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DESIGN OF ENERGY-EFFICIENT COMMUNITIES

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Annex 22 "Design of energy-efficient Communities"

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1. Local Energy Planning (LEP)

During the last 15 years, "Local Energy Planning" (LEP) has been developed in several countries as instrument to design "energy-efficient communities". Discussions at the workshops of the working group of Annex 22 so far have shown that there are quite different opinions on the definition of LEP, dependent on national or local supply structures or legal responsibilities of local administrations. Since a common opinion on this issue has not been achieved yet within the working group, the contents which today generally ascribed to "LEP" in Germany is given in the following as a tentative "working definition". It is based on the traditionally decentralized organisation of the public administration in Germany, required by the German constitution:

"The municipalities are entitled to govern all affairs of the local community within the general legal framework in their own responsibility."

According to the general interpretation of this requirement in Germany, this concerns also all aspects of energy supply, which, due to the decision of the individual municipalities, is realized either by themselves or, e.g. using concession contracts, by local or regional utilities.

1.1 Objective

The objective of an LEP-project is to develop a conception to find environmentally acceptible cost-efficient solutions for the supply of a defined area with (low temperature heating) energy. The conception is oriented to a general system of goals and subgoals derived therefrom, which are to be defined at the start of the project under interaction of the relevant groups and decision makers affected by the LEP-conception. This system of goals shall be optimally achievable through the implementation of the LEP-conception. Table 1 shows an example for a general system of goals to be agreed with between decision makers and planners.
The LEP-planner has to find a well-balanced consensus among the relevant groups. His proposals shall serve as a basement of decisions within the urban management and for possible investors into local energy supply structures or energy saving measures as well and provides them with informations on immediate or future consequences of their decisions.

1.2 General content

Using data on the present situation of energy demand and supply within the LEP-area and its environmental conditions, logically consistent measures are to be developed - according, for example, to the scheme shown in table 2 - to achieve the given system of goals by a strategy of decisions and measures considering the actual legal requirements and the latest technology. During the planning process, the actual situation of the investigated area is analyzed with respect to possible weaknesses, problems and improvement potentials. Short-term and medium-term activities are to be defined which are suited to achieve the given goals in the best possible way.

System of Goals	Methods and tools to measure the contribution to goals	Measures, indicators
Cost-effectiveness of energy supply	Economic analyses and optimization, sensitivity analyses	Costs, prices
Energy saving	Urban energy balances, methods of analysing energy use performance	Relative and absolute energy consumption, time-dependent energy demand development, comparison to similar energy users
Use of regenerative energies	Consideration of potentials and optimization options	Relative use of regenerative energy as compared to conventional energy sources
Security of supply	Import balances	Shares of imported energies from different countries, share of primary energies with short-ranged availability
Environmental tolerance	Emission balances, immission calculations, environmental impact assessment (EIA)	Comparison to actual standards or requirements of environmental legislation, external costs of pollutants
Social acceptancy	Economic analyses and impact to socialindicators; social surveys	Prices, social costs, flexibility, safety, comprehensibility
Compatibility with the goals of regional and urban planning and generic goals of national economy	Qualitative description and comparison of options according to their contribution to urban and national planning goals	Specific demand indicators; growth effects, effects to balance of payment

Table 1: A possible system of goals of LEP and their verification

The conception consists of a general "frame-conception" and a consistent set of short-term measures to remove acute weaknesses or realize given potentials. The conception adresses all groups affected by these proposals. It provides - where possible quantified - informations concerning the extent to which the given goals can be achieved or will be failed.

1.3 Subject

The subject of LEP is a defined "administration area" (town, agglomeration area, county) and the *low-temperature heat supply* of the public, private and commercial sectors herein. The industrial sector is only considered as far as solutions are discussed which adress more than one company or enterprise, as, for example, waste heat utilization projects. High temperature heat supply is generally *not* subject to LEP, as well as electricity supply, if not connected with direct heating or cogeneration. Moreover, LEP is not a marketing concept of supply companies or an internal utility optimization program such as demand side management nor does it consider the traffic sector.

