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Local Energy Planning

Local Energy Management Processes and Programs in Italy, Sweden, the Federal Republic of Germany, and the United States

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LOCAL ENERGY PLANNING

Local Energy Management Processes and Programs in Italy, Sweden, the Federal Republic of Germany, and the United States

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ABSTRACT

Saving energy has become a significant issue in the economies of industrialized countries. In the face of the changed energy situation of the last decade, Europe and the United States have established energy policies at the national and local levels. Many local communities have processes in place for comprehensively selecting the most appropriate supply and conservation measures to deal with their particular energy problems.

National characteristics establish the boundaries within which local energy planning and program development occurs, including import/domestic fuel supplies, national energy policies (e.g., government vs. private leadership), national and local government relationships, energy supply institutions, socio-political conditions, and cultural factors. These diverge widely among countries.

This project explores energy planning issues in the four countries of Italy, Sweden, the Federal Republic of Germany, and the United States. After presenting national energy supply and use data and summarizing national energy policies, the report considers the roles of government, private and public utilities, and others in solving energy problems. The current state of energy planning is explored through in-depth analyses of the experiences of three or four "focus communities" in each country, a description of their decision-making processes and organization, and the local energy issues they address. From this is derived a set of problems and their solutions, with respect to both planning processes and the contents of plans. Finally, a set of technical solutions to local energy problems is presented, based on the focus-community experience.

The conclusions suggest elements that appear to promote success in local energy management: (1) clear national direction, (2) some local energy experience, (3) quantification in evaluating proposals, (4) public participation in plan review and approval, and (5) the existence of prior projects that can be expanded.

CONTENTS

CONTENTS (Cont'd)

TABLES

TABLES (Cont'd)

FIGURES

FIGURES (Cont'd)

FIGURES (Cont'd)

PREFACE

International Energy Agency

To strengthen cooperation in the vital area of energy policy, an agreement on an international energy program was formulated among a number of industrialized countries in November 1974. The International Energy Agency (IEA) was established as an autonomous body within the Organization for Economic Cooperation and Development (OECD) to administer that agreement. Twenty-one countries are currently members of the IEA, with the Commission of the European Communities participating under a special arrangement.

As one element of the International Energy Program, the participating countries undertake cooperative activities in energy research, development, and demonstration. A number of new and improved energy technologies and institutional arrangements, which have the potential of making significant contributions to our energy needs, were identified for collaborative efforts. The IEA Committee on Energy Research and Development (CRD), assisted by a small secretariat staff, coordinates the energy research, development, and demonstration program.

Energy conservation in buildings and community systems

The International Energy Agency sponsors research and development in a number of areas related to energy. In one of these areas, energy conservation in buildings, the IEA is sponsoring various exercises to predict more accurately the energy use of buildings, including projects on energy planning and monitoring, system simulation, auditing and glazing, and air quality and inhabitant behavior.

Although most of the Buildings and Community Systems projects are concerned with improving the energy performance characteristics of buildings, Annex VII is concerned with investigating local government functions in energy conservation and the use of local energy resources in communities.

Annex VII: Local energy planning

The worldwide recognition of the need to manage and plan for energy conservation and development more effectively has created new demands on local governments. As the level of government closest to the citizenry, local governments have a unique responsibility to help their people, businesses, and institutions quickly respond to the immediate pressures brought about by unpredictable energy costs and uncertain supplies. Over time, local governments need to develop their planning and management capability, in concert with private entities, to help ensure a reliable and efficient energy future.

Under the auspices of the International Energy Agency, researchers in four member countries have investigated local government functions in energy conservation and the use of local energy resources in communities. Within this broad area, research has focused on two topics. The first identifies innovative techniques that local governments use or support to reduce energy consumption by their citizens while preserving a high standard of living. Educational programs, grants and loans, construction programs, and other means are used to carry out this function. Some communities have given attention to the needs and concerns of rental buildings, an area with unique institutional problems in all countries.

The second topic involves a problem internal to municipal governments. Although many local governments have long established means of setting policy for and managing a variety of functions, energy decision making has not been fully institutionalized. Effective planning and decision-making methods cannot always be readily adapted from other areas of government. There is also a lack of understanding of the relationship between municipal organizations and the many municipal and extramunicipal organizations and firms that play a major role in all phases of energy production, transmission, consumption, and conservation.

This report covers the second of these topics. The research reported here identifies innovative local approaches and, through comparative analysis, hopes to inform local governments of improved opportunities for energy management and planning capabilities.

The participants in Annex VII are Italy, Sweden, the Federal Republic of Germany, and the United States.

This report is one of the two principal products of the Annex VII research. The companion report is titled *Energy Conservation Programs and Their Impact on Rental Buildings in Italy, Sweden, the Federal Republic of Germany, and the United States*. The individual country reports on which this material is based are included in the reference list at the end of this document.

INTRODUCTION

Purpose of the report

This report documents work conducted under Subtasks C and D of Annex VII and is concerned with identifying, documenting, and analyzing local energy management processes and programs in the four participating countries. It considers technical and procedural methods for local energy planning, the roles of private institutions and government agencies at various levels, and the results that are achieved -- including the range of solutions proposed and implemented to solve both supply and consumption problems.

Initially, Subtask C was to have concentrated on the process of local energy planning, with the United States (U.S.) as lead country. Subtask D was to consider plan contents and solutions, under the leadership of Sweden. However, in reviewing the working papers at the experts meeting in Basel in October 1983, the working group of researchers decided that the issues were intertwined and needed to be considered jointly, as they are here.

This report is a collaborative effort by researchers in both countries. The U.S. has had lead responsibility for Chapters 1-4, 7, and the appendices; principal authors are Norman F. Kron, Jr., and Michael J. Meshenberg. Chapters 5 and 6 were written by a Swedish team consisting of Bjorn Sundstrom, Sigvard Olsson, Folke Snickars, and Michael Pellijeff. However, researchers from each country contributed to each chapter, and overall responsibility is shared.

This report is expected to be useful to local, regional, and national government planners, energy program designers, and policy analysts and the organizations serving them, such as consultants, associations (leagues or unions of local authorities), private advisory groups, and research institutes. The information can provide valuable suggestions on how communities in the four countries have addressed the difficult problems involved in designing and carrying out comprehensive energy plans.

Prior cooperative activity

The research reported here is based on a scope of work adopted by representatives of the four participating countries in an IEA Implementing Agreement in September 1981. This had been preceded by about a year devoted to generating the work scopes, soliciting expressions of interest from IEA members, obtaining commitments, and finally writing the Agreement. The four signatories are:

- National Council of Research, Italy
- Nuclear Research Centre, Federal Republic of Germany
- Council for Building Research, Sweden
- Department of Energy, United States

In each country, work was further subcontracted to research or consulting organizations that conducted the required research.

The United States was selected as Operating Agent for Annex VII, with responsibility for overall management and execution of the work, setting up and chairing workshops, and reporting to the Executive Committee. Originally, this function was performed within the U.S. Department of Energy; later the Operating Agent functions, along with the U.S. portion of research, was transferred to the Department's Argonne National Laboratory.

Each subtask was assigned to a "lead country" responsible for maintaining the work schedule, refining the analytical framework, and conducting cross-country comparisons.

The lead country responsibilities were:

- Energy conservation in rental buildings, Subtasks A and B: Italy
- Local energy management processes and programs, originally separate Subtasks C and D, were later consolidated under the joint responsibility of Sweden and the U.S.

Research design

Approach

In conducting this work, each country selected at least three comparable focus communities and/or programs that represented the issues to be analyzed. Focus communities are as follows:*

Italy:	Brescia Reggio Emilia Modena Bologna
Federal Republic of Germany:	Berlin Saarland Rhein-Main Region
Sweden:	Kristianstad Angelholm Uppsala Ornskoldsvik Sundsvall
U.S.:	Ann Arbor, Michigan Portland, Maine Richmond, Indiana

Data about these communities and programs were obtained from available sources; no primary data were developed nor were field studies conducted.

The work on consolidated Subtasks C and D proceeded generally through four phases:

Phase 1: Documentation of existing programs

This phase included the following work activities:

a. Documentation of legal powers of the local governments in energy planning and management, including relationships between different levels of government.

b. Energy planning processes, including methods for systematic evaluation of alternatives and final plan contents.

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*The U.S. authors regret that their word processing equipment is not prepared to include special European letter forms, such as ä.

c. Decision-making processes, implementation activities, and existing plans and programs.

d. Organization of the energy planning and implementation activities in each focus community, including roles of public and private bodies.

e. Energy issues in each community that may govern the planning process.

f. Documentation of energy supply/demand characteristics in the focus communities, including use of conventional and alternative fuels.

Phase 2: Evaluation of planning processes and programs

Based on a framework developed by the lead countries, the focus community plans and planning processes documented in Phase 1 were evaluated to identify and provide an operational description of problems regarding:

a. Institutional constraints.

b. Attitudes and knowledge of local officials concerning available options and possibilities.

c. The information-collecting process and its organization.

d. The decision-making process and its organization.

e. The implementation process and its organization.

f. Instruments and measures used in implementation.

g. Contents of energy plans.

Phase 3: Identification of potential solutions

Here, the problems among the community programs identified in Phase 2 were analyzed in an effort to search for general solutions that may be applied within existing country constraints.

Phase 4: Comparison between countries

Based on the individual country analyses and recommendations, the lead countries critically compared the results to develop findings and conclusions. The resulting synthesis should be applicable to the several countries and others in helping improve organization, processes, and implementation of local energy management plans.

It is Phase 4, based on the significant work preceding it within each country, that is presented in this report.

Process

The research proceeded through an extensive series of framework papers, working papers, drafts, and final intracountry reports, many of which were submitted to the various members of the working group for review and comment. In addition, a series of workshops was held, approximately annually, in which the previous year's work was reviewed and specific plans made for conducting the later work. Workshops were held in Washington, Bologna, Basel, and Stockholm. Preliminary findings were presented at the conference titled *Energy Planning for Communities*, held in St. Paul, Minnesota, U.S.A., in September 1985.

Benefits and usefulness of the report

This report is expected to benefit its intended local audience in the various countries by:

- Identifying the country and community characteristics such as energy supplies/demands, supply systems, local authorities' powers and duties, roles of institutions and citizens, etc., that enable and limit local energy programs.

- Presenting innovative projects and approaches as a source of ideas to local officials.

- Identifying common characteristics that may -- or may not -- exist within the programs and activities.

- Helping determine whether characteristics exist that promote success of programs or planning methods.

- Helping broaden the search for solutions to problems faced by local governments in different countries.

- Helping further the process of establishing an international network of researchers interested in promoting local energy planning and management.

Limitations of the research

Although this and the companion Annex VII report should be of great benefit within and outside the four countries, important limitations exist. These limitations result both from the subject area investigated and from the process of conducting the research.

The major difficulty inherent in analyses of policy- or administrative-based issues across international boundaries is the presence of major differences among countries that can obscure the similarities. National characteristics establish the parameters within which local energy planning and program development must occur, and these parameters diverge widely among the countries. These characteristics include import/domestic fuel supplies, national energy policies (e.g., government vs. private leadership), national vs. local government relationships, energy supply institutions, sociopolitical conditions, and cultural factors.

Although statistics can be presented to describe various programs, activities and results, the findings are, by necessity, mostly qualitative rather than quantitative.

Moreover, because of these overriding conditions, researchers have spent a significant amount of effort describing country conditions to establish a common understanding before making meaningful cross-country comparisons. Thus, a significant amount of national background data has been assembled here, substantially more so than, for example, the other technical topics covered in the Buildings and Community Systems Implementing Agreement.

In addition, because of national differences, the application of the research frameworks developed by lead countries has varied. Data are not always available in identical formats or even units, and in some instances are missing entirely. Similarly, individual researchers necessarily interpreted work activities from their own national perspectives, leading to occasional inconsistencies in the analysis.

Perhaps the most important contribution of this research process, therefore, is the presentation of a large body of case-study-based descriptive data and its analysis along some common dimensions. Many interesting projects, programs, and methods are described, and common themes are identified where appropriate. But relatively few conclusions can be drawn that cut across international boundaries, and little effort has been made to develop standards, normative models, or common solutions.

Annex VII project management

Annex VII has been an international collaborative effort involving researchers and research managers from the four participating countries. Although originally intended to be managed by a steering committee composed of one representative from each country, it quickly evolved into an organization in which the management and conduct of the research were consolidated within the single group of experts. Thus, the meetings, attended by the key researchers from each country, became both technical workshops and management meetings.

Perhaps surprisingly for a project lasting more than four years, there was relatively little attrition; most of the key people participated throughout. Changes in the management personnel of funding organizations were more frequent, resulting in some mid-course changes.

Principal participants from each country are listed below; many others had smaller roles. Where roles are clearly limited to one of the two major project subtasks, these are noted (A/B = rental building energy conservation; C/D = local energy planning):

Federal Republic of Germany

Management:	Armand Duetz, Nuclear Research Center
Research:	Andreas Volwahsen, Prognos AG Bernhard Michel, Prognos AG Martin Sattler, Prognos AG Ph. Oswald, Prognos AG N. Lutzky, Prognos AG

Italy

Management:	Cesare Boffa, National Research Council Fabio A. Roversi Monaco, University of Bologna

Research: A/B - Egeria Di Nallo, University of Parma
Rosanna Canella, University of Parma
C/D - Paola Alia, University of Bologna
Mario Genova, Centro Informazioni Studi Esperienze

Sweden

Management: Lars-Erik Sundbom, The Windborne Group
Britt Olofsdotter, National Swedish Council for Building Research

Research: A/B - Tage Klingberg, Swedish Institute for Building Research
C/D - Sigvard Olsson, K-Konsult
Bjorn Sundstrom, K-Konsult
Folke Snickars, Royal Institute of Technology
Michael Pellijeff, K-Konsult

United States

Management: Floyd Collins, Department of Energy (DOE)
Jacob Kaminsky, DOE (also Operating Agent, 1981-1982)

Research: Michael J. Meshenberg, Argonne National Laboratory (ANL) (also Operating Agent, 1983-1985)
Norman F. Kron, Jr., ANL
A/B - Kim Suchy, ANL
Ivan Von Zuckerstein, ANL

Each participating country individually bore all costs associated with activities under this Annex, including management, research, and travel to the meetings. Levels of funding varied among the participating countries and in some instances were uncertain during particular periods. These factors may have contributed to occasional difficulties encountered in meeting deadlines.

In light of the results of the Annex VII research, it appears that one fruitful area for further international research is an analysis of the nature of energy policymaking among various levels of government. National and local energy interests do not always coincide. Based on the findings here, it would be instructive to determine the degree to which national-local relationships are determinants of the degree to which local governments help or hinder implementation of national objectives.

On behalf of the many researchers who contributed to this work, the Operating Agent welcomes feedback and suggestions for further research.

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Argonne, Illinois U.S.A.
October 1985

1. SUMMARY

Subtasks C and D involved research on questions related to the local energy planning process and the results of that process. For each subtask, each country selected focus communities for in-depth analysis of their energy characteristics, policies, and programs. In turn, this information was presented and analyzed in a standardized three-step method:

1. Documentation of existing programs.
2. Evaluation of planning processes and programs.
3. Identification of potential solutions.

The results of the individual country research have been presented in earlier Annex VII reports (see References). Here, the lead countries for Subtasks C and D (the United States and Sweden) have developed a cross-country comparison of focus community approaches and results. The goal has been to report commonalities and differences in approaches rather than to present extensive detail about characteristics of the individual focus communities; the latter generally are available in the country reports.

1.1 Major findings

Topics discussed cover legal powers of local governments, energy management processes, decision making, planning organizations, types of energy issues being addressed, solutions to local process problems proposed by local energy managers, and technical solutions to local problems.

1.1.1 Legal powers of local government

- Local government authority to carry out energy management programs varies by country. The Italians and Germans tend toward central control of programs, while the Swedes and Americans allow local governments more autonomy. For example, if the Federal Republic of Germany (FRG) central government orders that local governments must do energy planning, local plans will be written. In Sweden, the central government may request plans and provide incentives (such as grants) and can order plans made, but if orders are given, the central government has little control over the quality of the plans that are produced.

- The United States (U.S.) and the FRG have similar mechanisms for making decisions on central plant siting -- the states are responsible.

- Public-private cooperation is very different from country to country. In the U.S., the two sectors are distinct; industry works out its own conservation programs (if any are done at all). In the FRG, government and private-sector planners meet to set mutual goals and jointly plan for the best ways to achieve them.

- Cities vary on how much authority they have over utility ownership and control. Italian cities have control over natural gas and district heating systems, but have almost no control over electricity (which is supplied by a national government monopoly). Swedish cities control all, with limited private ownership allowed. German and U.S. control depend on the state, city size (home rule), and ownership of the utility.

1.1.2 Energy management processes

- Every city used a different process to complete its energy plan. But sufficient similarities can be identified to develop a composite approach.

- National models or methodologies have been important influences on the processes followed by local governments. All of the Swedish communities, at least one Italian community, and all of the U.S. communities were directly influenced by generic approaches.

Many of the management problems identified are unique to one community. Most of these are classified as problems in:

- Data availability.

- Funding.

- Unclear local government power, jurisdictional problems.
- Unclear lead authority regarding the agency that should be in charge of the energy program.
- No direct city control over utilities.
- Evaluation of program results, lack of methods, funds, time, motivation.
- Overreliance on a single option.
- Lack of monitoring of results of implemented programs.
- Lack of supply/demand coordination and coordination of energy with other plans.
- A narrow perspective that may limit interest to certain sectors, technologies, geographic areas, or municipal projects.

1.1.3 Decision making

- As in the U.S., the decision for European communities to start planning is based on the severity of local problems and the availability of outside grant funds to finance planning.
- The parties responsible for plan implementation vary among the communities, depending on whether utilities are public or private, whether there is need for private-sector cooperation, whether there is national participation in local affairs, and the options being implemented.
- At least one computer-based decision-making method has been developed to aid in optimizing local energy supply choices, but thus far, automated decision-making methods are rarely used in local energy planning.

1.1.4 Planning organizations

- Government agencies almost always direct local energy planning efforts.

- Utilities, planning offices, public works departments, waste disposal agencies, miscellaneous city offices, private and public expert advisors, and consultants frequently help in the planning process.

- In Europe, the government planning staff is sometimes helped by a fairly small committee of experts. In the U.S., an expert committee may be used, but more often a lay citizen committee provides advice.

- Communities that had the municipal utility in charge of planning tended to have little public involvement. The utilities tend to hold substantial independent implementation power. These plans avoid recommending programs that cannot be directly implemented by the local utility.

- Sweden tends to have several city offices work on an energy plan simultaneously. Each office prepares a plan for the topic of its expertise (thus, the office of land use plans land use as it relates to energy, the building design office considers buildings, etc.). This varies from the U.S., where a single office (often the planning office, city manager's office, or public works department) writes the entire plan, perhaps consulting with other departments.

1.1.5 Energy issues being addressed

- Six major issues are addressed by most local programs: (1) imported oil dependence, (2) high and escalating energy prices, (3) possible energy shortage, (4) need to build or expand a district heating system, (5) need for public education, and (6) need to use more alternatives. These issues were cited by at least 10 of the 16 communities.

- Seven of the 16 communities cited these five issues: (1) need to increase public-sector efficiency, (2) no local conventional sources, (3) refuse management needed, (4) high local government energy costs, and (5) environmental preservation. Although some of these issues overlap, they emphasize that these communities share many of the same concerns.

- Some national patterns include Sweden's desire to switch from oil to hydroelectricity, U.S. interest in public education, German and U.S. concern with finding capital for energy projects, Italian concern with waste management, and the European interest in expanded district heating (compared with much lower U.S. interest).

- Structural barriers may preclude resource use; such barriers include fixed land use patterns, technological limitations, need to keep housing affordable, narrow streets, low population density, and industrial relocation away from central areas.

- Local issues were addressed in part by looking at alternative resource and conservation options. The following list shows the most prominent options considered and the number of communities that seriously looked at each:

Resources	Number of Communities
Refuse	13
Solar	10
Hydroelectricity	8
Coal	8
Wood and Waste	6
Industrial Heat	6
Wastewater	6
(no others with more than 3)	

Techniques	Number of Communities
Conservation	14
District Heating	14
Cogeneration	10
(no others with more than 3)	

1.1.6 Solutions related to the role of local government

- Increased relative prices of oil are reshaping the world energy market. In pre-energy-crisis times, countries (and communities) could seek the cheapest supplies without regard to the origin of those supplies. Now, local sources are reemerging in importance because the increased oil prices have made the problems of fuel or resource extraction and use economically surmountable.

- Recent decreases in oil prices have universally quashed enthusiasm for energy conservation and innovative supply systems. Countries that have been able to sustain interest in conservation have found large returns in terms of energy savings. But for a given building, as more funds are put into conservation, the smaller the marginal return. Sweden notes that while conservation can provide large returns, supply options must also be considered or the maximum benefits of energy activities cannot be achieved.

- The sheer numbers of local governments, geographic fragmentation, and split functional responsibilities within local governments have contributed to a lack of comprehensive, coordinated solutions in all the countries. The Swedish national government has taken action to reduce the number of municipalities. U.S. communities have placed planning offices in various city departments, experimenting with different approaches to see which is most effective.

- The less power held by municipalities, the more likely a national government will bypass them to implement its programs by working directly with energy suppliers and users.

- Financing energy programs in general, and large energy supply systems in particular, is a problem in all the communities. National support is universally seen as a solution. The U.S. tends to see more of a need for an expanded private-sector role and has developed a number of financing tools to encourage private participation.

- Inexperienced staff is a problem in nearly all of the communities. Two solutions proposed were to improve training programs or to seek expert help from local utility suppliers, consultants, or experienced consumers.

- Lack of public awareness and interest was frequently cited as a problem, and media presentations and demonstration programs were commonly suggested solutions. Nationally sponsored information campaigns were strongly recommended.

- Lack of reliable (or any) information about energy supply and use was common to most focus communities. Some communities found that extensive data collection consumed much staff time and funds. Solutions tended toward three changes in planning processes: either (1) simply collect fewer data and focus on the data truly needed for analyzing realistic options, (2) use advanced techniques such as computer-aided data bases and cluster analysis, or (3) structure national data collection (such as the census) to ask energy-relevant questions that local planners may use. Care must be taken to ensure that the data are available in a timely manner (consider, for example, the value of 1970 census data in 1975).

- Evaluations of local energy conservation and supply options tended to focus on one option at a time rather than looking at the potential combined effects of several simultaneously implemented options. Methodological tools are emerging that can cut across supply/demand and residential/commercial/industrial lines. Probably, these tools can be best developed nationally, where duplication of effort will likely be minimized.

1.1.7 Technical solutions

- Focus communities have implemented a wide variety of technical solutions. Solutions pursued seem to depend on the economics of the new project as compared with existing alternatives (for example, district heating vs. natural gas in the U.S.), local resources (for example, inexpensive hydroelectricity and municipal wastewater for heat pumps in Sweden), major energy-using sectors or problem areas (for example, automobile-related programs in the U.S.), proximate location of a new energy supply and a significant user (for example, landfill biogas and an industrial user in Italy), experience with technology (for example, low-temperature hot water district heating in Sweden), and local attitudes (for example, the tendency in the U.S. and FRG to implement solutions for individual buildings rather than to begin large-scale cooperative projects).

- The higher the cost of energy and the more unreliable the supply, the more likely that major energy system changes will occur. In addition, the type of energy distribution system existing in a community plays a key role in the options chosen for implementation. For example, Sweden has extensive district heating networks. The communities in that country emphasized technologies to supply heat to the system more cheaply or from domestic sources. Thus, a very large solar system designed to feed heat to a hot water distribution system was attempted in Sweden. The solid fuel, heat pump, and most other technical options found in Sweden also are designed to feed the water-based heat network. Some Italian communities have substantial natural gas distribution networks; thus the biogas option is an expectable experiment. The general lack of distribution systems in the U.S. for low-temperature hot water often make options based on this technology too costly when compared with the existing natural gas network. To some extent, the FRG shares this problem when trying to introduce district heating options.

1.2 Conclusions

In conclusion, what seem to be the most important factors influencing the implementation of energy projects? In the Annex VII communities, six factors stood out:

1. Clear National Direction: (1) giving local governments a goal and justification for their own programs, and (2) committing the national government to fund long-term planning, research, and implementation.

2. Some Local Energy Experience: previous knowledge of how energy systems work seems to help energy managers when they try to plan and implement programs.

3. Quantification in Proposal Evaluation: if the quantified effects of a proposed local program are known, the program will more likely be implemented if warranted.

4. Community Organization for Review/Approval: either an expert or lay panel seems to be important to having proposals implemented.

5. Building on Past Projects: successfully implemented programs tend to be outgrowths of existing national programs or expansions of existing operations. Precedents, previous commitments, and incremental building on established successful projects are important to future success.

6. Outside Project Funding: the national government or other outside sponsors should bear much of the risk of project failure -- especially for large-scale capital projects that further national as well as local policy objectives.

Thus, local governments have a valuable role to play in the accomplishment of energy objectives, but that role is difficult to fully realize without strong, consistent, and continuous national leadership.

2 PRESENT ENERGY SITUATION, CURRENT POLICIES, AND GOALS OF PARTICIPATING COUNTRIES

Chapters 2 and 3 provide background information on the four Annex VII countries. The data highlight similarities and differences in the countries' energy supply/demand patterns, their energy import situations, and the organization of their local governments, as a basis for the later analysis of their energy management processes, problems, and programs.

2.1 General data on participating countries

Table 1 provides national data on Italy, Sweden, the FRG, and the United States.* These data are briefly discussed below:‡

- All countries and the U.S. Northeast and North Central census regions are in a steady or slow-growth mode that should contribute to energy objectives by keeping down population-driven increases.

- High Italian and German population densities suggest lower-volume dwelling units and shorter home-to-work commuting distances. These characteristics could decrease per-capita energy use.

- The U.S. population increase suggests that there will be continuing pressure to increase energy use, while the more constant European populations should help contain growth in energy use.

- Currency values are provided to give a basis for economic comparisons between countries. The European Currency Unit (ECU), calculated by the Statistical Office of the European Communities (Eurostat), is a standard monetary unit whose calculation is explained in detail in Eurostat publications (including Ref. A3).

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*For the U.S., data were to be limited to the Northeast and North Central census regions. Due to problems with regional data availability, some statistics are reported for the entire U.S.

‡In all tables, decimal points and commas follow standard U.S. notation. For example, 1,800 is one thousand eight hundred, while 1.800 is one and eight-tenths.

Table 1 General conditions in the four countries

Characteristic	Italy	Sweden	FRG
Population, 1980 (10^6)	57.04[a]	8.31[a]	61.56[a]
Population, 1970 (10^6)	53.67[b]	8.09[b]	61.68[b]
Change, 1970 to 1980 (%)	+5.9	+2.7	-0.2
Urban, 1980 (%)	--	82	--
Rural, 1980 (%)	--	18	--
Area			
(mi^2)[a]	116,303	173,665	95,815
(km^2)	301,225	449,793	218,161
Population Density, 1980			
(per mi^2)	490.44	47.85	642.49
(per km^2)	189.36	18.32	248.07
Population Projection (10^3)[c]			
1990	57,258	8,399	60,640
2000	57,925	8,386	59,143
Labor Force, 1982 (% per sector)[c]			
Agriculture	12.4	5.6	5.5
Industry and Commerce	37.0	30.3	42.7
Services	50.6	64.1	51.8
Unemployment Rate	10.5	3.1	6.8
Economy[c]			
Currency Values (1982 Average)			
1 European Currency Unit =	1323.78	6.14336	2.37599
Therefore:	1.00 lira	0.00464	0.00179
	215.48	1.00 SEK	0.38675
	557.15	2.58560	1.00 DM
	1351.20	6.27059	2.42520
Gross Domestic Product			
1981 (10^9 European Community Units)	317.7	101.0	614.2
Per-Capita, 1981 (PPS)[e]	7,424	9,570	9,590
Annual Growth Rate, 1970-1981	2.6[f]	1.6	2.4

2.2 Energy data for participating countries

This section provides energy statistics on the energy situation in each participating country. The tables and figures are:

- Table 2: Energy End Use by Sector (provides IEA statistics).
- Table 3: 1981 Energy Production and Imports.
- Figure 1: Evolution of Energy Imports.

Table 1 (Cont'd)

Characteristic	U.S. (Northeast and North Central)	U.S.
Population, 1980 (10^6)	108.0	226.5
Population, 1970 (10^6)	105.6	203.2
Change, 1970 to 1980 (%)	+0.3	+11.5
Urban, 1980 (%)	74.5	73.7
Rural, 1980 (%)	25.5	26.3
Area		
(mi^2)[a]	417,636	3,618,467
(km^2)	1,081,677	9,371,830
Population Density, 1980		
(per mi^2)	258.50	62.43
(per km^2)	99.80	24.10
Population Projection (10^3)[c]		
1990		245,472
2000		263,829
Labor Force, 1982 (% per sector)[c]		
Agriculture	--	3.6
Industry and Commerce	--	28.4
Services	--	68.0
Unemployment Rate	--	9.5
Economy[c]		
Currency Values (1982 Average)		
1 European Currency Unit =	0.97971	0.97971
Therefore:	0.00074	0.00074
	0.15947	0.15947
	0.41234	0.41234
	1.00 U.S. $	1.00 U.S. $
Gross Domestic Product		
1981 (10^9 European Community Units)		2,603.2
Per-Capita, 1981 (PPS)[e]		11,706
Annual Growth Rate, 1970-1981		2.6

[a]Ref. A1.

[b]Ref. A2.

[c]Ref. A3.

[d]Estimate.

[e]Purchasing power standard from Ref. A3.

[f]1970-1982.

The following observations are derived from these tables and figures:

- Table 2 (energy use) shows the high oil dependence of the European participants compared with the U.S. Coal is a much greater factor in the U.S. than in Europe. Nuclear power is still a minor factor in all

Table 2 National energy use by sector

Italy	1981 TWh[a]				
	Industry	Transportation	Other	Total	Per-centage
Oil	234	274	221	729	62
Solid Fuels	62	-	7	70	6
Gas	123	-	108	231	19
Electricity	91	-	64	155	13
Heat	-	-	-	-	-
Other	-	-	-	-	-
Total	511	274	400	1185	100
Percentage	43	23	34	100	-
Per Capita (MWh)[b]	-	-	-	20.7	-

Italy	1990 TWh				
	Industry	Transportation	Other	Total	Per-centage
Oil	204	326	152	682	48
Solid Fuels	88	-	15	103	7
Gas	206	-	157	363	25
Electricity	137	-	117	254	18
Heat	5	-	19	24	2
Other	-	-	-	-	-
Total	640	326	460	1426	100
Percentage	45	23	32	100	-
Per Capita (MWh)	-	-	-	24.2	-

Table 2 (Cont'd)

Sweden	1981 TWh Industry	Transportation	Other	Total	Per-centage
Oil	63	65	97	225	59
Solid Fuels	47	-	9	56	15
Gas	0.1	-	0.6	0.7	0
Electricity	41	2	45	86	22
Other	-	-	15	15	4
Total	151	67	167	387	100
Percentage	39	17	44	100	
Per Capita (MWh)	-	-	-	46.1	-

Sweden	1990 TWh Industry	Transportation	Other	Total	Per-centage
Oil	25	72	34	131	37
Solid Fuels	60	-	16	76	21
Gas	3	-	1	4	1
Electricity	46	-	58	104	30
Other	5[c]	-	34[c]	39[c]	11
Total	133	72	143	347	100
Percentage	38	21	41	100	-
Per Capita (MWh)	-	-	-	-	-

Table 2 (Cont'd)

FRG	1981 TWh Industry	Transportation	Other	Total	Per-centage
Oil	334	440	449	1223	56
Solid Fuels	221	-	60	281	13
Gas	174	-	177	351	16
Electricity	151	10	156	317	14
Heat	7	-	34	41	2
Other	0	-	0	-	-
Total	887	450	876	2213	100
Percentage	40	20	40	100	-
Per Capita (MWh)	-	-	-	35.9	-

FRG	1990 TWh Industry	Transportation	Other	Total	Per-centage
Oil	361	432	454	1247	50
Solid Fuels	198	-	47	245	10
Gas	291	-	209	500	20
Electricity	198	10	221	429	17
Heat	12	-	58	70	3
Other	0	-	-	-	-
Total	1060	442	989	2491	100
Percentage	43	18	40	100	-
Per Capita (MWh)	-	-	-	40.8	-

Table 2 (Cont'd)

U.S.	1981 TWh Industry	Transportation	Other	Total	Percentage
Oil	1386	5028	1449	7863	53
Solid Fuels	772	-	44	816	6
Gas	1696	-	2227	3923	27
Electricity	786	-	1336	2122	14
Other	-	-	-	-	-
Total	4640	5028	5056	14724	100
Percentage	32	34	34	100	-
Per Capita (MWh)	-	-	-	64.1	-

U.S.	1990 TWh Industry	Transportation	Other	Total	Percentage
Oil	2396	4652	768	7816	47
Solid Fuels	1756	-	58	1814	11
Gas	2070	-	1989	4059	24
Electricity	1198	-	1570	2768	17
Other	35	-	105	140	1
Total	7455	4652	4490	16597	100
Percentage	45	28	27	100	-
Per Capita (MWh)	-	-	-	68.1	-

[a]TWh = terawatt-hours.

[b]MWh = megawatt-hours.

[c]District heating fuels (oil, electricity, and solid); National Board of Energy forecast.

Source: Ref. S10.

Table 3 1981 energy production and imports of the four countries

Country	Coal and Lignite (10^3 metric tons)	Crude Oil (10^3 metric tons)	Natural Gas (10^3 TJ [GCV])[a]	Nuclear[b] (GWh)	Primary Electricity[c] (GWh)
Italy					
Production	0	1,487	535	2,541	170,956
Imports	18,924	90,004	485	-	9,632
Available	18,924	91,591	1,020	-	180,588
Sweden					
Production	28	6	0	36,036	64,619
Imports	2,027	14,743	0	-	-2,646
Available	2,055	14,749	0	-	61,973
FRG					
Production	95,545	4,442	673	50,758	296,498
Imports	-593	64,991	1,306	-	7,899
Available	94,952	69,433	1,979	-	304,397
U.S.					
Production	698,062	478,416	21,203	272,681	2,086,551
Imports	-101,151	251,142	714	-	26,133
Available	596,911	729,558	21,917	-	2,112,684

[a]TJ: Terajoules; GCV = Gross Calorific Value.

[b]Electricity production only.

[c]Not including nuclear.

Source: Ref. A3.

countries. The U.S. total hydroelectric production is considerably larger than in Europe, but it is dwarfed by the total U.S. energy supply. Alternative sources (except for Sweden's 2% wood-waste use) are not yet factors in national energy supplies.

- Among the European participants, Sweden is unique in having little natural gas but well-developed district heating networks. The country's distance from established European gas networks, together with the competition between new gas lines and existing district heating networks, has slowed the introduction of gas. The improving FRG natural gas system is probably causing the reverse effect.

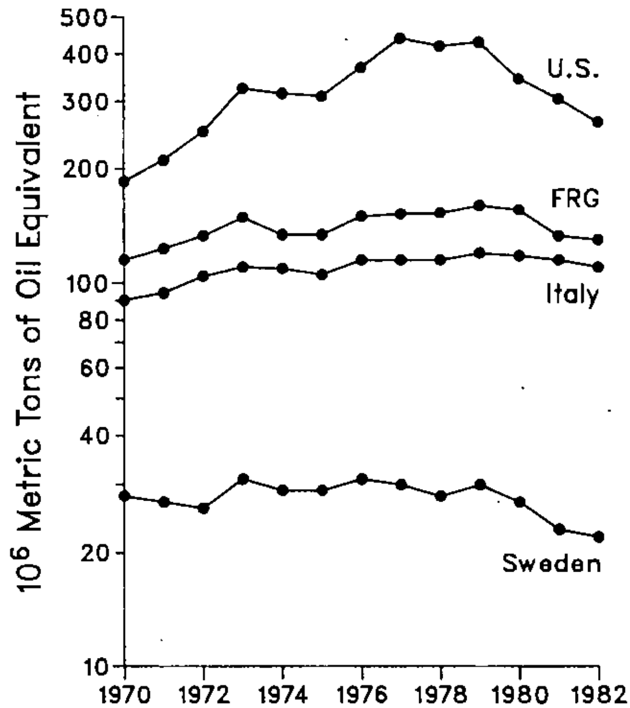

Figure 1 Energy imports of the four countries

- Together, residential and commercial uses (part of "other") consume 34 to 44% of each nation's energy supply. Except in the U.S., industry requires about 40% of the supply. Transportation consumes a larger portion of energy in the U.S. than in Europe, due in large part to the more widespread use of automobiles in the U.S.

- The import situation in Europe is considerably more severe than in the U.S., especially for oil.

- Domestic oil production appears to be a minor factor in the European energy picture for the participating countries, but is a major factor in the U.S.

- As shown in Figure 1, the quantity of fuel imports has been affected by the 1974-1975 recession and the 1979 OPEC price increases. Between these dates, imports rose significantly, suggesting that price and supply reliability have major effects on total consumption. The sharp U.S. decline in imports after 1979 is mostly due to increased fuel prices, conservation, and increased domestic production.

There seems to be little doubt that the biggest energy problems in all participating countries center on their reliance on expensive imported oil. This dependence has caused prices to quadruple, created trouble with trade balances, made supplies unreliable, and made all vulnerable to random events in politically unstable areas.

Italy and Sweden import more than 80% of their total energy supply. Although the U.S. imports "only" 14%, the absolute quantity of imported energy is higher than the total domestic and imported energy used in Italy and Sweden combined. Nearly 94% of the FRG's crude oil is imported.

The magnitude of the problems and the distribution of political power suggests there is need for action in all sectors by all government levels. All participating countries need to address the problem of oil use in transportation. Italy, with 54% of its electricity generated by oil-fired facilities, needs to implement measures to increase generation efficiency or change to more stable fuels such as coal. The U.S. also should look for improvements in electric generation -- 25.8% of U.S. electricity is generated by oil and natural gas. Only a very small amount of U.S. electric capacity is used in cogeneration. Thus, district heating options may be an important part of U.S. energy strategy once domestic fuel prices rise enough to make the technology economically viable.

All participating countries have identified problems in the residential, commercial, industrial, and transportation sectors. Massive improvements are possible in the thermal characteristics of building envelopes and in the efficiency of individual building heating systems. The FRG appears to be a leader in gaining voluntary energy use reductions from industry. In the U.S., recent price stabilization and seemingly stable supplies have slowed public enthusiasm for implementing energy projects.

More than 10 years after the first Arab oil embargo, all of the participating countries remain highly oil dependent. The Europeans, with fewer domestic resources, appear more vulnerable than the U.S. The per-capita use figures suggest that the U.S. may be able to significantly decrease its use, thus helping the international supply situation.

2.3 Highlights of current energy initiatives in participating countries

Each of the four countries has taken different major program initiatives that affect the energy planning programs of local governments. Some of the most important national actions are noted here.*

In Sweden, pricing and tax policies continue to play an important role in achieving energy policy objectives. A recent study of tariff systems for electricity, gas, and district heating recommended that energy prices should reflect long-term marginal costs. Swedish taxes are imposed on oil products and hard coal. Other fuels are not specially taxed but are liable for the normal value added tax (VAT).

The initial energy conservation rules in 1974 implied that the bulk of investment for conservation purposes was to be supported by state loans and grants. The rules were changed several times in response to market conditions. The total sum of distributed loans and grants as a straight sum of current prices for the period 1974 to 1982 is SEK 6,890 million.

In Italy, government price controls apply to many forms of energy. A serious financial problem exists in the electricity sector where tariffs continue to be subject to control by the Inter-Ministerial Pricing Committee (CIP), but the tariffs are set too low to recover all costs. Most oil product prices are monitored, requiring oil companies to provide price lists that refer to the average European inland price. Maximum prices for gasoline and liquefied petroleum gas (LPG) are fixed by the CIP. Natural gas prices to domestic and some industrial consumers continue to be controlled.

The Italian law on energy conservation was approved in May 1982 and provides incentives and authority for a number of useful fuel switching measures. The measures are for the power production, industry, transport, residential, and commercial sectors. The financial support to industry consists of grants and loans for energy saving measures and utilizing renewable sources or energy saving prototypes. Grants will be given to the transport sector for purchase of electric cars. Financial incentives will also be given for demonstration projects for the efficient use of gasoline. Financial support to the residential and commercial sector is through a group of incentives to

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*This section is a modification of material from Ref. S10.

use renewable energy sources and energy saving consumption in air conditioning through capital grants. In a new law, 3-1983, financial incentives are given to communities and regions for converting to coal in plants and for new construction of nuclear and coal-fired plants.

In the FRG, energy prices are generally not regulated. The exceptions are that (1) domestic coal prices are subsidized through a special levy on electricity in order to recoup the higher cost of domestic coal and (2) electricity tariffs to small-scale consumers are subject to approval by the regional (laender) government.

