen), Army officials told us that they did not consider continuing current operations because an earlier analysis had shown that a central coal-fired heating plant would be more efficient and economical. In the other three cases (those for Darmstadt, Ayers Kaserne and Bad Toelz), the supporting documentation showed that some current boilers were 30 years old or older, far exceeding USAREUR's 15-year boiler replacement standard, and that continuation of current operations was not considered.

In only one case (that for Neckarsulm) did the Army consider continuation of current operations. In that case, district heat (at a cost of $5,755,864) was shown to be less costly than current operations even when costs of modifications to meet German environmental standards were not included. (Total costs for current operations without upgrade were $6,783,535.) For the remaining three VII Corps analyses (prepared in late fiscal year 1984 for Ansbach, Augsburg, and Fuerth), we found that the analyses were inadequately supported and that engineering officials at the Corps and local DEH level were unable to explain how costs were developed. As a result, we could not determine whether the economic analyses justified the decision to convert to district heat.

The USAREUR Office of Internal Audit conducted a review of the Augsburg and Fuerth economic analyses in its review of the district heat program, and noted the same problems. The VII Corps officials took corrective actions to address the problems noted. In particular, they issued guidance to local DEH officials on what costs to include in the economic analyses and how to calculate certain of these costs.

The Air Force analysis we reviewed was not prepared in the same manner as the Army analyses, but was based on a comparison of current operating costs and allowances for boiler replacement with costs based on a third-party-financed heating plant proposal. However, the analysis covered only one year's operating costs for each alternative, and it did not include all costs associated with the new heating plant. The analysis showed the third-party-financed heating plant to be 38 percent less

costly than the current heating system. Because of this significant difference, the officials did not prepare a full life-cycle cost analysis of the two alternatives. DOD regulations require life-cycle cost analyses for large investment decisions. Compliance with these requirements is important because savings in operating costs might be insufficient to recoup investment expenditures; thus, a life-cycle cost analysis could lead to a decision different from one based on analysis of a single year's operations.

## Errors in the Analyses

When reviewing the analyses, we noted errors in all of them. In two cases where the impact of the errors could have been material, we asked Army officials to correct for the errors and rerun the computer-generated economic analysis. In these cases, district heat continued to be the least costly alternative.

One error, found in six of the eight Army analyses, resulted from the way costs for pollution control equipment to meet German air pollution laws were handled. Such costs were either not included in the analyses or were added as a lump sum after all other costs had been discounted for the 25-year life cycle of the project. During our review, USAREUR officials agreed that pollution control costs are a valid project cost and should be discounted based on the year that the equipment would be installed.

A second error, found in all five Army analyses for which supporting documentation was available, was that costs to be incurred in DMs for an alternative were converted to dollars and carried forward in the analysis as constant dollar costs. This effectively precluded a sensitivity analysis on the impact of exchange rate fluctuation on the life-cycle cost comparison. USAFE officials did not conduct a sensitivity analysis for the Sembach Air Base analysis, and the remaining three Army analyses were not sufficiently documented to determine how DM costs were handled.

A third error, found in the Darmstadt analysis, was that the costs of a new coal-fired central heating plant were initially calculated in DM and were converted to dollars at an exchange rate of DM2.52/dollar, rather than the DM3.02/dollar rate that was used elsewhere in the analysis. As a result, the costs of the coal-fired central heating plant were overstated. In addition, the costs for the district heat plant were based on uniform energy and basic charges for the entire life cycle of the analysis without recognizing that the district heat contract provided that, after

10 years, the basic charges would be significantly reduced because the investment costs of the plant would have been paid off. Costs of the district heat plant were thus also overstated in the analysis. When we asked the V Corps officials to rerun the computer analysis, correcting for these errors, the revised analysis showed district heat to be even less costly over the 25-year life cycle of the project than the original analysis showed.

A fourth error, found in the Ayers Kaserne analysis, was that the economic analysis did not include the costs of connecting the new district heat plant with the existing heating lines because, at the time the analysis was performed, the location of the new plant was not certain. At the time of our review, negotiations were underway with the local utility to add these costs to the contract, and the Army was planning to prepare a new economic analysis to determine if district heat was the least costly alternative. We asked the Army to recalculate the economic analysis using the price proposed by the utility which included these costs, and the revised analysis still showed district heat to be the least costly alternative.

