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ENERGY AND LAND USE PLANNING

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Foreword

How can cities be made more habitable and, at the same time, contribute to reducing global environmental problems? One means is to limit their energy consumption and therefore their pollution.

Case studies presented at an OECD workshop in Newcastle, UK (May 1992), show that some cities are already implementing cost effective measures and examples of good practices are available from the earliest stages of development planning to the operation of buildings, services and transport infrastructure and industrial processes.

However, progress is slow in comparison to the rate at which cities are developing and there is an urgent need to tackle energy demand management at the urban scale. There is a need to promote the concept of urban energy management to key public and private sector decision makers and encourage their collaboration in planning for high standards of energy efficiency.

Urban planning and restructuring should ensure that land uses, infrastructure proposals and development policies promote high standards of energy management. A plan that reconciles energy efficiency with the need for economic development opportunities and high quality local environments will encourage communities and businesses to bring forward practical proposals that will be more robust to energy market uncertainties.

In order to promote high standards of energy demand management land uses, development densities and mixes should be planned in such a way as to:

* reduce the need to travel;
* reduce service infrastructure costs;
* reduce the environmental effects of energy supply; and
* encourage buildings energy efficiency.

National governments have an important role to play in helping cities to:

* identify the best urban energy management practices available;
* provide independent authoritative information in useable form and disseminate it to the right decision-makers at the right time; and
* develop the means to analyse, monitor, target and compare the energy performance and environmental effects of cities regardless of climate and culture.

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1. PLANNING FOR ENERGY EFFICIENCY IN MARKET ECONOMIES

1.1 Introduction

The OECD's 1991 - 94 programme on "The role of cities in Sustainable Development" is concerned with the environmental, social and economic issues which impinge strongly on the contribution which cities can make to achieving sustainable development.

It is concerned with technology, not for its own sake, but for its potential to help reconcile conflicts between environmental, social and economic objectives, and for its implications for governmental and institutional arrangements.

The programme's particular concern with environmental issues is being brought into focus by the project on "Environmental Improvement through Urban Energy Management". This asks two fundamental questions about cities. It seeks to know:

* how can they be made more habitable ; and

* how can they contribute to reducing global environmental problems.

Its particular concern is with the process of managing their energy systems - the process of making decisions about energy technologies with a view to achieving positive changes in economic, social and environmental conditions.

1.2 Cities in Context

Cities are a major feature of human cultural development. Indeed, it can be argued that the history of cities is the history of the human predicament. As some people have benefitted from the safety of cities others have paid a high price in lost amenity and ill health.

Generally, human kind has prospered from the arrangement but, as the twentieth century draws to a close, a major turning point may be approaching as the world population grows and inventories of buildings, machines and vehicles expand.

In comparison, at the start of the century, no city in the world had more than about 5 million inhabitants. By 1950 there were six such cities. By the year 2000, the UN predicts there will be 60. Ten of them will have populations over 10 million each. By the year 2000 about half the world's population (say 3 billion people) is likely to be urbanised.

Already the average for OECD member states is about 70 per cent and in these highly urbanised countries people now use between 20 and 30 times more energy than their ancestors did before the industrial revolution. They also use about 20 to 30 times more than their contempories do in undeveloped countries where about 30 per cent of population is urban.

As well as a correlation between development, urbanisation and energy use there is a growing consensus of scientific opinion that a failure to move away from established technical inventories, and current trends, will produce dangerous geochemical and geoclimatic effects.

The social, economic and political implications are enormous and, amongst the questions to be addressed there are three specific ones relating to improving the environment through urban energy management in democratic market economies.

1.3 What strategies are likely to work ?

At the local level, decision-makers in individual cities are aware that their well-being depends on competing to attract investment capital and market goods and services. They also know that there are global environmental problems.

There is growing acceptance that a world environment in which population growth outstrips economic growth is no more sustainable than a national, regional or local environment in which people get progressively poorer or increasing competition for diminishing resources produce greater distortions in wealth distribution.

The risk is of a vicious downward spiral of under-investment, decay and growing social tension. In effect, a risk that urban economic engines will collapse under the weight they have to carry.