A number of FRG programs and measures have been adopted to realize the potential for conservation in space heating. The regulation on thermal insulation, in existence since 1977, and the 1978 regulation on standards for heating systems and hot water systems have been amended to enlarge their scopes.

The Program to Promote Energy Savings Investments (ModEnG) provides subsidies and fiscal incentives for insulation, upgrading of heating systems, etc., in existing buildings. Under the ModEnG, house owners investing in energy conservation measures can choose between a direct subsidy or an increased depreciation allowance.

In the FRG, energy conservation is stimulated mainly by six federal/laender programs, the effectiveness of which has recently been computed by the IFO-Institute in Munich. These six programs account for 2/3 of the total effect of federal measures up to 1985. Consumers are the primary focus for five of these programs. The focus of the sixth program -- the district heating program, which is by far the most expensive and the most effective program -- is the utility companies. The federal programs have become models for local energy programs.

Apart from the federal/laender programs, energy conservation is stimulated by municipal and regional energy plans designed and implemented by utility companies and local government agencies in joint efforts. Even these local attempts partly depend on federal decisions, because many of the so called "Ortliche und regionale Energie-versorgungskonzepte" (local and regional energy planning concepts) are subsidized by federal grants.

In the U.S., the identification and removal of market impediments has become the main facet of the national administration's energy policy. The intention is to allow energy prices to reflect world market conditions as closely as possible. Thus, in theory the myriad of decisions made by both producers and consumers will result in an efficient and responsive U.S. energy market.

Crude oil prices in the U.S. were decontrolled in 1981 and the national administration is moving toward the decontrol of the natural gas market. Electricity prices remain controlled to some extent because of local monopoly conditions. Solid fuel prices, as in most participating countries, are not generally subject to control.

The withdrawal of government interference in energy markets has also extended to a reduction in government funding for conservation and research and development programs.

The main programs in the U.S. residential and commercial sector are as follows:

- The Energy Tax Act of 1978 allows any individual to claim a 15% tax credit on the first U.S. $2000 spent on conservation measures applied in the home. A 40% cost credit may be taken or the first $10,000 spent on specific renewable resource measures such as solar heating, wind, and geothermal energy systems. Special depreciation and tax credits are available for industry, too. All of these tax subsidies probably will expire at the end of 1985.

- Large utilities were required by law to offer their customers retrofitting assistance through provision of energy audits and help in obtaining financing for energy conservation and the use of renewable energy sources. The program has been modified to reduce the regulatory burden on utilities.

2.4 Energy forecasts and goals of participating countries

2.4.1 Sweden

In 1981, the energy policy of Sweden was reformulated by Parliament to make a reduction of oil consumption a primary goal. One important reason for this was the steeply increasing relative price of oil in Sweden that, to a large extent, was caused by a gradual depreciation of the Swedish currency. The national objective for the period 1980-1990 is:

- A reduction of the current annual import volume of oil (27 billion tons) by 45% during the period. The goal is to reach a level less than 155 TWh. The expected change in the country's fuel mix was presented in Table 2.

This reduction is planned to be obtained by:

- Conservation efforts that cover 25% of the reduction.

- Substitution of oil for other fuels, including domestic solid fuel, hydro-electricity and introduction of heat pumps, etc.

The goal of the energy conservation program is to attain the lowest level of energy use compatible with social goals and economic needs. Sweden possesses virtually no oil, natural gas, or coal, but has a developed hydroelectric generating system and a major nuclear industry. Efforts to encourage energy efficiency and switching away from oil have been relatively successful to date. Oil consumption fell at an average of 2.8% per year between 1973 and 1981, with its share of total primary energy (TPE) declining from almost 60% to 45% over the same period.

2.4.2 Federal Republic of Germany

Energy policies in the FRG have followed the Third Revision of the 1973 Energy Policy Program, which was adopted in 1981 and concluded with a positive vote by the federal government on June 16, 1982. The main goals of the German energy policy as outlined in this program are to:

- Stimulate rational use of energy, particularly of mineral oil.

- Decrease the market share of mineral oil by increasing all other potential supplies.

- Stabilize the market share of German pit coal and to increase the share of imported pit coal.

- Secure the natural gas supply by diversification of countries of origin.

- Increase the percentage of power plants producing electricity and heat (cogeneration) to increase the contribution of district heating.

- Secure the oil supply by diversification of countries of origin.

- Increase the market share of nuclear energy.

- Improve coördinated action within the European Economic Community (EEC) and the IEA.

The government does not develop its own energy balance projection, but balance projections are prepared by independent research institutes.

2.4.3 Italy

The National Energy Plan, approved in 1981, emphasizes energy saving efforts and the development of coal and gas imports. Only a modest expansion in nuclear power is envisioned, as compared to previous estimates. The aim, as suggested by Table 2, is to stabilize overall oil consumption by 1990 at the 1981 level and to decrease the oil share in TPE from about 66% to less than 50%. In 1973, this share was 75%.

Italy's domestic energy sources are hydroelectricity, geothermal energy, and natural gas. Hydro and geothermal power contributed 7.8% and natural gas 8.4% to TPE in 1981. The major issue is to substitute oil for coal as a means of improving security of energy supply. Nuclear expansion beyond 1990 becomes an urgent issue if the country is to decrease its burden of imported energy in the long term.

2.4.4 United States

Over the past years, energy policies in the U.S. have undergone a significant change. The policy emphasis has moved strongly toward deregulation of markets.

Oil consumption has shown a strong decline, and crude oil requirements are now back to 1971 levels. It is not clear if these results are a response to market-oriented energy policy or to lower levels of economic growth. The total consumption of energy has decreased by about 5% between 1973 and 1981, due to a decrease in the industrial sector.

Forecasts have been done by several federal government organizations. Two projections were presented in the U.S. Subtask D, Element 3 report (U5). The two projections are very different in terms of the total quantity of energy to be consumed and in the quantity of renewable resources to be used. An IEA projection is shown in Table 2.

2.4.5 Cross-country comparison

Italy is the most oil-dependent of the four countries, although all are strongly dependent on oil as an energy source. Sweden uses the greatest percentage of solid fuel. In Sweden, industry uses the majority of all solid fuels. The U.S. possesses a great deal of domestic natural gas that is used in all sectors except transportation. Sweden has the highest share of electricity, mostly generated by hydro power and nuclear sources.

Of the four countries, Sweden has the most ambitious program for reducing oil consumption. This reduction will be made by lowering the use of oil in the residential and commercial sectors. The FRG is the only country that plans to reduce its oil consumption only in the transport sector. The U.S. will reduce its oil consumption both in transport and in the residential and commercial sectors. Italy will reduce its oil consumption in the industrial, residential, and commercial sectors.

All Annex VII countries have oil-dependence problems. As a result, the three European countries have exceptionally high energy costs and face the real possibility of serious economic consequences if another Mideast oil cutoff occurs. The U.S., with its relatively substantial domestic oil supply and its huge coal reserves, is comparatively less vulnerable. The fuel situation translates to variations in the degree of local government interest in energy issues and in levels of national government funding and moral support for local planning activities. Sweden, for example, with hydroelectricity as its only major domestic energy source and a serious need for heating and transport fuels, has a strong national mandate for local planning, offers several nationwide funding programs, and appears able to implement substantial capital projects -- such as extensions of district heating lines -- much faster than the other countries.

3 THE ROLES OF GOVERNMENT LEVELS IN SOLVING ENERGY PROBLEMS

This chapter describes the powers and duties of local, state, and national governments, and the relationships among them in the four countries as a basis for understanding how energy planning and implementation occurs. Charts illustrating these features in greater detail are presented in Appendix A.

3.1 Legal powers of local governments

3.1.1 Sweden

In 1978, the National Parliament of Sweden adopted a plan to reduce energy consumption in the existing stock of buildings by almost 30%. Oil reduction was the primary goal. Local governments received the responsibility for the associated planning and implementation activities. Two basic reasons underlie this decentralized approach:

- Energy conservation planning cannot be efficiently implemented unless it is integrated with the planning for other sectors at the local level.

- Local governments have an important function as entrepreneurs in the energy sector.

Hence, the role of local governments is twofold: planning authority and entrepreneur. Aspects of these two roles are shown in Table 4.

According to decisions of the Swedish Parliament, each municipality should:

- Establish local energy supply plans.

- Carry out conservation measures on its own buildings and measures that increase the efficiency of the supply systems (district heating systems, etc.).

- Provide nationally funded inspection and advisory services to private owners of buildings and administer the provision of energy conservation loans and grants.

Table 4 Energy roles of Swedish local governments

The role as an authority	The role as an entrepreneur
Energy planning concerning:	
- distribution of electricity	Distributor of electricity
- district heating system	Distributor of district heating
- fuel supply	Buying fuel for district heating
Traffic planning	Public transport
Building permits	Building and administering their own buildings

- Organize physical planning, planning of housing location, etc., so that energy supply and consumption aspects are considered properly.
- Finalize an oil reduction plan.

According to a national act in 1978, each local government is supposed to formulate a conservation program that should contain the following information:

- A selection of buildings that are candidates to receive financial support to cover the costs of conservation measures.
- Selection of geographic areas in which renovation and reconstruction measures should be coordinated with energy conservation measures.
- An investigation of how conservation measures will influence and are influenced by existing and planned systems for district heating.
- A 10-year time schedule (plan) containing a priority ranking for energy conservation initiatives of the local government.
- An implementation program showing:
  - The houseowners and areas selected for the information program.
  - The contents of the information program.

- The owners and areas that are to be offered advisory services and technical inspection.

- The inspection/advisory program.

The conservation program also must consider esthetic and similar aspects. Finally, the program should contain an evaluation of the effects of the conservation measures on (1) energy consumption, (2) employment, and (3) capital costs.

In 1981, the central government presented a bill providing guidelines for energy conservation decision making. A comprehensive approach was suggested in which conservation planning was interlinked with city renewal projects and the development of local energy sources. Local authorities were responsible for implementing conservation measures in municipally owned buildings.

National economic assistance for conservation measures has been available for private real estate owners since 1974. The terms for receiving loans and grants have changed over time. Loans and grants to private real estate owners are administered by local authorities.

With regard to the energy supply in municipalities, the responsibilities of local government are stipulated in an act of 1977:

- Each local government shall consider energy aspects in its planning activities in order to establish conditions ensuring a secure, sufficient, and cost-effective energy supply.

- Each municipal government must investigate the possibilities of cooperating with other municipalities. Energy producers and distributors shall, when requested, provide information needed for the planning of the municipality.

A 1978 act regulates the construction and maintenance requirements of new buildings. The local government is required to control the energy economy of new buildings. Moreover, the government approves the location of all industrial plants that have significant importance for energy conservation in the municipality.

Another goal is to reduce oil consumption 25-40% by 1985 and 50-75% by 1990. The main task for this planning is to produce the basis for the municipalities to make their own decisions and implement measures. State authorities help municipalities identify the possibilities to save energy and substitute oil. The planning activity includes all heated buildings, community-owned buildings and establishments, and district heating systems. Energy for industrial processes is not included, whereas energy for heating of industrial buildings is included.

The first step in planning is to describe the present situation, and the second step is to develop methods for oil reduction and the setting up of an oil reduction plan. A national "Oil Replacement Fund" has been instituted by the government to give financial support to municipalities for substituting oil. The State Industrial Board has developed a model for oil reduction planning in municipalities.

The planning activities of the municipalities can be summarized in the following steps:

1. Description of the present situation.
2. Possibilities to save and substitute oil.
3. Oil reduction forecasts.
4. Oil reduction program.
5. Prospects for implementation.

The oil reduction plan is an important basis for a continued dialogue between the state and the municipality. The plan is a first step in a continuing process that will lead to an improved decision basis for both the state and the municipality. To be an instrument to reduce oil consumption, the plan must be continuously revised. Planning and implementation should be integrated with the normal activities of energy supply and energy conservation. An energy/political action program can state the direction and produce the necessary coordination between planning for oil reduction, energy supply, energy conservation, and effective energy use.

In 1984, parliament revised the local authority energy planning act. By July 1, 1986, every municipality must have an overall energy plan approved by the municipal council. The plan is to cover the entire municipality and its energy supply, distribution, and use.

3.1.2 Federal Republic of Germany

The main goal of local energy management in Germany is to contribute to a more rational use of energy sources by coordinating supply strategies and by reducing the demand. Given the supply and demand structure of the FRG, this means the purposes are to:

- Increase the market share of coproduced heat and electricity, i.e., to expand district heating systems.
- Use all endogenous regional energy resources, particularly in rural regions.
- Make better use of industrial waste heat.
- Expand the use of decentralized new technologies such as heat pumps and block heating systems.
- Make use of alternative energy sources such as biomass, wind, and solar energy.

The main restrictions on the technical solutions considered by the local authorities are that they be (1) a safe and cost-effective energy supply and (2) a contribution to an improved environment.

Local energy management programs also clarify the role of local and regional suppliers in the decision process, the organizational framework for new supply systems, and finally, the potential legal and organizational incentives for energy saving strategies.

To date, most local energy management programs have not provided a clear picture of the supply alternatives. Future programs therefore will have to:

- Aim at better information transfer from utility companies to public bodies and end users.
- Collect qualitative and quantitative information about user and public body preferences.
- Illustrate alternative solutions so that lay persons can understand them.
- Provide an evaluation of alternative solutions according to the national goals of energy policy.

Three types of programs will have to be considered:

- Long-range strategic plans.
- Medium- and short-range concepts.
- Implementation plans.

Long-range strategic plans are the links between energy policy goals and the given local infrastructure. They analyze cross-impacts between energy demand, energy supply, technical development, and user behavior. They do not lead to specific investment decisions and have no legal implications. Rather, they look at a region's economic development, at the social impact of technologies, and at the environmental situation in general.

Medium- and short-range concepts try to secure the rational use of energy in a well-defined region. They analyze alternative organizational and technical concepts, assess changes in the settlement structure, calculate demand densities by sectors, and compare the capacity of supply systems with demand densities. The results indicate to all participants in the energy planning process where to start planning what.

Implementation plans are practical suggestions to the utility company or to the municipality to build up a certain supply infrastructure, including the dimensions and investments required.

There is a continuing discussion as to the spatial disaggregation required for all three types of energy management programs. Some programs -- even for larger urban regions -- try to compile information house-by-house or block-by-block, others contain information only by city quarter or neighborhood, and still others avoid any information below the administrative level of municipalities.

One FRG implementation program is ModEnG (a joint federal/laender program to promote investment toward the conservation of heating energy), a program originally available only to property owners. Communities have the right to direct 50% of the direct grants into urban renewal areas (Modernisierungszonen). In practice, however, communities dropped this right because of administrative and technical reasons. ModEnG undoubtedly stimulated much higher specific energy savings in urban regions than in rural regions because:

- A difficult application procedure often prevented the rural population from applying for grants.

- *Most applications came from owners of* single-family houses in urban fringe areas. Here, the large building stock built in the 1950s needed renewal investment anyway.

- Most of the benefits went into the large (public) housing companies that used the increased depreciation allowance for a general upgrading of their housing stock.

ModEnG is designed for both energy conservation and urban renewal. This dual goal was appropriate because of particularly high energy losses in dilapidated buildings.

Expected total energy savings from ModEnG for 1979-1985 amounted to 563 PJ (563×10^{15} J). In 1982, the new federal administration decided to cut funding for the program for two reasons:

- A general cut in most federal subsidies.

- An awareness that energy savings make sense even without federal and laender support.

Under these changed conditions, the rate of energy conservation in buildings may slow. On the other hand, the positive experience of many house owners with thermal insulation and new heating technologies has triggered a broad discussion on costs and benefits of energy conservation. *There is a clear trend in* federal and laender governments to move away from programs subsidizing energy conservation and to sponsor new supply technologies.

3.1.3 United States

In the U.S., energy decision makers constitute a large, extremely heterogeneous group that includes suppliers, converters and distributors, major commercial and industrial users, government agencies, and, of course, a host of individual consumers. Public- and private-sector decisions individually and collectively determine how energy is delivered and used in a locality. The interests of everyone need to be considered in any community energy management program. The institutions involved in the U.S. energy system are divided into three groups, as shown in Table 5.

In the U.S. energy system, many of the activities of private energy suppliers are regulated by a number of government agencies. Various private- and public-sector organizations are important "key participants" that supply energy or operate conservation programs. Often, the private and public participants cooperate to achieve mutual goals. The other interested organizations include groups that are usually passive participants in energy matters.

Local government often plays a central role in the community energy management process. Local government can be a motivator, educator, intervenor, regulator, staffer, and financier of energy projects. Some, but

Table 5 Participants in U.S. community energy planning

Participants	Role Played
Regulators	
State public utility commissions	Utility rate determination, facility siting rules
Federal department of energy and other federal regulatory agencies	Facility siting rules, most environmental protection regulations and some other rules; funding
Local government: Local planning and zoning commissions	Develop and administer local facility siting rules
Key Participants - Usually Private	
Electric utility company	Electricity supplier
Natural gas utility company	Natural gas supplier
Fuel oil distributors	Fuel oil suppliers
Gasoline dealerships	Gasoline/diesel suppliers
Other fuel suppliers	Coal, wood, kerosene, etc., suppliers
Key Participants - Public	
Local energy office	Program initiators, planners
Mayor, city council	Vote necessary for implementation of major projects
Citizen interest groups	Provide public pressure for action
Other Interested Organizations	
Industry	Users of energy, potential suppliers
Commercial businesses	Users of energy
Financial institutions	Users of energy, sources of funds
Real estate firms and land developers	Builders of new structures
News media	Information outlet to the public
Other groups	Users of energy, sources of people
Individual citizens	Users of energy, sources of help

not many, local governments also have a role as entrepreneur, owning energy utilities and distributing electricity or natural gas.

There is a widely held belief that local government has less political and institutional influence than do private utilities and fuel suppliers, and a related feeling that the state, national, and international character of energy issues may diminish the role of local governments.

3.1.4 Italy

In 1976, Italian municipalities were given power of control of thermal insulation in buildings, energy saving in the use of heating systems, and inspections on the daily and monthly operating cycles of heating systems in civil buildings (these inspections were established by decree in 1979-1981). Local government had earlier been left out of the administration of energy.

Before the energy crisis, public authorities focused more on promoting revenue and trading regulations than on energy planning. Only after the crisis did public authorities realize the need for a rational administration of energy sources in the country. The problem of lowering energy consumption was at last considered as an important object of public intervention and of administrative action.

Administrative action was needed from the state and also from local government. There were two reasons for local involvement: (1) indifference to energy problems would not be economically wise and (2) there is a close link between energy problems and land use, and Italian local governments have a primary role in this field. The use of energy is also linked to building, industry, agriculture, and transportation, and in these fields regional and local government have definite roles.

An important national article (Decree no. 616/ 24.7.1977) requires local government to participate in regional development plans. In practice, regional planning involves the state, regions, and municipalities. Municipalities do more than just put forth requests; they can propose and share in decision making.

3.2 Cross-country comparisons of local authority

Powers of national, regional, and local governments are different in the four participating countries and can differ between governments within a single country. For example, energy-related powers of local governments in the U.S. can vary from state to state or between different-size cities within a single state.

Table 6 provides a simplified guide to the powers of governments within each country (more-detailed information is provided in Appendix A). A number of interesting differences exist. The European situation seems to be oriented toward greater national control than in the U.S. Italy has the only electric system that is almost totally nationalized, although major parts of the Swedish system are also nationally owned. The FRG and U.S. systems are more free-market-oriented, with a mix of public and private electric companies. Regional governments vary widely in their influence. In the FRG and U.S., they have important decision-making power over utility companies' siting decisions. In the FRG and U.S., electricity rates are regulated by regions (states or laender); in Italy and Sweden, this is generally a national responsibility. Swedish and Italian regional governments seem to have minor roles in energy programs.

National governments have varying amounts of control over local governments. Italy and the FRG can order local governments to do energy planning and (at least in Italy) implement national programs. The U.S. and Swedish national governments have little direct control over their independent local governments. Both rely on favorable grants and loans to encourage local energy programs. In the U.S., a financial contribution by the local units is often needed before a national grant is awarded. For example, a recent U.S. national funding program for local governments to complete district heating feasibility studies required $2.00 of local contributions for every $1.00 from the national government.

Relationships between governments and the private sector are significantly different in the four countries. In the FRG, voluntary cooperation is a highly effective tool: the national government and major industries work together to develop common goals. In the U.S., government and private-sector planning are relatively separate. Because the Italian government holds a virtual monopoly on electricity generation and a significant part of the natural gas system, most Italian supply system planning is highly

Table 6 Energy-related powers and activities of government levels in the participating countries

Italy	Sweden
<u>National Government</u> 1. Sets national energy policy. 2. By law has required local governments to: A. Create standards for new buildings that include: a. Insulation to be upgraded whenever a building license (permit) is issued. b. Change their own building heating system operation to heat only at certain times of day/season or over 20°C (68°F) (seasonal and time-of-day rules may be relaxed if methane or cogeneration is used). 3. Owns nearly all electric generation capacity, controls prices and production methods (has recently changed laws to allow more activity by local government).	<u>National Government</u> 1. Sets national energy and oil-reduction goals. 2. Provides grants and loans to local government and individuals for energy planning and implementing energy saving improvements in buildings. 3. Provides funding for district heating and alternative energy source projects. 4. Provides funding to develop energy planning methods. 5. Regulates electricity prices.
<u>Regional or State Government</u> 1. May choose to develop model-building standards (for #1 above) for use by its municipalities that lack expertise. 2. May choose to do limited planning and lawmaking in energy related areas.	<u>Regional or State Government</u> 1. The lansstryrelser (counties) carry out the policies of the national government. 2. The Landsting are important for health care and traffic planning, but have little energy concern. 3. The Association of Local Authorities, a national group, coordinates regional aspects of the energy plans of local governmente.
<u>Local Government</u> 1. Must carry out national law. 2. May pass energy-efficient land use regulations. 3. May, through the General Town Plan and Executive Plan, implement energy policies. 4. Can set an example for others to follow, such as in developing cogeneration or waste incineration plants. 5. Can set an example by purchasing decisions - for instance, can enter into "shared savings" arrangements with private companies. IACP (the public housing authorities) can upgrade housing under its control for energy efficiency.	<u>Local Government</u> 1. May choose to carry out national policy, but is not required to do so. Thus, may do local energy planning. 2. Distribute electricity and district heating service. 3. Administers building codes. 4. Offers energy audits and advisory services to residents. 5. Responsible for fuel supply to district heating systems, thus many are involved in wood chip, coal, and refuse-to-energy system development. 6. Responsible for energy use in their own facilities, including schools, public housing, and municipal buildings.

Table 6 (Cont'd)

FRG	U.S.
National Government	**National Government**
1. Sets national policy. 2. Operates nearly all of the country's energy programs, including funding, information, joint programs with regions (laender), and industrial cooperation programs. 3. Regulates building insulation and heating plant characteristics. 4. Taxes fuels on the basis of national objectives. 5. Provides tax credits for oil substitution projects. 6. Funds substantial research activities in alternative fuels. 7. Helps industry market energy efficient goods. 8. Coordinates local efforts.	1. Sets national energy policy. 2. Provides some funding for local energy programs, including planning, district heating, alternative sources, schools/hospitals and low income housing weatherization. 3. Regulates some aspects of fuel use and locations of utility facilities. 4. Has provided major tax incentives for individuals and businesses to buy energy saving equipment. 5. Set maximum highway speed limit. 6. Has developed voluntary building weatherization standards for local builders. 7. Provides some funds to local governments for capital improvement projects, including job-creating energy projects. 8. Set up a major energy information office to assist local governments.
Regional or State Government	**Regional or State Government**
1. Laender (states) regulate utility siting. 2. Operate several funding programs jointly with the federal government, including business and household tax credits, funds for cogeneration plants, funds to expand the gas network, and others. 3. Taxes natural gas and oil extraction.	1. States may fund local activities, set building standards, do planning, regulate the rates and building activities of private utility companies, provide individuals with tax rebates or incentives to install energy saving equipment, provide information and promotion. 2. Can build capital projects.
Local Government	**Local Government**
1. Regions, municipalities, and utility companies - at federal order - must plan for energy supply. 2. May do energy-related research for decreasing automobile use. 3. May set up showcase projects on energy efficiency in older structures. 4. License utility suppliers, thus avoiding duplicate supply lines while providing a method to avoid monopoly abuses. 5. Generally responsible (through corporations) for generation and distribution of pipe- and wire-distributed services. Smaller communities delegate this task to regional supply companies. 6. Can set up utility corporations when necessary. 7. Can allocate funds gained from utility operations to nonenergy functions.	1. May carry out national and state policy. 2. May pass energy efficient land use or building codes, plan for energy, upgrade municipal facilities, tax energy sales (in some states and always within state-developed limits), provide information and promotion, encourage recycling, plan for energy-saving waste management, and set an example in its own facilities. 3. May build capital projects, within the limits of state utility franchises and local budgets.

centralized -- apparently with little private-sector influence.

In all four countries, local governments have enough authority to do energy conservation planning and some implementation. Some communities can do energy supply planning. The supply side is confused by the different ownership patterns of local utility services. Italian cities have good control over district heating and natural gas systems, but almost none over electricity systems. Swedish cities can control all. Control in the FRG and the U.S. depends on the city and state, and whether the energy utility company is city-owned, regionally controlled, or private.

4 THE PRESENT STATE OF ENERGY PLANNING

This chapter describes the current state of the art of energy planning in the focus communities that were used to illustrate national planning approaches. The discussion has five parts:

1. Introducing Focus Communities, describing the communities chosen for in-depth study by the Annex VII study teams.

2. Energy Management Processes, describing the steps and methods used in local energy planning.

3. Decision Making, describing who is involved in difficult planning decisions and who is involved in implementation decisions for large projects.

4. Organization for Planning, describing the groups that work to develop an energy plan and the structure of their participation.

5. Energy Issues Being Addressed, describing the problems that energy plans are helping to solve.

4.1 Introducing focus communities

The Annex VII agreement specified that each country would report on energy management activities in at least three typical focus communities. As listed in Table 7 and mapped in Figures 2 and 3, a total of 15 focus communities were discussed in Subtasks C and D.

4.2 Focus community characteristics

Detailed data describing numerous features of the 15 focus communities are found in Appendix B. This section presents a summary of the principal findings from those data.

Not all data were available for all communities because of differences in national reporting and also depending on whether the city was originally in focus for Subtask C or D. Comments on the more important data follow:

- Populations and growth rates of the cities cover a wide range. The U.S., Italian, and

Table 7 Annex VII focus communities

Country and Community	1980 Population (10^3)	Primary Economic Base	Energy Use per Capita (MWh/y [10^6 Btu/y])
Italy			
Bologna	455	University, industry	24 (82)
Brescia	210	Transport, manufacturing	26 (89)
Reggio-Emilia	131	Food, transport	15 (51)[a]
Modena	164	Electronics, machinery	no data
Sweden			
Kristianstad	69	Food	36 (123)
Angelholm	29	Services	29 (99)
Uppsala	145	Services	34 (116)
Ornskoldsvik	61	Manufacturing	137 (468)
Sundsvall	95	Manufacturing	15 (51)[b]
FRG			
Saarland	1,069	Steel/Coal	69 (235)
Berlin	2,202	Electronics	29 (99)
Rhein-Main	2,100	Manufacturing	No data
U.S.			
Ann Arbor, Mich.	107	University	43 (147)
Portland, Me.	62	Transport	48 (165)
Richmond, Ind.	41	Manufacturing	67 (230)

[a]Does not include the transportation sector.

[b]Heating only.

FRG communities (except Rhein-Main) are "cities" in the traditional definition, whereas the Swedish communities (and Rhein-Main in the FRG) are similar to U.S. counties or Italian provinces.

- Climatic data suggest that the U.S. and Swedish communities share similar temperatures. Italy, as expected, is warmer, but yet is cold enough to have heating demands.

- Age of housing is surprisingly similar among these communities.

- The main housing type in the U.S. is the single-family residence. The European cities are mixed in their single/multifamily split; the Swedish communities in particular seem highly variable in this regard.

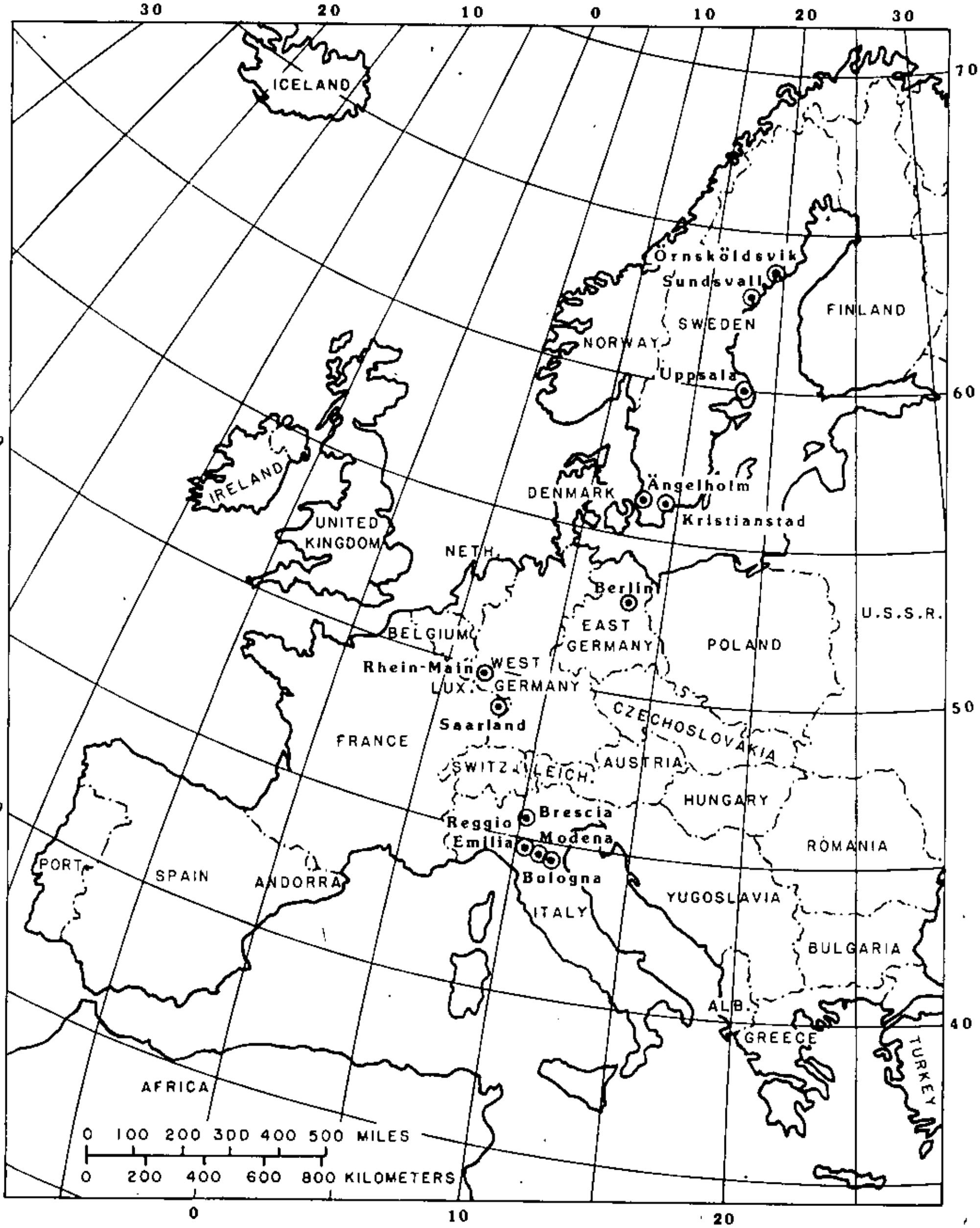

Figure 2 Participating European countries and focus communities

Figure 3 U.S. focus communities

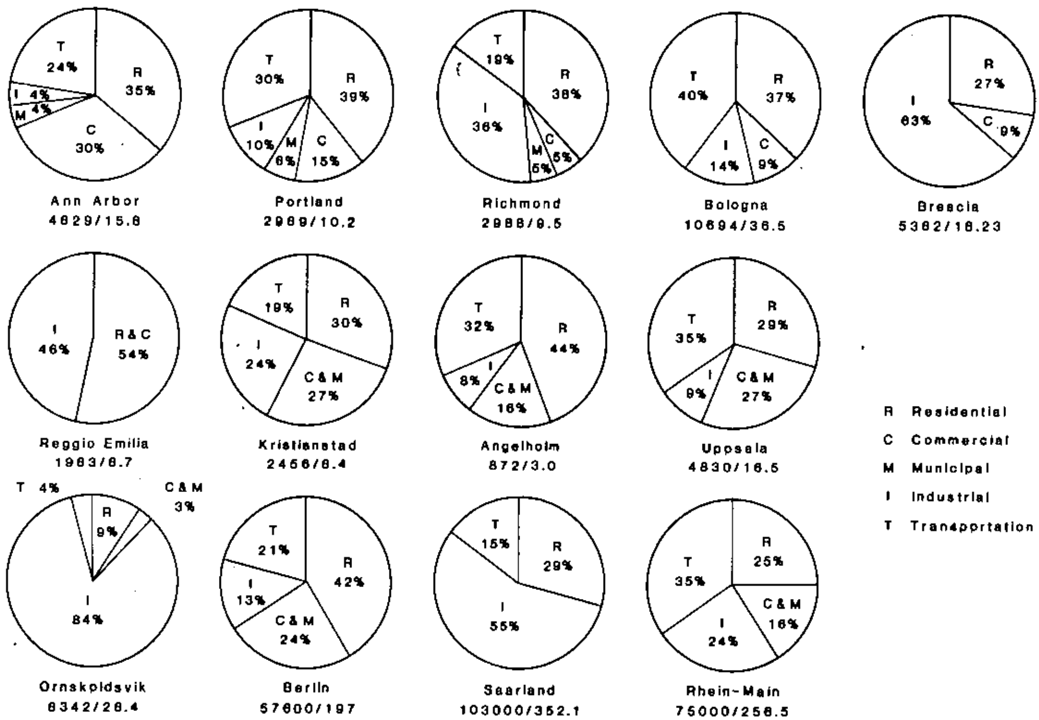

Figure 4 Focus community energy use by sectors (numbers below each graph signify total energy use by the community in GWh and 10^{12} Btu)

- As shown in Figure 4, energy use within sectors is fairly similar (with the exception of heavily industrialized Ornskoldsvik). Residences require about 35% of the total energy supply in all communities. Transportation requires about 30% except in the more heavily industrialized communities. The remainder of energy use is mixed among sectors, based on local economies or energy accounting methods.

- Energy use by fuel (Figure 5) shows the heavy Swedish and FRG dependence on oil, extensive use of natural gas in the Italian cities, and a mix of fuels in the U.S. cities. Still, U.S. oil dependence is substantial, especially in Portland. When heating oil is considered along with gasoline, none of the communities is less than 43% oil-dependent. Saarland's large coal use denotes a heavily industrialized area with local coal supplies.

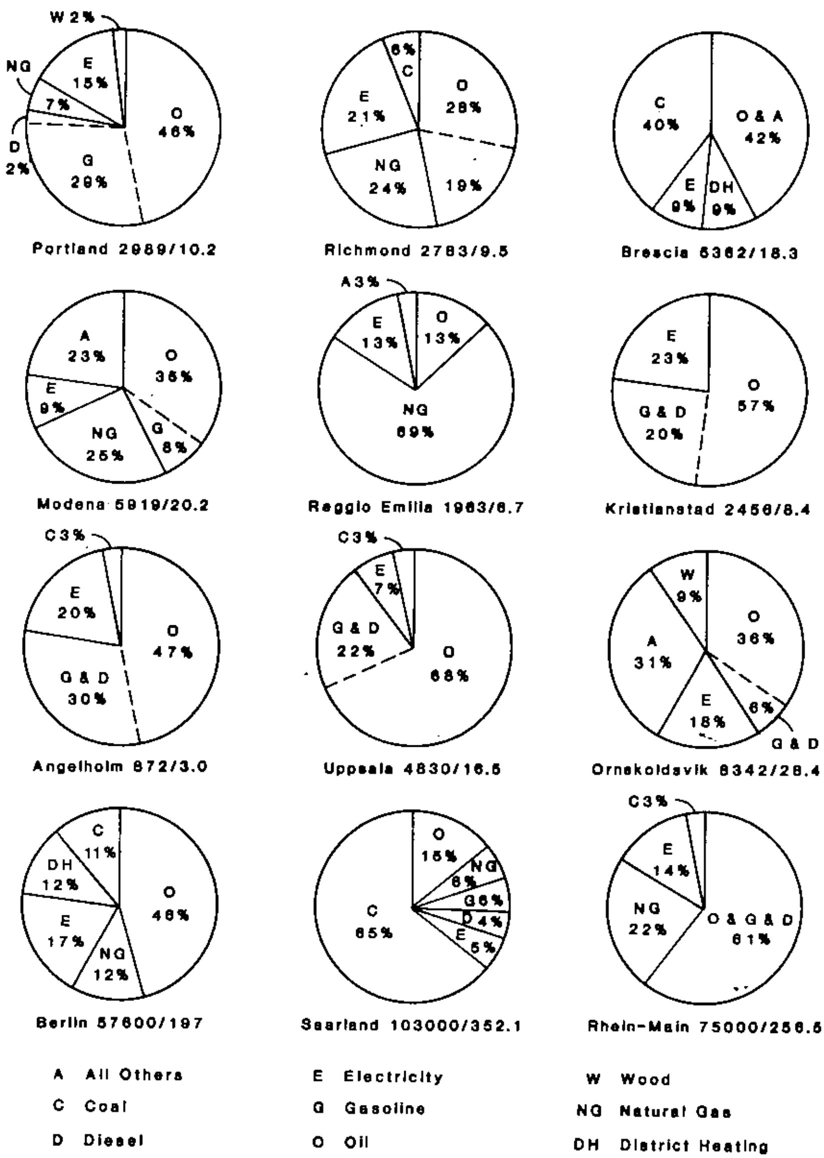

Figure 5 Focus community energy use by fuel (numbers below each graph signify total energy use by the community in GWh and 10^{12} Btu. Ann Arbor did not estimate its energy use by fuel during its planning process)

- The Swedish, FRG, and U.S. communities consume about the same percentage of their total fuel use through electricity. The Italians use significantly less.

- Energy use per capita is similar in all European communities (except industrial Ornskoldsvik) and is much higher in the U.S. cities.

- As shown by the more detailed data in Appendix B, the commercial sector in the U.S. seems significantly more energy-intensive than that in Europe. Transportation energy consumption, while higher in the U.S. than in Europe, is surprisingly similar on a per-capita basis. Ann Arbor's low (for the U.S.) per-capita transportation demand may be explained by that city's large university population, which tends to have fewer on-campus vehicles per capita than the general population.

- The residential sector in all communities would be seriously affected by an oil cutoff. As indicated by the detailed data in Appendix B, of the European cities, only Uppsala, Saarland, and the Italian communities have the start of a diverse residential fuel mix. The commercial sector shows more fuel balance than the residential sector, mostly due to its higher electricity use. Industrial oil use is high in all communities.

Considering the four countries and 15 communities as a group, oil dependence appears to be the critical problem -- especially for the Europeans. The focus communities share this problem to a greater or lesser degree depending on the availability of other fuels (coal in the U.S. and FRG, wood wastes or electricity in Sweden, and natural gas in Italy). Thus, the energy problem in Europe is clearly an oil problem, while the energy problem appears more diverse in the U.S. simply due to the assortment of fuels that require action and their price variations. For example, in many urbanized areas in Sweden, district heating is an economic alternative because the fuel displaced by the district system is, almost universally, expensive imported oil. In the U.S. and often in the FRG, new district heating systems are generally noncompetitive when compared with existing natural gas heating. Thus, the U.S. and FRG are often forced to look at other solutions, such as individual building weatherization, that may require voluntary cooperation by many individual energy consumers.

4.3 Energy management processes

As illustrated in detail in Appendix C, each community followed a slightly different process in conducting its energy planning. If the planning process steps followed by at least 50% of the focus communities were diagrammed, the result would be Figure 6. The steps are briefly described here:

1. Authorization. Most programs begin with an indication by national or civic leaders that energy planning is necessary. In Italy, planning efforts may be authorized by municipal concerns, independent of general municipal governments. The Saarland plan was initiated by the city-owned utility company supplying electricity, natural gas, and heat.

2. Funding. Resources must be allocated to begin the planning effort. Grant funds from outside the municipality appear to be very important for the creation of energy plans.

3. Expert Advisory Committee. An advisory committee is often formed to help staff identify feasible alternatives and do analyses. In some communities, the committee directs the work.*

4. Data Collection. Nearly every local effort collects energy demand and supply data, often including data on community demographics and buildings. Often, energy data are derived from easily available statistics on physical characteristics of buildings. Data come from several sources, especially national census records. Table 8 lists the data sources used by the communities. Expert opinions collected by interviews are widely used.