<table>
<tr><th colspan="2">Investigation of actual energy situation</th></tr>
<tr><td>Energy demand
- demand of usable energy
- consumption of end energy
- consumption of primary energy</td><td>Energy supply
- organisation/responsibility
- supply structure
- endogenous potentials
- cost/price-levels</td></tr>
<tr><th colspan="2">Analyses of actual energy situation
(weaknesses, impacts, potentials)</th></tr>
<tr><td>local energy balances
Indicators of energy performances and
Environmental impacts
Social indicators</td><td>Local map of heating demand
Heat supply structure map
Improvement potentials</td></tr>
<tr><th colspan="2">Development of short-term and medium-term activities according to an integrated "frame conception"</th></tr>
<tr><td>Evaluation of options and their effects</td><td>Comparison to the general system of goals</td></tr>
<tr><th colspan="2">Development of concrete recommendations and organisational proposals for the community</th></tr>
<tr><td>Explanation of the conception and catalogue of measures:
- option of activities
- decision demands
- organisational requirements</td><td>Priorities due to weighted goals:
- time-dependency
- flanking measures to increase performance and acceptance
- controlling measures</td></tr>
</table>

Table 2: Schematic flow of LEP-development

1.4 Responsibility

As explained above, the development of "local energy conceptions" belongs to the competence of the local administration which is responsible for urban development and/or environment in cooperation with independend experts. A close integration with energy supply companies or utilities shall be established. Once developed, the conception shall be revised and actualized regularly, due to changing conditions and goals. One instrument of regular actualization is the "communal energy report" which shall be edited annually by the community.

2. Working approach of Annex 22

The LEP-process consists of two main components, which interact with each other in manifold ways:

i) the actual process of planning and design

and

ii) the transfer of the results to the various groups involved to implement the conception.

According to this and the project objectives stated above, the work was subdivided into four Subtasks, with Subtasks A and B closely related to i) and Subtasks C and D to ii):

Subtask A	Software Tools in Energy Planning
Subtask B	Models for the Calculation of Environmental Aspects
Subtask C	Means to Represent, Demonstrate and Advertise Planning Solutions
Subtask D	Implementation and Integrated Planning Procedures.

The main work within Annex 22 is to be done by the Lead Countries for each subtask: they are responsible for the detailed working plan and the guidelines, how to do the work for each subtask. In the present work phase the Lead Countries are preparing review reports, in which the Lead Countries experiences are evaluated. Together with the Participating Countries the state-of-the-art in each country is later going to be reviewed, based upon national case study analyses. The results are then evaluated by the Lead Countries, and a final synthesis report will be made in co-operation with the Operating Agent.

The final report will contain an assessment of the experiences and progress made in the participating countries with the instrument of LEP *and* its implementation. It shall give information and guidelines on procedures, tools and methods, which have been established in the field, for the planner as well as for communal administrators or managers. Furthermore, conclusions and recommendations for further work shall be drawn from it.

According to a decision of the ExCo in 1991, the participation of IEA-member countries in Annex 22 should be held open until the second quarter of 1992. We were happy to welcome two additional participating countries since then, France and Sweden. Sweden was able to take the lead in Subtask A. Therefore, the complete Annex 22 can be carried through as planned according to the original proposal accepted by the ExCo. The final list of participating countries is shown in table 3.

From the four Subtasks, Subtask C is finished by and large, with the exception of evaluating of the contributions of the participating countries. Subtask B and D have been completed to some 60 %, whereas Subtask A is at the very beginning due to the delayed start.

Country	Status	Subtasks			
		A	B	C	D
Belgium	*	P	P	P	L
France	*			P	P
Germany[1)]	*	P	L	L	P
Italy	*	P	P	P	P
Sweden	*	L	P	P	P
Turkey	*	P	P	O	P
EEC	a	O	O	O	O
OECD	a	O	O	O	O

1)	Operating Agent
*	Participation and funding confirmed
a	Participation assumed
L	Lead Country
P	Participant
O	Observer

Table 3: Annex 22 Participation Status, May 1992

3. Some highlights of Subtask B

Subtask B consists of the following 3 parts:

Part I: ***"Systems energy efficiency"***

In this basic evaluation characteristic data on energy systems with respect to their energy efficiency are developed, according to optimized systems which are characteristic for the individual participating country. This is of particular relevance for bivalent systems such as cogeneration or heat pump systems. When comparing different supply systems, comparison data which result from the national energy supply structure, such as the fuel mix for electricity production, are needed. Such data are considered in this part I.

Part II: ***"Basic data and informations on the environmental impact of energy systems"***

In the LEP-process an agreement has to be found as to the "environmental properties" of the different energy systems to be considered. These properties can vary largely between different countries, due to different environmental requirements, different technologies used, different properties of fuels etc., which are of essential influence to emission factors. Part II gives an overview on actual data on these issues, which are the basement of any environmental comparison.