A fifth error, found in the Neckarsulm analysis, was that officials assumed that, under current operations, the boilers would be replaced in 13 years instead of the USAREUR engineering standard of 15 years. This resulted in the costs of the current operations alternative being overstated by about $124,000, which was not a material difference.

## Independent Studies Find District Heat Cost-Effective

The Energy Information Administration in the U.S. Department of Energy,[1] and Kling Lindquist, Inc., a private consulting firm,[2] each released studies in 1986 showing district heat to be a less costly alternative than coal-fired heating plants in Germany. They found both district heat and gas-fired heating plants to be significantly less costly than anthracite coal-fired plants.

The Energy Information Administration study found that, on the basis of usable energy output, existing anthracite coal plants are almost three times more expensive than district heat and natural gas plants. Coal costs considerably more because of handling and transportation expenses, greater cost of the boilers and pollution control equipment,

[1]Implications of Mandated Coal Use by the Department of Defense, Service Report, Aug. 1986

[2]Economic Analysis of Heating Options in Europe for Headquarters, US Army Europe, Philadelphia: July 18, 1986.

and higher plant operations and maintenance costs. Also, the study reports that existing coal plants in Germany have an average 45-percent efficiency ratio, compared with 65 percent for oil and gas and 96 percent for district heat. The Kling Lingquist, Inc., study, prepared for the Army, involved five alternatives for replacing existing boilers or converting to heating plants fired by oil, natural gas, or coal. These alternatives were compared in cost with equivalent capacities provided by district heat. The economic analysis included the investment costs of the boilers, buildings, distribution systems, operation and maintenance costs, and energy costs. Boiler costs included all costs for equipment to meet the latest German environmental pollution standards. The study used a 25-year life-cycle cost estimate for each alternative.

In the analysis, district heat placed a close second to gas-fired heating plants as the least costly means for providing heat. According to the report, the district heat price used was a weighted average of 1985 district heat prices, including those contracts based on coal. The report noted that, "on an individual basis, some of the district heat contracts may have lower average costs and lower life-cycle costs than gas-fired plants." Therefore, it concluded that the cost-effectiveness of district heat must be evaluated on a case by case basis, as the Army currently requires.

# Actual and Potential District Heat Contracts and Coal Use in Germany

This appendix presents information on all of the contracts for district heat in Germany which had been signed as of February 1987 (see table II.1), and the number and locations of other installations where the Army believes district heat is feasible (see table II.2).

**Table II.1: District Heat Contracts Signed by the Army and Air Force in West Germany as of February 1987**

| Army contracts, by community, signed before fiscal year 1985 | Number of installations served |
|---|---|
| Ansbach | 5 |
| Ansbach | 2 |
| Augsburg | 8 |
| Berlin | All major installations |
| Darmstadt | 1 |
| Darmstadt | 1 |
| Frankfurt | 1 |
| Frankfurt | 1 |
| Frankfurt | 3 |
| Giessen | 1 |
| Giessen | 2 |
| Giessen | 1 |
| Goeppingen | 2 |
| Goeppingen | 2 |
| Grafenwoeh | 1 |
| Hanau | 1 |
| Hanau | 1 |
| Heidelberg | 6 |
| Holtenfels | 1 |
| Karlsruhe | 3 |
| Mainz | 1 |
| Mainz | 1 |
| Mannheim | 9 |
| Munich | 2 |
| Munich | 1 |
| Nuernberg | 2 |
| Nuernberg | 6 |
| Nuernberg | 1 |
| Pirmasens | 1 |
| Stuttgart | 1 |
| Stuttgart | 1 |

(continued)

| | Number of installations served |
|---|---|
| Wuerzburg | 1 |
| Wuerzburg | 1 |
| Wuerzburg | 4 |

**Army contracts, by community, signed during fiscal year 1985 and 1986**

| | |
|---|---|
| Bad Kissingen | 2 |
| Bad Kreuznach | 2 |
| Bad Toelz | 2 |
| Baumholder | 2 |
| Baumholder | 1 |
| Darmstadt | 1 |
| Frankfurt | 3 |
| Frankfurt | 1 |
| Fulda | 2 |
| Garmish | 4 |
| Giessen | 1 |
| Giessen | 2 |
| Giessen | 1 |
| Giessen | 3 |
| Heilbronn | 3 |
| Heilbronn | 1 |
| Heilbronn | 2 |
| Kitzingen | 3 |
| Stuttgart | 3 |
| Wiesbaden | 7 |
| Wildflecken | 2 |
| Wuerzburg | 1 |