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*The majority European use of government experts differs from the U.S. Comprehensive Community Energy Management Program approach, which relied heavily on lay citizen committees to help form options and recommendations.

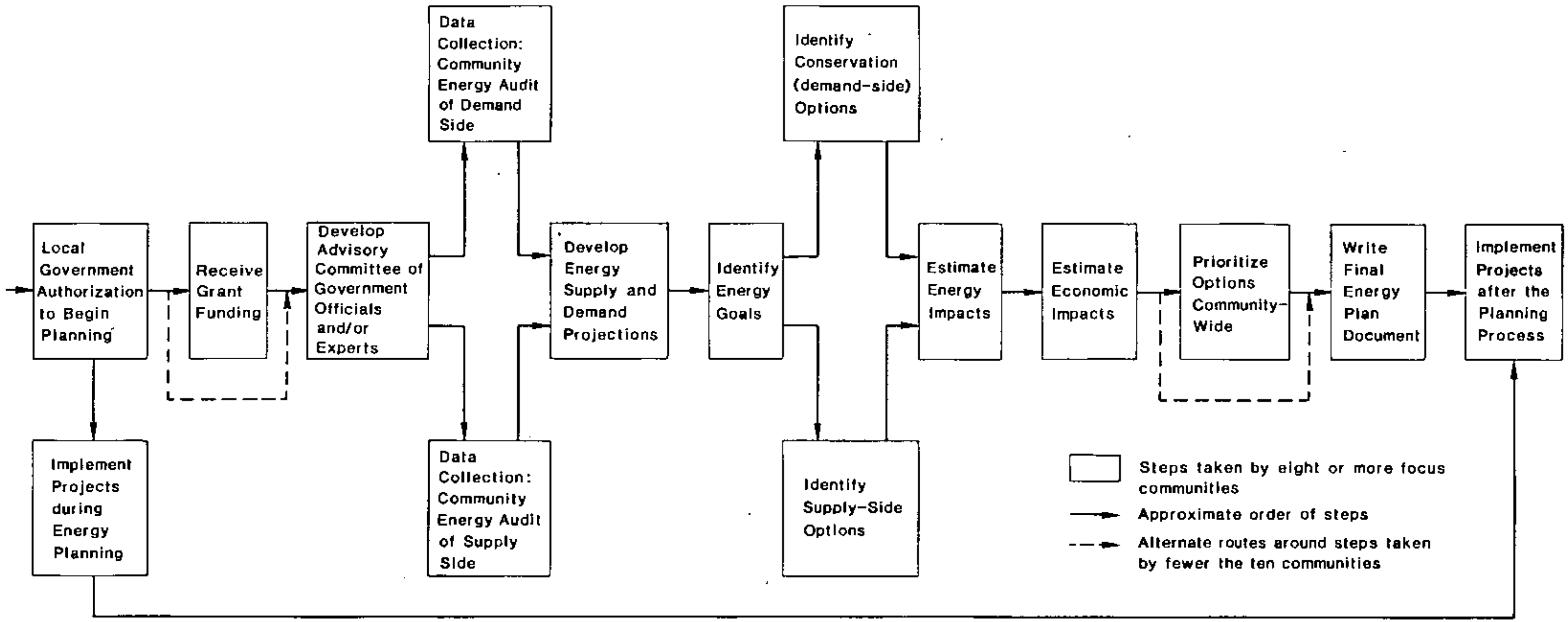


Figure 6 Annex VII generic planning process

Table 8 Data sources used for community energy audits

Data Source	Number of Communities Using the Source
Official National Statistics	9
Population census	9
Housing census	9
Type, function	6
Age	6
Heating technology	6
Interviews/Meetings	7
Building owners/users	6
Utility officials	5
Government officials	4
Neighborhood groups	4
Teachers	3
Trade unions	3
Oil dealers	2
Professionals	2
Students	2
Mayors/Councillors of neighboring cities	1
Political parties	1
"District Committees"	1
Lenders	1
Test Program Results	7
User assistance	5
High-efficiency boilers	1
Landfill biogas wells	1
Source separation of glass and paper	1
Wood-burning plant	1
Surveys	7
Wind and alternative resource potential	5
Refuse production by neighborhood	1
Geothermal potential	1
Aquifer location	1
Plans Review	5
Comprehensive	3
Supply	2
Urban renewal	2
Housing	2
National Evaluation Methodologies	4
Questionnaires	4
Building owners	4
Utility Accounting Registers	3
Electric utility	2
Gas utility	1
Heat production utility	1
Special District Heating Feasibility Studies	4
District Heating System Instrumentation	1

5. Projections. Future energy conditions are usually based on projected population, building activity, utility services, or preferences as indicated in local plans.

6. Goals. Generally quantified in Europe, goals indicate targets for future energy consumption or desired decreases in fuel (oil) use. In some programs, it appears that goals and projections may be combined, with the desired fuel mix goal also used as the future projection that results from implementation of the energy plan.*

7. Options Identification. All communities identified their options for saving energy, switching fuels, or otherwise changing their energy situations. In Sweden and the FRG, the emphasis is usually on supply options -- in particular district heating and conversion of oil heat to electric heat. In Italy, a slightly more balanced approach exists, but supply options still dominate their plans -- probably due to the leading role often played by energy-supplying municipal concerns. U.S. options tend to be demand-side (conservation) oriented. This is probably due to the relative lack of control that many U.S. communities have over their energy supplies and the lack of supply system knowledge of many U.S. energy planners.

8. Impact Assessment. Generally the energy and economic effects of individual options are analyzed. Rarely, however, are the combined effects researched in a systematic way. For the most part, it seems each option is considered as an independent item, whose costs and benefits have little

*The Germans divide their municipal energy program goals into four main areas: (1) management, including changes in the building stock, employment, and the local budget; (2) reliability of supply, including diversification, flexibility, and demand reduction; (3) environmental quality, including air, water, and efficient resource use; and (4) social compatibility, including housing costs relative to income, consumer freedom of choice, housing quality, and contribution to urban revitalization.

effect on other options. In U.S. communities, energy and economic assessment may not be done at all.

The Swedes and Germans tend to do more detailed quantitative impact assessments than the U.S. and Italians (see Appendix C). The differences may come from the greater control that the Swedish and German planning authorities have over their energy suppliers, their relative lack of interest in mobilizing community support, their higher knowledge of the technical aspects of energy planning (district heating) studies, or national differences in opinion on the scope of an initial energy plan. Many of the calculations completed by the Swedes and Germans in their initial energy plan are, in the U.S. and probably in Italy, considered to be part of more advanced planning. The Swedes and Germans, by anticipating the implementation of district heating, essentially skip the early portion of the planning process that seems to be the main concern in Italy and the U.S. Thus, the Swedes and Germans save much valuable time and effort that is used in Italy and the U.S. to organize the community support that is required in the latter countries to achieve widespread implementation.

9. Prioritize Options. Simple-payback period analysis seems to be the most common tool used for ranking the value of projects. Rarely are options prioritized for neighborhoods; instead options are considered for their community-wide effects.

10. Write Plan. The focus communities took two approaches to writing the plan. In all communities except Ann Arbor and Brescia, the plan was written near the end of the planning process -- the document essentially described the results of a relatively long period of data collection and options analysis. In Ann Arbor and Brescia, a preliminary plan was written by the planning staff and then subjected to public comment for revision. Therefore, in these two cities, most of the planning process was spent in explicitly gathering

public support for the plan and editing a basic text.

11. Implement Projects during and after the Planning process. All communities implemented some projects after planning. Many also completed projects during planning. In the U.S., the projects completed during planning generally save very little energy, but are considered important to building political support for the plan. In Sweden, it appears that most of the projects may have occurred regardless of the overall planning effort -- for example, district heating systems are constantly being modified, and the Swedish local housing inspection/ information projects probably do not need larger planning processes for their implementation. Italian projects implemented during planning were mostly informational.

Community energy planning methodologies developed by national organizations (the federal government in the U.S., and the Association of Local Authorities in Sweden) have been very influential in guiding the focus communities. In the U.S., two of the three focus communities began their process with the national Comprehensive Community Energy Management Planning (CCEMP) model. The third U.S. community explicitly avoided using it. In Sweden, all the communities used a form of the national model.

4.4 Decision making

4.4.1 Planning

According to the Swedish report *The Role of Local Governments in Meeting Long Term and Short Term Energy Problems* (Ref. S3), the key decisions in the planning process are the (1) decision to make a plan and (2) decision to approve a plan. The decision to make a plan is based on the severity of local problems and/or the availability of grant funds to finance the planning effort. As noted in Chapter 3, funding availability appears to be a key factor in launching programs.

4.4.2 Implementation

The people who make decisions to implement plans vary by country and community. In Italy, implementation decisions are usually made by the municipal elected officials or the directors of municipal concerns. Decisions by elected officials mostly relate to conservation programs because the decisions on electricity, gas, and other fuels are handled by national government companies or independent municipal concerns. According to one of the Italian Annex VII research reports:

> Thus, the fact that local communities have taken little part in the energy issue is in most cases the result of the jurisdictional restrictions and obstacles which (exist in the Italian legal system). (Ref. I7.)

In Sweden, supply decisions may be made by elected municipal boards, private utility companies, or local authorities that administer utilities. Conservation decisions are split between local officials, who may set up voluntary building inspection/information programs, and the national boards of housing, which develop loan and grant programs.

Implementation decisions in the FRG are guided differently for different energy forms. A nearly free market exists for petroleum products, coal, and wood, with most decisions left to the private sector. Electricity and piped fuels are controlled by a variety of national, regional, and local companies. The companies are generally owned by the government or have a large percentage of their stock owned by government -- only 3% are classified as private. Decision responsibility for district heating systems and probably most other utility services was summarized as follows:

> The responsibility for fundamental supply decisions (allocation of licenses) lies in the hands of the municipalities, the responsibility for a balanced cost-benefit ratio (tariff approval) with the gas and electricity supply (departments) of the states, and the responsibility for a balanced use of primary energy (import restrictions) with the federal government. (Ref. G3.)

The FRG federal and state levels also provide financial programs to stimulate desired supply mixes and research new technologies.

In the U.S., the decision-making situation varies. A local government's elected council may choose to adopt a plan, but is under no obligation to implement any of its provisions. Electric and gas utilities are generally operated by private companies that almost always operate independently of the local government's energy plan. Local government conservation programs, such as improvements in building codes, new district heating systems, etc., generally require decisions by the elected municipal council before they can be implemented.

4.5 Organization for planning

4.5.1 Parties involved in energy planning

The parties involved in local energy planning differ by country and community. Table 9 lists the focus communities and the groups that were primarily responsible for the projects. Government agencies usually directed the planning efforts, but sometimes a municipal concern (utility), rather than general government, may be in the leadership role. Supporting actors include utilities, planning-building offices, public works operations, waste disposal agencies, committees of government and nongovernment experts, and consultants.

4.5.2 Organizational structures of local energy planning projects

As illustrated in Fig. 7, four main organizational arrangements are used in focus communities.

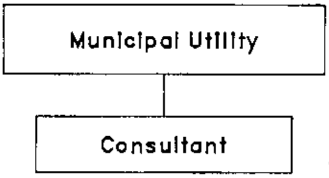
A. Single-Organization Approach: A utility supplier or local government completes the plan in-house, with or without consultant help. The document preparation process tends to be fairly quick. There is usually relatively little (if any) public involvement in the planning process. Results typically favor district heating and other energy supply solutions, but this could be an indication of national preemption in many of the conservation areas (for example, building codes in Sweden are enacted by the national government). Brescia, although using a simple in-house organization, had extensive public discussion of the plan. The Brescia municipal concern, as lead entity, drafted the plan without outside help. It then convened 100 public meetings to discuss the plan, make revisions, and gain public support for capital projects. In contrast

Table 9 Organizations involved in local energy planning

Organization	Total Number of Communities[a]
Lead Entity	
Elected officials committee	5
Local energy office	3
Local planning office	2
Community development office	1
Local utility supplier	4
Other city office	3
Assisting Entities	
Electric utility	6
Gas utility	3
District heating utility	3
Solid fuels company	1
Planning office	2
Office of buildings and land use	4
Building design office	4
Central building committee	1
Community development office	2
Industrial authority	1
Public works	1
Office of streets and roads	2
Public transit	2
Board of health and care	2
Waste disposal and sanitation	1
Engineering	1
Office of local government	2
Consumer information office	1
Regional association of governments	1
Committee of city department heads	7
Nongovernment committees or groups	5
Chamber of commerce (private)	1
Consultants	9

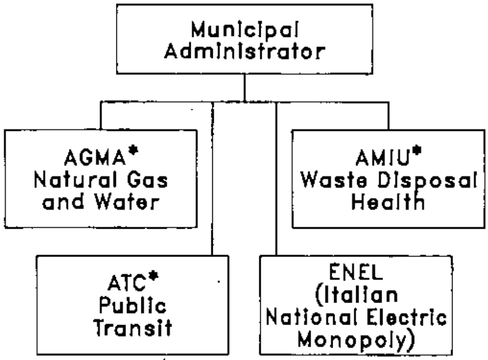
[a]Some lead entities were double-counted when joint responsibility existed between them.

A. Single Organization Approach
(Example: Saarland, FRG)



Variations used in Saarland, Reggio-Emilia, Brescia, Ornskoldsvik after 1981.

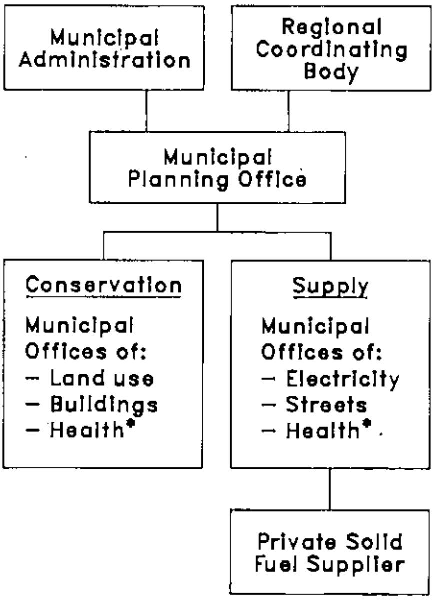
B. Coordination Approach
(Example: Bologna, Italy)



*Independent municipal concerns

Variations used in Bologna, Angelholm, Ornskoldsvik before 1981, and Berlin.

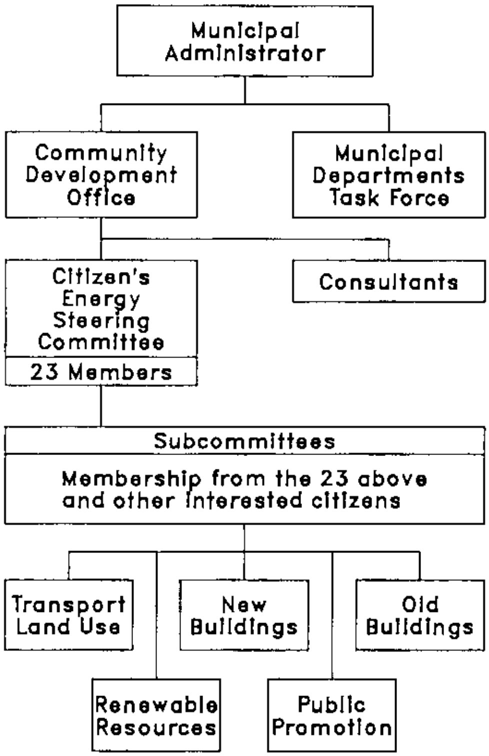
C. Planning Office Approach
(Example: Kristianstad, Sweden)



*Environmental aspects

Variations used in Kristianstad, Uppsala, Rhein-Main. (Rhein-Main was a regional plan with the municipal offices above replaced by municipalities and utilities.)

D. Involvement Approach
(Example: Ann Arbor, U.S.A.)



Variations used in Ann Arbor, Portland, Richmond. (Some communities arrange subcommittees by function: i.e., conservation, supply, promotion.)

Figure 7 Typical organizational approaches in focus communities to the usual single-organization plan that can be completed within a few months, the Brescia planning process took well over a year.

B. Coordination Approach: The local government, with little control over its public utilities, assumes a "coordinating" role, providing a neutral forum for the utility companies to discuss opportunities for cooperation and to resolve their differences. The plan, as a product of the utility suppliers, tends to suggest supply options and often does not deal with conservation options and nonutility fuel alternatives (coal, oil, wood).

C. Planning-Office Approach: Again, planning is done within a single organization, but a planning office is responsible for the work in this case and advisory committees are set up, drawing experts from different departments within the lead entity. In Kristianstad and other Swedish communities, the plan was completed in two parts, conservation and supply; each group of municipal departments acted as a task force to provide data and other assistance to the central planning office. On completion of the plan the departments were expected to implement the projects within their functional areas. This organizational approach seems best suited to countries/communities with firm control over land use, building codes, and (most important) utility supply systems. The method seems to assume that local government has strong regulatory power over private activities and is able to make changes in the utility supply pattern. Here, the local government is largely planning its own activities, much as in the single-organization approach.

Rhein-Main offers an interesting variation. There, the lead entity was a state (land) Ministry of Economic Affairs and Technological Development. The places of the municipal offices in most countries were taken by 50 municipalities, 19 natural gas suppliers, and 17 electricity suppliers. The thrust of the plan was to identify district heating opportunities on a regional scale. The Rhein-Main plan was not completed in-house, as in Kristianstad, but was done by a set of specialized, knowledgeable people with direct interests in energy supply.

D. Involvement Approach: The plan is produced by one or more committees representing community leaders, neighborhood groups, utilities, and interest groups. Sometimes, a committee of experts is convened. Considerable effort is spent in coordinating the work of the various committees, in an effort to reach consensus. Dozens of citizens may be directly involved in creating the plan. The approach tends to develop conservation-oriented plans, often lacking recommendations for mandatory or regulatory implementation.

The distinction between European and U.S. experience appears fairly clear. With some exceptions, U.S. communities use an approach that allows for much public input and, also, tends to spend more money and time on the planning process. European communities typically limit public involvement and rely on experts; with some exceptions, their plans are produced more quickly and at lower cost. In either case, implementation is more likely if the local entity that directs the planning effort controls the utility services.

The institutions involved in focus community energy planning are listed in Table 9. They fall into four groups: (1) government, which typically initiates and manages the program; (2) energy suppliers, including suppliers of utility services (sometimes including commercial distributors of oil, gasoline, and coal), and occasionally, alternative resource suppliers such as solar system contractors; (3) consumers, including business and industry; and (4) consultants.

4.5.3 Roles of institutions in the planning process

Five basic elements of a community energy program roughly approximate the tasks that must be completed to produce a successful energy plan. These are:

1. Organization: Bringing together people, agencies, and firms in an integrated and efficient structure that facilitates decision making, political support, and accomplishment of work.

2. Management: Deciding what needs to be done, securing funding, and scheduling and completing the work in a timely way and logical sequence.

3. Work: Obtaining the information needed to make decisions, using appropriate analytical tools to determine what the information means, and communicating results to persons outside the energy project structure.

4. Implementation: Seeing that decisions are carried out by appropriate parties.

5. Monitoring and Evaluating: Evaluating programs to see that they are accomplishing their goals, and keeping informed about new problems and opportunities (U7, p. 123).

The following discussion reviews the institutions most often involved in each of these tasks.

Organization is almost always completed by the lead entity (see Table 9). When grant funds are used, the lead entity usually writes the funding proposal and then assumes control, sets up advisory committees, and selects consultants. In U.S. programs operated by a municipal government, consulting arrangements and committee memberships are usually approved by the local elected leadership (mayor or council). Sometimes, utility company members of advisory committees may help in finding or supplying funds for specialized projects that may directly help the operations or public image of the utilities.

Management of community energy programs has two components. The first involves routine tasks, such as scheduling work, budgeting, and supervising staff; these are handled by the lead entity and its consultants, usually without outside help. The second component consists of decision making and option selection as they relate to the substance of the energy plan (U8). Someone must decide which energy supply and conservation options are best for the community and, hence, are worthy of inclusion in the written energy plan.

In the second case, the differences in the organizational approaches presented in Figure 7 become apparent. With the organization in Part A of the figure, the in-house planning group decides plan content with little outside input. A similar situation exists in Part B, but, there, the lead entity is in a weak position to advocate energy options that are not supported by the independent entities. In Part C, the lead entity may be able to override the objections of the members of its in-house committees if the local energy situation is critical or if the lead entity has political support from the municipal administration. In Part D, the lead entity ultimately decides which options appear in the plan, but its choices are largely determined by the decisions of the advisory committees. In some U.S. cities, the committees essentially write the plan and the lead entity acts as little more than editor of the final report.

Work includes data collection, analysis, and supply; communications with the public or others outside the planning structure, and other substantive activities that contribute to completion of the plan. The lead entity rarely does all of the substantive work on the project, but, instead, hires consultants or uses its advisory committees to work out technical tasks. Data collection and analysis is generally handled by the entity working on a particular task. An alternative approach is to concentrate all data collection in a single function to avoid duplication of effort.

Energy supply and use data may be supplied by any of the entities listed in Table 9 or by other source. In the U.S., businesses and private utility companies are often reluctant to give city energy planners much energy consumption or cost information because of fears about what competitors may learn. In Sweden, the national government requires industry to provide energy data to planners.

Communication with the public and others is often done by the lead entity or by members of the municipal administration.

Implementation can occur during and/or after the planning process, and any of the entities listed in Table 9 may be involved. The European Annex VII countries, emphasizing utility supply options, tend to have the local electric or district heating supplier as the implementation leader. On the conservation side, Sweden's nationally mandated insulation and building inspection programs are carried out by city offices. In the FRG and U.S., industrial conservation programs are generally outside the scope of community energy planning. In Italy, if municipal concerns are involved in the energy project, they will be the implementing entities. In the U.S., if the energy planning lead entity exists beyond the end of the planning process, it typically leads ongoing implementation. For U.S. projects implemented during the planning process, the lead planning entity or special private interest groups usually complete the work.

Monitoring and evaluation seem to be rarely done. Some utility-sponsored programs include monitoring to justify rates or prove the effectiveness of the decisions and actions taken. Some city programs include monitoring as an aid in justifying the results to funding sponsors.

4.5.4 Cross-country comparisons of organizations

Summarizing the main features of the local government organization, we find the following.

Italian experiences suggest that the more control that the planning leadership has over implementation, the simpler the organization can be. The Italian municipal concerns, each with its own implementation power, seem to be able to choose whether to involve the public or the local government. This is far different from the U.S., where city energy planners have very little implementation authority and thus try to involve large numbers of citizen advisors in the hope that public influence will bring about implementation.

Swedish communities all show a firm organization centered on government offices and with little private-sector or citizen involvement. Committee structures are limited in number, which seems to speed up the planning process. Most actions recommended for implementation seem to reflect projects directly controlled by local government offices.

Looking at the FRG situation as a whole shows that several organizations are involved in energy supply decision making. At the local government level, it appears that utility companies and private fuel suppliers are important in local supply planning. In the FRG, the vast majority of utility companies are either wholly owned or controlled by the public sector.

The pattern in the three U.S. communities is a single staff that puts together an energy plan covering all local aspects of energy supply and demand. Although there is advisory committee input, the actual plan documentation is done by the single group. This is different from Sweden, where different offices may have responsibility for developing an energy plan for topics within their expertise.

Common features and differences in European and United States community energy planning are noted:

1. Local energy planning processes follow similar patterns in all the countries. Nearly all communities evince a conceptual split between supply and conservation options. All collected energy data, and virtually all were interested in energy savings and economic effects. Interest in the environmental impact of new energy options varied greatly, depending on local pollution conditions.

2. There is no one best way to organize a local energy planning effort. Different organizational approaches work in different countries and in different communities within a single country.

   The relationships between the national government and local governments can affect the progress of energy planning. Sweden offers an example of two distinctive approaches: municipalities are largely independent of the national government; they may be required to write an energy plan, but the requirement need not be followed or, if followed, the content of the plan is decided by the local government. On the other hand, the Swedish county administration must follow national directives; the national government can directly implement energy policy within the limited jurisdiction of the counties (health and some traffic responsibilities), but must rely on the good will of its municipalities for general local energy planning.

   In all of the countries, national government involvement in local planning appeared to be largely limited to providing funding, limited technical assistance, and occasional monitoring of how funds were spent. Generally, the local governments worked independently of their national governments; thus, it was possible for a local government to recommend planning solutions that differed from national policy.

3. Although not universally true, it appears that supply-side options are more readily

advanced by planning approaches with little public involvement. As a result, cogeneration, district heating, change in power plant fuel, and similar activities sometimes seem to follow from a planning process in which participants are limited to utility suppliers and potential users of service. At least this pattern seems to work for most European participants. In contrast, conservation-side options, such as land use, building code, behavioral, or end-user changes seem more likely to be recommended if the general public or its representatives are brought into the planning process. In other words, the nature of the results appear to be substantially determined by the degree of broad-based participation.

4. Implementation follows control. If the entity in charge of planning also has control over the energy supply system, changes in the supply system are more likely to occur.

5. Clear national direction in support of local planning and the availability of funds from outside of the community are very important to the initiation of local energy programs.

Energy supply and cost are national problems that can be addressed by local actions. Local actions, to be most effective, should be taken under a carefully developed plan containing recommendations that avoid duplicated efforts and address significant goals. The focus communities have demonstrated that effective local plans can be developed in a variety of national and local situations with a variety of lead entities, with differing planning processes, and with different mixes of supporting institutions.

4.6 Energy issues being addressed

4.6.1 Relative importance of issues

A review of all countries' Subtask C and D reports resulted in the creation of Table 10. As can be seen, six issues are almost universally important:

1. Imported Oil Dependence. All communities have imported oil problems, but these

Table 10 Most-cited energy issues in focus communities

	U.S.			Italy			
	Ann Arbor	Port-land	Rich-mond	Bologna	Brescia	Modena	Reggio Emilia
Imported oil dependence	X	X[a]	X	X[a]	X[a]	X[a]	X[a]
High and escalating energy prices	X[a]	X[a]	X	X	X	X	X
Possible energy shortage, scarcity	X[a]	X	X	X	X	X[a]	X
Need to build or expand district heating systems			X[a]	X	X	X	X
Public education needed	X	X	X	X	X	X	X
Need to use more alternatives	X	X		X[a]			X
Increase civil-sector efficiency		X				X	X[a]
Need for improved refuse management[b]			X	X	X	X	
High energy costs for local government	X	X					X
Environmental preservation	X		X				
No local conventional sources	X		X				
Need to increase use of electricity			X				
Need for capital to invest in energy projects		X	X				
Building pattern too dispersed for district heating			X				
Dollars spend on energy leave local economy	X		X				
Need to invest capital in the utility system					X[a]		
Need to pressure region for action on renewables[c]			X[a]				
Safe supply							

Table 10 (Cont'd)

	Sweden					FRG		
	Kristian-stad	Angel-holm	Uppsala	Ornsk-oldsvik	Sunds-vall	Berlin	Saarland	Rhein-Main
Imported oil dependence	X[a]	X[a]	X[a]	X[a]	X[a]	X[a]	X[a]	X[a]
High and escalating energy prices	X	X	X	X	X	X	X[a]	X
Possible energy shortage, scarcity	X	X	X	X	X	X		
Need to build or expand district heating systems	X[a]	X[a]	X[a]	X	X[a]			X[a]
Public education needed	X	X	X	X			X	X
Need to use more alterna-tives	X	X	X	X[a]	X	X		
Increase civil-sector efficiency	X	X	X	X				
Need for improved refuse management[b]	X	X	X					
High energy costs for local government	X	X	X	X				
Environmental preservation	X	X	X	X				X
No local conventional sources	X	X	X		X			
Need to increase use of electricity	X	X	X	X		X	X	
Need for capital to invest in energy projects						X	X	X
Building pattern too dis-persed for district heating		X		X			X	X
Dollars spend on energy leave local economy								
Need to invest capital in the utility system								
Need to pressure region for action on renew-ables[c]								
Safe supply							X[a]	

Table 10 (Cont'd)

	Community Total		Percentage of Communities by Country				Number of Countries
	Number of Communities	Number Most Important	U.S.	Italy	Sweden	FRG	
Imported oil dependence	15	14	100	100	100	100	4
High and escalating energy prices	15	2	100	100	100	100	4
Possible energy shortage, scarcity	14	2	100	100	100	33	4
Need to build or expand district heating systems	13	6	33	100	100	33	4
Public education needed	13	0	100	100	50	67	4
Need to use more alternatives	10	2	67	50	75	33	3
Increase civil-sector efficiency	7	1	33	50	50	0	3
Need for improved refuse management[b]	7	0	33	75	38	0	3
High energy costs for local government	7	0	67	25	50	0	3
Environmental preservation	7	0	67	0	50	67	3
No local conventional sources	6	0	67	0	63	0	2
Need to increase use of electricity	5	0	33	0	50	0	2
Need for capital to invest in energy projects	5	0	67	0	0	67	2
Building pattern too dispersed for district heating	4	0	33	0	25	33	3
Dollars spend on energy leave local economy	2	0	67	0	0	0	1
Need to invest capital in the utility system	1	1	0	25	0	0	1
Need to pressure region for action on renewables[c]	1	1	33	0	0	0	1
Safe supply	1	1	0	0	0	33	1

[a]Most heavily emphasized, most important. Two listed per community.

[b]As evidenced by importance of proposed waste-to-energy systems.

[c]Many other issues were listed by only a single community, but were not considered the "most important." These issues have been omitted for brevity.

differ among communities in severity and implications. For Ann Arbor, oil is almost exclusively used for transportation. A supply disruption would not seriously affect nontransport sectors. In Portland and Rhein-Main, individual heating systems and transportation would be hurt if oil supplies were cut off, but electric generation would not be affected very much. In all the Swedish communities, nearly all the fuel used is imported oil, implying a potential disaster if imports stopped.* In all countries, imported oil has probably contributed to balance of trade problems, although the FRG has (alone among the four countries) managed to maintain a favorable international balance of trade.

2. High and Escalating Energy Prices. All the focus communities have been directly or indirectly affected by the 1973 and 1979 OPEC price increases. In the U.S., which has substantial domestic supplies, cost is generally considered a greater problem than is continued supply.

3. Possible Energy Shortage, Scarcity. This issue may be measuring the imported oil dependence problem again, because the two are closely linked due to the Arab oil embargoes.

4. Need to Build or Expand District Heating Systems. In Europe, district heating seems to be considered a nearly universally acceptable energy option.‡ The situation is less clear in the U.S. because prices for conventional energy sources are considerably lower and interest rates have been considerably higher than in Europe. There may also be some bias in all countries' data because the more active communities in energy management are more likely to consider the district heating alternative. Interest in district heating also is linked

*Hydro and nuclear electric generation would prevent the country from being completely without energy.

‡The FRG has been studying conservation vs. district heating due to system cost-benefit concerns (Ref. G3).

to other issues. For example, a district system can help solve a refuse disposal problem through incineration; can help a utility company's revenue problem by expanding the number of products sold, increasing efficiency, and expanding annual revenue; and can help increase the use of pumps connected to the sewage treatment system.

5. Public Education Needed. Nearly all communities indicated that conservation is likely to be a useful energy strategy only if the public receives more information on how to conserve and on the benefits of conservation.

6. Need to Use More Alternatives. In regard to oil dependence and concerns about scarcity and energy prices, most communities see a need to develop local resources. Table 11 lists the resources and techniques considered in the communities. Despite the different geography of the communities, their potential local energy sources are quite similar. Refuse, hydropower, coal, and economic by-products (i.e., industrial waste heat, wood chips, agricultural waste, heat from wastewater, etc.) have been seriously considered for widespread use. Other energy alternatives such as wind, peat, solar, and geothermal are restricted to fewer communities due to their high cost, lack of extraction facilities, unproven technology, or lack of a proven reliable supply. Many of these other alternatives may be mentioned as possible long-term future options by nearly all communities; only in rare cases are they seen as helping in the short term solution.

Returning to Table 10, assuming the focus communities' issues are representative of local issues in each country, one notes that some issues are not shared in all countries. Of the top six issues, district heating seems to be much more important in Europe than in the U.S. In general, European issues are more supply-oriented, while the U.S. addresses conservation. In the remaining 11 issues, some national patterns include Swedish interest in increasing electricity use to better take advantage of local hydroelectric power production, U.S. interest in educating the public about the loss of energy dollars

Table 11 Recommended alternative resource and technique use by focus communities

Resources and Techniques	Sweden					FRG		
	Kristian-stad	Angel-holm	Uppsala	Ornsk-oldsvik	Sunds-vall	Berlin	Saarland	Rhein-Main
<u>Resources</u>								
Refuse	St	Lt			Lt			
Solar	L		Lt	Lai	Lai	Lap		
Hydroelectricity		LmS			L	Sc		
Coal	Lc				Lc	Lc		Lc
Wood and wood wastes	St	St	St					
Industrial waste heat	S			L	L	St		
Wastewater	Lh		Sh					
Geothermal and ground water	Lh							
Wind	L							
Peat	Lt	Lt			Lt			
Natural gas production/ use						L		
Agricultural wastes								
Earth-coupled heat pumps	L							
Tides								
Nuclear electric				S				
<u>Techniques</u>								
Conservation	S	S	S	S		S		S
District heating	S	S	S	L	S	L		L
Cogeneration	L	S	S		L	L		L
Materials recycling (glass, paper, aluminum, oil)								
Electricity management								
High-efficiency natural gas boilers						L		

Table 11 (Cont'd)

Resources and Techniques	U.S.			Italy				Totals		
	Ann Arbor	Port-land	Rich-mond	Bologna	Brescia	Modena	Reggio Emilia	Short-Term	Long-Term	Total
<u>Resources</u>										
Refuse	Le	Le	Lc	Se	Sg	Stg	Lc	4	6	10
Solar	Lapi		SpLai	Lap			Lp	1	8	9
Hydroelectricity	Lm		Lm	Lm				1	5	6
Coal			Se				Sc	2	4	6
Wood and wood wastes		Si	Li	Lc				4	2	6
Industrial waste heat			L	S				3	3	6
Geothermal and ground water			Lh				Lt	0	3	3
Wind		L	L					0	3	3
Peat								0	3	3
Natural gas production/ use				S				1	1	2
Agricultural wastes			Lc				Lc	0	2	2
Tides		L						0	1	1
Nuclear electric								1	0	1
<u>Techniques</u>										
Conservation	S	S	S	S		S	S	13	0	13
District heating			L	L	S	L	S	7	6	13
Cogeneration			L	S	S	L		5	6	11
Materials recycling (glass, paper, aluminum, oil)	S				S	S		3	0	3
Electricity management					S			1	0	1
High-efficiency natural gas boilers							S	1	1	12

Key to letter symbols:

S - suggested as part of a short-term strategy
L - suggested as part of a long-term strategy
a - active
c - for cogeneration
e - for electricity
g - gasification or gas production
h - heat pumps
i - in individual buildings
m - microhydro (small-scale hydropower)
p - passive
t - for thermal production (large scale)

from local economies, FRG and U.S. interest in finding capital for energy projects, and Italian concern with refuse management.

4.6.2 Implications of local issues to policy objectives

The congruence between national goals and local issues suggests the benefits to national governments of using local governments as prime conduits to implement national policy. For national governments to receive enthusiastic and effective local support and cooperation, both adequate funding and national leadership are required. Neither funding nor direction should cease at the end of the planning process, but should continue through to implementation at levels that will provide local governments with real incentives to implement worthwhile projects.

National funding could offset a basic dilemma faced by local government energy managers: most energy issues require changes in the ways that the private sector supplies or uses energy. Relatively few issues relate directly to local government operations such as cost reduction in municipal building heating or police car operation. In addressing the private-sector problems, the local government must spend money. But the benefits of this spending rarely return directly to the local government; rather, they flow to the private beneficiaries of the program. Thus, while a particular energy program may address an important energy issue, the local government rarely sees a direct economic benefit for its action. Local budgets, being very limited, can ill afford to continue energy programs that cannot be justified due to the lack of directly measurable benefits accruing to the local government. The indirect benefits of money retained in the community, i.e., increased property valuation, job stability, increased consumer comfort, etc., have thus far been either insufficient, too remote, or too uncertain to maintain local programs without sponsorship by national or regional governments.

The similarity of issues among the focus communities demonstrates the similar impact of energy price increases on local governments. Economics largely drive local actions. But in addition to economics, local experience with and knowledge of different types of energy systems and differing local energy resources are reflected in the issues that local energy program managers choose to address. The local resource base and energy supply systems drive the supply options. Thus, for example, district heating systems --

commonplace in Sweden and more familiar in Europe than in the U.S. -- are issue-creators in Europe but less so in the U.S. The U.S. leans toward building conservation and related solutions -- partly because that country's energy-intensive building stock offers good energy savings opportunities at relatively low initial cost. Additionally, single-building issues often can be addressed without need for large collective decisions about altering energy supply patterns through capital-intensive projects.

The U.S. may emphasize conservation issues for at least two reasons: (1) if, as much of the U.S. public believes, the energy crisis is a short-term problem, it makes little sense to develop expensive long-term supply solutions when short-term conservation solutions are adequate for now, and (2) as discussed in Section 4.5, U.S. communities tend to use an involvement approach to energy planning rather than a more in-house, government-centered approach. The U.S. approach is often characterized by leadership that is provided by many nonexperts. The issues that the nonexperts will tend to address will be those that they find familiar. Few people in the U.S. are familiar with energy supply technologies (especially district heating and cogeneration), but all are familiar with their own homes and lifestyles. These are the familiar realms of human experience and are those in which conservation actions are most likely to be successful. The U.S. local energy committee members, as laypersons, are also more likely than experts to see the need for public education on energy issues, partly because many of them will have had little energy experience before addressing the community's energy issues.

5 PROBLEMS AND SOLUTIONS RELATED TO THE ROLE OF LOCAL GOVERNMENT

5.1 Introduction

This chapter presents a comparative analysis of the problems experienced in local energy planning in the four countries. It also discusses solutions to problems of local energy planning that are open to and attempted by local actors. The examples below are typical of how problems are formulated and solved in the different countries.

The comparisons will proceed from requisites to consequences, i.e., from formulating constraints that influence the courses of action open to local energy planners to the strategies of solution implementation. Both similarities and differences will be discussed. It is hypothesized that the way that demand for energy is determined from the behavior of different actors in the local arena is basically similar in the different nations. The outcomes or solutions are also hypothesized to be similar when it comes to the economic forces that drive supply. On the other hand, it is hypothesized that the organizational structures of the different local energy planning bodies are very different.

The interesting question is whether the deviations can be explained by comparative analysis. Are the policies or solutions tried in Sweden applicable in Italy? Are they applicable now or might they become of more pronounced interest in the future? How would the solutions opted for in the U.S. be implemented in the FRG organizational structure that surrounds the local energy planning arena? This is the direction taken in this chapter.

5.2 Resource supply and constraints

The resource endowments of different nations and regions bring about varying comparative advantages in the supply and use of energy. Factors usually mentioned in this context on the supply side are the availability of hydropower potential, the discovery of oil wells or other hydrocarbon resources, the presence of climatic conditions conducive to certain technological options such as solar or wind power, or appropriate conditions for the use of renewable resources such as forest products in the form of wood chips or peat. The relative abundance of such resources in different regions has led to interregional and international trade in energy supply resources. Thus, the supply options for different regions and nations not only involve locally found resources but are determined by global comparative cost considerations.

The interregional and international supply developments have become more and more evident since World War II with the emergence of road transport in practically all parts of the world. The decrease in the relative price for petroleum products led to an increased oil dependence in all industrialized nations. Global technology out-competed local supply options. As a consequence, more and more local communities adopted the global trend to minimize cost in the short term. Minimization of marginal costs of energy supply could be achieved through the installation of oil-based heating systems, even in regions where climatic conditions made the heavy base load period of each year a lengthy one.

With the advent of the current trend of increased relative prices of oil, national and local diversity of energy resource endowments has again become important. In a sense, this is a step back to a time when petroleum products were not marketed globally at large scale, at least not for heating. The latest 10-year period has been characterized by a substantial reduction and redistribution of global trade in energy resources. It has also entailed changes in the connections between regions within a nation, both in large countries such as the U.S. and in advanced European economies such as the FRG, Italy, and Sweden.

These changes in energy resource trade and the efficiency of energy utilization have been supported, reinforced, and induced by national economic policies. The oil bill has become so much more expensive for advanced Organization for Economic Cooperation and Development (OECD) countries that their governments have initiated large efforts in research and development, demanded changes in legal structures and regulatory systems at the national level, and instigated specialized supply and conservation policies directed toward energy suppliers and users at the local level. Ambitions have been higher in the more oil-dependent nations. The level of ambition has also been tied to the openness of the economies to the world market. The change in comparative advantages between different regions in the U.S., i.e., the New England area with its partly obsolete building stock and harsh climate vs. the more recently industrialized sunbelt states, is a cross-national issue in Europe. The efforts of European nations to give preference to domestic, sustainable, and renewable energy resources should be seen in the light of these considerations.