Part III: ***"Methods to compare environmental impacts of energy systems"***

This is the most ambitious part of the work on subtask B, since it aims to integrate the more "one-dimensional" approach of simple quantitative comparisons or optimizations, for instance with respect to economics, with complex environmental assessment procedures developed recently in different countries in accordance with EEC-requirements. Those procedures intend to achieve an increasingly broader approach to the problem of the assessment of environmental impacts and will presumably be applied also in LEP-projects in the future.

3.1 Relative energy saving potential of cogeneration processes

A central issue in LEP-projects is the question of cogeneration potentials within the area of investigation, due to the very high potential of primary energy saving which in general is ascribed to this technology. This theoretical potential has to cope with a number of restrictions and impediments. It is one of the genuine tasks in LEP to figure out the optimal design of cogeneration applications and its real energy saving potential.

Generally, cogeneration is applicable when a major - and continous - demand of low or medium temperature heat energy is accommodated by a similar demand structure of electricity and thus can be supplied more economically by a cogeneration process than by separated generation of heat by a boiler and purchasing electricity from the utility. This condition will in general be fulfilled, when the electric energy output of the cogeneration process is roughly equal to the user's electricity demand and most of the annual cogeneration heat energy output can be utilized.

If it is assumed that the cogeneration electric output replaces electricity from a large hard coal power plant with steam condensation as the typical medium load power plant type in West-Germany, the primary energy saved by this replacement is credited to - that means subtracted from - the primary energy consumption of the cogeneration process. The remaining amount of primary energy is related to the thermal cogeneration output, thereby resulting into the "specific fuel consumption" for one unit of heating energy, β_Q^{cog} [MWh_{PE}/MWh_{th}]. For a cogeneration process with an electricity/heat-ratio σ one gets the resulting β_Q^{cog} by

$$\beta_Q^{cog} = [(1+\sigma)/\mu_{cog} - \sigma/\eta_{el}^K] ,$$

with η_{el}^K as the electric efficiency of the compared power plant process and μ_{cog} as the energy utilization factor of the cogeneration plant (given by the quotient of the usable energy output and the primary energy input).

For real world results, however, one has to consider, that

- cogeneration plants are generally used as base load plants: the total heating demand is supplied by the cogeneration plant (typically 65 - 90 %), supplemented by a conventional peak load boiler (PLB).
- For cogeneration plants supplying district heating networks, additional losses have to be considered due to heat losses L_Q in the district heating pipelines and due to the electric energy e_Q necessary for circulating the heating water to the consumers.

Using these additional terms, the overall specific primary energy demand necessary to provide one unit of usable heat is given by the following expression:

$$\beta_Q = [(1+\sigma)/\mu_{cog}] \cdot (1+L_Q/100) - (\sigma - e_Q/100)/\eta_{el}^K + PLB.$$

Fig. 1 shows the corresponding specific consumption of primary energy β_Q according to the general formula given above for heat supply in real district heating networks with different cogeneration processes.

The results of these considerations show, that due to real conditions the very high theoretical energy saving potential of district heating by cogeneration has to be reduced substantially. Whereas district heating using steam from back pressure turbines hardly allows for any energy saving - and in fact *increases* the CO_2-emission, when hard coal is used - gas turbines have a real saving potential of some 50 % compared to conventional heating plants. In general, the saving potential will be the higher, the larger the electricity/heat-ratio σ of the cogeneration process is. Therefore, combi-plants or combined heat and power ("CHP") plants with high thermodynamic standard will meet the requirement to save energy in a very good manner. In addition, there is a roughly corresponding reduction potential for polluting emittants and CO_2, which makes centralized (CHP) and decentralized cogeneration systems as well to key technologies for community systems to realize their environmental goals, wherever they are applicable. It is one of the most important tasks of the LEP-process, to discover the optimal use of these techniques in the local case.

A summary of figures on the primary energy performance β_Q for different heating processes is shown in table 4 (for German conditions). Such figures can be used as basis to compare different options of energy supply within an LEP-project.