**Air Force contracts signed for Air Force bases in Germany**

| | |
|---|---|
| Rhein Main Air Base | 1 |
| Bitburg Air Base | 1 |
| Sembach Air Base | 1 |

**Table II.2: Potential District Heat Locations in West Germany**

| Community | Number of installations to be served |
|---|---|
| **Army** | |
| Ansbach | 1 |
| Bamberg | 1 |
| Baumholder | 9 |
| Darmstadt | 4 |
| Frankfurt | 21 |
| Fulda | 4 |
| Giessen | 2 |
| Grafenwoehr | 4 |
| Hanau | 12 |
| Heidelberg | 4 |
| Hohenfels | 3 |
| Karlsruhe | 1 |
| Kaiserslautern | 5 |
| Mainz | 7 |
| Norddeutschland | 4 |
| Nuernberg | 8 |
| Schweinfurt | 3 |
| Stuttgart | 20 |
| Weisbaden | 1 |
| Vilseck | 1 |
| **Air Force** | |
| Kaiserslautern | 3 |
| Hahn Air Base | 3 |

Figures II.1 and II.2 show the amounts of anthracite and bituminous coal burned by USAREUR installations between 1980 and 1986 and projected consumption for years 1987 through 1991. Figure II.1 shows future coal consumption based strictly on 56 signed district heat contracts. Figure II.2 shows future coal consumption based on existing contracts and 61 pending district heat contracts.

**Figure II.1: Actual and Estimated USAREUR Consumption of Anthracite and Bituminous Coal Fiscal Years 1980-1991** (Based on District Heat Contracts Signed Through February 1987)

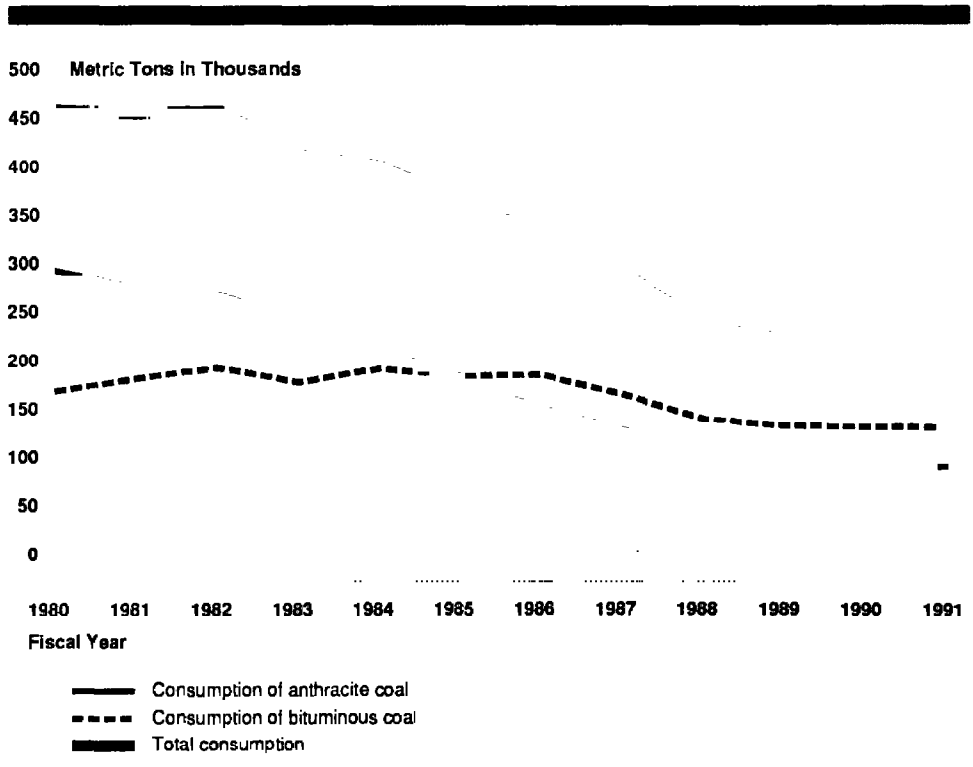
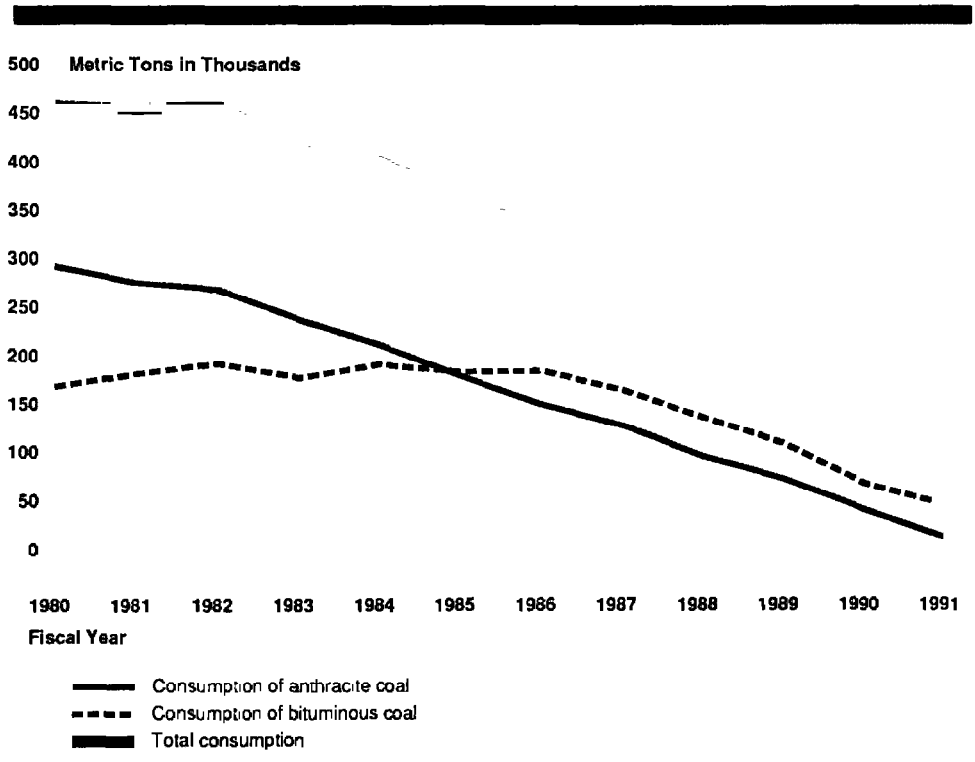