The earlier discussion of resource availability and resource constraints may be further illuminated by a comparison of the focus communities in the respective countries. Such a summary comparison is attempted in Table 12, in which a shorthand description of the range of endowments and planned exploitation schemes is presented. The comparison is based on the set of 15 local communities in the four countries. There is a wide variation in foreign resource dependence among the nations. The level of oil dependence among the Swedish communities is by far the most pronounced of the four countries. None of the local communities in the other nations has a level of import of petroleum products comparable to that in Sweden.

If we compare the level of utilization of regional and local resources, a scattered picture also emerges. Where there is an abundance of competitive local energy resources, those resources are used to supply energy. In continental Europe, natural gas is important to the local supply. The building of national and international gas distribution networks will change this condition markedly. At least this will be the case if the connection between the Soviet and Eastern European networks has a substantial capacity. Local resources of renewables or solid wastes are not now used to their technical potential. Neither are new technological options. There is an overall strengthening of collective supply systems at the expense of the individual ones.

Swedish local communities have led in the strategy of reorganizing supply toward collective systems based on domestic resources. Strong political pressure exists in Sweden to restructure the energy system. In view of the heavy dependence on imported oil, this strategy is an economic necessity. Some focus communities stress energy conservation as important when contemplating local resource use. The marginal effectiveness of conservation exhibits decreasing returns. This is one of the reasons that Swedish communities do not stress this aspect as much as communities in the FRG and the U.S. Unlike the latter countries, Sweden's building stock was energy-efficient at the outset of the energy price hikes; thus Sweden found conservation to quickly decrease in marginal benefits per SEK spent.

In all countries, market forces have slowed the substitution of renewables and conservation for oil due to the less rapid increase in the relative price

Table 12 Energy resource use and trends in focus communities (about 1980, and projected to 1985)

Country	Level of Usage of Foreign Resources	Level of Usage of Regional and Local Resources	Trends in Regional and Local Local Resource Use
Sweden	Share of oil for heating generally above 80%.	Use of refuse, peat, wood chips, or other solid fuels generally below 10%	Strong increase in district heat, built on fuel mix with refuse, peat, or wood chip base, cogenerated electricity.
FRG	Share of oil for heating generally between 20 and 50%.	Heavy use of coal and natural gas, depending on local availability and networks.	Energy conservation is stressed, along with a strengthening of district heat and gas networks.
Italy	Certain share of heating based on imported oil, with large regional variations.	Base load carried by natural gas. A few examples of refuse burning for heating exist.	District heat expensive, along with solar heat systems.
U.S.	Fuel imports are of moderate importance. Oil or natural gas dominate heating, using domestic fuels.	Local resource use varies substantially. Use of renewables generally below 5%.	Emerging considerations of district heat based on waste heat or local resource deposits.

of oil during the 1980s. Also, conservation has turned out to be much easier to accomplish than originally anticipated. The potentials for follower nations are indeed substantial if Sweden is looked upon as a leading nation. Conservation has removed some 25% of heat demand in existing Swedish building stock in less than 10 years. This has been possible even starting from a level of building efficiency not attained by many other nations.

5.3 Institutional constraints

New roles are being played by local governments in reshaping energy systems in reaction to new external conditions. In many countries, this new mode of development has led to increased numbers of actors in the municipal energy planning field. This has increased the need for coordinating activities.

Three primary types of institutional arrangements exist. They are legal, organizational, and financial. Energy policy may be guided by one or several of these schemes of arrangement. Municipalities are constrained by laws and regulations both in their roles as authorities and in their roles as suppliers and users of energy.

Their authority role may be in conflict with the other two roles, and the two latter may also conflict. This may cause tensions within the local governments themselves as different departments have responsibility for different activities. Organizational problems may emerge because of the division of labor among planning, economic action, and responsibility. Financial issues should be separated from the others because of the differences in the use of financial instruments in the different countries under study. Some nations engage in indirect policy through the manipulation of relative prices or costs while others are more likely to enter into the local energy planning through laws, demands placed on the performance of planning actions, or various compulsory or voluntary regulatory practices. Table 13 gives a summary of the results of the comparative study as regards institutional constraints.

The legal status of municipal energy planning differs considerably among nations. These differences are to some degree due to the differences in legal power of the local governments. The FRG and the U.S. are federally organized nations, and much of the responsibility of interaction with local authorities lies with the states or the laender. In Sweden and Italy, several layers of regional and local governments exist

Table 13 Institutional constraints in the focus communities (about 1980)

Country	Legal Authority	Organization Scheme	Financial Support
Sweden	Rapid development of laws and acts for municipal energy planning, both to stop choices (nuclear, heat pumps) and to encourage them.	Unclear division of labor between different branches of the municipalities and between policy fields.	Frequent changes over time in taxes and fees, as well as subsidy and grant systems, causing unclear planning requisites.
FRG	The legal authority of local energy planning is small and special laws and regulations exist.	Utility companies have strong positions, and federal and state levels compete with different programs.	Support schemes have been redirected from conservation to supply options in recent times.
Italy	The legal status of local energy planning is weak, leading to problems in exercising direct powers.	The organizational structure of municipal governments has no special role for energy planners.	No national funds provided for local energy planning; conventional local sources are used.
U.S.	Local governments exercise powers granted by the state level. Although not precluded by state law, so far few laws exist for coordinated local energy planning. In some states, even cogeneration needs complex prior approvals.	Terms for elected officials too short for long-range decisions, leading to insufficient experience in coordination and management.	Because financing operates in a free market context, there is a lack of funds for experimental investments guided by public-sector choices.

through which nationally decided legal schemes must pass to become applicable at the local level. The focus communities differ in size. Sweden has gone through several municipal reforms, in each stage reducing the number of municipalities. One important reason for this reduction has been the effectiveness of public-service provision. However, the energy supply systems have not been crucial when the municipal borders have been decided upon. Italy has a very large number of small municipalities, or communes, each having relatively minor planning and decision-making responsibilities. The local governments in the U.S. are also small and their boundaries usually coincide poorly with functional regional subdivisions. The local authorities in the FRG are integral parts of the laender and have no direct connection with the federal level.

The legal authority of municipalities in energy planning differs among nations because the position of municipalities in total differs. Thus, differences in the organization of local energy planning are not the only variables. Sweden's strong municipalities have been put under a strict national energy planning law. That law was changed frequently during the 1970s. The less powerful municipalities in the other countries are more often bypassed by energy planning laws and regulations directed at the influential actors among utility companies, building owners, and maintenance enterprises.

The strength of the Swedish municipalities brings bright prospects for effective local energy planning in furthering the fulfillment of national energy policy. But the organizational complexity brought about by a large administrative apparatus can also hamper goal achievement. The need for coordination among branches of local government stressed by the national level is often felt as a burden by small- and medium-sized municipalities and as a violation of their independence. It appears that organizational problems are present in all local communities. The U.S. experience is that short-term issues dominate local decision making, partly because of the short terms for elected officials. A long-term problem, such as local energy supply, is difficult to handle by such an organization. In the FRG and Italian cases, coordination problems due to the large variety of actors were heavily stressed.

Because of the infrastructure properties of energy supply systems, special considerations need to be given to the financing of investments in these systems. The conflict between public or private utility companies and building owners becomes especially clear when national policymakers decide to support collective district heat systems.

Financial inducements may be used both to stimulate a certain choice of investment options and to suppress the options open to individual building owners. Financial constraints are different in the various countries. In some focus communities, the capital market is free. Different energy supply options may be evaluated through standard cost-benefit methods. In other cases, financial support is used to influence behavior in the local energy markets.

Institutional problems seem to be quite similar among countries. Major problems are to be found in the coordination of different branches of local energy planning, as the integration of conservation and supply measures. The organizational problems stem from involvement of different offices in planning and the lack of skilled specialized staff with experience in coordinating technical and social issues.

Italian local governments have problems exercising their control powers rationally due to the scarcity of specialized staff and the bureaucratic organization of municipalities in relation to the new energy tasks.

To solve organizational problems, focus municipalities in Sweden have made up special decision-making or project groups with participation from the energy authorities, the offices of buildings and land use planning, and the political parties. The Swedish study emphasizes that an energy conservation plan or program must be constructed in such a way that its implementation can be integrated with other activities of the local authorities (S3).

The U.S. study suggests university-level training for planners to improve project planning and management. Through the establishment of a clear lead agency for energy projects, conflicts within government can be lessened. The lack of financing of local energy planning projects is a strongly binding constraint. In Sweden, energy conservation programs have been supported by government grants, but grants are rarely available for investments such as domestically fueled boilers (U3).

Financing problems in the U.S. are partly due to the perception of energy management as a low-priority activity. They cannot be solved until energy planners prove their value to the community. Therefore, as a first step, local energy planners and managers need to do a better job in implementing and demonstrating the success of programs that achieve measurable dollar savings for the local government and for various sectors of the local economy.

One possible solution to chronic shortages of this type may be to find a new location for the energy office. In Seattle, for example, the energy planning function was moved from city government to the city-owned electric utility. Before the move, the energy office used federal and local tax funds. After the move, the office received most of its funds from electric utility receipts.

Several communities in the U.S. have proposed (but not implemented) taxes on energy consumption, with revenues to be set aside for energy planning. In these proposals, a major emphasis has been to lessen the dependence of the energy office on general tax revenues. Each proposal stresses the development of independent revenue sources tied to the measurable performance of the office. In this sense, these proposals are a first step toward transforming the publicly accountable energy office into a quasiprivate venture.

5.4 Constraints stemming from attitudes and lack of knowledge

Many U.S. constraints on successful introduction and fulfillment of energy planning objectives at the local level stem from obsolete attitudes and poor knowledge. This refers to both local officials and individual actors in households, organizations, and businesses.

Both in the U.S. and Sweden, public officials, especially in branches of local government involved in local energy planning, have been somewhat skeptical of the value of overall energy planning. In both countries, this attitude can be explained by the relative newness of energy planning as an activity of local government, one not naturally linked with other main planning activities such as tax planning, financial planning, physical planning, and planning for special sectors.

Researchers in the U.S. recommend improvements in planning education, especially an increased emphasis on tools to speed up the planning process, to control costs, and to manage implementation projects. Staff members need better training and instructions on how to make committee work more interesting and productive. There is a critical need to demonstrate to local officials the economic advantages of energy management.

In the FRG, the public sees the introduction of district heating as a problem due to its higher private costs than individual systems. Application procedures for a direct subsidy are cumbersome and this often has prevented low- and middle-income house-owners from taking advantage of these programs.

The U.S. public is still skeptical about the extent and duration of the energy crisis. Many people remain convinced that the oil shortage was created by the oil companies. Public education and information may be a means to increase awareness, although there is little evidence to show that education programs are effective in stimulating action.

Both Sweden and the FRG use similar methods to inform people of the need to conserve. In Sweden, information about the importance of energy conservation and possibilities of getting loans and grants for energy conservation measures are given to the public on a national level through newspapers and television. At the local level, residents are offered information, energy inspections, and advice from energy advisory offices, partly financed by governmental subsidies.

A special government committee on energy conservation has been set up in the FRG for a constant review of energy conservation policy. Information and advice is deemed necessary, especially for the private consumer, to facilitate decisions on how to use energy more efficiently and economically. The federal government presently pursues long-term information campaigns through newspapers, radio and television advertisements, and special information brochures. There is an increasing response to services that offer unbiased individual advice to private consumers. The federal government will continue to give financial backing to the information and advisory services of the Association of Consumers.

The FRG federal government will also continue its financial assistance to the special advisory service on energy-saving measures for small- and medium-sized companies. This covers both individual advice and training and information seminars. The federal government is also committed to continuing to include teaching objectives relating to energy conservation in revised training regulations, especially those in the industrial technical arena. Such teaching objectives are also included in school curricula.

A general conclusion from this section is that local energy planning attitudes among final users of energy may restrict the pace of introduction of new technology. Individual households may not feel the same economic encouragement to choose efficient energy options as large energy users, especially in a context of sluggish growth in the level of per-capita income.

5.5 Collection of information for local energy planning

The successful development of local energy planning is hampered not only by resource and institutional constraints; the proper information base is also lacking. An information base of high quality is necessary for efficient energy planning. This information base can take a variety of forms. At the most basic level, there is a need to assess the current state of the energy supply system, as well as the different components of energy demand at the local level. At a more elaborate level, there is a need to systematize and analyze this basic information so that the costs and benefits of different supply and demand alternatives may be compared. Furthermore, there is a need to develop planning methodologies that better utilize the information that is collected. Here, problems related to the measurement of energy system performance at the local level will be discussed.

The oil crisis began as a national problem with national planning for national solutions. In most nations, information collection channels were primarily developed for the national level. Of course, most national information must be collected at the local level and aggregated nationally.

However, sampling techniques may be employed to gain sufficient information at the national level without leaving the local level with statistically reliable information. Broadly speaking, the information sources used in the formation of aggregate national energy policy need not be of any significant use to decision makers at the local level. Also, local decision making is often devoted to problems that are of minor significance at the national level. To obtain realistic and adequate comparison of alternatives, the local energy planner will need to have detailed information on the characteristics of the building stock and the specific energy uses of the activities performed within the different parts of the stock. Because energy planning in this respect is a recent phenomenon, such information may not be available at all, either in historical census data or in more recent building stock registers or tax records. Local energy planning will also need information about the technical and economic properties of the current energy supply system and development options. Such information is normally available from energy suppliers, but may not be available to local energy planners for reasons of confidentiality among utility companies and energy system developers.

Many of the problems concerning the provision of basic information for the local level energy planning are similar in Sweden, the FRG, Italy, and the U.S.

Reliable data are difficult to find in official statistics. Data are not available due to the secrecy of proprietary information (oil and utility companies and, in the U.S., industrial energy users). A gap also exists between the planning process period and the period after which data become obsolete. The U.S. study considers that these problems can be lessened by increasing funds available to the local energy offices, improving planner training, and making census and other general data collection efforts (i.e., tax assessments) include energy-related questions. Improved data collection, analysis, and presentation would help clear up these basic problems.

Data collection methods can be speeded up. Streamlined methods for community energy audits could be developed at the federal level to avoid duplication of effort and to concentrate resources. In large part, problems in the existing U.S. audits were due the early belief that citywide energy use estimates were needed by local analysts before planning could really begin. Cities such as Ann Arbor suggest that this much audit detail may not be very important, at least during the early stages of planning.

When confronted with the problem of analyses of heat demand, utility companies in many FRG cities complained about the lack of reliable statistics. Because of this, for instance, recent energy plans for Berlin were based on a very detailed analysis of heat demand house-by-house and apartment-by-apartment. Buildings were grouped by a cluster analysis to find out typical building characteristics. For the typical buildings, the actual final energy demand as well as the final energy demand computed by a simulation model were compared and traced back to the primary energy required. Social structure, supply alternatives, and pollution levels were similarly considered. The coordinated results of all four analyses were finally compared house-by-house. All data were stored in an information system to facilitate cross-comparisons.

Planning for energy conservation and implementation programs requires information about the building stock. Even small municipalities may have thousands of buildings. Hence, such an information set will grow rapidly, and manual handling of information will become impractical. To handle large quantities of energy conservation information, the Swedish Association of Local Authorities, with financial support from the government, has developed a special computerized information system.

The basic data in this information system are derived from central registers and special surveys. Information from the central registers cover such real estate data as year and type of construction, type of heating installation, and owner. More-detailed information about the buildings on construction types, heating and ventilation systems, and insulation and energy consumption is collected with the help of questionnaires to real estate owners, as well as through special inspection reports. As a further source of information, loan applications related to energy conservation investments are used together with follow-up reports on the investments made with these funds.

The Swedish information system is used as an example of the development of basic information collection tools. The system can be used for a number of purposes ranging from the provision of background information for on-site inspection of the energy performance of individual buildings to detailed reports on the ages of individual oil boilers in a residential district. There is a definite need for further steps in the direction of this Swedish example, utilizing modern computing and information display technology.

Local energy planning will remain constrained by the lack of recent and reliable data in the future. Until now, the problem of updating local information has received little attention. It is only when local energy planning is based on a solid platform that these data problems can ultimately be resolved. The solutions will take time, especially in a country such as Italy where basic information at the local level is lacking.

5.6 Procedures for systematic analysis and evaluation of local energy plan alternatives

Among the problems to be solved by local energy planners are some that relate to institutional and attitudinal inertia. Others stem from the several layers of uncertainty surrounding the choices to be made at the local level in a swiftly changing economic and technical environment. At least four problems were shared by focus communities:

1. The division of responsibility is unclear among different actors at the local level. In some communities, such as those in Sweden, the tasks of local energy planning have been distributed among several municipal offices. In the U.S., the short tenure of energy management officers has hampered the organizing of permanent planning activities. In the FRG and Italy, a variety of private actors sometimes seem stronger than the public offices.

2. The attitude toward local energy planning among households, firms, and organizations is still ambiguous. Planners need stronger arguments to establish the usefulness of the activity. This problem seems to be present in almost all of the focus countries. The process of attitudinal change may be slowest among small users of energy such as households.

3. There is a deficient information base for local energy planning. This tends to increase the level of uncertainty in the process of rational choice among alternatives. The uncertainty stems from such basic problems as the lack of knowledge of current energy use and energy system costs at the local level. The problem has arisen because of the poor quality of current procedures and methods for collecting local-level statistical information in official registers. There is a strong tendency in the focus communities to look toward modern computing methods to help create reliable information bases. However, the problem also relates to the lack of confidence at the local level in analyses and projections performed in other regions or at the national level.

4. There is a lack of well-established procedures for the evaluation and implementation of options in the energy planning context. Some focus communities stress the need for better and more reliable evaluation methods. In others, the process of implementation of preferred alternatives is seen to be the crucial

> one. Differences of opinion may be related to the degree of formal status and organization of energy planning. The importance of a more efficient planning process was stressed by focus communities in which the institutions for local energy planning are weak.

Thus, none of the focus municipalities in Sweden attempted to systematically relate planned extensions of their energy systems to scenarios of energy system components and to future settlement and activity patterns. Instead, system extensions are most often looked upon as minor, although they may mean a complete restructuring of a local energy system. Similar observations are made in the U.S. study. Combinations of options are often evaluated in simple ways and probably distort synergistic effects. Even more important, the decision methods currently used are not capable of handling the existing information on future energy technology. Research is needed to separate methods of local energy planning from the standard techniques of evaluation of marginal and independent investment options.

The remainder of this section will be devoted to a set of examples of methods and procedures used in evaluating energy system alternatives at the local level in the four countries. Some of the examples refer to methods currently practiced. Others represent developments suggested by recent research.

In Sweden, the standard approach to energy supply planning is characterized by a four-stage sequence of activities. A schematic description is made of building stock characteristics considered to be of central importance to the demand for energy, i.e., age, insulation standards, type of construction, etc. An overall description of the economic structure in the municipality is made. This description is usually quite aggregate, but special regard is given to the presence and characteristics of those industries that may deliver waste heat to a district heating system. Plans and forecasts of the future construction of dwellings are compiled. These forecasts are normally done by agencies other than those involved in energy planning. Forecasts of economic activity are used to a very limited extent. A description is given of the energy use structure by fuel, energy carrier, heating technology, etc. This description of the existing energy system is normally quite detailed, and it also involves a detailed picture of the district heating system if there is one.

When using this background material to discriminate between energy system extension in terms of district heat, collective or individual end-use heating systems, or conservation measures, the municipal energy planners must comply with a number of laws, rules, and regulations imposed by the national government. They also must weigh the importance of taxes levied by the national government on fuels and subsidies given to certain technological developments. It is this part of the planning process that is most difficult to handle and to change.

Within the Swedish national study, a case study has been performed in which tools have been developed for a more systematic evaluation of the costs and benefits of alternative actions in this important stage of the planning process.

The core of this methodology is a flow chart of the complete energy system structured after the degree of collectiveness and size of the system components. An example of such a chart is given in Figure 8 for the focus community of Sundsvall. The region has somewhat less than 100,000 inhabitants and is a center of the Swedish paper and pulp industry. An aluminum smelter also adds substantially to the waste heat potential in the region. The chart shows how different plants can choose between a variety of fuels (indicated by dots in the chart). Via the vertical bars (in bold), transformed energy flows from large-scale to ever smaller-scale system components to the individual houses or other end users at the right of the chart.

The boxes in the chart represent alternative technologies or groups of technologies, each provided with technical and economic characteristics. The problem to be solved by this energy system analysis is how to fulfill the energy demands at the lowest present value of the total system cost, measured over the planning horizon. That horizon should be long enough to allow a major restructuring of the total energy system. This energy system model may be seen as an advanced tool for use in a local energy planning context. The fact is, however, that methods of this kind are employed in some regions in Sweden. The utilization of such tools is also in line with the recent demands from the national government that the municipalities set up comprehensive energy plans for the entire local community.

Researchers in the FRG have presented a schedule of a working plan for local energy systems management. The suggested six steps in this planning exercise are similar but not identical to the preparatory stages mentioned in the Swedish system. An initial framework

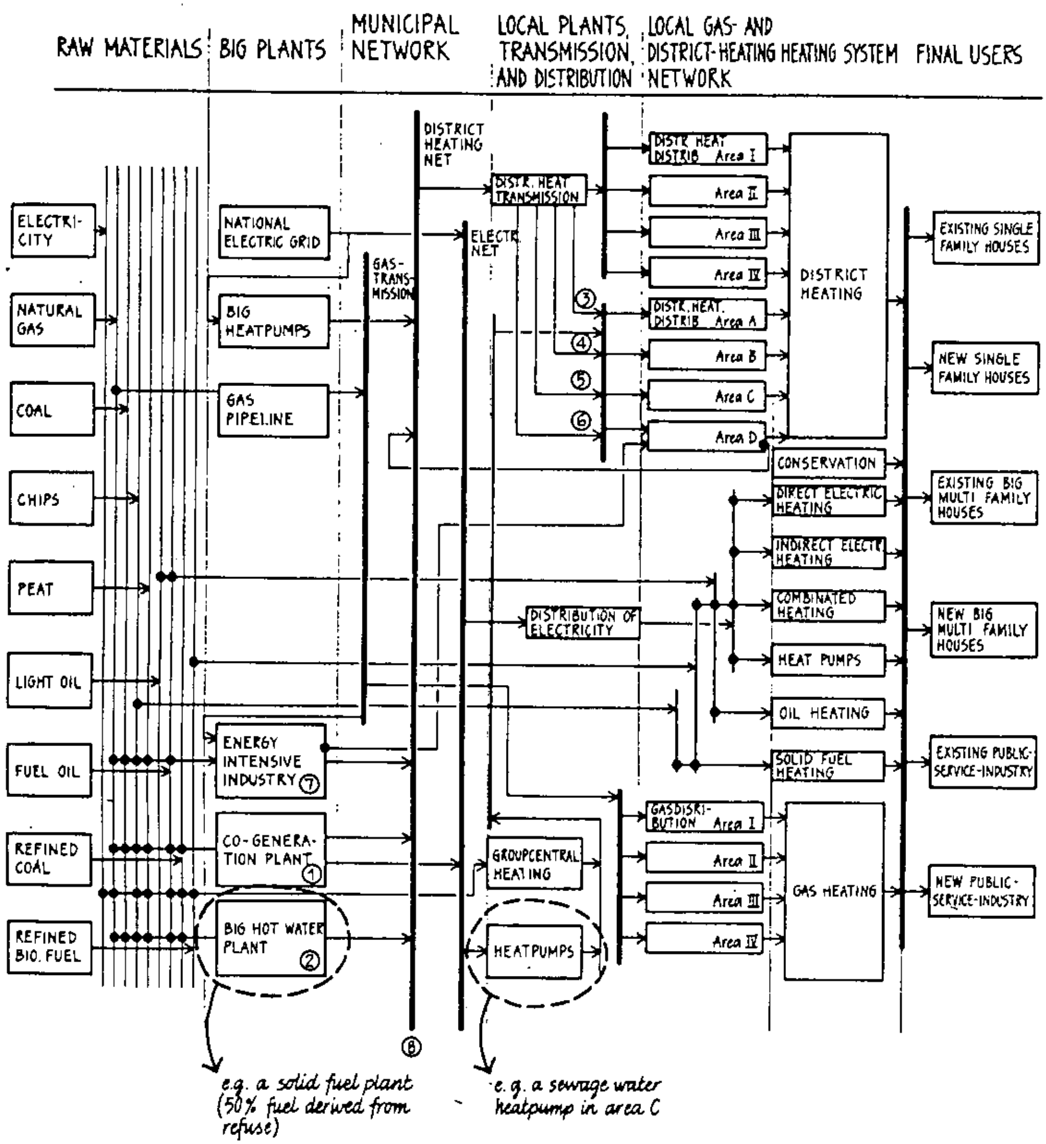


Figure 8 Flow chart of the energy system of Sundsvall

stage involves an analysis of existing energy management programs, an identification of parties to be involved in the process, the general goals of the activity, and a discussion of overall expected benefits. In the next stage, the current status of the area under study and its projected development through time are described. The work contains both demand and supply analysis, as well as a treatment of environmental issues. A conceptual stage that follows can be split into two parts. The first part deals primarily with goal formulation and the identification of technical and organization options. The second stage is an analysis of the decision problem with the help of the concepts defined earlier. At the end of this stage, a set of complete alternatives to be accepted or rejected will exist. The decision stage that follows involves both general decision strategies and detailed analysis of financial and other consequences of taking the actions necessary to implement the chosen alternative. The last stage of implementation involves both organization, building, or other investment-oriented activity.

Figure 9 contains an example of a planning activity developed within the framework delineated above. It refers to the development and evaluation of local energy systems in Berlin. There are three strategies to be considered: an increase in district heating, an increase in gas usage, and an increase in energy conservation by insulation.

The concept for action in one of the geographical areas will be defined as a specific mix of all three strategies mentioned in the figure. These concepts or scenarios are evaluated in a third step of work according to the policy criteria, social structure, environment, economy, and energy savings.

The final selection of one of the scenarios depends on the sum of these evaluations. Some of the criteria are expressed in monetary units, others in quantitative units, and still others by a qualitative description of advantages and disadvantages. The result is a multidimensional evaluation of the proposed scenarios for a particular organization and geographical setting.

The situation in Italy seems to be somewhat less developed than that in Sweden or the FRG when it comes to the utilization of systematic methods for choosing energy system alternatives. This may be due to a lower demand for energy for heating than in the other focus communities so that energy planning deals primarily with the choice of alternative fuels for other types of energy system installations. It may also be due to the weak role of local governments in the energy planning field.

The latter argument may also be used to explain the relatively limited use of comprehensive planning schemes and methods in the U.S. Energy decision makers constitute a large and extremely heterogeneous group that includes suppliers, converters and distributors, major commercial and industrial users, government agencies, and a variety of groups of

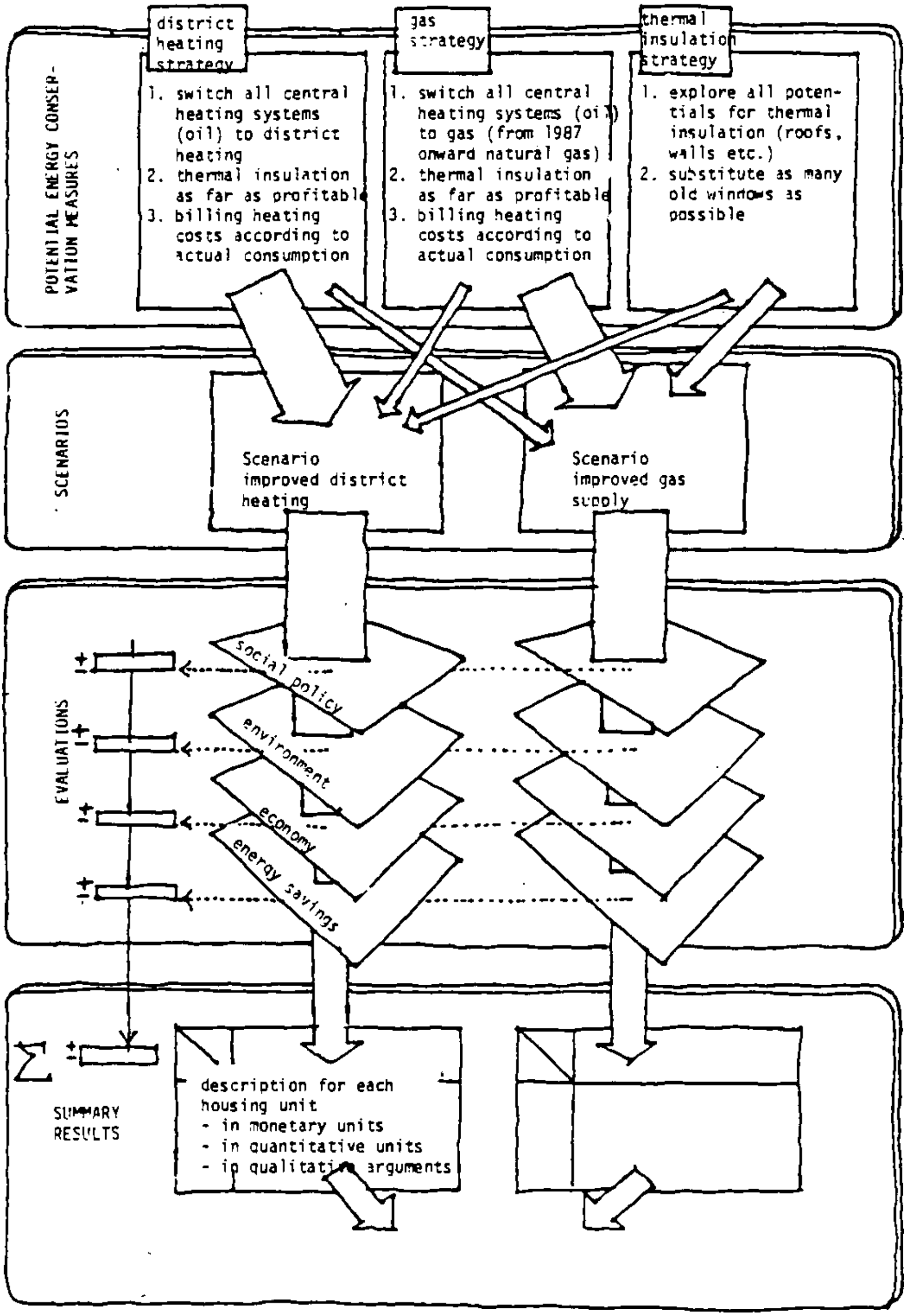


Figure 9 Development and evaluation of local energy systems in West Berlin

individual consumers. The interests of these pressure groups would need to be accommodated in any community energy management program.

A scheme of local energy planning in the U.S. would share many of the elements listed in the Swedish and German examples above. The main difference would be in the constraint identification and implementation phases. It is only when energy system development and management would cause major external negative effects on the rest of the local community that constraints must be identified in the free market context of the U.S. Such constraints might arise because of zoning regulations. In the implementation stage of local energy planning in the U.S., the role of local governments may be more limited than in the other countries for similar reasons. The nature of energy planning is such that state or national levels of decision making may be more central to the introduction of public policy than the local level. As seen from an analysis of the energy planning process in the focus communities in the northern U.S., e.g., Ann Arbor, climatic conditions play a significant role. The network aspect of local district heating systems may call for more public intervention in these parts of the U.S. than in the sunbelt states.

5.7 Implementation issues

Until the early 1970s, the energy systems developed at the local level were relatively free of government or local authority intervention in all four countries. Changes in the relative price of energy, and in some countries the debate on safety problems related to nuclear power technologies, altered this situation drastically during the remainder of the 1970s. In the 1980s, the international energy markets have been more stable. In spite of these trends, many nations continue to stimulate the restructuring of their energy systems toward domestic and renewable fuels and a more efficient use of energy. A variety of direct means have been used to steer the course of action of both suppliers and users of energy. They have taken the form of sets of laws, rules, and regulations. Several classes of indirect means have also been used, including tax and subsidy schemes oriented toward both management of existing energy systems and investment in new system components. Other indirect means have also been employed. A massive effort in R&D related to the energy sector may be seen as a part of a national policy. In practice, a considerable number of local energy projects have been started under the auspices of such national R&D programs. Regional and local initiatives have included information and education campaigns.

Many problems related to the implementation process are connected to previously presented problem areas, such as financial problems, personnel difficulties such as scarcity of skilled people, and poor coordination between different planning schemes. Further problems are associated with implementation tools. Several problems involved in using various implementation tools are discussed briefly below.

Benefits of information and education schemes at the local level are hard to measure. Several researchers have found that general appeals designed to elicit energy conservation practice tend to be relatively ineffective. It has been difficult to make energy users see the merits of making energy conservation investments independently of other new construction or renewal activity. Educational materials should provide specific instructions for specific audiences, and more than one medium should be used (for example, both radio and newspapers).

Incentives may provide monetary and nonmonetary rewards for voluntary energy conserving actions. Voluntary inducements may or may not stimulate action. A serious problem with financial incentives can be their cost. For example, in the FRG, experts evaluating specific impacts of one federal conservation program on energy consumption in buildings had to call it the window program because most of the investments and subsidies induced went into the substitution of windows. This was considered a negative effect because the cost-benefit ratio of energy conservation turned out to be particularly poor for this substitution.

Nonfinancial incentives, such as providing rapid processing of energy-efficient building permit applications, have encountered relatively few problems, at least in the U.S. A minor difficulty -- potentially solvable through better education -- is that the administrators who are expected to implement energy incentives in building codes or zoning ordinances may know little about the characteristics that distinguish an energy-efficient development from an inefficient one.

Much of municipal energy planning is to be implemented through the introduction of local regulations, at least in the U.S. Compliance with such regulations will be difficult if the regulation is not related directly to community energy problems or issues that the public understands. The solution to this problem may be to include a detailed preamble in the regulation that describes the problem being addressed and the manner in which the regulation is expected to help solve it.

Regulations that have not been carefully explained to the public over a fairly long period of time are rarely understood by the community, thus making approval difficult. Energy agencies should take the time to explain proposed regulations, again pointing to the need for assured funding and a well-trained staff. Regulations will be attacked if their objectives could be achieved through other means, such as information, persuasion, and incentives. Energy agencies should act creatively, it is argued, by testing other approaches and solutions first.

Problems with demonstration projects occur in both Sweden and the U.S. In the U.S., problems with demonstration projects have arisen from their often high cost, lack of clear relationship to necessary changes in community management, tendency to reach few people, and potential for diversion of staff attention from the central planning/management effort. These problems are inherent features of demonstration projects. Facilities tend to be costly, especially in a time of high interest rates. A potential solution would be cost-sharing by several parties. In that way, neither government nor private developers would have to pay the entire cost. The high cost also relates to the fact that these projects reach few people and at the same time, because of their single nature, demand excessive staff resources.

Financing capital-intensive projects at the local level is a constant problem, particularly during a recession. A number of capital-raising instruments have been developed. Several examples from the U.S. are given here. Municipal general obligation bonds must be paid back from tax revenues whether or not the financed project is successful. Therefore many communities avoid this type of bond. Revenue bonds can be sold by a local government undertaking a risky project that will produce revenue. The risk to the municipality is lower because the bonds are secured by the anticipated revenues from operation of the facility.

Another way for a municipality and a private corporation to implement a project is to finance a facility investment with the corporation's own bonds, with the municipality providing some sort of guarantee. Industrial revenue bonds are issued to finance an industrial plant or equipment that will either be sold or leased to a private corporation. In this way, the state or municipal government can help a private corporation finance a facility that will supply a public good. Industrial revenue bonds are widely used in the U.S. and involve relatively few problems, provided that both public and private partners fulfill their obligations.

Another U.S. option is leasing. Leasing arrangements are still fairly new; therefore, many problems are the result of unfamiliarity with lease arrangements or delays required for education. As leasing becomes more common, these problems should decrease.

The examples given for the U.S. are also generally applicable in the other countries. It may be more common in Sweden and the FRG than in the other countries to secure national government or federal government guarantees for large-scale energy investments at the local level. In Sweden, a special national investment bank has been opened to deal with the financing of risky industrial projects of central societal value. That bank has become involved in the financing of metropolitan energy system development.

5.8 Summary

The large-scale energy systems built during the post-war period all bring energy in the form of heat, natural gas, or electricity to the final users. To achieve this, primary energy must be transformed, distributed, and connected to the end users. The organizational entity called the municipality, or sometimes the local government or the local authority, plays a role in this chain today. The role is different in different regions of a nation. It is also different in different nations, depending on how the energy system is organized and how the society itself functions.

Municipal energy planning in effect stands for a set of efforts by a public authority to influence the development of the energy system in a direction in which a market mechanism would not take it. There are two opposing lines along which this task can be fulfilled. One is for the municipality to act as a middleman in the implementation of national energy policy. In this mode, the municipality follows rules and regulations introduced at the national level without reflecting upon the applicability and profitability of those actions for the inhabitants, organizations, and physical and social environments of the municipality. This is a relatively passive role.

In the other mode, municipal energy planning aims at removing market imperfections and ascertaining a decent distribution of welfare among the persons living and working in the municipality. This implies an active role for the municipality, a role of coordinating local interests to arrive at equitable compromise solutions. A smooth organizational strategy is called for to introduce this coordinative planning activity into the branches of the municipal administration.

The most crucial choice is that between supply-oriented and demand-oriented perspectives. In energy planning in general, or at least in most European focus communities, the supply perspective is the standard one. Demand is given and proceeds independently of other aspects of energy supply. The objective is to fulfill demand at lowest cost. The demand-oriented perspective is different in that the level of activity in various economic sectors, including housing and transport, gives rise to a derived demand for energy. This demand may be strongly influenced by price and availability. Energy conservation becomes an equally natural way of removing excess demands as investment in new supply alternatives.

Generally, the range of characteristics among different communities within one nation would be expected to be smaller than the differences in the typical municipality of different nations. The study indicates that this may not always be the case. The range of problems and solutions within one nation may well encompass several of the other nation's ranges. The current study has not been able to illustrate this fully, however. This is due to the uneven quantity and quality of background material from the different nations.

Table 14 summarizes the main characteristics of constraints, problems, and solutions in local energy planning in the four countries. Six factors are compared.

One striking difference that appears from an inspection of the table's U.S. information vs. that of the European countries is that the latter have implemented several of the mentioned solutions to local energy planning problems, while this has not often happened in the U.S. A sharp reduction in funding of energy programs has occurred in the U.S. Thus, proposals in the U.S. correspond to a large extent to concrete developments in Europe, at least in northern Europe.

Table 14 Constraints on, and solutions to, local energy planning problems in the four countries (early 1980s)

Constraint	Sweden (Five communities)	FRG (Three communities)	Italy (Four communities)	U.S. (Three communities)
Resource supply and constraints	Determined effort to use local resources up to potential of local communities	Strong stress on energy conservation and domestic resources	Relatively limited use of local resources except natural gas	Nationwide competition for energy resources may hamper local resource use
Institutional constraints and configurations	Strong position for municipalities, sometimes in conflict with utility companies	Competition between federal and state levels and utility companies	Overall influence of municipalities weak, leading to problems for energy planning	State changes in local authority; multiyear funding of energy offices; stable funding sources
Constraints stemming from attitudes or knowledge	Uneven distribution of competence among municipalities	National energy information via media, and funding of private information groups, demonstration programs	Contingent on the local need for heating and cooling	Energy-related staff training improved; promotion of energy program benefits
Channels of collection of information for local energy planning	Demand data often obsolete, lacking for workplaces; reorganization under way	Local solutions to information collection problems (questionnaires, sample building stock data)	Hampered by negative attitude to information delivery	Adapt census data to energy needs; develop streamlined audit methods
Procedures for systematic analysis and evaluation of local energy plan alternatives	Introduction of energy system models, even at local level	Federal energy conservation committee; evaluation by multifactor analysis at local level	Evaluation tools are one order of magnitude less developed than in the other countries	Improved, more-specific planning methods needed as well as presentation techniques
Implementation issues	Variety of subsidies so large that local authorities cannot cope with them; rapid changes through time	Product information systems for energy technology; local loan programs for energy projects	Stress on solar technology relative to other nations	Combination of approaches: education, information, demonstration, financing (de)regulation

Also of interest is the difference in European and U.S. approaches to information collection and decision making. Technological improvements are recommended in Europe, and specific new methods are presented to improve quantitative analysis. While the U.S. is concerned about technical methods, of greater concern is the methodology for group decision making and for attaining compromise agreements among different community interest groups.