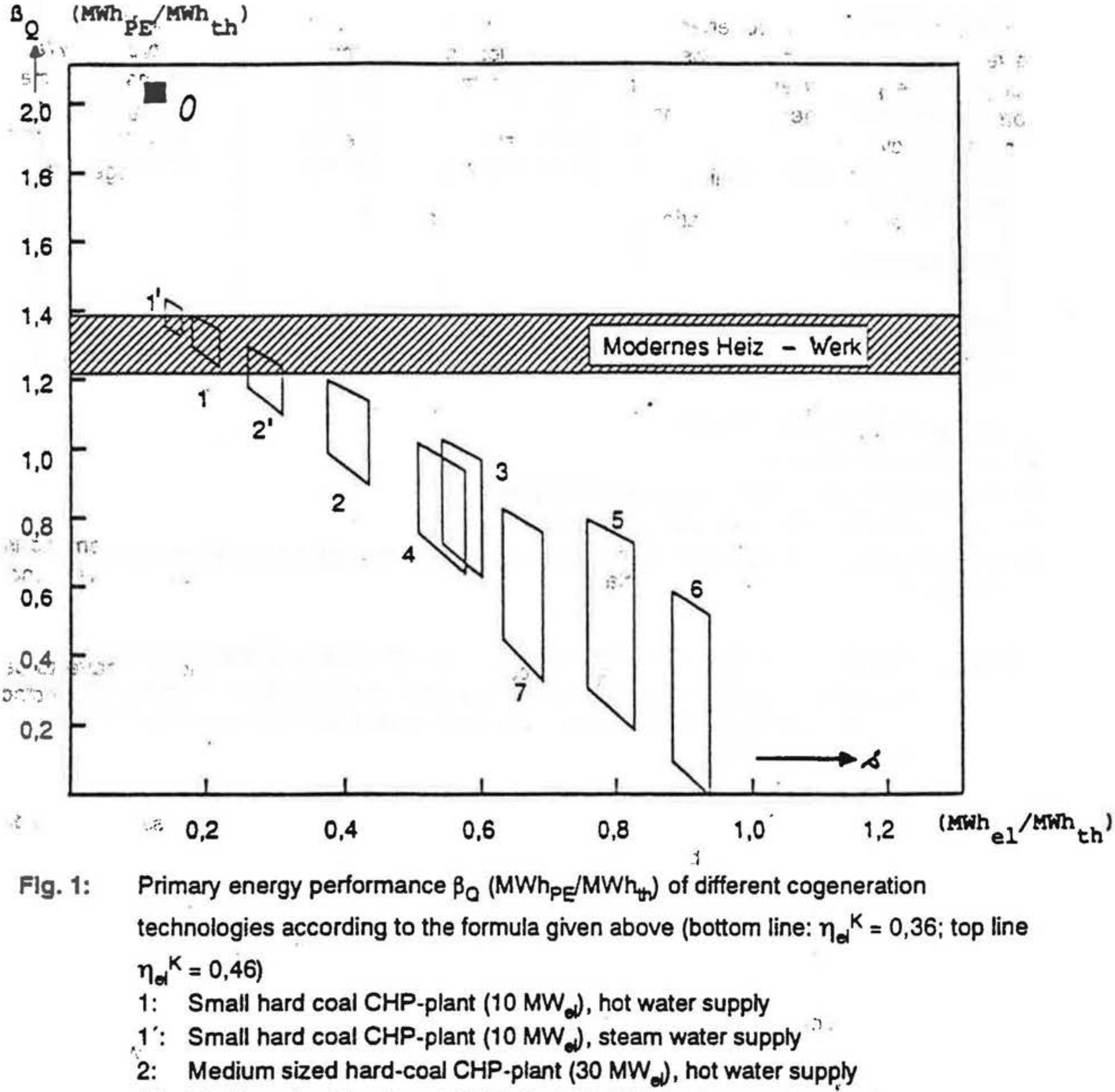

Fig. 1: Primary energy performance β_Q (MWh_{PE}/MWh_{th}) of different cogeneration technologies according to the formula given above (bottom line: $\eta_{el}^K = 0,36$; top line $\eta_{el}^K = 0,46$)

1: Small hard coal CHP-plant (10 MW_{el}), hot water supply
1': Small hard coal CHP-plant (10 MW_{el}), steam water supply
2: Medium sized hard-coal CHP-plant (30 MW_{el}), hot water supply
2': Medium sized hard-coal CHP-plant (30 MW_{el}), steam water supply
3: Gas-turbine with reject-heat utilization (5 MW_{el})
4: Small gas-engine cogeneration plant (200 kWh_{el})
5: Gas/steam-turbine (20 MW_{el})
6: Large Diesel-engine cogeneration plant (5 MW_{el})
7: 5 with maximal after-burner