Unfortunately the reverse situation, in which economic growth exceeds population growth, will not be sustainable either, unless it is based on the right mix of technologies. If past behaviour is a good indicator then business-as-usual is likely to choke urban populations in a vicious upward spiral of congestion and ill health. Consequently, the future of human society appears to depend heavily on the success of urban processes. Also, the problem appears to be less one of technical know-how than social innovation.

In this regard, with fundamental changes occurring in eastern and central European, there is a tendency to assume that market competition guarantees a path to success.

However, environmental problems are being identified beyond time horizons that normally interest investors and consumers. Therefore, whatever strategies are proposed for technical changes it is essential to understand that markets cannot be relied upon to help create sustainable economic growth unless the environment is priced.

1.4 How does national policy affect local action ?

It is axiomatic that cities need to be more habitable and contribute towards reducing global environmental problems that carry a potentially catastrophic price.

However, even if international agreements can be reached between competitor nations the question remains whether intentions at national level will be reflected through appropriate management and investment decisions in real local market conditions.

The evidence from around the world is that the necessary technical competences exist. It is possible to monitor the energy and environmental performance of urban areas and plan to encourage development in ways that are sympathetic to energy efficiency, sustainable economic growth and environmental improvement.

However, political will and investor behaviour at local level appears to be constrained by uncertainty based on concerns to avoid competitive disadvantage.

Policy guidance and performance targets agreed at national level enable local authorities to set enforceable objectives whereas uncertainty heightens the prospects for inconsistent decisions producing market distortions.

Without clear price signals and guidance on practical land use and infrastructure options national governments cannot reasonably expect the energy market to help local authorities deliver economic developments and environmental improvements.

1.5 What should cities seek to achieve ?

Energy planning has traditionally focussed on maintaining supply but energy efficiency has improved worldwide. However, gains have been outstripped by demand and OECD countries, representing about 20 per cent of world population, now consume about 80 per cent of world energy. People are habituated to reliable, reasonably priced energy supplies and, as 70 per cent to 80 per cent of OECD population live in urban areas, about 60% of world energy use can be attributed to OECD towns and cities.

Urban areas comprise inventories of buildings, services and transport infrastructure. They continue to develop in relatively large increments that are durable and expensive. So, a consistent thread of concern for public and private investors is to work marginally in advance of demand and optimise use of assets.

As energy market conditions and environmental regulations can change relatively quickly, cities need to be robust enough to adapt to forseeable change. They may also need to deal with unforseen change with potentially drastic consequences.

Although there are local variations, across the world energy sources are currently available and cheap. There is no global threat to city dwellers from energy supply failure. However, cities are the main vehicle on which human kind will travel into the deep future and energy market conditions in fifty years time could differ from today. The robustness of cities needs to be considered now so that land use and infrastructure development is sympathetic to energy efficiency.

1.6 Energy and land use planning

The main message from current work throughout the world is that improved energy efficiency is the best available means to achieve economic development and environmental quality objectives. This indicates, not that energy efficiency is a policy but, all policies should be energy efficient in order to reduce the likelihood of conflict between economic, social and environmental objectives.

The evidence is compelling that :-

* sustainable economic growth will depend heavily on more habitable cities that help reduce global environmental problems; and

* achieving such cities will require the harnessing of competitive markets towards meeting performance targets that are widely accepted.

It is also clear that if sustainable economic development cannot be willed it can at least be managed if a concern for the more rational use of energy is reflected in planning policies, collaborative action and information dissemination.

In the face of massive demand for urban development and regeneration replication of established development practices may choke cities in their own pollution and contribute in large measure to disrupting geochemical and geoclimatic cycles.

Energy is required to sustain economic development and maintain the quality of the built environment. However its use is constrained by the effects of energy supply on the quality of the natural environment. Energy efficient cities hold the key to reconciling the economic and environmental goals of society but the energy market will only help to improve the environment through effective urban energy management.

1.7 The way forward

Interest in energy management at the urban level is growing because the local environment in cities need to be improved and the cities can make a major contribution to improving the global environment and reducing per capita consumption of natural resources in an increasingly populated world.