This split between technological issues and organizational issues may reflect the different institutional environments in the respective communities. The European nations seem to have stronger national energy planning leadership than the U.S. The reason may also be that the authority of central governments as compared to local governments are stronger in Europe than in the U.S. This explanation would seem less likely than the first one. In the U.S., although funding and some direction come from the higher government levels, for the most part, local communities are now generally on their own when it comes to implementing energy planning programs. This means that U.S. energy planning offices have a larger number of complex agreements among interest groups to worry about. In Europe, the conflicts have often been brought to the political level, even in communities of moderate size. However, one cannot say that local energy planning is as constrained by local-opposition pressure groups as is, for instance, traffic planning. The environmental problems seem to be less formidable in the former planning context.

Resource constraints are quite different in the nations and communities studied. So is demand, especially in regard to the level of heating needed for the building stock. For example, insulation standards are quite different for housing in Sweden and housing in Italy. In spite of these basic differences, there is a large degree of commonality in the perception of problems and suggestions of solutions in the different communities. There is an almost unanimous outlook on the problems of changing attitudes and enhancing knowledge about local energy planning among community inhabitants. The same kinds of policies seem to be pursued in all nations, that is, information campaigns and demonstration projects.

The differences are greater when it comes to the organization of local energy planning and the information base and evaluation methods for that activity. Some of the differences in this respect between European countries and the U.S. have already been pointed out. Here, it can be further stressed that the level of knowledge about the energy performance of the building stock seems to be very uneven among communities. Furthermore, the methods to collect such information seem to be quite different and peculiar to the individual communities (although the number of communities in the sample of comparison is quite small).

Implementation issues are at the core of this comparison. There is a wide variety of methods for implementing local energy policy in the sample. Some of these are direct or mandatory, as required by the law on municipal energy planning in Sweden. Other channels of implementation are indirect and involve various economic inducements. Different ways are proposed and used to finance those investments in the local energy system that have been regarded as beneficial to the municipality as a whole. Thus, the variety of local solutions to energy problems is further extended by a multitude of implementation schemes. The similarity among nations, in this case, lies in the wide scope of implementation options.

6 TECHNICAL SOLUTIONS

6.1 Introduction

This chapter describes the technical solutions that have been implemented or that are well on the way to implementation in the focus communities. The term "technical solutions" includes technologies for building conservation, energy conservation in the transport sector, and programs for energy management. Table 15 shows the different types of technical solutions used in focus communities. Level of detail in the descriptions varies, based on the information available.

6.2 Building conservation

Portland's "Weatherize Homes in Portland" (HIP) program, currently a pilot project, provides property owners, landlords, and tenants with a low-cost energy audit and an assortment of low-cost energy merchandise.

The HIP program includes these elements:

- Training workshops are held in Portland neighborhoods. The workshops show how to evaluate the energy items needed for the home and demonstrate the installation techniques.

- In-home energy audits are performed by trained auditors who use a microcomputer to estimate energy loads and costs and the effectiveness of various improvements that the building owner may make.

- The first two elements above identify low-cost (minor) and high-cost (major) retrofits. Building owners can receive a weatherization kit, valued at about $40, free of charge. The contents of the kit vary depending on the building's needs, but can include fiberglass insulation, caulk, weatherstripping, and door thresholds. A separate hot water energy kit includes a water heater jacket, flow restrictors, low-flow shower head, and pipe insulation.

- Two neighborhoods of 2,000 households each are involved in the demonstration phase.

Table 15 Technical solutions in focus communities

Country and Community	Building Conservation	Heat Pumps	Solar Energy	Bio-gas	Solid Fuels	District Heating	Waste Incineration	Electricity Production	Transport
Sweden									
Kristianstad					X	X	X		
Sundsvall					X	X	X		
Uppsala		X	X		X	X	X		
Ornskoldsvik		X				X			
U.S.									
Ann Arbor								X	X
Portland	X								
Richmond						X			
Italy									
Brescia				X					
Modena					X				
Reggio Emilia				X		X			

A 25-to-35% participation rate is expected. The goal is to complete all 11 Portland neighborhoods. Of the city's 24,000 households, about 8,400 will be reached by the program.

- Funding for program planning came from local private utility companies, with some contributions by state agencies. Cost of initial planning was $20,000. Demonstration funding comes from one-time grants from local private utilities and the state. Local merchants and residents have given in-kind contributions of materials and labor. Long-term funding has not yet been worked out, but the expectation is for the private utilities to redirect their Residential Conservation Service (RCS) budgets to this program. (RCS was required by federal law. Almost all utilities are required to offer free on-site energy audits to all residential customers who request them.) The utilities typically maintain secretarial staff to arrange audit appointments and keep a staff of trained auditors who visit with building owners to check their buildings and give an energy evaluation. These audits, as currently done in Portland, cost $80 to $100 each. The theory in the HIP program is that more actual implementation can be accomplished with the same money by using mass production techniques to deliver energy materials and training. Only an abbreviated building audit would be completed. If the demonstration project proves that the HIP concept is feasible, the utilities may redirect their RCS programs to HIP. Such a change is allowed by federal law and could improve the utility companies' public image. Public image is important to the utilities because they must ask the state public utility commission for rate changes. The utilities in the Portland area have had serious problems with public image due to recent nuclear power plant operation and financial problems.

- The economic analysis was straightforward, and highlights are presented below.

Cost per household: $60, of which $40 is for materials and $20 is for administration/labor. Savings per household were estimated at $150/yr. The average energy bill in the state of Maine has been documented to be $1,430. The low-cost measures are assumed to save about 10% of the annual bill, and were assumed to be effective for four years. Life-cycle savings per household would be $600 over four years. The city made no calculation of inflation effects.

Citywide costs of minor measures (8,400 households participating):

Cost of materials kits	$336,000
Cost of administration	$168,000
Total	$504,000

Of the 8,400 households participating, only half were expected to request an in-home audit by a city or utility auditor. The in-home audit will result in a materials kit being given to the building owner (or renter) and a set of recommendations for major energy improvements that the owner can choose to do. Of the 4,200 households with audits, 3,150 are assumed to complete at least one major improvement (see Table 16).

Total program costs (all payers):

Major measures	$ 946,000
Minor measures	$ 504,000
Total	$1,446,000

Table 16 Investments and economic data for energy saving technologies, Portland HIP program

Financing Method	Number of Households	Average Investment ($)	Annual Incremental Savings ($)	Average Life-Cycle Savings 10 Yr ($)	Life-Cycle Savings for all Participants ($$10^6$)
Self-financed	1,575	800	175	1,750	2.75
Loans from Utilities or Others	1,325	1,200	225	2,250	2.98
Grants from Utilities, State, or Others[a]	250	1,200	225	2,250	0.57
Total	3,150	-	-	-	6.30

[a]Grants are available for participants with very low incomes.

6.3 Heat pump technologies

6.3.1 Uppsala heat pump project (sewage water)

Kungsangsverket, the central sewage plant of the municipality of Uppsala, processes about 23 million m^3 of wastewater per year. The water temperature varies over the year from 10 to 20°C (50 to 68°F). Thus, the water contains much energy that in earlier days was impossible to use. In the autumn of 1982, a 39-MW heat pump plant was installed at Kungsangsverket. This heat pump plant makes it possible to exploit much of the earlier unusable energy in the district heating system.

The Kungsangsverket sewage plant has three steps; mechanical, biological, and chemical.

The mean wastewater flow is about 63,000 m^3/24 h; during weekends it is normally about 75% of that figure. Flow and temperature vary over a longer period. The largest flow and the lowest temperature have been recorded during the snow-melting period. The smallest flow and the highest temperature occur during the summer. Average annual temperature is 13.5°C (56.3°F).

Clarified sewage water is pumped from the purification plant to the heat pump plant and is distributed to three 13-MW heat pumps. The heat pumps raise the low-temperature energy from the sewage water to a temperature high enough to make the energy useful in the district heating system. The average Coefficient of Performance (COP) for the heat pumps is 3.2, which means that more than 2/3 of the energy transferred to the district heating system comes from the sewage water and less than 1/3 from electrical energy. The heat pumps can be regulated from a control room from which all energy production plants in the district heating system can be opened to achieve the lowest total production cost.

To get as much energy as possible from the wastewater, special arrangements have been made to connect the heat pump plant to the district heating system. Two of the main return pipes are connected to the plant. Normally, 57% of the total flow in the district heating system passes through these pipes. In summertime the flow is small, however, which may cause some trouble because the heat pumps must always have a certain flow to work properly. To guarantee this minimum flow, the installation has pipes and valves that make it possible to recirculate previously heated water to the heat pumps. The amount of energy transferred from the plant to the district heating system is calculated to be 280 GWh/year, or about 15% of the total heat demand.

From the start in November 1982 to June 1983 the plant has delivered about 110 GWh; this is somewhat less than planned. The smaller production is caused by some minor trimming problems. None of these problems, however, has been serious enough to cause anxiety for the future.

Economic performance has been impressive. The total investment is SEK 42 million. The heat pump plant lowers the consumption of oil used in the district heating system by about 2500 tons/year. A cash-flow calculation made after the plant began operation showed that the investment was already paid back at the beginning of 1984, which indicates a payback period of only 1.5 years.

6.3.2 Ornskoldsvik heat pump project (industrial wastewater)

A district heating system is under construction in the city of Ornskoldsvik. The dwellings and industries that are planned to be connected have a thermal power demand of 100 MW. At the MoDo paper mill three kilometers from the city center, a substantial quantity of low-temperature wastewater is available for the district heating system.

The wastewater consists of:

- Cooling water from a scrubber, approximately 400 metric tons/h at a temperature of 57°C (134°F).

- Bleachery water, approximately 350 metric tons/h at a temperature of 44°C (111°F).

This wastewater has been used to supply the baseload heat for the district heating (DH) system. The wastewater is pumped through plastic pipe to the DH boiler plant. Two electrically driven centrifugal heat pumps with a thermal output of 19 MW are installed in the plant. The heat pumps heat the water returning to the DH plant from 60-80°C (140-176°F). The temperature of this water is then raised with oil-fired boilers, electric boilers, or steam. The steam used is surplus steam from the paper mill produced by wood waste. The heat pumps operate 7,000 hours annually, which results in low capital cost per kilowatt-hour produced. The heat pumps deliver about 50% of the total heat demand in the DH system. Peak load is covered by the surplus steam from the paper mill, electric boilers, and oil-fired boilers.

A heat pump is more efficient when operated at low output temperatures. Efficiency increases approximately 1% for every degree Celsius that the temperature in the DH network can be reduced.

Studies are in progress to discover how temperatures in the network can be reduced. Several measures have improved the control equipment, the dimensioning of valves, heat exchangers, and other items.

6.4 Biogas

6.4.1 Brescia

During 1981, several investigations collected data relevant to biogas production in Brescia's urban waste. The average composition of urban solid wastes and other similar wastes collected by ASM Brescia (the municipal concern that handles electricity, gas, water, district heating, public lighting, public transportation, and waste disposal) is reported in Table 17. The high organic content suggested that usable quantities of biogas could be produced from Brescia's disposal site. Investigations discovered usable biogas, with a composition as reported in Table 18.

Table 17 Average composition of urban solid wastes at ASM Brescia

Waste Material	Composition (%)
Organic Animal Material	23
Cellulose Materials	
paper	29
wood	14
plastics	10
Iron and Other Metals	8
Glass	9
Earth, Ashes, Inert Materials	7
Total	100

The gas pressure ranged from 1 to 50 mm of water and the temperature was about 23°C (73°F). The lower heating value was 5.35 to 5.5 kWh/m^3.

Analysis of water samples collected during the drilling of 15 wells made it possible to check the speed of biomass biodegradation. The rate corresponds to a first-order kinetic model and consequently, the transform semiperiod turned out to be 7.87 years; the length of time that biogas production would continue was 23.8 years.

On the basis of these elements and the topographic pattern of discharge, a plan for biogas collection and transport was drawn up. It consists of a network of draining wells, each well having a calibrated valve that permits control of the depression value (pressure) and each set at about 80 m from the other. The wells are interconnected by plastic pipe. Two aspirators, 750 m^3/h each, with overall power of about 600 mm of water, are used. A gas purification system that removes suspended solid particles and a gas cooling system that reduces humidity will be located downstream of the extractors-aspirators.

Table 18 Average biogas composition of ASM Brescia discharge, 1981

Constituents	Composition
Hydrocarbons	52-56% (methane 50-54%)
CO_2	38-45%
N_2	0.2-0.3%
O_2	0.03-0.07%
H_2S	1-17 ppm
CO	10-80 ppm
H_2O	1.8-2.5%
Mercaptans	1-21 ppm

The waste disposal site is located in a gravel and sand quarry that is still being used by a private building firm. For its own requirements, the firm's electrical and thermal consumption are about 200 kW and about 11.6 GWh/year, respectively.

Consequently, the possibility of supplying this building firm with the biogas has been researched. The expectation is that gas will be burned in existing boilers after installation of new dual-fuel burners, and with or without installation of a conventional gas source of about 5,000 m^3 capacity to compensate for periods of maximum demand. Brescia has also studied the possibility of installing a small electric generating plant to produce sufficient electricity to meet the firm's needs.

6.5 Solar heating

In the village of Storvreta, Sweden, 13 km north of Uppsala, is a new area with houses under construction. From 1981 to 1984, 550 houses were built. The houses are heated by a DH system supplied by a solar energy collector field connected with seasonal heat storage.

The system consists of three main parts: storage, solar collectors, and distribution. The storage is a rock cavern. The only practical way to build the rock cavern was to construct an uninsulated cavern using the rock itself as insulation. The rock had to be sufficiently tight so there would be no heat loss from water flowing into, out of, or around the storage.

The project was carried out in two steps. In the first step, only 15% of the required solar collectors were installed. The rest of the energy was produced in an electric boiler. (Most Swedish electricity is produced by inexpensive hydro sources.) In the second step, the remaining 85% of the solar collectors will be installed. The second step is expected to be carried out during the latter half of the 1980s.

The cavern is 75 m in diameter and 30 m in height. The roof is 30 m below the surface (see Figure 10).

The temperature levels are 40°C (104°F) at the bottom and 90°C (194°F) at the top. The control equipment is situated in a tunnel between the storage and the rock surface.

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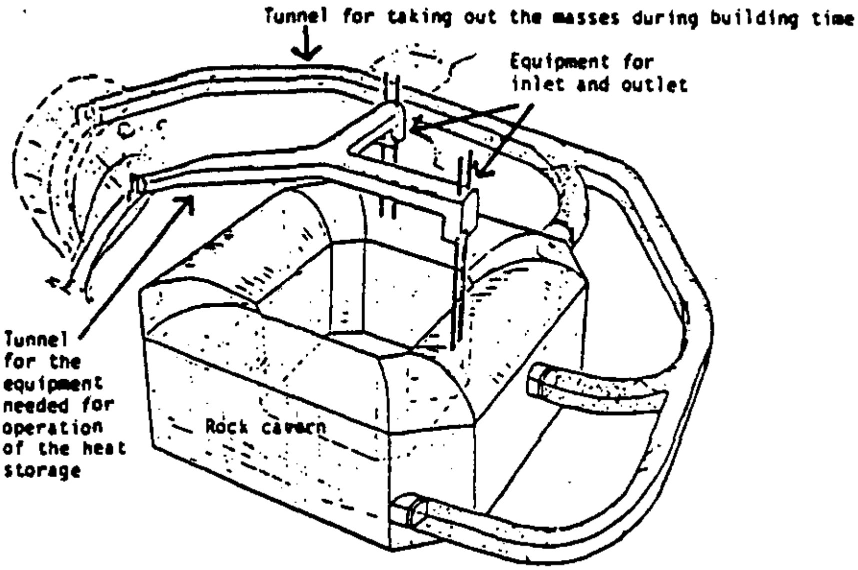

Figure 10 Rock cavern design for seasonal solar energy storage at Storvreta

The cavern was blasted out between August 1981 and April 1982 and was filled with water in September 1982. Heat storage began in the summer of 1983.

The first step in the solar system consisted of installing 4,300 m^2 of flat plate collectors. Each collector occupies 12 m^2. The absorber is an aluminum plate with a selective layer and in the middle there is a copper tube for the fluid. The "sunstrips" in each collector are coupled in series, which gives a total length of 80 m. The water inlet is at the bottom of the collector and the outlet at the top.

The cost of the whole project with heat storage, 15% solar collectors, electric boiler, and distribution system is about SEK 39 million; 50% is financed by the Swedish Council for Building Research as a loan for experimental building, and the rest is financed by Uppsala Kraftvarme AB (the district heating company in Uppsala), Skanska Cementgjuteriet (the cavern contractor), and HSB (one of the house contractors). The residents will pay the same for the heat as if they were connected to the central DH network in Uppsala.

The cost of energy produced by this project is far too high today to compete with other kinds of energy sources. But this does not mean that solar energy with seasonal storage cannot be used in the future. After improvements are made in components and systems, the price will decrease while the costs of other energy sources will increase. This project is one way of using solar energy with seasonal storage. The project will provide experience with new technologies that possibly can be used in the future for very large storage systems.

6.6 Solid fuels

6.6.1 Sundsvall solid fuel plant

At present, the ordinary production of DH energy at Sundsvall is through oil firing in the Korsta plant and from waste heat from an adjacent paper mill. The Korsta plant, which supplies most of the energy demand, consists of two hot water boilers, each with a capacity of 80 MW, and a cogeneration unit with a heating capacity of about 110 MW.

As a first step to reduce oil dependency, the municipality of Sundsvall has built a solid fuel steam boiler. As a second step, the municipality has advanced plans to convert the existing combined power and heating plant; with heat pumps, it will use low-temperature waste water as an energy source.

The new solid fuel plant is able to use several fuels: peat, refuse-derived fuel (RDF), and wood waste. To burn all these fuels, the municipality of Sundsvall has chosen to construct an all-round fluidized bed boiler. The chosen boiler is provided with a fast fluidized bed (Figure 11). This means that a sand bed in the furnace is fluidized by a powerful air supply from the bottom of the furnace. At the same time, fuel is mixed in the bed. Fuel particles and fines from the bed are allowed to follow the gases from the furnace, and unburned particles are separated in a cyclone. The separated particles are returned to the fluidized bed. The fluidized bed plant has a capacity of 20 MW. The energy production of the plant is calculated to be about 150 GWh/year through the following supply of fuels:

	Fuel demand (tons/year)	Energy production (GWh/year)
Peat	40,000	75
RDF	25,000	60
Wood Waste	7,000	15

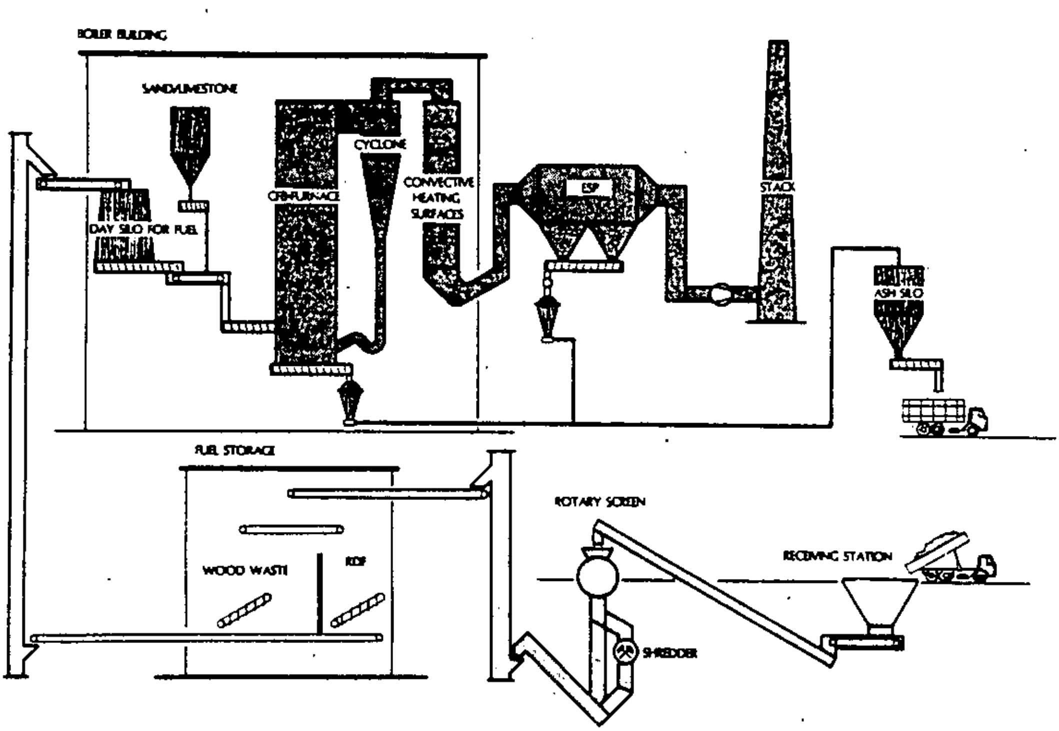

Figure 11 Fluidized bed boiler plant for peat, RDF, and wood waste at Sundsvall

The peat is delivered to the plant in small pieces and has a moisture content of about 50%. The RDF is a sorted paper- and plastic-fraction from refuse, produced at the central refuse plant of the community. The wood waste consists of bark and chips from lumber mills.

The handling system of the fuels at the Korsta plant includes (1) receiver hopper, (2) rotary screen to separate oversize pieces, (3) shredder for the oversize pieces, and (4) storehouse with a volume of 2,500 m^3.

The total investment costs of the solid fuel boiler including the costs of the fuel handling system, is calculated to be SEK 60 million. The costs of the different solid fuels vary between SEK 10 and 80/ton. As a result of the low fuel price, the cost of the plant -- compared to one that is oil-fired -- will be repaid within about six years.

6.6.2 Wood-chip fired plant in Knivsta

The village of Knivsta is situated about 15 km south of Uppsala and has about 4,000 inhabitants. A local DH system supplies 70% of the urban area. To reduce oil dependency and gain experience with substitute fuels, a hot water boiler plant designed to burn wood was built in 1980. The plant, supplying the total demand of DH energy, consists of three boilers: one basic boiler of 7 MW for wood fuels only, one combined boiler of 7 MW designed for wood and oil fuels, and one oil-fired standby boiler of 7 MW. The wood-handling equipment includes a hopper for receiving wood chips from trucks, and a storage silo of 2,500 m^3. Internal transport of fuel is by screw conveyers.

Since the Knivsta plant started in November 1980, several problems and defects have occurred in connection with the wood-handling equipment. Through rebuilding and operational changes, however, the defects now are rectified. Last heating season, about 90% of the heating demand was satisfied by wood-chip firing.

Operating experiences from the use of different fuels are:

- Chips of deciduous trees and pine trees can be burned with excellent results.
- Bark can be used if mixed with more than 50% chips.
- Sawdust, ground demolition timber, and straw are less suitable fuels.

The investment cost of the Knivsta plant was (in 1980) SEK 20 million. The investment cost for a corresponding oil plant would have been about SEK 10 million. Plant operating costs are high compared to those of oil-fired plants. But wood chips are cheaper than oil, and as a result, the total annual cost of the Knivsta plant is considerably lower than the corresponding cost of an oil-fired plant. This means that by 1983, the higher investment cost of the wood-fired plant was repaid.

6.7 District heating

6.7.1 Kristianstad

Installation of the DH system in the city of Kristianstad started in 1979. According to the plans, the DH system will grow rapidly until 1990. The load in the year 2000 is calculated to be 116 MW and the energy demand 261 GWh per year.

The community has investigated possible energy sources to be used for heat production. One alternative was a waste incineration plant with heat recovery. The amount of waste available near Kristianstad is approximately 88,000 metric tons per year. Of this, 68,000 tons can be used for heat production. With waste obtained from a somewhat greater distance, the figures would be 152,000 and 107,000 metric tons, respectively.

The community has decided that the basic load of the district heating system is to be met by heat from a waste incineration plant (Figure 12). Unsorted combustible refuse from the region will be transported to the Nasby incineration plant in Kristianstad during those times when the heat can be used in the DH system. During other parts of the year, the surplus combustible refuse will be disposed of with the rest of the refuse.

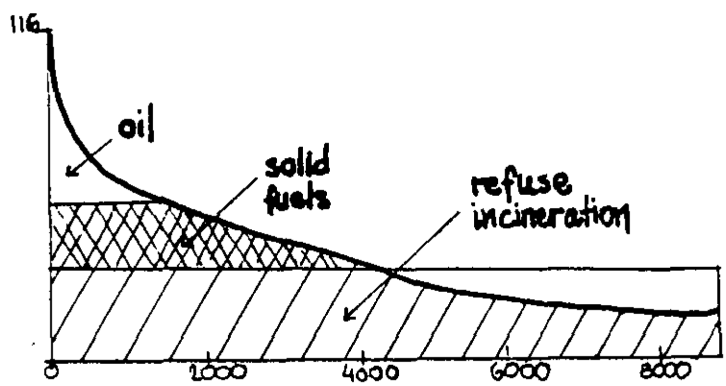

Figure 12 Fuel supplies for meeting district heating demand in Kristianstad

Plans for the main production plant show that it will be equipped with the following boilers:

Waste incineration with heat recovery	2 x 10 MW = 20 MW
Solid fuel	2 x 20 MW = 40 MW
Oil	2 x 8 MW = 16 MW
Total	76 MW

In addition to the main production plant, three existing plants will be connected to the district heating system. All are equipped with oil-fired boilers and will be used to cover the peak loads and serve as backups for the main plant.

The network will be built up in stages to get the best economy during the build-up period. Hot water (120/65°C, or 248/149°F) is used as a heat-transfer medium. The central network and the heat production plants are shown in Figure 13.

6.7.2 The Richmond district heating project

Richmond, Indiana, is introducing a small district heating system that will be based on existing excess boiler capacity at a nearby state mental hospital. The boilers currently supply steam to 25 hospital buildings. A heat exchanger system will be added to the boilers to produce hot water that will be piped to 2.8 ha (7 acres) of existing greenhouses. Heat from the coal-fired steam boilers will replace heat currently produced by an oil-fired greenhouse heating system.

The central plant consists of four existing coal-fired steam boilers with a total capacity of 140,000 lb of steam per hour (41 MW). Although the boilers are not new (two were installed in 1941, one in 1962, and one in 1970), they have recently been refurbished and will require little more than a heat exchanger system to supply hot water to the greenhouses. The city does not know whether air pollution control equipment will be required to remove SO_2 or particulates from the stack gases. The plant is exempted from most federal air pollution regulations because of its small size. The Indiana state government is somewhat concerned about increases in particulate matter, but has not yet required control equipment.

The distribution system for the central plant to the greenhouse will consist of a two-pipe hot water

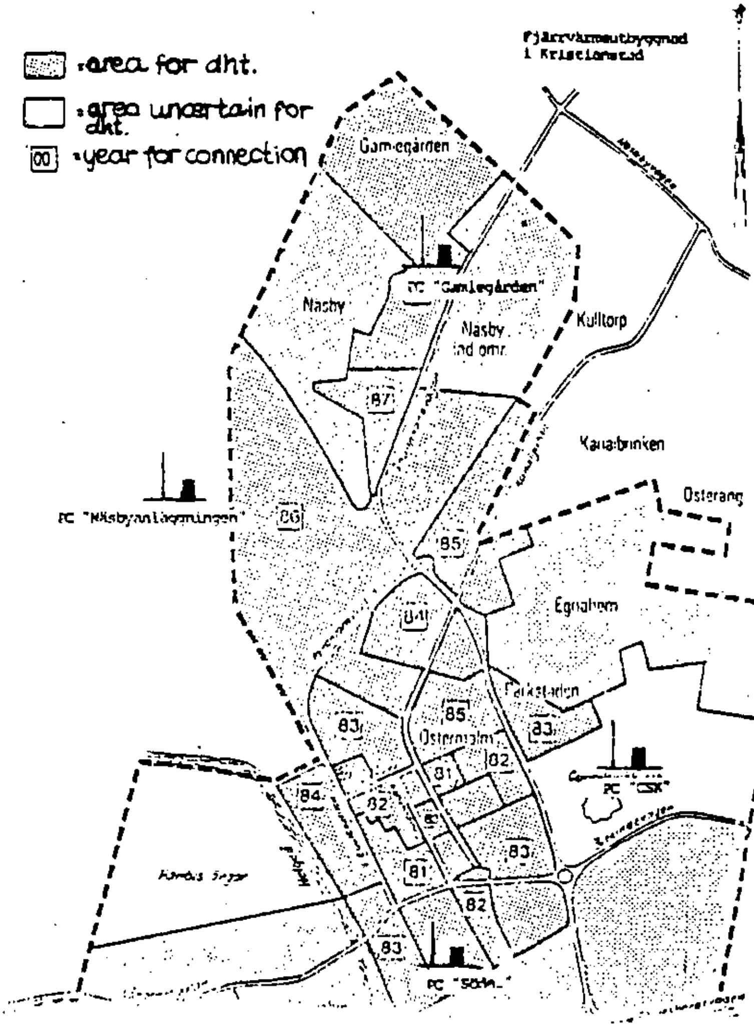

Figure 13 District heating development in Kristianstad

system, probably using a 35.5-cm (14-in.) diameter pipe with foam insulation in plastic jackets. The pipe length is about 0.4 km (0.25 mi) and is expected to cost $500,000. According to the city, water was preferred over steam as the distribution medium because future system expansion should be easier.

The end-user is the greenhouse, which is under single ownership. Currently, the greenhouse burns 2,650,000 L (700,000 gal) of No. 6 fuel oil per year for heating. When the system is completed, this oil will be entirely displaced by coal. About $200,000 will be spent for retrofitting the greenhouse in-building systems to accept hot water.

Preliminary estimates suggest a 3.1-year payback for the system, assuming that no air pollution control equipment is required. Without pollution controls, the total system will cost $1.4 million; with controls, it will cost $2.1 million. This project is expected to be completed late in 1985, but may be delayed due to unexpected financing problems within the Indiana state government. If financing works as planned, the U.S. Department of Commerce will provide $500,000 of the cost as an emergency job-retention grant (this grant is designed to save the jobs of the greenhouse workers, which otherwise could be lost if the greenhouse owner decided to go out of business or move elsewhere). The greenhouse owner will pay $200,000 to retrofit his buildings, and the Indiana Department of Administration (the owner of the existing central plant boilers) will pay for central plant improvements.

Administratively, the hospital will use the boilers to generate heat that it will sell to the city's public utility company. The utility company will own the distribution system and will retail the heat to the end-user.

At the start of project planning, the price of No. 6 fuel oil was about $1.00/gal. With the oil glut and increased domestic production, the price has dropped to $0.65/gal. But even with this dramatic decrease in fuel prices, the project will go forward when financing agreements are completed.

6.8 Waste incineration

6.8.1 Uppsala

The original waste incineration plant at Uppsala was built in 1962. Since then, the plant has been rebuilt in several steps and the last waste furnace began operating in the summer of 1982.

The existing incineration plant in Uppsala has a capacity of 22 metric tons/h, which corresponds to a heat output of about 45 MW. More than 100,000 metric tons/year of waste are treated in the plant. The waste is collected from Uppsala and 5 to 10 nearby municipalities. Some of these municipalities (for example, Gavle and Sandviken) are more than 100 km away. Yet from a practical and economic standpoint, it is advantageous for these municipalities to transport their waste to the established incineration plant at Uppsala rather than establish their own facilities.

The Uppsala plant generates steam that is used for industrial purposes and for producing hot water for the DH system. During 1983, 200 GWh of energy was produced at the plant. That is equal to roughly 13% of Uppsala's entire energy production.

Reconstruction work is now under way at the Uppsala incineration plant to enlarge the heat production capacity by exchanging two old low-capacity furnaces for a new high-capacity unit. The new furnace is provided with a mechanical fire grate and an economizer. The temperature of the flue gases from the furnace is reduced from about 240°C to about 130°C (464/266°F) by the economizer and the energy is captured. Through the installation of the economizer, the thermal efficiency of the waste-fired furnace can be improved from about 77% (normal efficiency of waste furnaces) to almost 90%. The capacity of the incineration plant will also be increased to about 250,000 metric tons/year. This means that an additional 100,000 metric tons/year of waste from the northern suburbs of Stockholm can be treated by the Uppsala plant. The total energy production of the expanded plant is about 550 GWh/year, corresponding to one-third of Uppsala's entire energy demand for district heating.

Until 1986, the energy from the waste incineration will replace expensive energy that would otherwise be produced by oil. The income from energy production has (among other things) made it possible for Uppsala to pay SEK 30 per ton of waste to the other municipalities that deliver waste to the incineration plant.

The investment cost of the new waste furnace was about SEK 70 million. The payback time of this investment is estimated to be seven years, considering that from 1986 substitute energy will be produced by peat and coal rather than oil.

The DH network in Uppsala, which meets the heating demand of 90% of urban Uppsala, in 1980 was 92% oil dependent. The remaining 8% was met by refuse incineration. By expanding the refuse incineration plant, installing heat pumps at the sewage treatment plant, and using solid fuels, electric boilers and solar heating, the city will reduce its oil dependence to 3% by 1990 (see Figure 14). Figure 15 shows that the largest oil reduction possibilities in Uppsala are to be found in the district heating system.

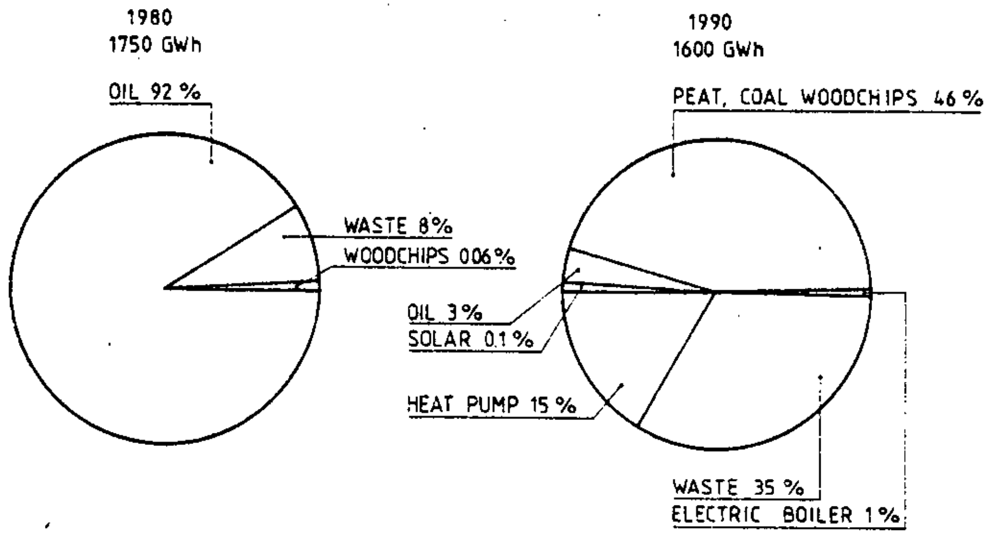

Figure 14 Energy sources for heat production in Uppsala district heating system

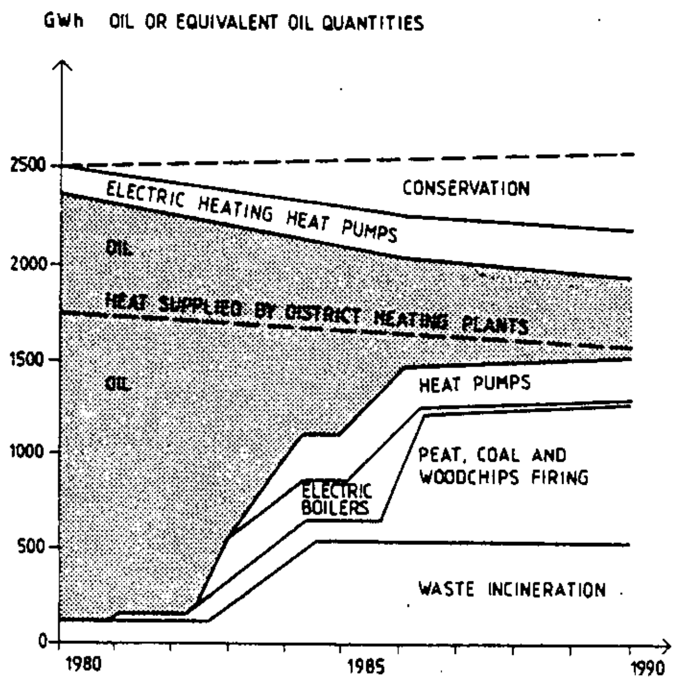

Figure 15 Heat supply and estimated oil requirements in Uppsala

6.8.2 Modena

The municipality of Modena uses a waste-burning plant located near a new sewage water purification plant. This steam production plant is of a conventional type. The capacity is 300 metric tons/day of waste, with a steam production of 24 metric tons/h at 24 ATE and 240°C (464°F).

The plant will be enlarged to absorb 500 tons/day of waste and to produce 42 metric tons/h of steam at 24 ATE and 240°C. The electric power produced by the steam will be used in both the waste-burning plant and the water-purifying plant. Surplus electric power will be used in the town's electric power network if possible. The steam exhausted from turbines will supply energy to industries and hot water for remote heating.

Estimated steam availability will be 24 tons/h, in addition to an estimated self use of 44 tons/h for plant operations. If the plant is used for electric power production only, the electric power produced will be 4 MW.

With an estimated 7,000 (or 8,000) working hours per year for the turbines and an average efficiency of 80%, the energy production data will be as follows: (data are provided for both 7,000 and 8,000 working hours per year for the turbines).

Electric power production only:

4 MW x 7,000 (8,000) hours/yr x 0.8 efficiency = 22,400 (25,600) MWh/yr

Electric power and steam cogeneration:

electric power; 3 MW x 7,000 (8,000) hours/yr x 0.8 efficiency = 16,800 (19,200) MWh/yr

Steam; 18 tons x 7,000 (8,000) hours/yr x 0.8 efficiency = 100,800 (115,200) tons/h/yr

The waste-burning plant and the sewage water purification plant nearby are expected to utilize 4,000 MWh and 10,600 MWh respectively; consequently, energy availability per year for external users, less internal plant use, will be:

	(7,000 turbine hours)	(8,000 turbine hours)
Electric power production only (MWh)	7,800 MWh	11,000 MWh
Electric power and steam cogeneration		
electric power (MWh)	2,200 MWh	4,600 MWh
steam (tons)	100,800 tons	115,200 tons

6.9 Electricity production

The city of Ann Arbor is bisected by the Huron River. From 1912 to 1920, the private utility company (Detroit Edison) built four small hydroelectric dams on the river to take advantage of the river's power. In 1962, Detroit Edison closed the powerhouses and removed the old turbine generators; preferring instead to generate base-load power with coal-fired plants.

In 1963, the City bought the old power dams to use their facilities for water supply and recreation. In 1972, the city considered installing new turbine generators to create a new city revenue source. The proposal was largely ignored until the 1973 and 1979 oil price increases made the project economically attractive.

Construction is currently under way to install new turbine generators at the two most economically attractive dam sites. The Barton site will have a new 900-kW turbine generator, and the Superior site will receive a new 600-kW turbine generator. When completed, the two sites are expected to produce 7 to 8 MWh/yr.

Both turbines will have bulb-type runners and variable-pitch blades fed by a siphon penstock arrangement. Westinghouse is the equipment supplier, but the turbines are supplied by Faust-Alpine, a Swiss firm. Ideal induction generators by Westinghouse will be used for power generation. The turbines will be supplied with water on a "run-of-the-river" basis, meaning that there will be essentially no water impoundment reserved for low-water periods. Thus, in spring, the city will generate about 1.5 to 1.6 MWh/month, but in August, this will fall to nearly zero. Turbine types and capacities were selected after engineering optimization; the original Detroit Edison turbines were nearly twice as large but much less efficient.

The city will sell its electricity to Detroit Edison for about $0.06/kWh. This price is based on Detroit Edison's costs for coal-fired electricity generation. The city's equipment has a life expectancy of 50 years, and the contract for sale of power to Detroit Edison is for that duration. The city will receive an adjustment for inflation, but only for the fraction of the electricity price that represents the cost of coal for the utility company. Thus, $0.04/kWh of the electricity price is fixed for the duration of the contract, while the other $0.02/kWh will increase in price at the same rate that coal increases in price. The price will be recalculated each year to adjust for inflation. Because Detroit Edison experiences its peak power demand in summer, while the city's peak water supply is in spring, the city receives no extra revenue for helping to decrease the utility company's capacity problem.

Funds for construction are from local sources. The city sold $3.5 million in general obligation bonds to pay for the project. This is a somewhat unusual financing scheme, but it shows the faith the city has in the project. A general obligation bond is paid back from the city's general taxes so that if the project fails, the city is still forced to pay for the project. A more common financing method for this kind of project (because it entails less risk to the city) is the revenue bond, which is only paid back if the project generates revenues. Very likely, the use of general obligation bonds allowed the city to sell the bonds at a lower interest rate due to the decreased risk for the investors. The Ann Arbor project is an example of a city's taking advantage of an existing facility to create a revenue source and replace combustion-based electricity.

6.10 Transportation

The European communities addressed building and supply options, but did not deal with transportation issues. This was due partly to the lesser need for transportation options in Europe (due to its more dense urban development, better mass transit systems, and lower private vehicle ownership and vehicle miles traveled) and partly to national preemption in the transport area (for example, the FRG national government has a voluntary agreement with auto manufacturers on future fuel economy improvements in new automobiles).