Heating system	β_Q [MWh_{PE}/MWh_{th}]	c_s [DM/MWh_{th}]	f_{CO_2} [$kg\ CO_2/MWh_{th}$]
Electricity (direct heating)	3,25	115	700[1] 971[2] 488[3]
Boilers:			
gas	1,11 - 1,18	80	316 - 338
heating oil	1,14 - 1,23	80	367 - 400
coal-briquettes	1,60	70	628
Cogeneration:			
gasturbine	0,50 - 0,65	50 - 60	143 - 185
CHP-hot water[4]	1,05 - 1,15	60 - 70	411 - 450
CHP-steam[4]	1,20 - 1,30	75 - 85	470 - 509
large CHP with turbine heat extraction [5]	0,70 - 0,80	35 - 45	275 - 320
Heat pumps:			
electric	0,80 - 1,28	110 - 130	130 - 200[3]
gas-engine	0,61 - 0,64	95 - 115	172 - 204

[1] average of German power plants (1989)

[2] modern hard coal power plant

[3] average of base load electricity supply (nuclear and lignite)

[4] CHP ... combined heat and power plant (hard coal, 20 MW_{el})

[5] large condensation power plant with heat extraction as source for the base load of a large district heating network (> 100 MW_{th})

Table 4: Primary energy utilization performance β_Q, specific costs c_s of heat supply (at the "fence" of the generating plant or at the "city gate" of a large district heating network for case [5]) and CO_2-emission factors for different heating systems according to West-German conditions

3.2 Calculation of environmental impacts

Methods and tools to calculate environmental impacts in energy planning procedures have been developed intensively in recent years to cope with the requirements of the environmental policy, in particular with those of the clean air policy. In the first half of the eighties, one of the main objectives of environmental policy was to reduce and prevent air pollution, for which at this time energy conversion processes were the dominant source in Germany. The methods and tools mentioned above, available for urban managers in communal authorities as well as in consulting companies, were focused generally on the origin and distribution of atmospheric pollutants:

- *methods and tools to calculate pollutant emissions caused by energy conversion processes (domestic heating, electricity generation, traffic, etc ....)*
- *methods and tools to calculate immission concentrations of atmospheric pollutants caused by these sources.*

Basic data for these calculations such as emission factors, meteorological data and ambient air quality data are available as an input into the concrete LEP-project. As a good example, comprehensive air quality data bases, provided by air quality monitoring programmes partly due to the German Federal Immission Control act (Bundesimmissionsschutzgesetz BImSchG) and based on a growing number of monitoring networks should be noted here. Evaluation and comparison of different planning solutions with respect to economical and ecological objectives are supplied by "classic" evaluation methods such as the cost-benefit analysis.
We can conclude, that considerable efforts in the clean air policy in the eighties led to reliable basic data and a whole range of computer based tools are available for planning authorities in Germany when considering environmental impacts of pollutant emissions in energy planning procedures. Computer based models to calculate atmospheric pollutant diffusion, reviewed later in this paper, are representative for such instruments.

Whereas air control policy in the energy supply sector was quite successful in Germany, e.g. in decreasing of SO_2 and dust immission concentrations caused by energy supply, other environmental loads continue to increase (soil and water pollution, land use, degradation of biotops etc), and the climate effects of antropogenic greenhouse gases become even more subject of discussion. These facts led to a redirection in environmental policy in recent, with the following objectives relevant to energy planning:

- comprehensive and integrated investigation and evaluation of environmental impacts and
- precaution against environmental impacts and damages (both reqired by the enactment of the law on environmental impact assessment "UVP-Gesetz")
- greenhouse gas reduction.

Environmental impact assessment in general environmental planning procedures and local energy planning as well needs new, extended calculation and evaluation methods and tools in the decision making process. Currently, there are many efforts made in Germany to develop such instruments and to create the necessary data bases:

- aggregation and evaluation methods of different environmental impacts within the environmental impact assessment (EIA) process,
- computer based tools to perform and document EIA procedures,
- integration into computer based environmental information systems,
- environmental quality objectives and standards,
- costs and benefits of environmental improvement measures, monetarisation of environmental impacts, external costs of energy supply systems.

Some basic data on these issues and computer based instruments are already available at present. In the following, examples for these tools and some recent investigations on monetarisation of environmental loads and damages are reviewed.