Poor urban environments, polluted air and water, noise, industrial and municipal waste, inefficient energy provision and use affect living conditions of citizens, as well as the profitability of firms which have not yet cleaned up their production process. In addition, and maybe above all, such poor urban environments discourage new investments, new firms, new comers, especially those highly skilled who are attracted by pleasant environments and who influence the location’s and choices of their firms.

This is true for many old industrial cities, but also for expanding cities with weak planning and environmental constraints, where existing and new industrial plants generate traffic, energy consumption and waste. If environmental conditions deteriorate in these cities, it might hinder economic development in the same way as has already been the case in many old cities.

Therefore, private as well as public policies need to include environmental considerations - not as marginal items, but as deeply integrated concerns at all stages. In the same way that safety and social concerns are already integrated in the functioning of all OECD countries.

New public and private urban projects, as well as existing infrastructures, facilities and plants will have to be established or adapted in such a way that they will be environmentally acceptable. This is not only necessary to protect urban citizens but also to protect future generations.

Clean technologies for products and processes affecting cities or being used in cities need to be developed, but many are already available and could be quickly adopted provided that social and environmental costs were properly internalised in the market economy. Consumers pay for the "goods", they should also pay for the "bads". Environmentally conscious urban planning and organisation can provide the right framework for land and other urban "resources" to be used with more attention being given to quality and conservation. In certain fields, like urban energy and transport, it may even mean controlling, or limiting, demand. Space in cities cannot expand without limits on any single activity and cities cannot expand without some minimum planning or organisation.

Overall it is apparent that the way forward for improving the urban environment needs to be based on at least 3 principles:-

* putting a price on environmental damage caused by polluters in cities and including this price in the cost of activities undertaken by these polluters (charges, taxes, fees...);

* adopting comprehensive urban environmental programmes, including better coordination at local level and better integration of environmental considerations in policies affecting cities;

* developing new forms of local co-operation between public authorities, the private sector and local citizens.

Unfortunately existing urban environmental policies tend to be piecemeal and lack comprehensiveness. The integration of environmental considerations into local and national policies is rather limited and so is the degree to which environmental costs are internalised into activities affecting cities.

More "preventive" urban policies are needed to anticipate the urban impacts of technical and socio-economic change in order to offer future generations a more "sustainable" urban environment. It is time, now, to consider an urban dimension to evolving national and international policies which are not specifically urban but which have important urban impacts.

In this regard, minimising the environmental impact of urban energy use is of the greatest importance globally. On one side, over the past 20 years, energy efficiency (energy consumption per unit of GDP) has improved by 25 per cent. On the other side, total energy consumption has increased by 35 per cent in the OECD area and by 60 per cent in the world as a whole.

Depletion of non renewable resources, atmospheric pollution, and global warming cannot be addressed adequately without comprehensive energy management policies for cities. They are the main final energy consumers through transport, housing and economic activities of all kinds. In most countries, cities account to 60 to 80 per cent of the total consumption of energy. To obtain drastic changes in urban energy consumption, mobility needs will have to be limited or even reduced and energy requirements for heating and cooling buildings will also have to be reduced.

Growing public concern about environmental quality means that consensus about the actions to be taken will need to be achieved through better information, demonstration projects and public participation. In addition, conversion to an energy efficient urban society will require much better integration of effort between central government and local authorities.

In a number of OECD cities, one can already observe concrete, positive results. For instance, combined heat and power plants (CHP) have significantly reduced energy demand and pollution. Helsinki, for instance, has set up plants which use steam and hot water for district heating and for co-generation of electricity. The use of this system has resulted in a dramatic decrease in sulphur dioxide levels as well as greater energy efficiency. Fuel requirements are some 30 per cent less than when electricity was generated in a condensing power plant and heating was generated by a boiler in each building.

In Denmark, 50 per cent of heating requirements is met by district heating and 27 per cent by CHP. Before the year 2000, CHP is expected to meet 37 per cent of total heating requirements.

Subsidies play an important part in encouraging the use of "environmentally friendly" energy sources. When district heating was introduced in Helsinki, subsidies made widespread implementation possible.

Once economies of scale were created, further expansion of the district heating system could take place without subsidies.