U.S. communities have considered transportation options aimed at reducing automobile gasoline consumption. The options generally fall into five groups: (1) improvements in vehicular flow and point-to-point traveling times by reducing traffic congestion; (2) modal switches from automobiles to bicycle, bus, train, or foot, usually through promotional or pathway construction programs; (3) increases in vehicle occupancy by carpooling or vanpooling; (4) long-range decreases in work or shopping-trip length through locating new housing nearer to business centers, increasing density near existing centers, or planning new commercial areas near existing housing; and (5) other changes, such as implementing pilot programs utilizing electric or natural-gas-fueled vehicles in place of gasoline-powered city-owned automobiles, experiments with small automobiles for police work, and encouraging home occupations.

6.11 Cross-country comparisons

6.11.1 Building conservation

The HIP program in Portland is similar to the programs in Swedish municipalities that include home visits to building owners. But program funding is different. The Swedish programs are financed by federal funds, while the HIP-program is financed by local private utility companies and some funds from state agencies.

The technical solutions are quite similar in Portland and the Swedish municipalities. In Sweden, oil substitute measures, such as installation of heat pumps, electric boilers, and solid fuel boilers, and connection to district heating, are more common. There is more diversity in the structure and operation of building conservation programs in countries other than Sweden.

6.11.2 Heat pump technologies

During the last few years, large heat pumps have been installed in a several DH or group heating systems in Sweden. Twenty-nine heat pump plants are delivering 1,900 GWh_{th} to municipally owned DH systems. This corresponds to 5% of the total heat production in Swedish DH systems.

Most of those heat pumps use sewage water as a heat source (a source owned by the municipalities), but some use lake water, sea water, or industrial waste-water.

A great number of heat pumps have also been installed in group heating systems using ambient air, ground water, untreated sewage water, and other resources as heat sources.

Smaller heat pumps for individual buildings are being installed using different heat sources such as ambient air, exhaust air, surface soil heat, and ground water. These heat pumps are normally installed with no involvement by the municipalities.

About 200,000 heat pumps are presently installed in the FRG. Almost 50% of these supply heat only to domestic hot water systems. The others supply heat to radiator heating systems. Two-thirds of these are the air/water type and one-third are the water/water type.

Only a few larger heat pumps connected to DH group heating systems exist. Around 300 larger gas-motor-driven plants have been installed in sport facilities, schools, and commercial buildings.

Approximately five million heat pumps have been installed in the U.S. Of these, 50% serve single-family houses and 50% commercial buildings. Almost all are electrically driven and are the air/air type. For commercial buildings, combined systems for cooling and heating are fairly often installed. Market penetration is largest in the areas of the United States with hot climates and substantial cooling needs.

Large heat pumps connected to DH and group heating systems are common only in Sweden. The reasons for the high market penetration for large-scale heat pumps in Sweden are:

- Low prices of electricity.
- Existence of many large coherent heating systems where long running times can be achieved by operating the heat pumps for the base load.
- Swedish district heating systems use low-temperature hot water, which results in a high coefficient of performance (COP) for the heat pumps.
- Substations in the DH systems give low return-water temperatures (heat exchangers connected in two or three stages), allowing the heat pumps to be used as preheaters for makeup water for fuel- or electric-fired boilers.

- Relatively cold climate and high heating needs.

In other countries, the prices of electricity are higher than in Sweden and large coherent heating systems are less frequently used.

Existing DH systems in the U.S. normally use steam as the heat transportation medium. Steam is not feasible for heat pump use. Low-pressure steam is also commonly used for heating systems in older commercial and apartment buildings.

In the FRG and Italy, existing heating systems are often sized for higher temperatures than in Sweden; normally 90/70°C (194-158°F) outside temperature, compared with 80/60°C (176-140°F) in Sweden. New buildings in Sweden must have heating systems with 60/40°C (140-104°F) water temperature according to the national building code. In recent years, Italy and the U.S. have begun using Swedish hot water technology for district heating.

In the FRG, Italy, and the U.S., natural gas is competitive with district heating. Use of natural gas and biogas for running heat pumps in these countries could be of interest.

6.11.3 Biogas

Biogas projects are only reported from Brescia in Italy. Exact information on the number of biogas systems in the countries involved are not available.

A test plant with biogas production from urban waste of the same type as in Brescia is under way in a city in southern Sweden. The same type of project probably also exists in the FRG.

Systems using biogas from digesters in sewage treatment plants for heat and electricity production for internal needs exist in all four countries to different degrees.

Biogas production in sewage treatment plants for external delivery to buildings is found in the U.S. and Sweden. In some communities in Sweden, biogas is delivered to district heating and group heating systems.

Biogas can be produced from sewage treatment plants and from urban waste discharge. That means that biogas is a municipally owned energy source that at the local level can substitute for oil.

Where these solutions are economically feasible, no other obstacles should exist. Biogas can be used in almost all types of combustion heating systems, provided they are converted to use the fuel. Biogas can also be used for electricity production.

6.11.4 Solar heating

The solar heating projects in Uppsala and Kristianstad are typical of the solar energy trend in Sweden. Due to the cold climate, large-scale solar heating projects with seasonal storage are the most promising solutions and several demonstration projects have been built in different Swedish communities. Different storage technologies are tested, such as water tanks, rock caverns, clay soil, and rock storage with drilled holes. At present, these projects are not economically feasible, and most of the projects are financed with state subsidies.

Several projects involving single-building passive solar systems are under way in all of the countries, and energy savings of up to 35% (and sometimes more) can be achieved. Normally those projects are carried out without municipal involvement.

Solar heating is still in the experimental phase in all four countries. The technologies with seasonal storage tested in Sweden could be of interest in some parts of the northern U.S. that have the same climate conditions as Sweden.

6.11.5 Solid Fuels

Domestic solid fuels such as peat and wood are used to a much higher degree in Sweden than in the other countries (Table 19). The reasons for this are:

- High prices of imported oil in Sweden.
- Large resources of wood and peat.
- Existing large heat distribution systems, which means that solid fuel boilers can operate with long duration time as base load boilers.
- Lack of natural gas that can economically compete with domestic solid fuels.

Table 19 Solid fuel use in focus communities

	Coal	Solid Waste	RDF[a]	Wood Chips	Processed Biofuels	Peat
Uppsala	x	x				x
Kristianstad		x		x	x	
Sundsvall	x		x	x		
Reggio Emilia	x	x				
Modena		x				
Richmond	x					

[a]RDF: Refuse-Derived Fuels.

In large district heating plants in Sweden, solid fuels such as coal, peat, wood chips, and solid waste are utilized. In smaller plants, wood chips or processed biofuels such as briquettes, pellets, and powder are normally used.

In the U.S., coal is used to a rather high degree (which is natural, due to the country's very large domestic coal resources). Some smaller plants using biofuels have been built in recent years in some parts of the northern U.S. These areas have good resources of wood waste. The possibility of using peat is under investigation in some parts of the northern U.S. Many larger U.S. cities are implementing or seriously investigating mass burning and RDF as energy sources and methods to conserve landfill space. Urban wastes are considered a more likely long-term energy source than wood or peat.

6.11.6 District heating

In all focus communities in Sweden, the municipally owned DH systems are near maturity. District heating systems are now established in about 100 communities and cover 27% of the heat demand for space heating and domestic hot water generation in Sweden. The connected thermal load in 1981 was 15,300 MW and the delivered heat 26 was TWh per annum. Penetration of DH is greatest in multifamily dwellings (47%). Penetration is also high (16%) in the commercial and public sectors.

The reasons for the high penetration of DH systems in Sweden are:

- Cheaper fuels can be used than in individual boilers.

- Electricity and heat can be produced in cogeneration plants.

- DH systems have a higher total efficiency than that of individual plants (at least in high-density areas).

- Environmental reasons favor DH over individual boiler plants.

During recent years, the most important argument for DH was flexibility, i.e., the opportunity to use different fuels, particularly domestic fuels such as wood, peat, domestic waste, etc. Centralization is necessary if these fuels or industrial process heat are to be used.

Low-temperature heat sources such as industrial waste heat, ground water, sewage water, sea water and ambient air can be used in systems by using heat pumps. In 1980, oil dependence in Swedish DH systems was 90%. This dependence has now decreased to 34%.

While significant in absolute terms, district heating accounts for only a very small part of end-user demand in the U.S. The precise contribution is not known due to the lack of complete statistical information. However, an estimate puts total installed district heating capacity at 40,000 MW_{th} (A4). The district heating load is divided among universities, military establishments, hospitals, housing complexes, and industry.

Most of the existing DH systems in the U.S. are steam systems, which means high thermal losses, low efficiency and other operational problems. In a few cities, new DH systems of the European hot water type have been introduced. Projects using excess capacity from boiler plants in hospitals and universities have been examined in several U.S. communities.

District heating has had a significant impact in the FRG, in absolute terms. At the end of 1981, total installed heat capacity was 31,000 MW_{th}. Seven percent of the energy demand for heating and tap hot water generation is provided by district heating.

Many older buildings have no central heating systems, which makes the investment level for district heating extremely high. These circumstances have prevented the expansion of DH in the FRG.

In Italy, the first district heating system was built in Brescia in 1978. Another 18 cities have plans to establish such systems. The intention of a federal plan is to build district heating systems at the rate of 300-400 MW a year. In Reggio Emilia, oil and natural gas will be replaced to a high degree by coal and solid waste in establishing a DH system. The economic production of electricity in a cogeneration plant with a hot water distribution system will also be utilized in Reggio Emilia.

The reasons that the other countries do not have extended DH systems to the same degree as Sweden are:

- They have access to natural gas and existing natural gas distribution systems that often compete with district heating and that are often economically superior.
- They normally have lower heat densities in built-up areas.
- Their communities have less experience with energy production and distribution than do the communities in Sweden.
- Some of the countries do not have the same dependence on imported oil as Sweden.
- Residents are more in favor of individual systems (this is especially true for the U.S.).
- Their heating systems are not as uniform as in Sweden. Sweden has almost 100% low-temperature, in-building hot water systems. Other countries have a mixture of steam systems, high-temperature hot water systems, warm air systems, and individual systems in each apartment.

6.11.7 Waste incineration

Twenty Swedish communities use solid waste as an energy source in DH systems. This is equal to 9% of the total fuel consumption in the Swedish DH systems. Almost all communities with solid waste incineration are using unsorted urban solid waste (mass burning). In Sundsvall, RDF will be mixed with peat and wood waste for use in a fluidized bed boiler.

Solid waste incineration plants exist to a certain degree in the U.S., FRG, and Italy, but not with the same penetration as in Sweden. The reasons for this, in addition to the high oil prices in Sweden, are the frequency of large coherent DH systems in which the incineration plant can be used as a base-load plant.

An existing distribution system with an established customer base is economically important in incineration projects due to the high investments required for this type of system and the opportunity to use the heat produced the entire year.

6.11.8 Electricity production

Sweden has the highest production of electricity per capita of the four countries, generating 10.9 TWh per capita; the U.S. is second, with 9.3, followed by the FRG (6.1), and Italy (3.2). In total production, the U.S. is by far the leader, generating 2106 TWh. The FRG is next (373), followed by Italy (195), and Sweden (91).

Electricity production is 54% oil-dependent in Italy. In the U.S., oil is also used to a large extent. Oil dependence is extremely low in the FRG.

Technologies for electricity production were only described for Ann Arbor, which is installing several small hydroelectric turbine generators. Several Swedish communities are involved in similar projects. The economy for these projects is not favorable at present because of the existing surplus and low price of electricity in Sweden. But many of the communities in Sweden have long been involved in electricity production (hydroelectric, cogeneration plants, nuclear plants) and electricity distribution; thus even these small-scale hydroelectric projects are of interest to them.

6.11.9 Transportation

Transportation accounts for approximately 20% of the energy used in the four countries (Table 20).

Transportation is heavily dependent on oil in all countries. Energy consumption per capita is four times higher in the U.S. than in Italy. Sweden and the FRG have almost the same consumption per capita.

Municipalities have tended to take few transportation actions. In all countries, the municipalities are responsible for traffic planning, which in some cases can result in energy conservation. Normally, municipalities have more important goals for traffic planning than energy conservation (such as improvements in traffic flows, environment, and air pollution).

Table 20 Energy consumption by transportation in the four countries

Energy source	Italy	Sweden	FRG	U.S.
Solid Fuels (TWh/yr)	1	0	0	0
Natural Gas (TWh/yr)	3	0	0.3	176
Oil (TWh/yr)	316	78	447	5454
Electricity (TWh/yr)	15	2	10	0
Total (TWh/yr)	335	80	457	5630
Per Capita (MWh/yr)	5.9	9.1	11.6	24.8

6.12 Conclusions

In a comparison of the technical solutions in the different countries, some differences emerge, especially between the European countries and the U.S. First, the European projects emphasize new equipment. They tend toward new central plants, new distribution systems, and fairly large capital expenditure. The U.S. projects typically utilize old equipment in new ways -- by reactivating abandoned equipment, by increasing the utilization of under-used facilities, or by retrofitting conservation measures into individual buildings.

Second, the projects seem to operate on different scales. The reported European projects are fairly large in geographic coverage. The U.S. projects typically are much smaller.

Third, with respect to supply systems, the Europeans spend time, effort, and money to build large distribution systems. The U.S. is hesitant to build even short distribution lines. Cost is the single biggest obstacle to U.S. distribution piping; both the cost of construction and the relatively low cost of conventional fuels (in particular, natural gas) often make it difficult for expensive distribution piping to be economically justified.

An attempt to explain the reasons for these differences is given below.

- European energy costs (plus taxes) have been much higher than in the U.S. for a much longer time.

- European central governments are willing to finance large multiyear projects. The U.S. government tends not to follow suit in this area.

- In the U.S., the energy problem has been seen as temporary, whereas the domestic source situation in the European countries proves that their energy problem is ongoing.

- The U.S. experience with existing district heating systems is less than encouraging. Most existing systems are falling apart from age, neglect, and poor original design. There are few good examples to point to, although interest is growing.

- On the whole, we speculate that the U.S. public prefers solutions that can be used on individual buildings, such as solar cells or collectors -- partly because these have received much media attention.

- In many areas of the U.S., the land use pattern precludes thermal transmission systems; the load on an MW/km^2 basis is too small to justify the cost of the thermal distribution system. In high-density urban areas, the cost of retrofit installation is usually too high to justify the capital cost.

Thus, local experience, fuel availability, and economics drive the search for technical solutions. Local communities have proved to be valuable testing grounds for new technologies as national governments and the municipalities themselves search for permanent solutions to problems of energy cost and availability.

7 CONCLUSIONS

The problems faced by the focus communities and the solutions they have proposed are surprisingly similar when considering the differences in their economies, populations, geography, and national contexts. Oil supply, price, and imports are the major overriding problems. Acquiring knowledgable personnel and adequate funding are major planning problems. Lack of economically suitable resources is a substantial obstacle. Getting agreement among many interested groups such as elected officials, utility suppliers, neighborhood groups, and the public appears as a time-consuming obstacle for some local energy managers.

One area that is encouraging is that all of the communities, with the recent changes in Italy, have sufficient authority to do energy planning and to implement programs. Chapters 5 and 6 dealt with major programs or technical solutions in the focus communities. Table 21 summarizes the broader-range programs that have been implemented or launched in focus communities. The programs suggest these major areas for local action: (1) district heating and other supply-oriented options (especially systems using local fuels) and (2) conservation programs (especially those that contact the public). Feasibility studies and construction programs for local resource use, including refuse, wood, hydropower, solar, and wastewater, are generally managed locally, with much of the funding from upper levels of government.

Differences exist in implementation programs. The Swedes are committed heavily to district heating, while the communities in other countries are working with smaller systems or none at all. In large Swedish cities, there is a push to convert oil home heating to electricity. This is possible because of that country's large hydro and nuclear electric generation capacity. The strategy would fail in Italy, the FRG, and nearly all areas of the U.S. because of their predominantly fossil-fuel-based electric generation facilities.

If implementation of significant programs is considered as a general criterion for success, what elements seem to be important to successful energy management? The following is a first attempt at a list of critical elements:

1. Clear national direction. Both Sweden and Italy have developed consensus national policies on their

Table 21 Programs implemented or substantially under way in focus communities[a]

	Program	Sweden					FRG		
		Kristian-stad	Angel-holm	Uppsala	Ornsk-oldsvik	Sunds-vall	Berlin	Saarland	Rhein-Main
1	Build District Heating System	L	L	L	S	L	L		L
2	Information for Energy Users	S	S	L	S		S	L	
3	Building Energy Audit Programs	S	S	L	S			L	
4	Government Buildings - Conservation Programs	L	L	S	L			L	
5	Cogeneration Plants						L		L
6	District Heating Network Extensions	L	L	L		L	L		
7	Refuse Plant (Electric, Heat, Co-generation, Processing)	L		L		L			
8	Technical Assistance to Energy Users							L	
9	Wood Waste (Heat, Processing, Contracts)	L		L					
10	Solar Demonstration Projects			L[b]					
11	Recycling Programs								
12	Building Design - Voluntary Conservation Program								
13	Biogas Production from Waste Water or Landfill								
14	Fuel Switch to Coal in District Heating								L
15	Fuel Switch to Electricity in District Heating			L					
16	Natural Gas Production								
17	Electricity Management Program								
18	Government Buildings - Shared-Savings Contracts								
19	Form Area Solid-Fuel Company	L							
20	Small Scale Hydroelectricity								
21	Industrial Waste Heat Plants							L	
22	Energy-Efficient Building Codes								
23	Bikeway Systems								
24	Wastewater-Linked Heat Pumps			S					

Table 21 (Cont'd)

	Program	U.S.			Italy				Totals		
		Ann Arbor	Portland	Richmond	Bologna	Brescia	Modena	Reggio Emilia	Large-Scale	Small-Scale	Total
1	Build District Heating System			S	S	L	S	S	7	5	12
2	Information for Energy Users	S	S	L		L			4	6	10
3	Building Energy Audit Programs	S	S	S					2	6	8
4	Government Buildings - Conservation Programs	L	L	S					6	2	8
5	Cogeneration Plants			S	S	L	L	L	5	2	7
6	District Heating Network Extensions					L			6	0	6
7	Refuse Plant (Electric, Heat, Co-generation, Processing)				S		L		4	1	5
8	Technical Assistance to Energy Users		S	S	L		S		2	3	5
9	Wood Waste (Heat, Processing, Contracts)		L[c]		S				3	1	4
10	Solar Demonstration Projects			S	S				1	2	3
11	Recycling Programs	S				L	S		1	2	3
12	Building Design - Voluntary Conservation Program	S		S				S	0	3	3
13	Biogas Production from Waste Water or Landfill				L			S	1	1	2
14	Fuel Switch to Coal in District Heating								1	0	1
15	Fuel Switch to Electricity in District Heating								1	0	1
16	Natural Gas Production				L				1	0	1
17	Electricity Management Program					L			1	0	1
18	Government Buildings - Shared-Savings Contracts				L				1	0	1
19	Form Area Solid-Fuel Company								1	0	1
20	Small Scale Hydroelectricity	S							0	1	1
21	Industrial Waste Heat Plants				S				0	1	1
22	Energy-Efficient Building Codes		L						1	0	1
23	Bikeway Systems		S						0	1	1
24	Wastewater-Linked Heat Pumps								0	1	1

[a]L = Large-scale; S = small-scale.

[b]District-heating-related.

[c]For individual users.

desired energy future. In Sweden, imported oil use is to be cut by 45% during the 1980-1990 period, with conservation to account for 25% of the reduction. Fuel substitutions and other measures will make up the remainder. This goal has two primary effects. First, it gives local governments targets for their own programs, helping localities justify energy expenditures. Second, it commits the national government to take action; thus national programs to fund energy planning, fund implementation projects, and encourage local actions have legislative precedent.

2. Some local energy experience. Programs seem to have a better chance for implementation if they are proposed for municipal operations or for utility services supplied by the municipality. Either the political control of the operations is important or, possibly, the planners who develop the proposals have more expertise in these areas, or both. In Sweden, district heating options are common partly because the utility service is usually municipally controlled. In Brescia, an electricity management program can work partly because the lead planning entity (ASM) operates the electricity supply system. In the U.S., local building codes are often subject to consideration or change for energy purposes because the planning office that helped develop the codes generally has an important role in energy planning. Knowledge of how municipal systems operate, when combined with new energy knowledge, appears to greatly enhance energy activity.

3. Quantification in proposal evaluation. Implemented programs seem to be those whose effects have been quantified the most. Decision makers have a better idea of the project's energy and economic limits, which seems to make agreement more likely.

4. Community organization for review/approval. There are two major theories about setting up groups to provide data, advice, review, and approval of energy proposals made by city staff. In the vast majority of communities, the advisory groups consisted of technical experts and government department staff. In the minority, representatives of the general public were consulted. Either approach seems to work, although the public process seems to take more time. Because, as far as can be told from the available data, there are no instances of a community that did

not use an advisory committee, having one must be considered necessary.*

5. Building on past projects. Implemented programs often seem to be outgrowths of national directives (Sweden's building inspections, Italy's insulation requirements, and the U.S. conservation tax credits) and expansions of existing operations (district heating in Sweden and Italy).

The existence of "something to build onto" seems to help encourage future action. This is especially true with district heating, where the existence of a piping network and an established group of users allows opportunities for creative fuel switching with less risk (i.e., if the refuse-fired boiler doesn't work, the old oil boilers can be restarted and the community knows that the heat can be sold). Political opposition may also be less because the previous commitment to a certain technology helps provide justifications for improvements.

6. Outside project funding or risk allocation. In virtually every project example presented in Chapter 6, national or other extra community funding was needed to stimulate implementation. For the most part, communities appear unwilling or unable to find local financing for large, speculative (risky or experimental) energy supply projects. Thus, if national governments want the assistance of local governments for major projects, national government financial support appears to be necessary.

European and U.S. energy programs can be differentiated in several ways, including:

- Degree of public involvement vs. internal government agencies.
- Emphasis on supply vs. demand.
- Technical evaluation of proposals vs. political and organizational evaluation.

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*It would be interesting to test the alternative of a staff working without outside help. Probably the most widespread examples of this would be found among private utility suppliers in the U.S. and Sweden, or in some municipal concerns in Italy.

Similarities also exist, such as:

- Need for additional knowledge by the public, decision makers, and energy staff.
- Nearly universal need for outside financial incentives to stimulate both planning and implementation.
- Tendency for government entities to assume the lead community planning role.
- Tendency of national governments or organizations to try to fill knowledge gaps via the creation of generic planning methodologies.
- Lack of reliable data bases for evaluating individual options.
- Lack of significant actual use of methods designed to give cross-sector or cross-option evaluations of energy proposals.

The differences and similarities could suggest policy choices for these countries. For example, is there a pressing need for one or more generic quantitative planning methodologies in each country, or should resources be pooled to determine the feasibility of a generic methodology that could be adapted to national and local circumstances? Could further efforts be made to conduct joint ventures to develop energy technologies that would lower the cost of using district heating, solar energy systems, electric vehicles, and other technologies? But before these and related questions can be answered, a policy choice must be faced by the countries, that is, whether to have an energy program at all and, if so, whether local governments should have a significant role in implementing that policy.

From the data presented and analyzed here, it is evident that local governments see energy as a problem, feel the effects of increased costs, and think that national governments should supply some type of support, assistance, and leadership. At the same time, local governments find that the financing of large projects is generally beyond their means. From the national perspective, local governments represent the vehicles through which the nation can implement its policies while being responsive to unique local conditions.

In sum, given enough knowledge, time, and funds, local energy management programs can make substantial contributions to local and national energy objectives.

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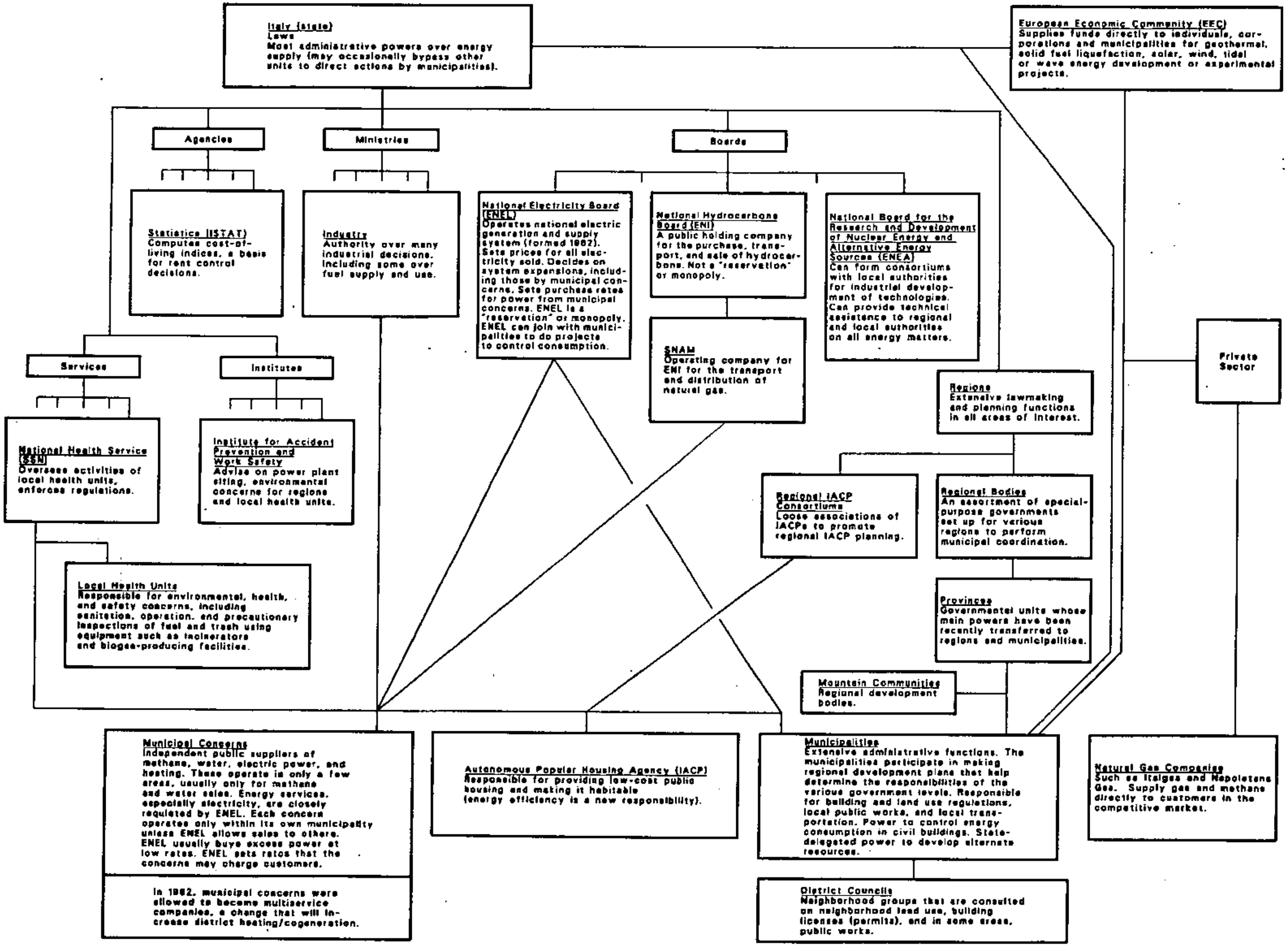
APPENDIX A

ENERGY RESPONSIBILITIES AND STRUCTURAL RELATIONSHIPS OF GOVERNMENTS AND THE PRIVATE SECTOR IN ANNEX VII COUNTRIES

This appendix contains organization charts of the different government levels in the four participating countries. Energy-related responsibilities are also noted.

Each government is set up similarly. Each country is divided into regions or states whose governments have some energy authority. Each has forms of local government that can plan for, and sometimes own, energy facilities. Italy and U.S. local authority is fragmented among many different types of local governments. Local units in Sweden and the U.S. are relatively independent of other government levels, making it difficult for the national governments to force local action on energy issues.

Figure A.1 Energy responsibilities of governments and the private sector in Italy



Italy (state)
Laws
Most administrative powers over energy supply (may occasionally bypass other units to direct actions by municipalities).
European Economic Community (EEC)
Supplies funds directly to individuals, corporations and municipalities for geothermal, solid fuel liquefaction, solar, wind, tidal or wave energy development or experimental projects.
Agencies
Ministries
Boards
Statistics (ISTAT)
Computes cost-of-living indices, a basis for rent control decisions.
Industry
Authority over many industrial decisions, including some over fuel supply and use.
National Electricity Board (ENEL)
Operates national electric generation and supply system (formed 1962). Sets prices for all electricity sold. Decides on system expansions, including those by municipal concerns. Sets purchase rates for power from municipal concerns. ENEL is a "reservation" or monopoly. ENEL can join with municipalities to do projects to control consumption.
National Hydrocarbons Board (ENI)
A public holding company for the purchase, transport, and sale of hydrocarbons. Not a "reservation" or monopoly.
National Board for the Research and Development of Nuclear Energy and Alternative Energy Sources (ENEA)
Can form consortiums with local authorities for industrial development of technologies. Can provide technical assistance to regional and local authorities on all energy matters.
SNAM
Operating company for ENI for the transport and distribution of natural gas.
Private Sector
Services
Institutes
Regions
Extensive lawmaking and planning functions in all areas of interest.
National Health Service (SSN)
Oversees activities of local health units, enforces regulations.
Institute for Accident Prevention and Work Safety
Advise on power plant siting, environmental concerns for regions and local health units.
Regional IACP Consortiums
Loose associations of IACPs to promote regional IACP planning.
Regional Bodies
An assortment of special-purpose governments set up for various regions to perform municipal coordination.
Local Health Units
Responsible for environmental, health, and safety concerns, including sanitation, operation, and precautionary inspections of fuel and trash using equipment such as incinerators and biogas-producing facilities.
Provinces
Governmental units whose main powers have been recently transferred to regions and municipalities.
Mountain Communities
Regional development bodies.
Municipal Concerns
Independent public suppliers of methane, water, electric power, and heating. These operate in only a few areas, usually only for methane and water sales. Energy services, especially electricity, are closely regulated by ENEL. Each concern operates only within its own municipality unless ENEL allows sales to others. ENEL usually buys excess power at low rates. ENEL sets rates that the concerns may charge customers.
In 1982, municipal concerns were allowed to become multiservice companies, a change that will increase district heating/cogeneration.
Autonomous Popular Housing Agency (IACP)
Responsible for providing low-cost public housing and making it habitable (energy efficiency is a new responsibility).
Municipalities
Extensive administrative functions. The municipalities participate in making regional development plans that help determine the responsibilities of the various government levels. Responsible for building and land use regulations, local public works, and local transportation. Power to control energy consumption in civil buildings. State-delegated power to develop alternate resources.
Natural Gas Companies
Such as Italgas and Napoletana Gas. Supply gas and methane directly to customers in the competitive market.
District Councils
Neighborhood groups that are consulted on neighborhood land use, building licenses (permits), and in some areas, public works.

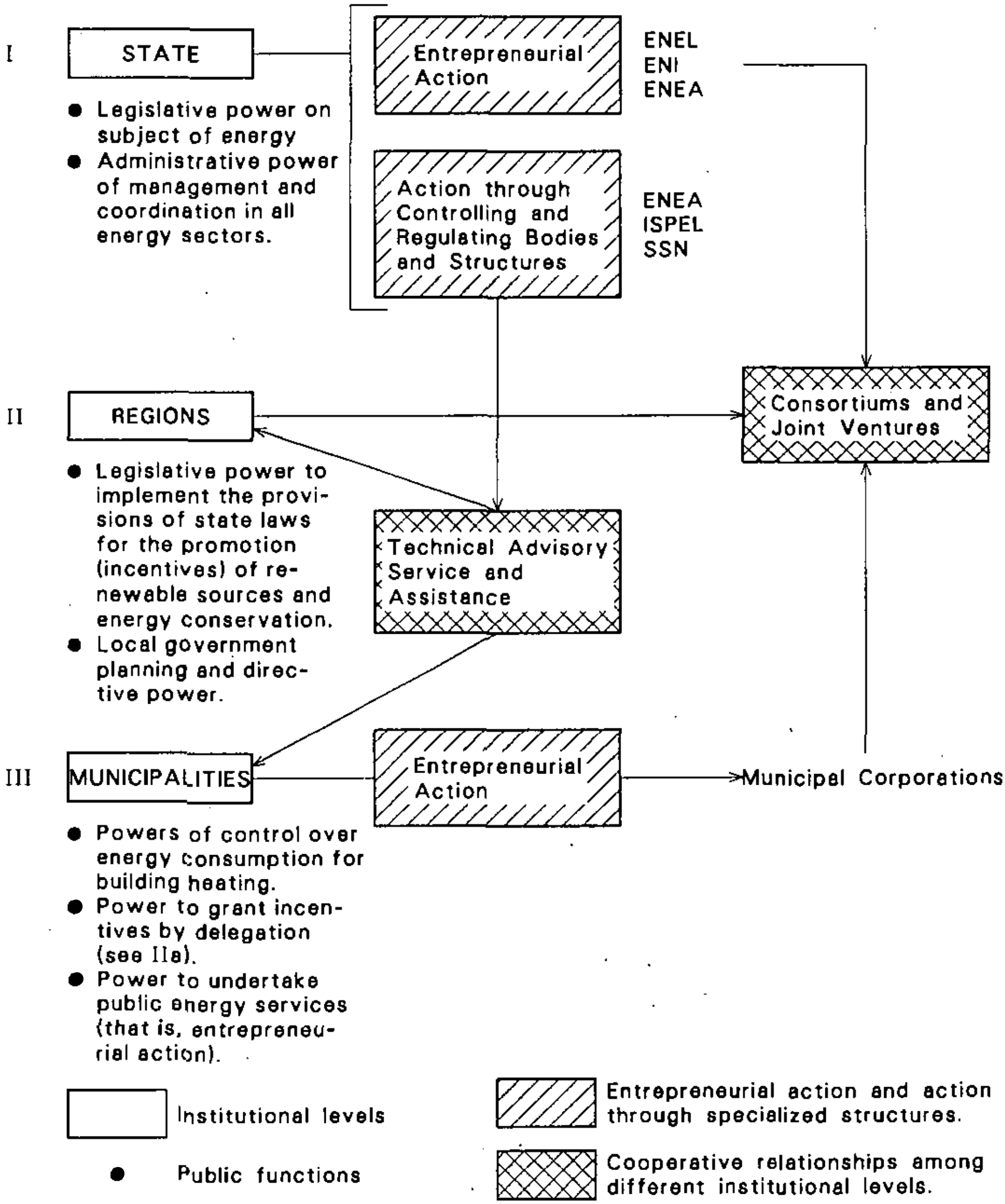


Figure A.2 Additional information on Italian structural relationships

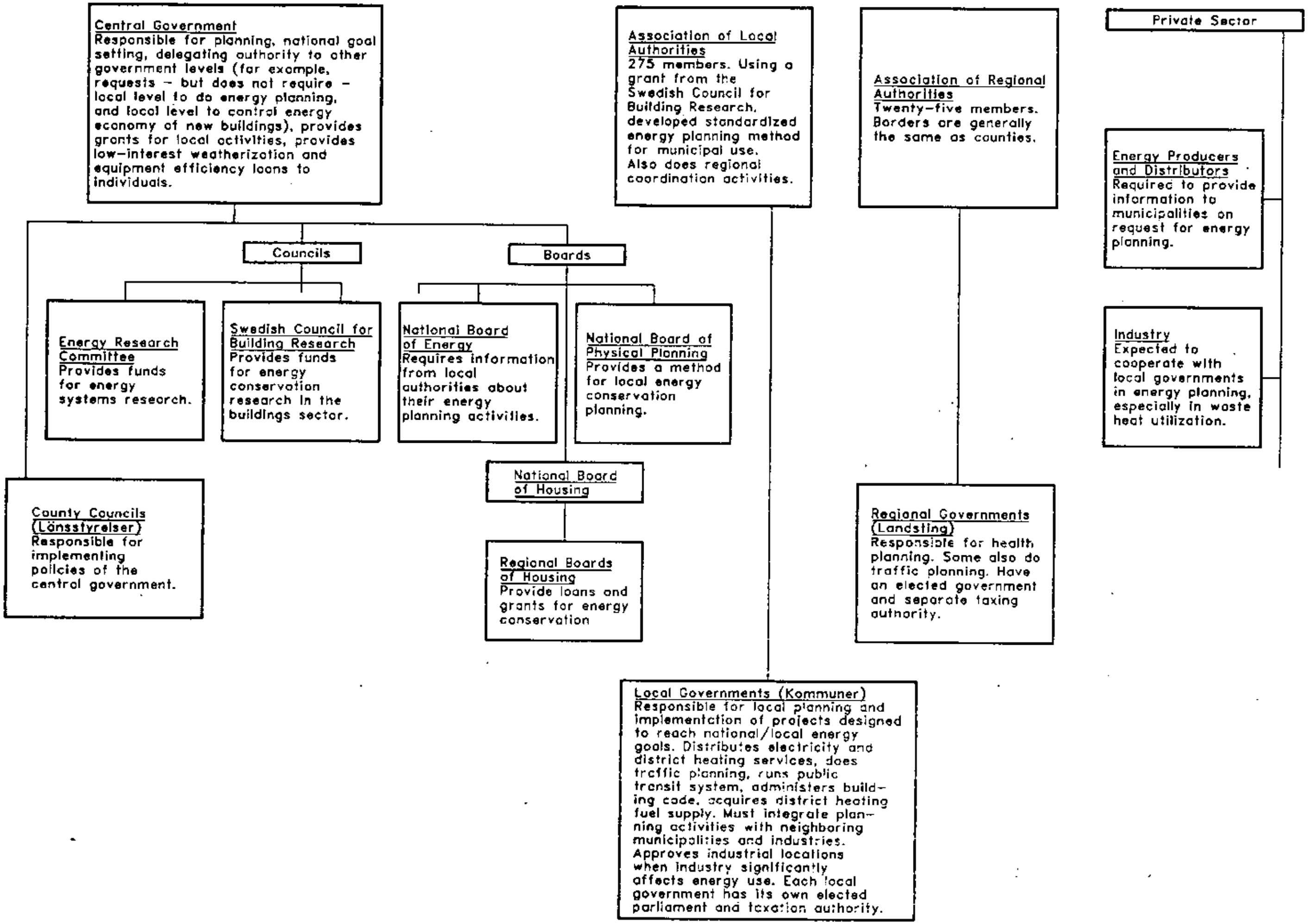


Figure A.3 Energy responsibilities of governments and the private sector in Sweden

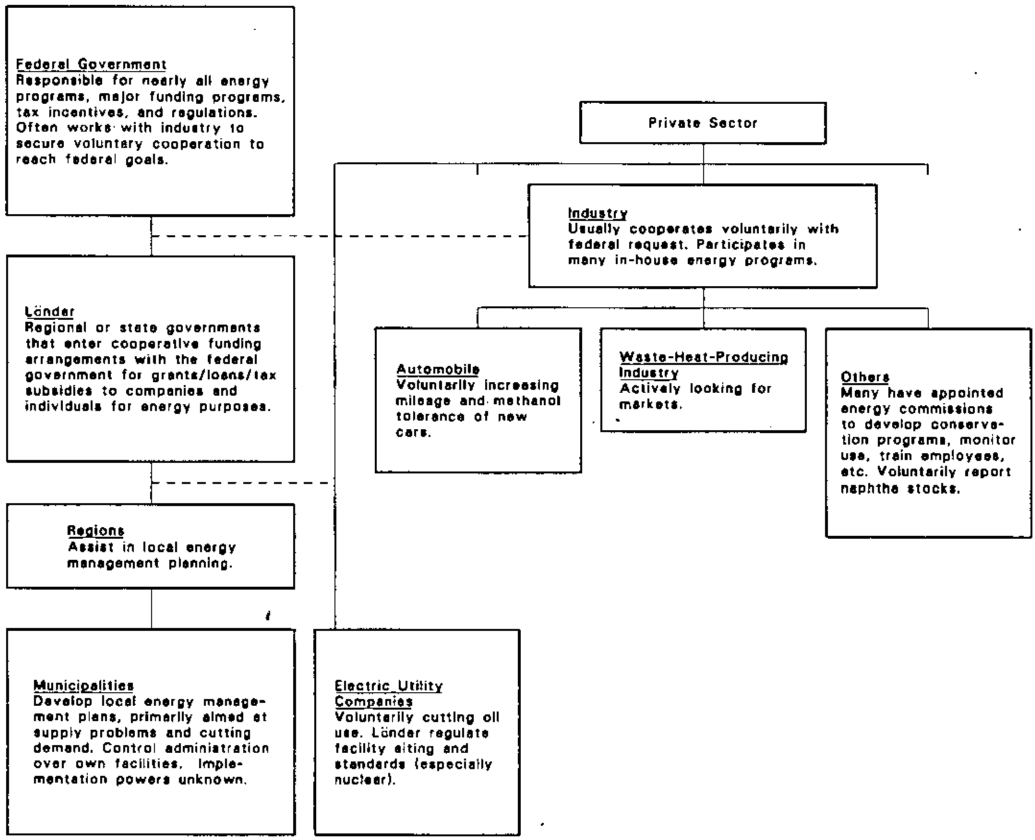


Figure A.4 Energy responsibilities of governments and the private sector in the FRG

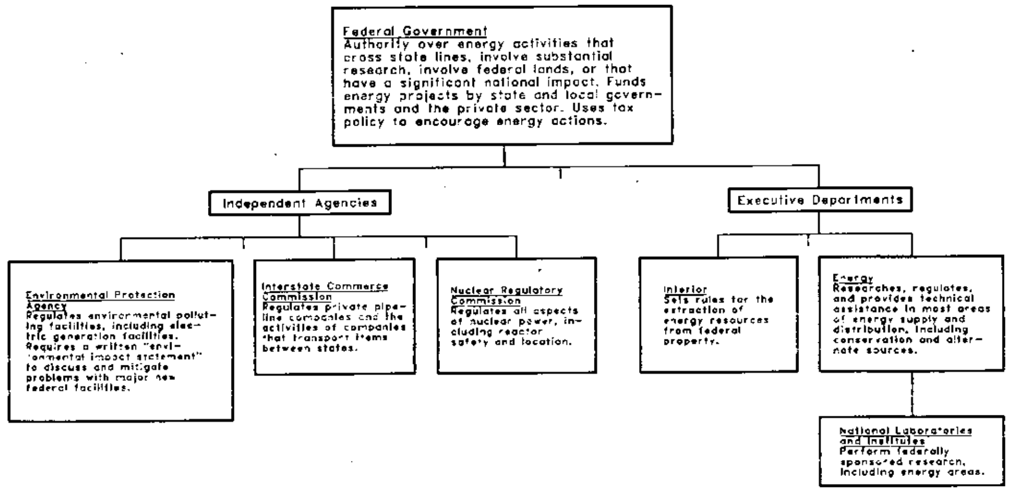


Figure A.5 Energy responsibilities of governments and the private sector in the U.S.