**Figure II.2: Actual and Estimated USAREUR Consumption of Anthracite and Bituminous Coal, Fiscal Years 1980-1991** (Based on Current and Planned District Heat Contracts)



# Information on Environmental and Security Considerations

Under Executive Order 12088, Federal Compliance with Pollution Control Standards, U.S. installations are required to comply with German air pollution control laws which require that certain emission standards be met. Meeting these standards would require installation of pollution control equipment costing millions of dollars. For environmental reasons, German communities have brought increasing pressure on the U.S. military to convert to district heat and to reduce its use of coal-fired heating plants. Under district heat, the public utility company, rather than the U.S. installation, is responsible for meeting pollution control laws.

Opponents of district heat conversion have questioned the security of district heat plants. Army officials do not believe that district heat significantly reduces the security of U.S. Army installations as these installations also rely on public utilities for water, electricity, and sewer services that are subject to the same types of security threats. USAFE officials stated that security is one factor that they consider, in addition to other factors such as cost, before entering into third-party-financed heat supply contracts.

## Environmental Concerns

USAREUR has begun to rely more on district heating for U.S. military installations in Germany because of growing environmental concerns and West German government opposition to coal-fired power plants. In recent years, Germany has imposed more stringent air pollution standards. In addition, local German governments may adopt more stringent standards to solve local air pollution problems. USAREUR officials said that German clean air standards require the use of best available technology for sulfur removal and, as new technology is developed, coal-fired plants will have to be retrofitted to incorporate the new technology. They stated that these standards, most recently updated in March 1986, apply to 149 existing USAREUR heating plants and that it would cost DM291 million ($145.5 million at DM2.0/dollar exchange rate) to retrofit these plants to meet the new air pollution standards. Under district heat, public utility companies use state-of-the-art emission control equipment to meet German air pollution standards. Also, many district heat plants use alternative fuels that do not generate as much pollution. Germany has responded to environmental concerns, according to USAREUR officials, by strictly regulating large fossil fuel-fired plants. German communities are eliminating small- and medium-sized coal-fired plants and replacing them with district heat networks or converting them to gas or oil. According to DOD, before fiscal year 1987 the Congress did not permit conversion of U.S. coal-fired heating plants to either

gas or oil. As a result, German national and local governments encouraged the United States to replace current coal-fired plants with district heat, which they believe is more efficient and causes less air pollution. German communities have written to the President and members of the Congress about their concerns over the potential construction of new coal-fired heating plants at U.S. military installations in Germany.