"Least Cost Energy Planning" is another approach, now adopted in the US to lower energy production costs. It treats energy conservation as an alternative source of energy : a new plant can only be built if it can be shown to be cheaper than conservation and demand management measures.

For instance in Seattle, load management has made less expensive, more efficient energy use possible. Seattle sends power south in the spring and summer for California's air conditioners and receives an equivalent amount in the winter to meet heating requirements.

Many practical measures could be adopted much more widely by cities with better information exchange, better awareness and more appropriate incentives. The diversity of technological, economic and administrative options promise great local economic and social benefits by:-

* stimulating local action, by introducing new services linked to a better energy management policy;

* providing new markets for new technologies;

* shifting resources from imported fuels to demand-side investments;

* creating local jobs in the energy and environment business as well as in the non-profit sector.

Improving energy management at local level will have major positive impacts on cities and at a global level. However, although the case studies point in the right direction, for the time being there are still more proposals and plans than concrete results, with some notable exceptions.

A lot remains to be done to include energy consciousness in urban activities. Most actions are the result of modest, day-to-day efforts. Technologies exist, but willingness is weak.

The most obvious progress is being made in the housing and industrial sectors. The area where almost everything remains to be done is transport. Urban transport will be the bottleneck for energy conservation and, in the end, it might be a hindrance to the mere functioning of cities.

The main lessons to be drawn from the case studies are:-

* there is a need for public consensus concerning a more rational use of energy;

* there is a need for strong political leadership at the local level; and

* there is a need for a much better integration between central and local governments.

But, also, there are three paradoxes:

* how to reconcile economic development and environmental improvement within a democratic system?

* how to increase local freedom and decentralisation, while keeping a strong national framework (through regulation, facilitation, incentives, subsidies, demonstration, etc)?

* how to improve the environment, but not at the expense of equity?

These paradoxes can be addressed by two essential means:-

* using the advantages of both the market and democracy. Planning is needed but, also, incentives and persuasion;

* more intensive collaboration between levels of government and between the public and private sectors.

Future activities relating to OECDs project on "Environmental Improvement Through Urban Energy Management" will comprise workshops on issues including Energy Advice Services, District Heating and CHP, Least Cost Energy Planning, Renewable Energy in Cities and Transport and Energy. The project will end with a conference in Heidelberg (Germany), on 8 and 9 September 94.

This report is based on the proceedings of the first workshop held in Newcastle-Upon-Tyne. Further reports will be written for subsequent workshops and the series will be developed into a handbook of good practice to be published at the end of the project.

Also, in order to reach a wider audience than is possible through workshops an OECD newsletter on urban energy management has been launched. It is issued as a means for cities throughout the world to communicate.

2. ENERGY EFFICIENT URBAN STRUCTURES

2.1 Energy and Urban Development

Security of energy supply and its environmental effects are likely to reinforce each other during the 1990's to provide an unassailable case for the efficient use of energy in all sectors of the economy. Towns and cities are major energy users and will be a major focus for attention.

Land use planning, siting and building regulations will be of considerable importance in urban energy management because energy systems are related in fundamental ways to patterns of land use and the structure of the urban environment. The relationship is complex but its main features are clear.

Land use patterns and the form of the built environment are important determinants of energy demand, especially in relation to transport and space heating (or cooling) in buildings. This influence is substantial: in the United Kingdom, for example, transport and space heating account for well over half of delivered energy needs and it is estimated that as much as 70 per cent of delivered energy may be subject in some way, and at some time, to the influence of land use planning.

Urban infrastructure is relatively permanent, but major uncertainties surround both the global environmental impacts of energy cycles, and future energy supplies. Furthermore, energy market conditions may change more rapidly than land use and infrastructure can adapt.

Neglect of energy considerations in the planning process will mean the continued development of energy-intensive urban areas by default.

2.2 Energy Demand and Urban Structure

The arrangement of land uses and the form of the built environment affect intrinsic energy needs. Urban structure also influences the efficiency with which energy needs can be met, because the technical and economic viability of certain energy technologies and transport systems is affected by factors such as urban density and the location and mixing of different land uses.

In OECD countries, higher levels of car ownership have permitted more dispersed patterns of urban development; these land use patterns in turn require longer journeys for most daily activities and have become increasingly difficult to serve by energy-efficient forms of transport.