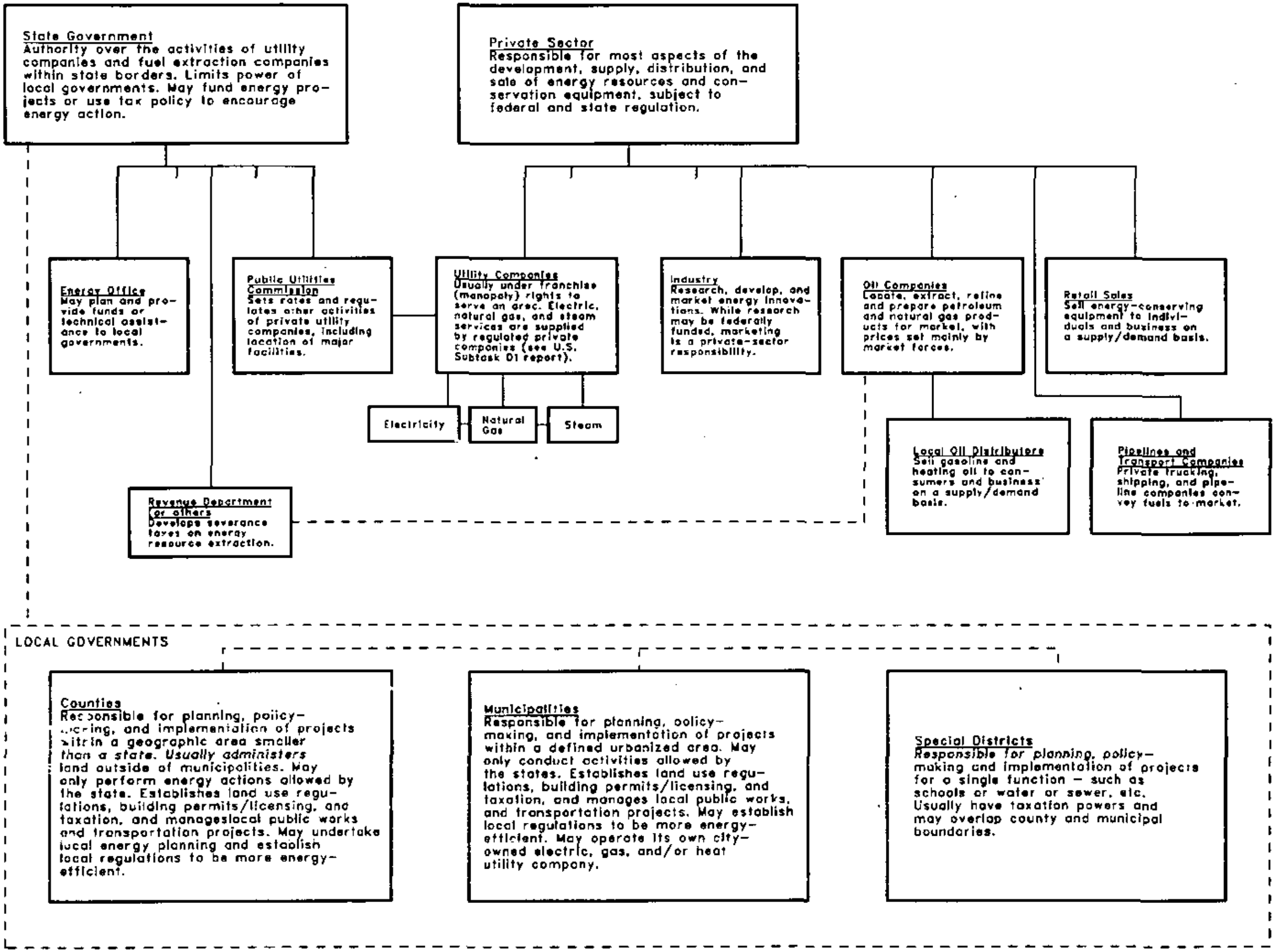


Figure A.5 (Cont'd)

APPENDIX B

FOCUS COMMUNITY CHARACTERISTICS

The 15 focus communities were compared on the basis of data available in the Annex VII reports and information that was easily accessible to U.S. Annex VII researchers. Because of the large volume of this information, it has been compiled as this appendix rather than as text material. The conversion factors shown in Table B.7 were used to standardize the assortment of energy and other units used in the four countries' reports.

Table B.1 General information on the 15 focus communities

Country	Italy			
Focus Community	Bologna	Brescia	Modena	Reggio Emilia
Population - 1980	455,000	210,027	164,000	131,000
1970	-	210,047	-	-
Population Growth Rate (%)	-	-0.0[b]	-	+0.6
Population of Central City or Area - 1980	455,000	210,027	-	131,000
Population of Metropolitan Area - 1980	-	-	-	409,932
Urban Population (%)	-	-	-	-
Rural Population (%)	-	-	-	-
Area of Community (mi^2/km^2)	5.7/14.7	3.4/8.9	-	-
Elevation (ft/m)	-	454/149	-	-
Heating Degree-Days[a]	-	2555	-	-
Design Dry Bulb, Winter, 97.5% (°F/°C)	-	22/-6[c]	-	-
Design Dry Bulb, Summer, 2.5% (°F/°C)	- -	87/31[c] 75/24[c]	- -	- -
Coincident Wet Bulb, Summer, 2.5% (°F/°C)	-	-	-	-
Labor Force (%)				
Agriculture	0.3	-	-	7.3
Industry	57.2	-	-	55.9
Services	42.4	-	-	36.7
Other	-	-	-	-
Primary Economic Base	University; Industry	Transportation; Manufacturing	Electronics; Machinery	Food; Transportation
Secondary Economic Base				
Special Conditions	Nearby mountains cause temperature extremes			

Table B.1 (Cont'd)

Country	Sweden				
Focus Community	Kristianstad	Angelholm	Uppsala	Ornskoldsvik	Sundsvall
Population - 1980	68,700[d]	29,400	145,000[d]	60,700	94,500
1970	67,500[e]	28,200[e]	138,100[e]	60,400[e]	-
Population Growth Rate (%)	+2.0[f]	+4.0[f]	+5.0[f]	+0.5[f]	-
Population of Central City or Area - 1980	30,800	17,100	101,500	30,358	51,004
Population of Metropolitan Area - 1980	68,700	29,800	143,000	60,715	94,500
Urban Population (%)	75	75	77	73	84
Rural Population (%)	25	25	23	27	16
Area of Community (mi^2/km^2)	478.6/1240	161.7/419	948.0/2456	2586.2/6700	1242.5/3219
Elevation (ft/m)	-	-	146/45	-	-
Heating Degree-Days[b]	-	-	-	-	-
Design Dry Bulb, Winter, 97.5% (°F/°C)	-	-	-	-	-
	-	-	8/-13	-	-
Design Dry Bulb, Summer, 2.5% (°F/°C)	-	-	74/23	-	-
	-	-	62/17	-	-
Coincident Wet Bulb, Summer, 2.5% (°F/°C)	-	-	-	-	-
Labor Force (%)					
Agriculture	11	13	5	7	-
Industry	9	9	7	32	25
Services	59[h]	62	71	45	60
Other	21	16	17	16	15
Primary Economic Case	Trade and Services	Services	Trade, University	Manufacturing	Paper and Pulp, Chemicals, Metals, Shipping Services
Secondary Economic Base	Government				
Special Conditions	One central urban area and 6 other major settlements. Dispersed building pattern	Central urban area and 5 other settlements. 75% of land area is forest and farm. District heating expanding	North of Stockholm. Central urban area is 70% of population, 3 other small urban settlements and 13 very small towns. Low-temperature district heating under construction	One major urban area and 20 smaller ones. Wood/paper industries dominate local energy use	Largest industrial city in northern Sweden. Major port city

Table B.1 (Cont'd)

Country	FRG		
Focus Community	Saarland	Berlin	Rhein-Main
Population - 1980	1,069,000	2,202,241	2,100,000
1970	-	2,115,300	2,100,000
Population Growth Rate (%)	+0	-0.03	±0
Population of Central City or Area - 1980	-	-	-
Population of Metropolitan Area - 1980	7,068,555	-	2,100,000
Urban Population (%)	61	100	85
Rural Population (%)	39	0	15
Area of Community (mi^2/km^2)	-	185/481[g]	772/2000
Elevation (ft/m)	-	-	-
Heating Degree-Days[b]	-	-	-
Design Dry Bulb, Winter, 97.5% (°F/°C)	-	-	-
Design Dry Bulb, Summer, 2.5% (°F/°C)	-	-	-
Coincident Wet Bulb, Summer, 2.5% (°F/°C)	-	-	-
Labor Force (%)			
Agriculture	10	-	2
Industry	30	-	30
Services	20	-	68
Other	40	-	0
Primary Economic Base	Steel, Coal Mining	Electronics	Industry, Central National Services
Secondary Economic Base			
Special Conditions	Industry	Commercial. Industrial	FRG's top metropolitan area in banking and insurance; airport; several important services (universities, governmental agencies, etc.)

Table B.1 (Cont'd)

Country	U.S.		
Focus Community	Ann Arbor	Portland	Richmond
Population - 1980	107,316	61,572	41,349
1970	100,035	65,116	43,999
Population Growth Rate (%)	+6.8[a]	-5.4[a]	-6.4[a]
Population of Central City or Area - 1980	107,316	61,572	41,349
Population of Metropolitan Area - 1980	261,345	183,457	76,058
Urban Population (%)	100	100	100
Rural Population (%)	0	0	0
Area of Community (mi^2/km^2)	23.5/60.9	21.6/55.9	13.7/35.5
Elevation (ft/m)	880/268	61/19	1138/347
Heating Degree-Days[b]	6400	7511	5640
Design Dry Bulb, Winter, 97.5% (°F/°C)	5/-15	-1/-18	2/-17
Design Dry Bulb, Summer, 2.5% (°F/°C)	88/31	84/29	90/32
Coincident Wet Bulb, Summer, 2.5% (°F/°C)	72/22	71/22	74/23
Labor Force (%)	-	-	-
Agriculture			
Industry			
Services			
Other			
Primary Economic Base	University	Shipping	Manufacture of Auto Parts
Secondary Economic Base	Services	Fishing, Agriculture	Services, Agriculture
Special Conditions	University dominates community; residents tend toward high educational attainment and high incomes	Largest city and metropolitan area in state. Seaport handled 13,261,131 short tons of cargo in 1979; ranked as 42nd U.S. seaport in tons handled	Serious air-quality problems due to SO_2 emissions from burning high-sulfur coal. Decline in U.S. automobile industry has seriously hurt city's industrial base

[a]1970 to 1980.

[b]All climatic data from the ASHRAE handbook except heating degree-days for Brescia.

[c]Data are for nearby Milan, Italy.

[d]1979.

[e]1975.

[f]1975 to 1979.

[g]But two Berlin neighborhoods were researched in depth; thus the actual area studied was smaller.

[h]33% are in the public sector.

Table B.2 Housing data on the focus communities

Parameter	U.S.			Italy		
	Ann Arbor	Portland	Richmond	Bologna	Brescia	Modena
Age of Housing (Number of units; percentage shown in parentheses)						
Year of Construction:						
1920 single-family				71302 (39)		
multifamily	10775 (27)	(66)				
1921-1940 single-family			(86)	47534[a] (26)		7161[b] (10)
multifamily						25361[d] (35)
1941-1960 single-family				31080[c] (17)		
multifamily						
1961-1975 single-family	29131 (73)	(34)				4945[b] (7)
multifamily				32909 (18)		25074[d] (35)
1975- single-family			(14)			1656[b] (2)
multifamily						7447[d] (10)
Missing data -						
single-family						
multifamily						
Total units -						
single-family	20055 (50)		(81)[e]		8800[f] (49)	13762[b] (19)
multifamily	19851 (50)		(19)[e]		1200[f] (51)	57882[d] (81)
Grand Total Units	3940 (100)		(100)	182825 (100)	18000[f] (100)	71644 (100)
Year of Data	1981					
Heating Systems (1980)						
Total Demand GWh/10^{12} Btu (%)						
Individual Oil Boilers						
Oil-Central				5000[g]		
Individual Electricity						
District Heating						
Solid Fuels						
Natural Gas				186000[g]		
Units heating with fuels (%):						
Natural Gas				97		
Oil				3		
Electricity						
District Heat						
Solid Fuels						
Annual oil used in oil-heated:						
Single-family units (MWh/10^6 Btu)						
Multifamily units						

Table B.2 (Cont'd)

Parameter	Sweden					FRG		
	Kristianstad	Angelholm	Uppsala	Ornskoldsvik	Sundsvall	Saarland	Berlin	Rhein-Main
Age of Housing (Number of units; percentages shown in parentheses)								
Year of Construction:								
1920 single-family	5236 (19)	2031 (17)	5890 (9)	3374 (14)	489[h] (2)			
multifamily	1459 (5)	498 (4)	2012 (3)	1000 (4)	767 (3)		445,000	136,000 (15)
1921-1940 single-family	2952 (10)	1185 (10)	2882 (5)	3554 (15)	889 (4)			109,200 (12)
multifamily	2063 (7)	458 (4)	4673 (7)	1071 (5)	1033 (4)	119,000	135,000	
1941-1960 single-family	2396 (9)	1273 (11)	2784 (4)	4252 (18)	1453 (6)			200,200 (22)[i]
multifamily	4155 (15)	1996 (17)	16178 (26)	3416 (14)	5849 (24)			
1961-1975 single-family	4670 (17)	2094 (18)	7450 (12)	3865 (16)	2106 (9)			354,900 (39)
multifamily	5158 (18)	2098 (18)	20717 (33)	3803 (13)	9529 (4)	130,000	537,000	
1975- single-family	--	988[e] (8)	1707[a] (3)	--	569 (2)			109,200 (12)
multifamily	--			--	1318 (5)			
Missing data -								
single-family	33 (0)	96 (1)	100 (0)	55 (0)	94 (0)			
multifamily	11 (0)	8 (0)	107 (0)	2 (0)	152 (1)			
Total units -								
single-family	15287 (54)	6679 (57)	19106 (30)	15100 (64)	5600 (23)	249,305	110,000 (11)	
multifamily	12846 (46)	5058 (43)	43687 (70)	8692 (36)	18648 (77)	(57)	990,000 (89)	
Grand Total Units	28133 (100)	11737 (100)	62793 (100)	23792 (100)	24248 (100)	(43)	1,100,000 (100)	910,000
Year of Data	1975	1975	1975	1975		1980	1,100,000 (100) 1979	1987
Heating Systems (1980)								
Total Demand GWh (%)								
Individual Oil Boilers	1061 (100)	422 (100)	1957 (100)	716 (100)				23,000 (100)
Oil-Central	(-)	(-)	(-)	(-)	(1)[j]		10,300	12,420 (54)
Individual Electricity	946 (90)	350 (83)	(26)[i]	584 (81)	(56)[j]	(33)	1500	460 (2)
District Heating	101 (10)	51 (12)	(7)[i]	79 (11)	(31)[j]	(26)	2400	2070 (9)
Solid Fuels	(1)	13 (3)	(66.8)[i]	57 (86)	(12)[j]	(41)	1100	690 (3)
Natural Gas	(-)	34 (8)	(0.1)[i]	(-)	(-)			7360 (32)
Units heating with fuels (%)								
Natural Gas	0	0	0	0		25	13	32
Oil	72	68	24	38		53	41	54
Electricity	28	30	11	19.8		27	3	2
District Heat	+0	+0	65	0.2		8	14	9
Solid Fuels and Coal	0	2[k]	+0	42[k]		10	29	3
Annual oil used in oil-heated								
Single-family units $MWh/10^6$ Btu	33/114			39/133			50/170	
Multifamily units	22/76			27/95			77/263	

[a]1920 to 1945.

[b]One and two flats.

[c]1946 to 1960.

[d]Three flats and over.

[e]Percentage of total residential floor space.

[f]Number of buildings containing residential units.

[g]Number of dwelling units

[h]All data are for the main central city of Sundsvall.

[i]Percentage of dwellings.

[j]Percentage of single-family units.

[k]Wood.

Table B.3 Focus communities: energy use by sector and fuel; oil use by end use

Parameter	Italy			
	Bologna	Brescia	Modena	Reggio Emilia
Total Energy Use/yr ($GWh/10^{12}$ Btu)	10694/36.5 (100)	5362/18.3[b] (100)	5919/20.2[c] (100)	1963/6.7 (100)[b]
Energy Use by Sector				
Residential	3955/13.5 (37)	1465/5.0 (27)		1054/3.6 (54)
Commercial	967/3.3 (9)	498/1.7[e] (9)		
Municipal				
Industrial	1524/5.2 (14)[f]	3369/11.5 (63)		908/3.1 (46)[f]
Transportation	4278/14.6 (40)			
Energy Use by Fuel				
Oil			2080/7.1 (35)[g]	263/0.9 (13)
Natural Gas			1494/5.1 (25)[c]	1348/4.6 (69)
Electricity		498/1.7 (9)	557/1.9 (9)[c]	263/0.9 (13)
Coal		2168/7.4 (40)		
Wood				
Gasoline			498/1.7 (8)[g,h]	
Diesel				
District Heating		469/1.6 (9)		
All Others		2252/7.6 (42)	1361/4.6 (23)	59/0.2 (3)
Oil Use by End Use				
Transportation	4278/14.6 (40)			
Gasoline			498/1.7 (8)[g,h]	
Diesel				
Heating & Processing			2080/7.1 (35)	263/0.9 (13)
District Heating				
Single-Family				
Multifamily				
Agriculture				
Industry				
Public Sector				
Miscellaneous				
Total Oil Use				

Table B.2 Housing data on the focus communities

Parameter	U.S. Ann Arbor	U.S. Portland	U.S. Richmond	Italy Bologna	Italy Brescia	Italy Modena
Age of Housing (Number of units; percentage shown in parentheses)						
Year of Construction:						
1920 single-family				71302 (39)		
multifamily	10775 (27)	(66)				
1921-1940 single-family			(86)	47534[a] (26)		7161[b] (10)
multifamily						25361[d] (35)
1941-1960 single-family				31080[c] (17)		
multifamily						
1961-1975 single-family	29131 (73)	(34)				4945[b] (7)
multifamily				32909 (18)		25074[d] (35)
1975- single-family			(14)			1656[b] (2)
multifamily						7447[d] (10)
Missing data -						
single-family						
multifamily						
Total units -						
single-family	20055 (50)		(81)[e]		8800[f] (49)	13762[b] (19)
multifamily	19851 (50)		(19)[e]		1200[f] (51)	57882[d] (81)
Grand Total Units	3940 (100)		(100)	182825 (100)	18000[f] (100)	71644 (100)
Year of Data	1981					
Heating Systems (1980)						
Total Demand GWh/10^{12} Btu (%)						
Individual Oil Boilers						
Oil-Central				5000[g]		
Individual Electricity						
District Heating						
Solid Fuels						
Natural Gas				186000[g]		
Units heating with fuels (%):						
Natural Gas				97		
Oil				3		
Electricity						
District Heat						
Solid Fuels						
Annual oil used in oil-heated:						
Single-family units (MWh/10^6 Btu)						
Multifamily units						

Table B.2 (Cont'd)

Parameter	Sweden					FRG		
	Kristianstad	Angelholm	Uppsala	Ornskoldsvik	Sundsvall	Saarland	Berlin	Rhein-Main
Age of Housing (Number of units; percentages shown in parentheses)								
Year of Construction:								
1920 single-family	5236 (19)	2031 (17)	5890 (9)	3374 (14)	489[h] (2)			
multifamily	1459 (5)	498 (4)	2012 (3)	1000 (4)	767 (3)		445,000	136,000 (15)
1921-1940 single-family	2952 (10)	1185 (10)	2882 (5)	3554 (15)	889 (4)			
multifamily	2063 (7)	458 (4)	4673 (7)	1071 (5)	1033 (4)	119,000	135,000	109,200 (12)
1941-1960 single-family	2396 (9)	1273 (11)	2784 (4)	4252 (18)	1453 (6)			
multifamily	4155 (15)	1996 (17)	16178 (26)	3416 (14)	5849 (24)			200,200 (22)[i]
1961-1975 single-family	4670 (17)	2094 (18)	7450 (12)	3865 (16)	2106 (9)			
multifamily	5158 (18)	2098 (18)	20717 (33)	3803 (13)	9529 (4)	130,000	537,000	354,900 (39)
1975- single-family	--	988[e] (8)	1707[a] (3)	--	569 (2)			
multifamily	--			--	1318 (5)			109,200 (12)
Missing data -								
single-family	33 (0)	96 (1)	100 (0)	55 (0)	94 (0)			
multifamily	11 (0)	8 (0)	107 (0)	2 (0)	152 (1)			
Total units -								
single-family	15287 (54)	6679 (57)	19106 (30)	15100 (64)	5600 (23)	249,305	110,000 (11)	
multifamily	12846 (46)	5058 (43)	43687 (70)	8692 (36)	18648 (77)	(57)	990,000 (89)	
Grand Total Units	28133 (100)	11737 (100)	62793 (100)	23792 (100)	24248 (100)	(43)	1,100,000 (100)	910,000
Year of Data	1975	1975	1975	1975		1980	1,100,000 (100)	1987
							1979	
Heating Systems (1980)								
Total Demand GWh (%)								
Individual Oil Boilers	1061 (100)	422 (100)	1957 (100)	716 (100)				23,000 (100)
Oil-Central	(-)	(-)	(-)	(-)	(1)[j]		10,300	12,420 (54)
Individual Electricity	946 (90)	350 (83)	(26),	584 .(81)	(56)[j]	(33)	1500	460 (2)
District Heating	101 (10)	51 (12)	(7)[i]	79 (11)	(31)[j]	(26)	2400	2070 (9)
Solid Fuels	(1)	13 (3)	(66.8)[i]	57 (86)	(12)[j]	(41)	1100	690 (3)
Natural Gas	(-)	34 (8)	(0.1)[i]	(-)	(-)			7360 (32)
Units heating with fuels (%)								
Natural Gas	0	0	0	0		25	13	32
Oil	72	68	24	38		53	41	54
Electricity	28	30	11	19.8		27	3	2
District Heat	+0	+0	65	0.2		8	14	9
Solid Fuels and Coal	0	2[k]	+0	42[k]		10	29	3
Annual oil used in oil-heated								
Single-family units MWh/10^6 Btu	33/114			39/133			50/170	
Multifamily units	22/76			27/95			77/263	

[a]1920 to 1945.

[b]One and two flats.

[c]1946 to 1960.

[d]Three flats and over.

[e]Percentage of total residential floor space.

[f]Number of buildings containing residential units.

[g]Number of dwelling units

[h]All data are for the main central city of Sundsvall.

[i]Percentage of dwellings.

[j]Percentage of single-family units.

[k]Wood.

Table B.3 Focus communities: energy use by sector and fuel; oil use by end use

Parameter	Italy			
	Bologna	Brescia	Modena	Reggio Emilia
Total Energy Use/yr (GWh/10^{12} Btu)	10694/36.5 (100)	5362/18.3[b] (100)	5919/20.2[c] (100)	1963/6.7 (100)[b]
Energy Use by Sector				
Residential	3955/13.5 (37)	1465/5.0 (27)		1054/3.6 (54)
Commercial	967/3.3 (9)	498/1.7[e] (9)		
Municipal				
Industrial	1524/5.2 (14)[f]	3369/11.5 (63)		908/3.1 (46)[f]
Transportation	4278/14.6 (40)			
Energy Use by Fuel				
Oil			2080/7.1 (35)[g]	263/0.9 (13)
Natural Gas			1494/5.1 (25)[c]	1348/4.6 (69)
Electricity		498/1.7 (9)	557/1.9 (9)[c]	263/0.9 (13)
Coal		2168/7.4 (40)		
Wood				
Gasoline			498/1.7 (8)[g,h]	
Diesel				
District Heating		469/1.6 (9)		
All Others		2252/7.6 (42)	1361/4.6 (23)	59/0.2 (3)
Oil Use by End Use				
Transportation	4278/14.6 (40)			
Gasoline			498/1.7 (8)[g,h]	
Diesel				
Heating & Processing			2080/7.1 (35)	263/0.9 (13)
District Heating				
Single-Family				
Multifamily				
Agriculture				
Industry				
Public Sector				
Miscellaneous				
Total Oil Use				

Table B.3 (Cont'd)

Parameter	Sweden			
	Kristianstad	Angelholm	Uppsala	Ornskoldsvik
Total Energy Use/yr (GWh/10^{12} Btu)	2456/8.4 (100)	872/3.0 (100)	4830/16.5 (100)	8342/28.4 (100)[k]
Energy Use by Sector				
Residential	723/2.5 (30)	321/1.1 (44)	1410/4.8 (29)	751/2.6 (9)
Commercial	646/2.2 (27)[h]	139/0.5 (16)[h]	1295/4.4 (27)[h]	224/0.8 (3)[h]
Municipal				
Industrial	585/2.0 (24)	69/0.2 (8)	444/1.5 (9)	6829/23.3 (84)[l]
Transportation	475/1.6 (19)	236/0.8 (32)	1106/3.8 (35)	509/1.7 (4)
Energy Use by Fuel				
Oil	1400/4.8 (57)	407/1.4 (47)	3296/11.2 (68)	2984/10.2 (36)
Natural Gas				
Electricity	544/1.9 (23)	180/0.6 (20)	325/1.1 (7)	1540/5.3 (18)
Coal		15/0.1 (3)[m]	139/0.5 (3)[m]	
Wood				740/2.5 (9)
Gasoline	505/1.7 (20)	260/0.9 (30)	1070/3.7 (22)	509/1.7 (6)
Diesel				
District Heating	7/0.0 (0)			17/0.1 (-)
All Others				3289/11.2 (31)[n]
Oil Use by End Use				
Transportation	710/2.4 (31)	302/1.0 (6)	1188/4.1 (25)	509/1.7 (15)
Gasoline	466/1.6 (21)	201/7.0 (4)	779/2.7 (16)	293/1.0 (8)
Diesel	244/0.8 (10)	101/0.3 (2)	408/1.4 (9)	216/0.7 (7)
Heating & Processing	1554/5.3 (69)	4730/16.1 (94)	3591/12.3 (75)	3000/10.2 (85)
District Heating	11/0.0 (0)	151/0.5 (3)	2786/9.5 (58)	17/0.1 (0)
Single Family	366/1.2 (16)	1761/6.0 (35)	333/1.1 (7)	320/1.19 (9)
Multifamily	233/0.8 (10)	1107/3.8 (22)	133/0.5 (3)	265/0.9 (8)
Agriculture		302/1.0 (6)		
Industry	488/1.7 (22)	544/1.9 (11)	139/0.5 (3)	2353/8.03 (67)
Public Sector	200/0.7 (9)	151/0.5 (3)		
Miscellaneous	266/0.9 (12)	704/2.4 (14)	200/0.7 (4)	45/0.2 (1)
Total Use	2269/7.7 (100)[o]	5032/17.2 (100)[o]	4779/16.3 (100)[o]	3509/18.1 (100)[o]

Table B.3 (Cont'd)

	FRG		
Parameter	Saarland	Berlin	Rhein-Main
Total Energy Use/yr (GWh/10^{12} Btu)	103,000/35.2 (100)	57600/197.0 (100)	75000/256.5 (100)
Energy Use by Sector			
Residential	29664/101.4 (28.8)	24192/82.7 (42)	18750/64.1 (25)
Commercial	13824/47.3 (24)	12000/41.0 (16)	
Municipal			
Industrial	56238/192.2 (54.6)	7488/25.6 (13)	18000/61.5 (24)
Transportation	17098/58.4 (16.6)	12096/41.3 (21)	26250/89.8 (35)
Energy Use by Fuel			
Oil	15141/51.8 (14.7)	26611/91.0 (46.2)	45750/156.5 (61)
Natural Gas	5665/19.4 (5.5)	6912/23.6 (12)	16500/56.4 (22)
Electricity	5150/17.6 (5.0)	10080/34.5 (17.5)	10500/35.9 (14)
Coal	66749/228.2 (64.8)	6451/22.1 (11.2)	2250/7.7 (3)
Wood			
Gasoline	6200/21.2 (6.0)		
Diesel			
District Heating			
All Others	4120/14.1 (4.0)	7124/24.4 (12.4)	
Oil Use by End Use			
Transportation		7900/27.0 (18.8)	
Gasoline	6200/21.2 (12.3)	6000/20.5 (14.3)	
Diesel	5400/18.5 (10.7)	1300/4.4 (3.1)	
Heating & Processing	800/2.7 (1.6)		
District Heating	8200/28.0 (16.2)	11500/39.3 (27.3)	
Single Family		810/2.8 (1.9)	
Multifamily			
Agriculture			
Industry		4600/15.7 (10.9)	
Public Sector		3050/10.4 (7.3)	
Miscellaneous			
Total Use		50600/173.0 (100)	42060/ (100)

Table B.3 (Cont'd)

Parameter	U.S.		
	Ann Arbor	Portland	Richmond
Total Energy Use/yr ($GWh/10^{12}$ Btu)	4629/15.8 (100)[a]	2989/10.2 (100)[a]	2783/9.5 (100)[a]
Energy Use by Sector			
Residential	1641/5.6 (35)	1172/4.0 (39)	1058/3.6 (38)
Commercial	1553/5.3[d] (33)	439/1.5 (15)	139/0.5 (5)
Municipal	205/0.7 (4)	176/0.6 (6)	139/0.5 (5)
Industrial	123/0.6 (4)	293/1.0 (10)	1002/3.4 (36)
Transportation	1113/3.8 (24)	908/3.1 (30)	529/1.8 (19)
Energy Use by Fuel			
Oil		1377/4.7 (46)	779/2.7 (28)
Natural Gas		205/0.7 (7)	668/2.3 (24)
Electricity		439/1.5 (15)	584/2.0 (21)
Coal		0/0 (0)	167/0.6 (6)
Wood		59/0.2 (2)	0/0 (0)
Gasoline		879/3.0 (29)	529/1.8 (19)
Diesel		59/0.2 (2)	
District Heating			
All Others			56/0.2 (2)
Oil Use by End Use			
Transportation	1113/3.8 (24)	908/3.1 (30)	529/1.8 (19)
Gasoline		879/3.0 (29)	
Diesel		59/0.2 (2)	
Heating & Processing		1377/4.7 (46)	729/2.7 (28)
District Heating			
Single-Family			381/1.3 (14)
Multifamily			
Agriculture			
Industry			
Public Sector			
Miscellaneous			398/1.4 (14)
Total Oil Use		2385/7.8 (76)	1308/4.5 (47)

Footnotes for Table B.3

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[a]All data for 1978; numbers in parentheses are percentages.

[b]Does not include the transportation sector.

[c]1980.

[d]Includes institutional use by the University of Michigan, which is /4.0 (25) of the total.

[e]Classified as "Terciary" by the Italians rather than "Commercial."

[f]Includes agriculture /0.11 (0.3) for Bologna; unknown for Reggio Emilia.

[g]1979.

[h]"Services" in the Swedish data.

[i]For Sundsvall, total energy use/yr = 1400/4.8; no other data available.

[j]1983.

[k]1977.

[l]77% of the total for wood and paper; 7% for all other industry.

[m]"Solid fuels" in the Swedish data.

[n]30% of the total is from "liquors"; 1% from all others.

[o]Unknown why this oil use total disagrees with the total reported above.

Table B.4 Focus community energy use per capita

Parameter	U.S.			Italy[a]		
	Ann Arbor	Portland	Richmond	Bologna	Brescia	Reggio Emilia
Total Energy Use/yr/capita[b] ($MWh/10^6$ Btu)	43/147	48/165	67/230	24/80	26/87	15/51[c]
Energy Use by Sector						
Residential	16/51	19/64	25/87	9/30	7/23	8/28
Commercial	14/49	7/25	3/12	2/7	2/8	--
Municipal	2/6	3/10	3/12	--	--	--
Industrial	2/6	5/17	24/83	3/11	16/55	7/23
Transportation	10/35	14/50	13/44	10/32	--	--
Energy Use by Fuel						
Oil	-	22/76	19/64	--	--	2/7
Natural Gas	-	3/12	16/55	--	--	10/35
Electricity	-	7/25	14/48	--	2/8	2/7
Coal	-	--	4/14	--	10/35	--
Wood	-	1/3	--	--	--	--
Gasoline	-	14/48	13/44	--	--	--
Diesel	-	1/3	--	--	--	--
District Heating	-	--	--	--	2/8	--
All Others	-	--	1/5	--	11/37	0/2

Table B.4 (Cont'd)

Parameter	Sweden					FRG[d]	
	Kristianstad	Angelholm	Uppsala	Ornskoldsvik	Sundsvall	Saarland	Berlin
Total Energy Use/yr/capita ($MWh/10^6$ Btu)	36/122	29/101	34/115	137/468	15/51[e]	69/233	29/97
Energy Use by Sector							
Residential	11/37	13/33	10/33	12/42	--	10/34	14/46
Commercial	10/33	5/16	9/31	4/14	--	--	
Municipal							
Industrial	9/29	2/8	3/10	115/393	--	18/62	3/10
Transportation	7/23	9/32	12/40	5/19	--	5/17	4/14
Energy Use by Fuel							
Oil	21/56	14/47	23/78	49/168	--	40/135	11/37
Natural Gas	--	--	--	--	--	4/14	8/3
Electricity	8/28	6/20	2/8	25/84	--	30/101	4/14
Coal	--	1/3	1/3	--	--	5/19	20/35
Wood	--	--	--	12/42	--	--	--
Gasoline	7/24	8/30	7/25	8/28	--	4/12	3/10
Diesel	--	--	--	--	--	1/2	1/3
District Heating	0/0	--	--	0/1	--	--	--
All Others	--	--	--	42/45	--	--	2/8

[a]Data missing for Modena.

[b]Percentages are the same as in Table B-3 for the entire community.

[c]Does not include transportation sector.

[d]Data missing for Rhein-Main.

[e]Heating only.

Table B.5 Fuel use by sector[a]

Parameter	U.S.			Italy		
	Ann Arbor	Portland	Richmond	Bologna	Brescia	Reggio Emilia
Residential (GWh/10^{12} Btu) (percentage shown in parentheses)	1641/5.6 (100)	1172/4.0 (100)	1055/3.6 (100)	3922/13.6 (100)	1611/5.5 (100)	1036/3.5 (100)
Natural Gas	–	88/0.3 (8)	469/1.6 (44)	1607/5.7 (43)	1113/3.8 (69)	850/2.9 (84)
Oil	–	879/3.0 (75)	381/1.3 (36)	1934/6.6 (49)	117/0.4 (7)	88/0.3 (8)
Electricity	–	117/0.4 (10)	205/0.7 (19)	381/1.3 (10)	176/0.6 (11)	88/0.3 (8)
District Heat	–	–	–	–	205/0.7 (13)	–
Coal	–	–	0/0.0 (0)	–	–	–
All Other	–	88/0.3 (8)	0/0.0 (0)	0/0.0 (0)	–	–
Commercial	–	586/2.0 (100)	–	–	530/1.7 (100)	–
Natural Gas	–	59/0.2 (10)	–	–	355/1.1 (67)	–
Oil	–	293/1.0 (50)	117/0.4 (22)	–	29/0.1 (5)	–
Electricity	–	234/0.8 (40)	–	–	117/0.4 (22)	0/0.0 (0)
District Heat	–	–	–	–	29/0.1 (5)	–
All Other	–	0/0.0 (0)	–	–	–	–
Industrial	–	324/1.1 (100)	1029/3.3 (100)	2091/7.2 (100)	3369/11.5 (100)	879/3.0 (100)
Natural Gas	–	59/0.2 (18)	176/0.6 (17)	967/3.3 (42)	1963/6.7 (58)	527/1.8 (60)
Oil	–	176/0.6 (54)	355/1.1 (34)	1025/3.5 (43)	263/0.9 (8)	176/0.6 (20)
Electricity	–	88/0.3 (27)	352/1.2 (34)	–	967/3.3 (29)	176/0.6 (20)
District Heat	–	–	–	–	176/0.6 (5)	–
Coal	–	–	146/0.5 (14)	–	–	–
All Other	–	1/0.0 (0)	0/0.0 (0)	119/0.4 (5)	–	–
Transportation	1113/3.8 (100)	879/3.0 (100)	527/1.0 (100)	–	–	–
Gasoline	–	–	–	–	–	–
Diesel	1113/3.8 (100)	879/3.0 (100)	527/1.8 (100)	–	–	–
Electric	–	–	–	–	–	–

Table B.5 (Cont'd)

Parameter	Sweden				FRG	
	Kristianstad	Angelholm	Uppsala	Ornskoldsvik	Saarland	Berlin
Residential ($GWh/10^{12}$ Btu) (percentage shown in parentheses)						
Natural Gas	723/2.4 (100)	328/1.2 (100)	1190/3.7 (100)	751/2.5 (100)	15500/52.6 (100)	29500/100.2 (100)
Oil	530/1.8 (75)	272/0.9 (85)	420/1.4 (53)	585/2.0 (80)	3900/13.2 (25)	-
Electricity	190/0.6 (20)	94/0.3 (13)	-	159/0.5 (20)	8200/27.8 (53)	12000/40.8 (41)
District Heat	3/0.0 (5)	5/0.0	665/2.3 (48)	7/0.0 (0)	400/1.4 (3)	5880/20.0 (20)
Coal	-	-	-	-	1200/4.0 (8)	4600/15.6 (16)
All Other	-	10/0.0 (2)	5/0.0 (0)	-	1500/5.1 (10)	1700/5.8 (6)
Commercial						
Natural Gas	643/2.4 (100)	139/0.5 (100)	1295/4.4 (100)	225/0.8 (100)	-	3300/11.2 (11)
Oil	420/1.4 (65)	79/0.3 (60)	180/0.6 (14)	46/0.2 (25)	-	-
Electricity	220/0.8 (34)	52/0.2 (40)	470/1.6 (36)	172/0.6 (75)	-	-
District Heat	3/0.0 (0)	-	-	-	-	-
All Other	-	8/0.0 (1)	645/2.2 (50)	7/0.0 (0)	-	-
Industrial						
Natural Gas	575/1.9 (100)	104/0.4 (100)	414/1.5 (100)	6632/22.6 (100)	29600/100.5 (100)	5500/18.7 (100)
Oil	475/1.6 (83)	80/0.3 (75)	125/0.4 (30)	2353/8.0 (35)	-	-
Electricity	100/0.3 (17)	24/0.1 (25)	89/0.3 (14)	1190/4.1 (18)	-	3050/10.4 (56)
District Heat	-	-	230/0.8 (56)	-	-	1760/6.0 (32)
Coal	-	-	-	-	-	260/0.9 (-)
All Other	-	-	-	3089/10.5 (47)	-	490/1.4 (7)
Transportation						
Gasoline	490/1.7 (100)	-	-	-	-	7400/25.1 (100)
Diesel	466/1.6 (94)	236/0.8 (100)	1070/3.7 (100)	590/2.0 (100)	-	5500/18.7 (75)
Electric	24/0.1 (6)	-	-	-	-	1900/6.5 (25)

[a] Unexplained differences may exist between this table and Table B.3. No data available for Modena, Sundsvall, or Rhein-Main.