## Security Concerns

According to U.S. Army officials, district heat does not create a greater security risk than U.S.-owned coal-fired heating plants. USAFE officials stated that they take into account the ability to continue providing heat should there be major disruptions to the private heating plant, and that this is one of the major factors they evaluate before signing a third-party-financed heating contract. However, critics argue that district heat presents a security risk because German fuel suppliers rely in part on the Soviet Union and Middle East countries for oil and natural gas supplies. They also argue that district heat plants cannot be protected from sabotage as effectively as U.S.-owned heating plants, which are usually located on guarded military installations.

USAREUR officials stated that U.S.-owned coal-fired plants are subject to risks similar to district heating plants. The U.S. plants cannot operate without German utilities which supply electricity, water, and sewer. Disruption of these services would also disrupt operations of a U.S.-operated coal-fired heating plant. Also, like fuel supplies to district heating plants, the U.S. coal supply system is vulnerable to supply interruptions.

According to the German Federal Minister of Finance, Germany has taken a number of steps to ensure the uninterrupted supply of coal, oil, and natural gas:

- It is giving priority to protecting and repairing district heat plants and distribution systems.
- It is stockpiling coal. Public supply companies maintain a 100-day reserve, and the government maintains a 25-million ton coal inventory. Also, Germany has coal reserves estimated to be sufficient for another 300 years.
- It is stockpiling oil. Public utility companies maintain a 1-year supply and the government maintains a 130-day oil reserve. Germany also relies on secure sources for its oil. For example, Great Britain is Germany's leading oil supplier, while the Soviet Union is its fifth leading supplier.

- It is increasing its natural gas underground storage capacity from 2.5 billion to 7.0 billion cubic meters.
- It is purchasing natural gas primarily from NATO countries. German utilities purchase 80 percent of their gas from German, Norwegian, and Dutch sources. Germany agreed to purchase more natural gas from Norway on June 3, 1986, a move U.S. Army officials believe will greatly enhance European energy security.
- It is integrating the national gas pipeline system with the European network to enhance security.

# Objectives, Scope, and Methodology

We reviewed economic analyses involving district heat contracts signed for nine Army and Air Force communities. We selected five Army analyses to include a range of project size and recency of analysis and to include analyses prepared by both the V and VII Corps—the two Corps who had primary responsibility for the Army economic analyses.[3] We also selected one Air Force analysis for the project at Sembach Air Base. Senator Specter's office requested that we review the Army VII Corps projects at Ansbach, Augsburg, and Fuerth. The nine projects we reviewed do not provide a basis for generalizing the results of our work to all analyses performed by the Army and Air Force.

Based on discussions with the Senator's representatives, for each analysis, we determined what costs were evaluated for each alternative and, where possible, traced significant costs to supporting documentation. We evaluated the reasonableness of the cost elements included in the analyses and the adequacy of the documentation supporting the cost estimates. We also interviewed officials who prepared the analyses. We did not (1) exhaustively trace all costs back to supporting documentation, (2) develop our own estimates for major costs in each analysis, or (3) conduct our own independent analyses. We also did not independently verify the accuracy of the information provided on security and environmental issues, nor did we examine the specific environmental or security considerations pertaining to the analyses are reviewed.

Our review was conducted from November 1986 through July 1987, in accordance with generally accepted government auditing standards.

[3]Army installations at Darmstadt and Kirchgoens-Ayers Kaserne (V Corps); Bad Toelz, Bad Kissingen, and Neckarsulm (VII Corps).

# Comments From the Department of Defense

THE OFFICE OF THE ASSISTANT SECRETARY OF DEFENSE
WASHINGTON, D C 20301 8000

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LOGISTICS

JUN 26 1987

L(EP)

Mr. Frank C. Conahan
Assistant Comptroller General
National Security and
International Affairs Division
U.S. General Accounting Office
Washington, DC 20548

Dear Mr. Conahan:

This is the Department of Defense (DoD) response to the General Accounting Office (GAO) draft report, "MILITARY FACILITIES: Conversion to District Heat in Germany," dated May 29, 1987 (GAO Code 391586/OSD Case 7309).

The Department has reviewed the report, concurs with its findings and has no further comments. The Department appreciates the opportunity to comment on this draft report.

Sincerely,

John A. Mittino
Deputy Assistant Secretary
of Defense (Logistics)

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