Total Emission Model of Integrated Systems - TEMIS

TEMIS is a computer based model for the calculation of pollutant emissions of energy supply systems, developed within the framework of the study "Total emission model for integrated systems" by ÖKO-Institut (= institute for environmental studies, Freiburg). The features of this instrument cope with some requirements of the present environmental policy:

- Consideration of the whole chain of energy conversion processes from primary energy production to the end use - including "embedded energy" by material input. Local and global emissions are calculated as well.
- Calculation of the emission of relevant greenhouse gases (CO_2, methane, N_2O and non-methane volatile organic compounds)
- Calculation of other quantitative environmental aspects such as land use and solid waste.
- Consideration of qualitative aspects such as intensity of land use, riscs, impacts on microecology.
- Aggregation and evaluation of environmental impacts caused by pollutants by monetarization based on avoidance costs.

TEMIS, first released in 1990 and still under development (the next version 2.0 will be adapted primarily for communal planners), is already frequently used in local energy projects in Germany and in other countries such as

- Newcastle upon Tyne study within the framework of the OECD-projekt Energy and the Urban environment,
- Urban CO_2-project of ICLEI (International Council for Local Environmental Initiatives, supported by - at the present - 14 cities in 3 continents)

Investigations on costs of environmental impacts

Recently, also several important projects on methods to monetarize environmantal impacts have been carried out. The results of these efforts are of great interest for LEP because the monetarization of environmental effects can support the planning staff in the decision making process in two respects:

- Different impacts on the environment, expressed in monetary units, can be compared with each other and aggregated.
- Evaluation in monetary terms can build a bridge between ecological and economic discussions.

The following important investigations should be mentioned here:

- *Research programme "Costs of Environmental Pollution/Benefits of Environmental Protection", initiated by the Federal Ministry of Environment.*

The research programme "Costs of Environmental Pollution/Benefits of Environmental Protection" has been initiated by the Federal Minister of Environment in order to estimate the costs of environmental damages and to investigate the applicability of different methods for evaluation of these costs. This programme, made up of ten individual projects, was finished in 1991 and evaluate environmental damage costs under

- media-specific aspects (air, water, soil, noise)
- structural aspects (private households, companies, the state)
- sector-specific aspects (agricultre and forestry, fishing, tourism, housing and construction industry as well as the water supply industry)
- damage-specific aspects (damage to health and material, fauna and flora as well as non-material damage).

Results are now available for further investigations on monetarization of environmental impacts caused by energy conversion processes.

- *"Social Costs of Energy Consumption" by O. Hohmayer*

In this first comprehensive study on external costs of energy supply, published in 1988, an attempt has been made to systematically quantify and monetarize relevant external effects with respect to the competition between conventional (fossil and nuclear) and alternative electric generation based on renewable energy sources (wind, solar). In this study, partly based on earlier pilot studies on monetarization of environmental damages (Federal Environment Agency, 1978 - 1986) considerable external costs for conventional electricity generation (and benefits for the renewables) have been investigated.
Results of these studies may be used in a very helpful way in LEP-projects.

Expert System for Computer-aided Environmental Planning Tasks - EXCEPT

EXCEPT is an expert system under development in cooperation between the Technical University of Hamburg-Harburg and IBM in order to support environmental impact assessment on the communal level. Since 1991, a prototype operates in the urban planning authority of Düsseldorf to collect practical experiences. Due to the high computing performance needed by the expert system, EXCEPT is implemented on a UNIX-workstation.
EXCEPT is designed to

- support the individual planner with a knowledge base, in particular on evaluation methods, and the necessary data base,
- allow extension of the knowledge base by scientific experts as well as by individual planners,
- document the evaluation procedure and its assumptions and their results.

One of the main issues in EIA is evaluation and aggregation of environmental impacts for justfying a certain project relevant to the environment. The aim in the EXCEPT-project is to perform these evaluation procedures automatically and well documented. Evaluation modules for atmospheric pollutants and for soil are under development. It is expected that EXCEPT will become a practicable instrument within two years.

3.3 Atmospheric pollution distribution

One of the most important issues in LEP-projects is the comparison of different energy supply options with regard to their immission effects (local and global). During the last decade, instruments to calculate these effects have been developed continously and are now available also to the individual planners as a planning tool. Since it surmounts traditional planning tasks, a widespread application of these tools is at the very beginning. In the following, a review on the state-of-the-art of this important field shall be given from the practical point of view.

Air transport of pollutants can be described by three processes:

- emission (exhaust characteristica, quantity, temperature, kind of pollutants, ...),
- transmission (transport with the air flow, chemical reactions, ...),
- immission (ground level concentration, deposition, fallout, rainout, ...).