[b] Includes public service.

Table B.6 Annex VII conversion factors

	thus
$Q = 10^{15}$	
$T = 10^{12}$	$TWh = 3.413 \times 10^{12}$ Btu
$G = 10^{9}$	$GWh = 3.413 \times 10^{9}$ Btu
M or MM = 10^{6}	$MWh = 3.413 \times 10^{6}$ Btu
K or k = 10^{3}	$kWh = 3.413 \times 10^{3}$ Btu

1 Quad = 10^{15} Btu = 293 TWh

1 TWh = 0.00341 Quad

Mmc methane or natural gas = 36.9×10^{9} Btu

derivation: 1032 Btu/ft^3

1 ft^3 = 0.028 mc or 35.71 ft^3 = 1 mc

mc gas = 36,857 Btu

toe, or metric ton of oil equivalent (crude oil assumed)

1 toe = 45.6×10^{6} Btu

1 Mtoe = 45.6×10^{12} Btu or 13.36 TWh

1 metric ton gasoline = 35.7×10^{6} Btu at 125,000 Btu/gal

cal = 3.968 Btu

Tcal = 3.968×10^{12} Btu

m^3 oil = 37.9×10^{6} Btu or 11.1 MWh

derivation: Crude oil/gal. = 142,000 Btu

1 ft^3 = 0.0028 m^3 = 1728 in^3 1 gal = 231 in^3

7.4805 gal/ft^3 x 35.743 ft^3/m^3 x 142,000 Btu/gal = 37.9×10^{6} Btu/m^3 oil

1 bbl/day/yr (42-gallon barrels of crude oil per day average for a year) = 42 gal oil/day x 365 day/yr x 142,000 Btu/gal oil = 2.18×10^{9} Btu/yr

1 bbl (42-gallon barrel of crude oil at 142,000 Btu/gal = 5.96×10^{6} Btu

1 mi^2 = 2.59 km^2
1 km^2 = 0.386 mi^2
1 metric ton = 1.1 English ton

APPENDIX C

FOCUS COMMUNITY PLANNING PROCESS DIAGRAMS

This appendix provides diagrams of the energy planning processes in the focus communities. Each figure is introduced below:

Figure C.1 shows the processes followed in the three U.S. communities. Ann Arbor chose to have city staff write a draft plan. The draft was modified by groups of government and other experts. In contrast, Portland and Richmond were part of the federally sponsored Comprehensive Community Energy Planning Program (CCEMP); thus, their processes are modifications of a national methodology. An outline of the CCEMP methodology is provided in Figure C.2.

Figure C.3 shows the process followed in Bologna. Although this diagram suggests the process was simple, in reality Bologna chose to develop an extensive community energy audit and complex evaluation methodology. The "reference energy system" method traces the origin and use of all the community's energy. The Bologna Energy Study (BEST) methodology is a technologically oriented optimization method; involvement by the public appears minimal. It should be noted that Bologna has little control over its public utilities because service is supplied by "municipal concerns." Therefore, the city largely plays a coordination role, with implementation decisions mostly in the hands of others.

Figure C.4 is the process used in Brescia. Here, the single "municipal concern" (ASM) has strong control over most energy supply decisions. Planning is centralized, but entails much public involvement. As in Ann Arbor, Brescia began with an expert-prepared draft plan. But with greater resources (and more at risk), Brescia could afford major public-involvement activities. It appears that the Brescia plan is primarily a capital improvements plan for the ASM utility, with a small conservation component.

Figure C.5 shows the planning process for Reggio Emilia. The "municipal concern" in this case chose an approach similar to the U.S. CCEMP methodology (Figure C.2). This plan has more balance between supply and demand options than the Brescia plan. The Italian processes suggest a central role for the energy-supplying "municipal concerns."

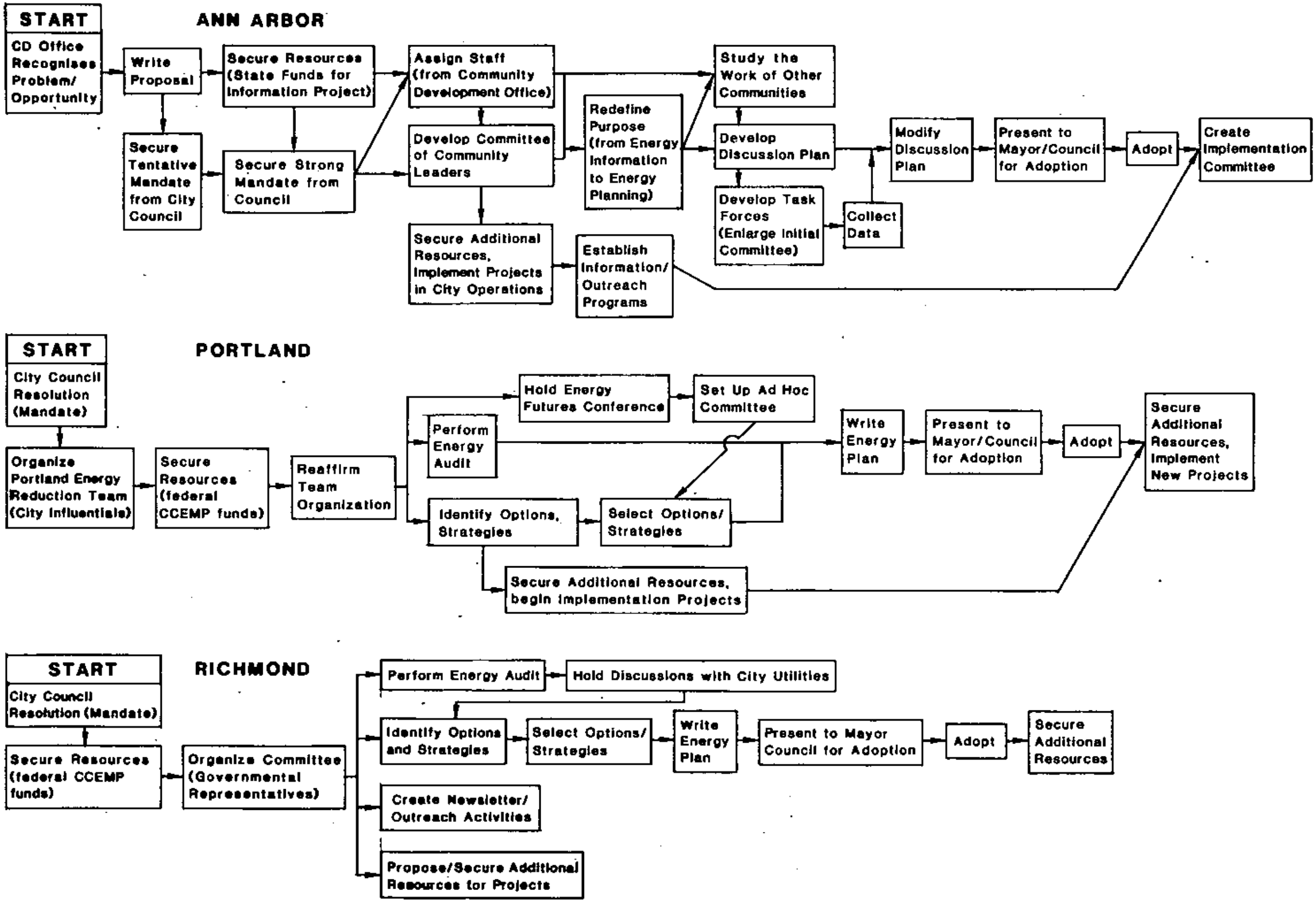

Figure C.1 Energy planning processes in U.S. focus communities

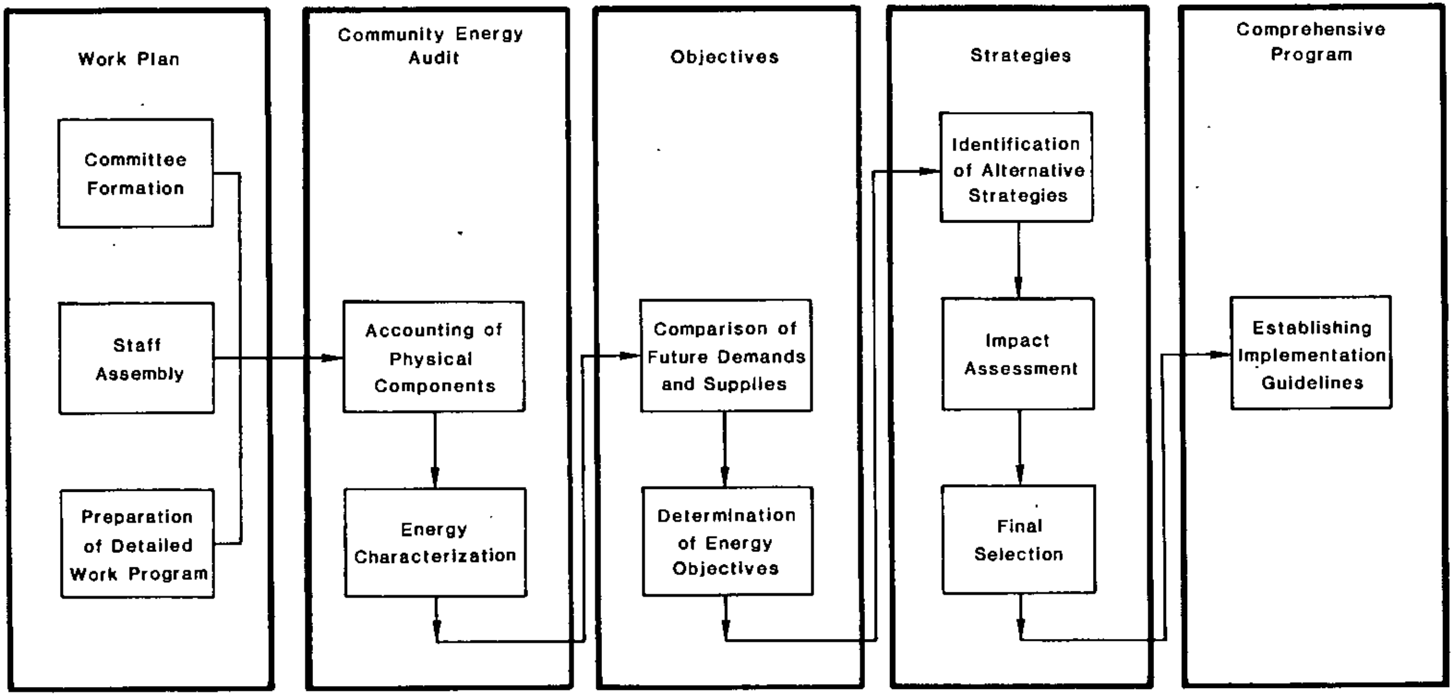

Figure C.2 Comprehensive Community Energy Management Planning methodology (U.S.)

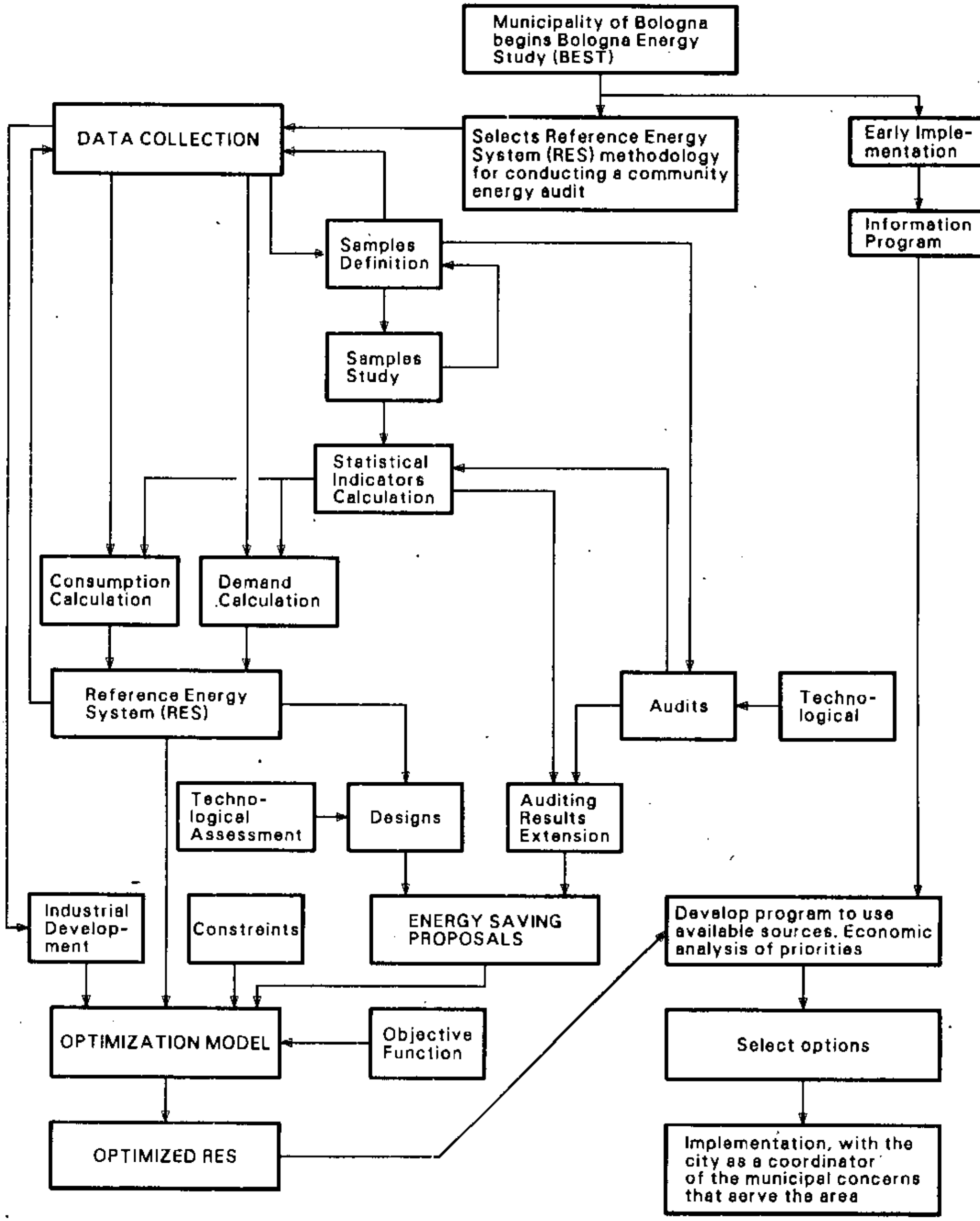

Figure C.3 Energy planning process in Bologna

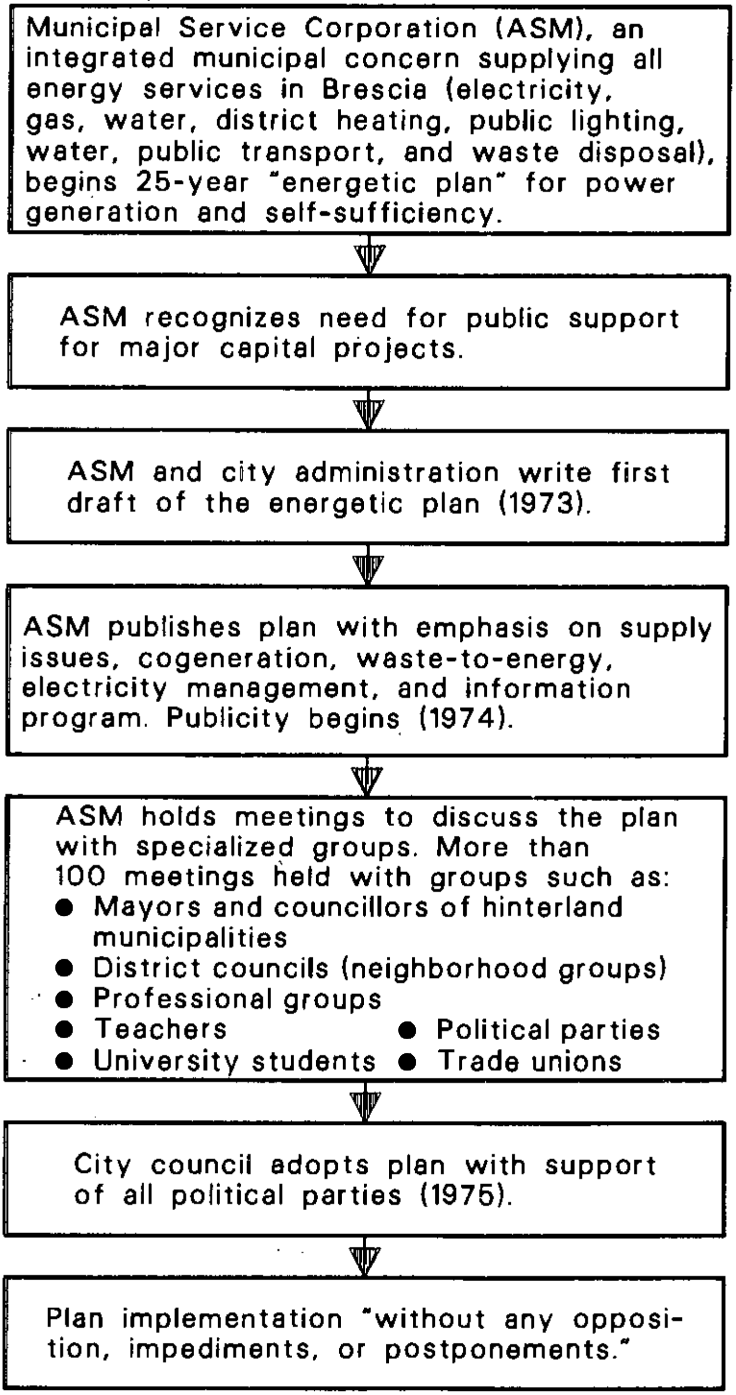

Figure C.4 Energy planning process in Brescia

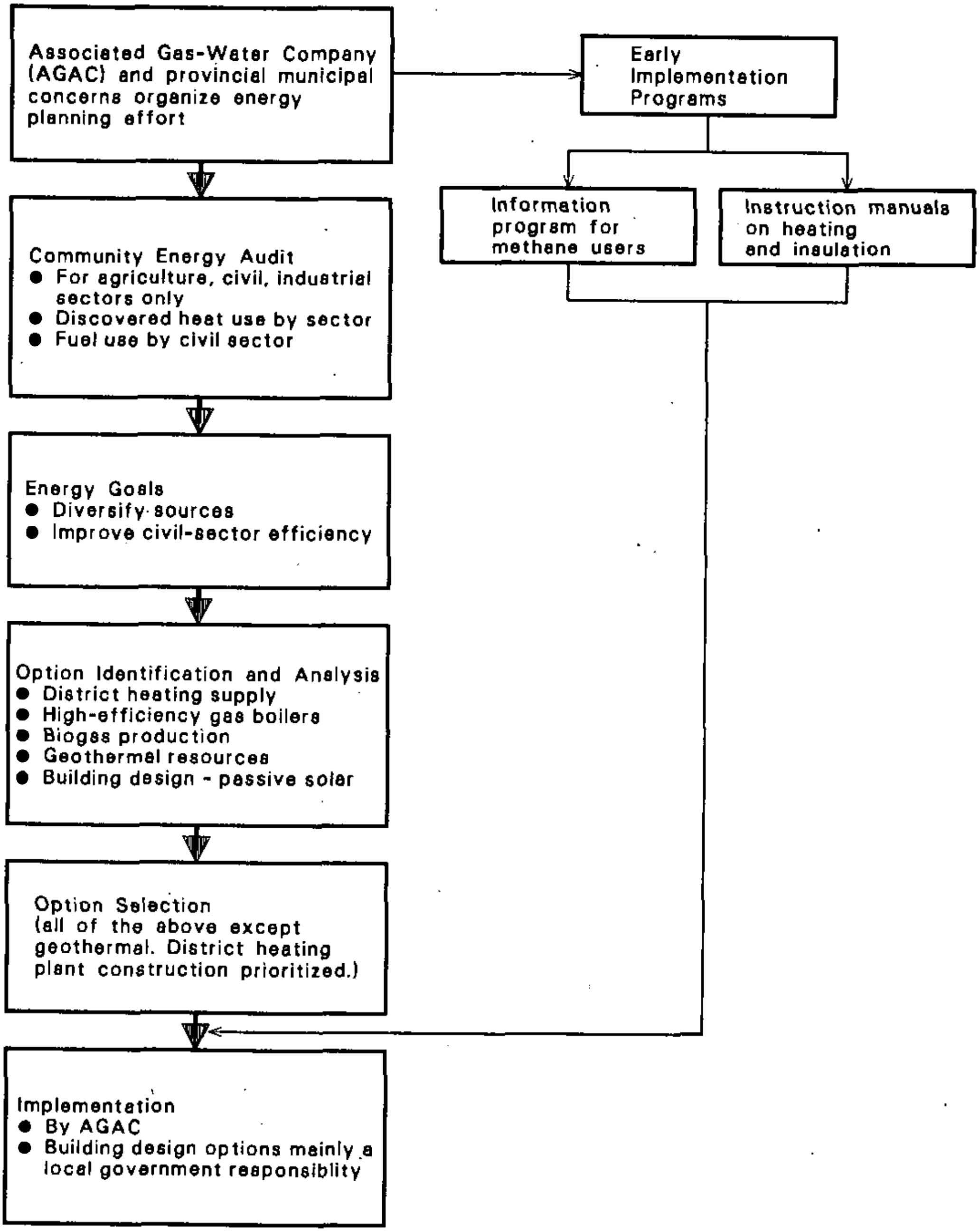

Figure C.5 Energy planning process in Reggio Emilia

Figure C.6 illustrates a generic Swedish energy planning process that was closely followed by the Swedish focus communities. The diagram approximates the Association of Local Authorities model. The key to the approach is the separate supply and conservation plans, which are then integrated into a unified plan. Energy planning is closely related to planning for other issues -- a major concern in Sweden but not seen as clearly in other countries.

The scheme depicted in Figure C.7 depicts a structuring of the issues in Sweden as developed by the Swedish team in this comparative study. Both energy supply planning and energy conservation planning are performed under a set of common criteria, resulting in an integrated energy program. The program will, in turn, lead to coordinated supply and conservation policies to be implemented through the separate institutional systems. There will also be a need to coordinate the implementation of energy policy with other implementation programs. It may be argued, however, that the high degree of organization and the balanced treatment of supply and demand issues suggested by the figure is unlikely to be achieved in most communities, even in Sweden.

Figure C.8 shows the process used in the FRG's Rhein-Main district heating study. This consultant study suggests only a limited role for local officials and virtually none for the public. This method recommends the development of scenarios to better see the possible effects of energy options and changes in demographic variables. The technical process is somewhat supply-side oriented.

The planning process in Saarland was carried out by the single municipal utility company, which has control of electricity, natural gas, and heat supplies. The plan was developed by the utility and its consultants, with little input from the general public before implementation (Figure C.9).

To find common approaches, Table C.1 was created. The focus communities are compared for their use of possible steps in the energy planning process. The steps came from a review of this appendix's figures and other published Annex VII reports. Unfortunately, a considerable amount of community data was missing, which allows poor comparisons for a city such as Modena. A tally of the results in each column provided an indication of the popularity of individual steps. These are rank-ordered in Table C.2. Results of these tables were used to construct Figure 6 in the text.

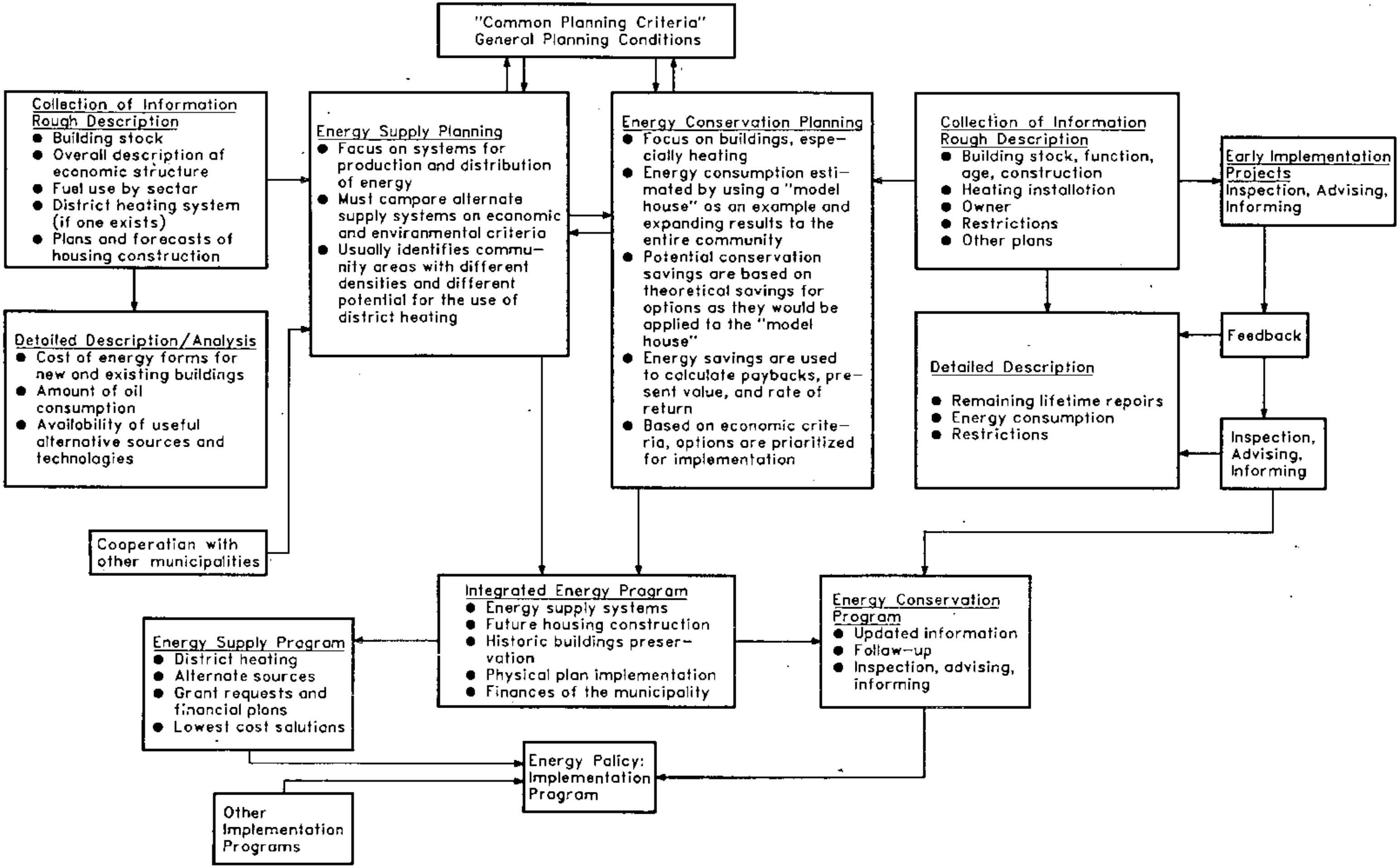

Figure C.6 Swedish local energy planning organization

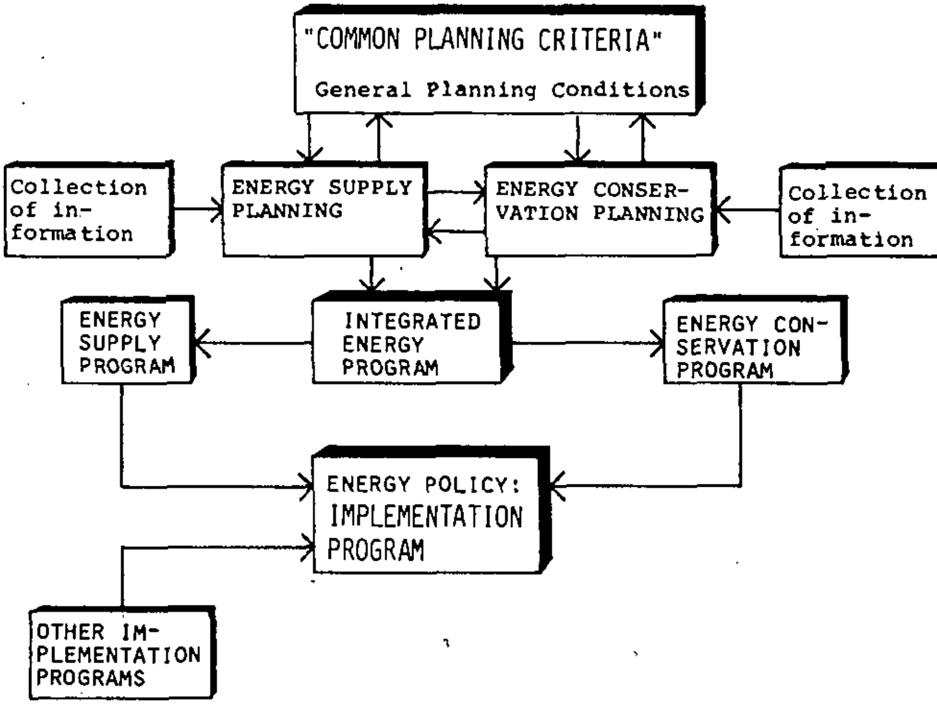

Figure C.7 Planning for conservation and for supply systems as a nonseparable pair

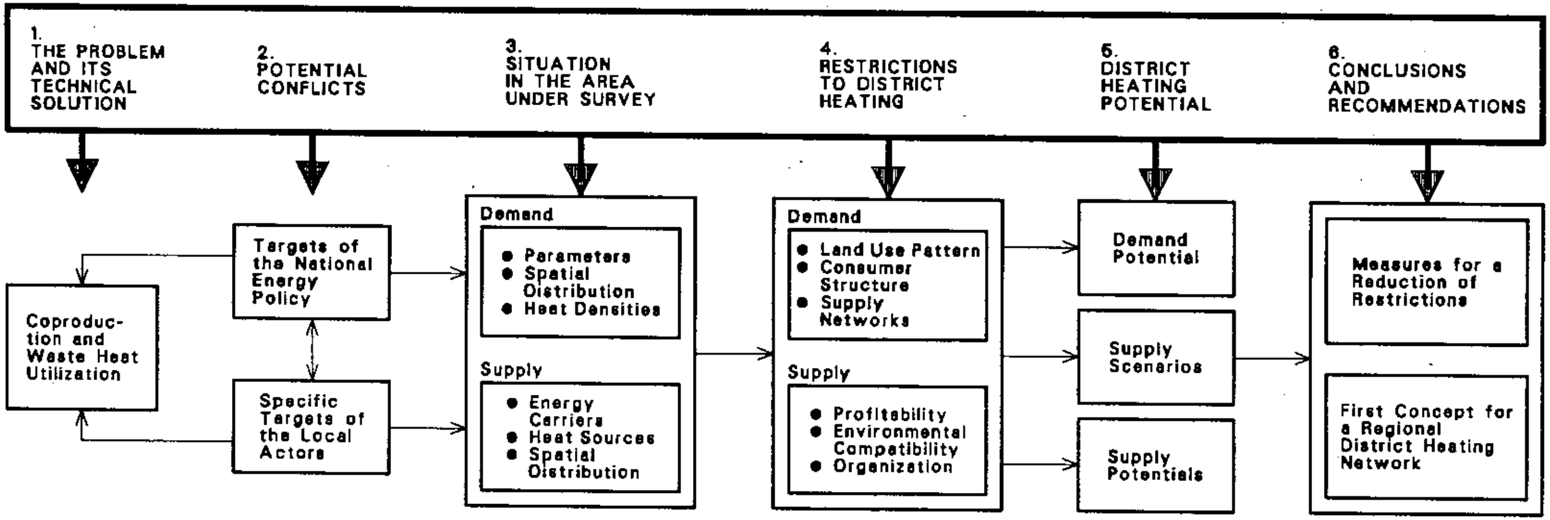

Figure C.8 Planning process used in Rhein-Main district heating study (Source: Ref. G5, Figure 21)

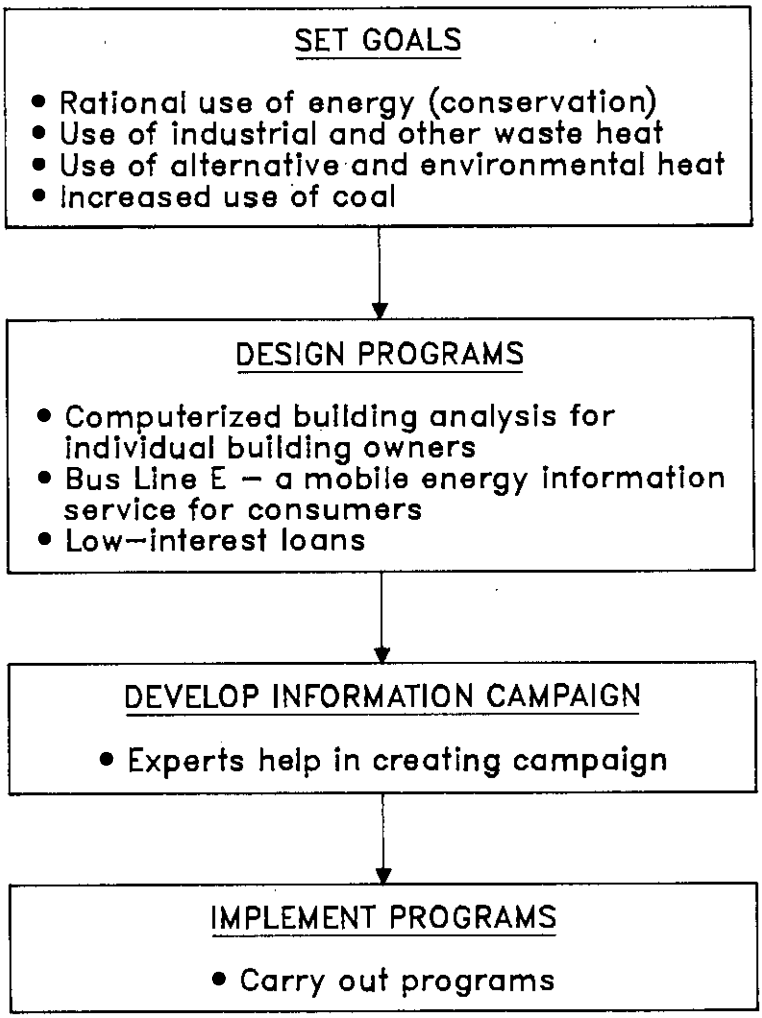

Figure C.9 Saarland energy planning process

Table C.1 Planning process steps followed by focus communities

Step	Italy				Sweden				
	Bologna	Brescia	Modena	Reggio Emilia	Kristianstad	Angelholm	Uppsala	Ornskoldsvik	Sundsvall
Explicit problem identification before planning		X		X					
National-level orders to begin planning					X	X	X	X	X
Local government authorization to begin planning	X	X			X	X	X	X	X
Write grant proposal for funding									
Receive grant funding					X	X	X	X	X
Develop advisory committee -- citizens									
Develop advisory committee -- government officials/experts		X			X	X	X	X	X
Collect data: perform community energy audit (demand side)	X	X		X	X	X	X	X	X
Collect data: perform community energy audit (supply side)	X	X		X	X	X	X	X	X
Develop energy supply/ demand projections	X	X		X	X	X	X	X	X
Identify energy goals	X	X	X	X	X[d]	X[d]	X[d]	X[d]	X[d]
Identify goal conflicts (energy goals with each other and other goals)								X	
Identify conservation options (demand-side or user)	X	M	X	X	X	X	X	X	X
Identify supply options (utility services)	X	X	X	X	X	X	X	X	X
Estimate energy savings of options	X	X	X	X	X	X	X	X	X

Table C.1 (cont'd)

	Italy				Sweden				
	Bologna	Brescia	Modena	Reggio Emilia	Kristianstad	Angelholm	Uppsala	Ornskoldsvik	Sundsvall
Estimate environmental effects of options									
Estimate economic effects of options	X	X	X	X	X	X	X	X	X
Develop scenarios of future conditions to identify impacts of options									
Prioritize options -- communitywide		X		X	X	X	X	X	X
Prioritize options -- by community subareas					X	X	X		X
Optimize options, integrate conservation and supply options	X				X	X	X	X	
Write significant early plan draft		X							
Hold public hearings for comments on the draft plan		X							
Write final energy plan	X	X		X	X	X	X	X	X
Explicitly coordinate energy plan with other local plans		X					X		
Coordinate plan with plans of other municipalities					X		X		
Plan adopted by local elected officials		X							
Implemented projects during the planning process	X	M	M	M	X	X	X	X	X
Implemented projects after the planning process	X	X	X	X	X	X	X	X	X

Table C.1 (Cont'd)

Step	U.S.			FRG			No. of Communities Performing Each Task	Generic Methodologies			
								CCEMP Workbook		Assn. of Loc. Auth.	Prognos
	Ann Arbor	Portland	Richmond	Saarland	Berlin	Rhein-Main		U.S.	Italy	Sweden	FRG
Explicit problem identification before planning	X	X	X	X	X	X	7		X		
National-level orders to begin planning							5		X		
Local government authorization to begin planning	X	X	X		X		11		X		
Write grant proposal for funding	X	X	X				3	X[a]			
Receive grant funding	X[b]	X	X		X	X	10				
Develop advisory committee -- citizens		X	M				2	X			X
Develop advisory committee -- government officials/experts	X		X			X	9		M	X	
Collect data: perform community energy audit (demand side)	M[c]	X	X		X	X	13	X		X	X
Collect data: perform community energy audit (supply side)		X	X		X	X	12	X		X	X
Develop energy supply/ demand projections		X	X		X	X	12	X		X	X
Identify energy goals	X	X	X	X	X	X	15	X		X	X
Identify goal conflicts (energy goals with each other and other goals)					X	X	3		X	X	
Identify conservation options (demand-side or user)	X	X	X	X	X		14	X		X	M
Identify supply options (utility services)		M	X		X	X	13	X		X	X
Estimate energy savings of options		X	X		X	X	13	X		X	X

Table C.1 (Cont'd)

Step	U.S.			FRG			No. of Communities Performing Each Task	Generic Methodologies			
								CCEMP Workbook		Assn. of Loc. Auth.	Prognos
	Ann Arbor	Portland	Richmond	Saarland	Berlin	Rhein-Main		U.S.	Italy	Sweden	FRG
Estimate environmental effects of options		X	X		X	X	4	X		X	X
Estimate economic effects of options	X	X	X		X	X	13	X		X	X[e]
Develop scenarios of future conditions to identify impacts of options		X		X	X	3			X		
Prioritize options -- communitywide			X			X	9	X		X	X
Prioritize options -- by community subareas					X		5		X	X	
Optimize options, integrate conservation and supply options							5				
Write significant early plan draft	X						2				
Hold public hearings for comments on the draft plan	X						2				
Write final energy plan	X	X	X	X	X		13	X		X	X
Explicitly coordinate energy plan with other local plans							2		X	X	
Coordinate plan with plans of other municipalities							2		X		
Plan adopted by local elected officials	X	X	X				4	X		X	X
Implemented projects during the planning process	X	M	X	X			13		X		
Implemented projects after the planning process	M	X	M	X			14	X		X	X

[a]Develop a work plan that may be part of a funding proposal.

[b]Small amount from the state government.

[c]"M" indicates a minor activity.

[d]Primarily a copy of the national goals.

[e]Includes impact on settlement structure.

Table C.2 Planning process steps performed most frequently in focus communities

Percentage of Communities[a]	Step
100	Identify Energy Goals
93	Implement Programs after Finishing Plan
93	Identify Conservation (Demand-Side) Options
80	Data Collection: Energy Audit, Demand Side
87	Identify Supply-Side Options
87	Estimate Energy Savings of Options
87	Estimate Economic Effects of Options
87	Write Final Energy Plan Document
87	Implement Programs during the Planning Process
80	Data Collection: Energy Audit - Supply Side
80	Develop Energy Supply-Demand Projections
73	Have Explicit Local Government Authorization to Plan
67	Receive Grants for Funding
60	Develop Advisory Committees of Local Officials/ Experts
60	Prioritize Options, Communitywide
47	Begin Explicit Problem Identification before Planning[b]
33	Have National Level Orders to Begin Planning
33	Optimize Options or Integrate Supply and Demand Options
33	Prioritize Options by Community Subarea
27	Plan Adopted by Local Elected Officials

[a]Missing data from several cities.

[b]All Swedish.

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