The energy and environmental implications of these trends are alarming because predicted traffic growth is likely to outstrip measures to improve the energy efficiency and environmental performance of vehicles.

Sustainable urban development must therefore include policies and measures to reduce the need for movement and to provide favourable conditions for energy-efficient and environmentally-friendly forms of transport. Land use planning policies are particularly important in the attainment of these objectives.

2.3 Movement

Reducing the need for movement

At the urban scale the most important factor is the physical separation of activities. This affects travel needs and, therefore, energy requirements for transport. The lower the physical separation, the lower travel needs are likely to be.

The key variables in this relationship are density and the degree of mixing of different land uses. Many studies show, fairly unambiguously, that as urban density increases, energy use for transport falls.

One way to reduce travel needs would be to bring homes, jobs and services together in a relatively compact urban centre to achieve a high level of accessibility with little need for movement. Higher densities tend to be associated with energy-efficient built forms, and they increase the viability of district heating or combined heat and power systems. But there are drawbacks too: eg. high densities limit the scope to use some forms of ambient energy, such as passive solar power.

There is also concern about the potential loss of urban green spaces, and ’town cramming’, if dependence on the car could be reduced, considerable amounts of land might be released for urban green space and a more compact pattern of urban development.

An alternative to reducing physical separation of activities is decentralising some jobs and services and relating them to residential areas, either within a single large urban area, or to form freestanding settlements which may or may not retain links with the original centre. Studies suggest that if rising energy costs or policy restraints restrict mobility, a pattern of ’decentralised concentration’ will be energy efficient because people will tend to use the jobs and services close to them.

In the UK decentralisation, over the past few decades, has produced suburbs and freestanding settlements with the potential to be self contained, but the level of autonomy typically attained is small.

A relatively robust form involves development in centres large enough to provide access to a good range of jobs and services without the need for long journeys, and with good public transport links to employment and other facilities to offer a viable alternative to the private car.

As well as reducing the physical separation of activities, therefore, land use planning must be integrated with positive discrimination in favour of walking and cycling, making them feasible not only in terms of distance but also by providing a safe and clean environment.

Promoting public transport through land use planning

It is vital that the interactions between land use, travel needs and transport mode are recognised and incorporated into an integrated system of land use and transport planning for urban areas within their regional context.

On the basis of average passenger loads, a bus travelling in uncongested road conditions uses least energy per passenger-kilometre, and a car used for commuting in an urban area the most; rail systems occupy a position somewhere in between.

Therefore, a shift from private to public transport could help to achieve wider energy and environmental objectives. Land use planning has a role in encouraging this shift to take place in the medium to long term.

Relative concentration of homes and facilities maximises accessibility to transport routes and encourages a high load factor. Also linear urban forms are particularly conducive to public transport. This need not mean ’ribbon development’, but could involve, for example, broad bands of urban development combining high densities along a bus or light rail route with moderate overall densities.

Appropriate planning policies for energy efficient movement

These would include discouragement of dispersed, low density residential areas or any significant development heavily dependent on car use combined with some degree of concentration, though not necessarily centralisation, of activities.

Comparative analysis of different structures suggests that energy efficient settlement patterns would consist of small to medium sized settlement clusters. Within settlements overcentralisation of employment and services would be avoided.

2.4 Buildings Energy Efficiency

There are three areas to illustrate the significance of urban form for energy requirements in buildings: the influence of built form on intrinsic energy needs; the effects of design, layout, orientation and density on solar access and other microclimatic considerations; and the influence of urban form, especially densities and the mixing of land uses, on the viability of energy-efficient combined heat and power systems. These factors have often been neglected in planning and building policies affecting the form or urban development.

Built form

Systematic trends towards built forms like terraced housing or low rise flats could result in significant reductions in energy demand. Such a trend would imply generally higher net densities, so there are also implications for the urban scale.

Smaller housing units, often in the form of terraces or flats, are particularly suited to meeting projected household needs, which in many countries are no longer dominated by the requirements of the nuclear family. In the UK, for example, 85 per cent of new households will be accounted for by single people by the year 2001.