A modeling of immission situations has to be based on precise data of every process.

Meterological base data

The modeling of the pollutant transport requires detailed knowledge of the atmospheric conditions. The specific form of the meteorological data resembles the modeling process. A common supplier for meteorological data is the DWD ("Deutscher Wetterdienst" = german weather service). DWD supplies meteorological data for two legal authorization procedures:

- "Technical Instruction Air 1986 ("TI-Air") of the BImSchG,
- §45 "Strahlenschutzverordnung" (radiation protection decree); evaluation of radiation exposition resulting from emission of radioactive substances out of nuclear plants (StrSchVo).

The data is compiled for the Gauss model as requested in these decrees and outlined as "dispersion class statistics". The dispersion class statistics is a three-parameter distribution combining wind direction, wind speed and dispersion class. About 70 of these statistics for designated areas in Germany are available at the DWD. These statistics are derived from synoptic data or from data of the wind-measuring grid combined with synoptic data. If data for a specific area is not available, two procedures are possible:

- a "qualified examination" considers the transferability of data from a similar area,
- a "synthetic dispersion class statistics" may be evaluated.

While good results are obtained by using dispersion class statistics combined with Gaussean models to calculate long term mean immission rates, a more detailed atmospheric flow data base has to be used for the simulation of immission rates in special weather situations or in areas with complex orographic structure such as:

- hills, valleys (causing jet effects)
- secluded valleys in mountain areas (areas shielded from wind)
- mountain slopes (causing thermal or cold air flow).

For such applications, DWD has developed the following models:

FITNAH	The FITNAH model (Flow over Irregular Terrain with Natural and Anthropogenic Heat sources) calculates meteorological parameters - eg. wind, temperature, humidity, etc. and their modification by natural and anthropogenic influences inherent in the synoptic conditions (covering a larger area).
KLAM	KLAM ("Kaltluftabflußmodell" = cold air flow-wind model) makes prognoses on the influence of planned construction works at hillsides on the cold air flow, which is vital to the ventilation of secluded valleys.
MKW	MKW ("Massenkonsistentes Windfeldmodell" = mass consistent wind field model) can calculate the wind field at near ground levels in areas with complex orographics. The use of MKW can taken as a supplement for time consuming and expensive measuring campaigns obsolete (tetroon experiments, tracer experiments, SODAR measurements, ...).
MUKLIMO	MUKLIMO ("mikroskaliges urbanes Klimamodell" = microscale urban climate model) calculates the influence of planned new (large) buildings on wind, temperature, and humidity.

Dispersion models

The modeling of pollutant dispersion has led to different models of which the Gaussean model is just one. All models are based on the Fokker-Planck-equation, but they employ different solutions. Models utilizing microscopic description methods require detailed description of the environment. Therefore, a precise, and thus very large data base is mandatory for such models.

For practical purposes the availability of algorithms which can be evaluated on micro-computers (PC's) is decisive for a widespread use in concrete LEP-projects. Fortunately, such models have been developed for typical questions such as annual average of immission concentration caused by a given emission. The Gauss-model, described below, and similar models are the most commonly and frequently used and available to every planner.

The following models - and many more - are currently in use:

TI-Air-model	This model is established in the TI-Air (= TA-Luft) since 1974 and its use in authorization procedures is obligatory. It is based on a Gauss dispersion model and has only limited adaptability to special orography, source conditions and weather situations. The Federal Environmental Agency has developed AUSTAL, a FORTRAN based reference program for use of the TI-air model on PC's.
VDI-model	This model was developed by the VDI - Commission for Preservation of Clean Air ("Verein Deutscher Ingenieure - Kommission zur Reinhaltung der Luft"). It can be regarded as an inproved TI-air model which is capable to modeling the influence

	of chemical reactions and washout and to consider inversion effects. Area- and volume-sources can be described explicitly and multiple sources can be integrated. This model is used frequently for diagnosis purposes in critical areas with high immission loads and can be run by PC´s.
uvf-model	The uvf ("Umlandverband Frankfurt", a "Frankfurt Greater City municipality") has developed a dispersion model based on Lagrangean particle dispersion algorithms. This model runs on mini-computers and is used to evaluate special immission situations in city areas.
IIASA-RAINS	This computer-based system was developed for the simulation, optimizing and mapping of bordercrossing/long-range air pollution in Europe. (IIASA = International Institute for Applied System Analysis). The RAINS-model combines, among others, informations on the emergence and impact of acid rain in Europe. The emission rates of SO_2, NO_x and NH_3 are calculated according to the national energy statistics for all 27 European countries. The hazardous impact on lakes, forest soil, and trees is simulated. The most recent version of RAINS can be run with PC´s.