Passive solar design

Siting, design, orientation, layout and landscaping can make the optimum use of solar gain and microclimatic conditions to minimise the need for space heating (or cooling) of buildings from conventional sources. It is essential, however, that these factors are taken into account at an early stage of the urban development process when important key factors like road layout are decided: the potential for later intervention or adaptation is limited.

There are some important implications for urban design arising from the advantages of a north/south building orientation and the need to avoid overshading, which in turn affect layout and development density.

Passive solar design does not require unattractive repetitive layouts and/or very low density housing. Advantage can be taken of solar gain with up to a 30 degree variation from a north/south axis, and with attention to layout and orientation, 80 per cent of the maximum possible savings can be achieved in passive solar houses on real sites with densities of up to 40 dwellings per hectare. (Densities of new private sector development are typically around 25 dwellings per hectare).

The most significant constraints are likely to be the size and shape of some urban infill sites, which are often developed to higher densities and where overshading by existing buildings may limit the scope to choose appropriate orientation and layout for exploitation of passive solar energy.

Microclimate considerations

Attention to microclimate can reduce heat loss from buildings in a number of ways, for example by controlling wind speed and by raising external ambient temperatures. Measures include the use of materials that are appropriate to the circumstances of use, attention to building layout, landscaping and the planting of shelter belts of trees. Savings might be of the order of at least five per cent and perhaps considerably more on exposed sites. Considerations would also influence the location of new development (avoiding very exposed sites, for example), but in most urban areas where land is scarce, the important requirement will be to make the best use of microclimate on sites selected for other reasons.

Combined heat and power systems

Combined heat and power (CHP) provides a clear example of an energy technology which is not equally viable in all forms of urban development. CHP systems provide both electricity and hot water and are highly (up to 80-90 percent) efficient in their use of primary fuel. Hot water is distributed to buildings through a system of pipes forming a district heating network. The implications for urban development arise mainly from the need to lay a heat distribution network in urban-scale schemes. Density, built form and the mixing of land uses are all important variables in this context.

Ideally, urban areas to be served by a CHP system should be relatively dense, mixed, on a reasonably large scale and capable of being reached by heat mains without significant disruption elsewhere in the urban system. Conditions are less stringent if heat networks can be installed at the time of development or redevelopment.

Where new development is planned which might be connected to an existing or future district heating network, consideration needs to be given to all of the above factor. In general, the factors which will facilitate the introduction of CHP at some stage are moderately high densities, built form which helps internal routing, linear layout, and mixing of land uses.

Development of CHP will also lead to a requirement for sites for urban power stations. Land requirements for typical schemes will be relatively small. For example a combined cycle gas turbine CHP station may only require one or two hectares of land to accommodate the main and ancillary buildings. Incoming gas supply and outgoing heat and electricity circuits will normally be laid underground and there may be opportunities to recycle otherwise derelict or difficult to use sites. Urban planning authorities need to be aware of potential siting requirements when they formulate land use plans.

Appropriate planning policies for buildings energy efficiency

Different energy supply systems can have different requirements in terms of urban structure. In order to achieve energy efficiency it is important to integrate land use and energy supply planning. Ideally, urban development and redevelopment should be planned from the outset to be structurally compatible with a desired energy supply and conservation strategy.

With full co-operation between urban planning authorities, developers and energy utilities (especially if the latter have adopted 'least cost planning'), urban areas could be planned to accommodate the most efficient combination of energy supply systems and conservation measures.

The planning of new development should aim to facilitiate the best possible combination. Where constraints prevent the most efficient supply systems from being installed, particular emphasis could be given to built form and to standards of thermal insulation.

Where land use planning and planning for energy supply are largely separate processes, apart from consultation procedures, there may be considerable scope for policy initiatives to promote integration.

2.5 The need for action

The evidence from theoretical studies and illustrative case studies is that energy-efficient urban structures could result in substantial energy savings in the longer term. Table 1 indicates the extent to which action in particular policy areas could produce positive effects.

In summary, the characteristics which emerge most consistently from the different approaches to identifying energy efficient forms are compactness, integration of land uses, and clustering of trip ends, together with at least some degree of "autonomy" or "self-containment" at the suburban scale.