In general it can be said that quite reliable software and databases are today available to LEP-planners. Due to limited knowledge these tools at present are less intensively used then the subject would require.

4. Summary of Subtask C (Means to Represent, Demonstrate and Advertise Planning Solutions)

One of the main issues in LEP is the transfer of planning results from the planning and engeneering level into the level of public acceptance of a conception. The actors participating in the approval processes are manifold and so are their aims and targets. Examples of the several actors include political decision makers, administrations, utilities, energy consumers and various interest groups. One of the most important output from the planning process is therefore to find ways of harmonization of the different actor´s interests, including learning and conflict resolution.
It is consequently very important to illustrate and edit communal energy concepts in the appropiate forms, i.e. to "sell" the results of energy planning to the concerned parties or actors in the decision process. Various municipalities in Germany are in fact putting considerable efforts into the "marketing" of energy projects. Several instruments or means have consequently been developed specifically to represent, demonstrate and advertise planning solutions accordingly.

The aims of Subtask C are to systematically illustrate and evaluate the information and the dissemination means in the context of LEP. The evaluation therefore concerns information media as well as the institutional arrangements. It would however not be possible nor worthwhile to produce an extended list of all German institutions dealing with LEP and their respective way of representing, demonstrating and advertising planning solutions. The national study report rather focuses on a representative number of examples and assesses the experiences made with these.
It is quite rational, instead to present the existing information media and the institutional arrangements in a systematic form and to characterize and measure their effectiveness. A quantitative assessment of the different means of information collection, transfer and dissemination according to energy related criteria, such as the achieved level of energy conservation, however is not feasible due to lacking information from special project-related evaluation studies. Only for parts, as e.g. the Working Programme of the Federal Ministries with its 25 field studies or the LEP support programme of the Saarland and Nord-Rhine Westfalia, relevant cross section analyses with different topical orientations are available.
The considerations on information media and means existing in Germany in the LEP context have been composed into a qualitative table of statements (table 5). The main criteria relevant in this context are

- the impacts on energy conservation,
- the volume of the target group addressed with the aspect of information dissemination,
- the anticipated multiplier effect
- and the relevant costs required for the realization of the measures.

Measures/ Institutions	**Energy Conservation**	**Addressed Target Group**	**Multiplier Effect**	**Cost**
Information and Consulting Campaigns	small	high	high	small
Specific Consulting and Qualification Measures				
- Energy Conservation Programmes	high	small	small	medium
- Demonstration Projects	small	high	medium	high
- Information System KEV 1)	-	-	-	-
- Energy Agencies	medium	small	medium	medium
Experience Exchange	small	small	medium	small
Specific Institutions at the Local Level				
- Energy Officer, energy Coordination Conference	high	small	small	small
- Energy Councils	small	small	high	small
Instruments for a rational Energy Planning	small	small	small	high

1) no assessment possible due to recent start of the programme test phase

Table 5: Summary assessment of the Measures

While discussing all those different efforts with respect to the results achieved, it has turned out so far that an evaluation of support and dissemination programs for energy conservation and their respective cost/benefit - yields has rarely ever been made. First conclusions from German experiences indicate, that a *combination of measures*, tailored to specific target groups, can be generally expected to be most effective.

A broad information campaign alone, for example, will have little impact. It should be accompanied by specific "on-the-spot" consulting, combined with financial programmes for measures which have proven to be economic, for instance, in order to surmount the implementation barrier of energy saving measures which generally have to compete with other possibilities of investment. The consulting process should preferably be organized by a public institution or an association. By this, in general, optimal public relation channels are accessible as well as support in organisation and management problems. Qualified service which is normally accepted by the target group is provided by this approach.

A very good example for such an integrated approach is given by the Swiss "Impulse program", by which incidentally, outstanding and very useful material for energy conservation in the building sector has been prepared in co-operation between universities, industries, consultants and the Swiss association of craftsmen. It is this integrated approach of combined and specifically tailored measures, which can be expected to be adapted most efficiently by the target groups, while at the same time the percentage of free-riders is kept low. In contrary, isolated measures, such as some energy conservation programmes, may turn out to be of quite doubtful success in terms of their cost/benefit ratio.