Table 1. Influence of urban form on energy demand

Land use variables	Mechanism	Energy implications
Combination of land use factors (shape, size, interspersion etc).	travel requirements (esp. trip length frequency)	variation of up to 150 per cent
Interspersion of activities	travel requirements (esp. trip length)	variation of up to 130 per cent
Shape of urban area	travel requirements	variation of up to 20 per cent
Density/clustering of trip ends	facilitates economic public transport	energy savings of up to 20 per cent
Density/mixing of land uses/built form	facilitates CHP	efficiency of primary energy use improved by c.100%
Layout/orientation/ design	passive solar gain	approx.12% energy saving in cool temperate conditions
siting/layout/ landscaping/materials	optimise micro-climate	energy savings of at least 5% more on exposed sites.

The figures suggest that transport energy requirements might vary by a factor of two or three, and space-heating requirements by a factor of two, between the least and the most efficient spatial structures. Taking the first and smaller set of figures implies that a society with a very inefficient spatial structure which used 16 per cent of its primary energy for transport and 50 per cent for space heating, could expect to reduce its overall primary energy consumption by about one third if it were possible to change to energy efficient land uses and activity patterns.

2.6 Criteria for success

The success of energy-integrated planning and development could be measured in terms of the extent to which it helps minimise the cost of meeting the social and economic needs of urban areas, where 'cost' includes the environmental externalities of urban energy consumption.

Energy-conscious land use planning, siting and building regulations could contribute directly to this objective by:

* **Reducing energy demand** (or the rate of growth of energy demand) by minimising energy required to fulfil other needs (such as warmth and access to facilities), and improving the viability of energy-efficiency technologies and transport. Units of measurement would be energy or money.

* **Reducing environmental impacts** at all scales. This will be closely related to reducing energy consumption. Some impacts may be quantified in physical or monetary terms; in other cases this is unlikely to be possible and a more qualitative assessment will be necessary. Models are now available which can predict the environmental impacts associated with particular policy options (see chapter 4). Powerful analytical tools might be developed by combining energy/environment models with land use/transport models which produce, as an output, the energy demand associated with different urban development patterns.

The long time scales involved make it very problematic to isolate the influence of urban structure from that of many other variables determining urban energy demand. However, energy-conscious development policies may be successful in terms of their congruence with non-energy objectives, for example the promotion of 'healthy buildings', the need to combat fuel poverty and the reduction of traffic congestion.

Perhaps even more significantly, land use planning and building policies can help to raise consciousness about energy use and thus contribute towards a lasting change in attitudes and philosphy towards energy efficiency.

2.7 Factors in good energy planning practice

Comprehensive urban energy management, incorporating land use planning, siting and building regulations is still the exception rather than the rule. Where it is being achieved, however, there is a commitment to energy management. If good practice is to become widespread this commitment must be reflected at all scales so that achievements in specific locations are not undermined by developments elsewhere.

Leadership, some experience of energy crisis and public participation all seem to be important factors that have influenced leading towns and cities :-

* Strong leadership by senior elected officials on behalf of the programme, who were willing to assume a degree of political risk by altering the traditional agenda;

* An extensive participatory process serving to legitimise the issue in the eyes of the electorate;

* A relatively greater tradition of open government and local resource management; and

* "Energy crisis" factors such as resistance to plans for new nuclear power stations, the effects of the 1973 oil embargo, gas shortages and hydroelectric shortages due to drought.

Less dramatic, but perhaps more durable, is the growing public concern about the quality of the local and global environment. A recent survey of local planning authorities in the UK revealed heightened awareness of the links between energy, environment and land use planning and an intention to adopt more energy-conscious planning policies.

2.8 Medium term options

What is required for implementation is information dissemination, political will and policy co-ordination. This is particularly true for action at the building/neighbourhood scale, involving:

* measures affecting individual buildings, such as insulation (which have not been discussed here, but are clearly essential);

* siting and other microstructural factors in relation to microclimate;

* design to maximise use/efficiency of particular energy sources (eg district heating network or passive solar energy).

Mechanisms to put these principles into practice are not always established; for example, in the UK considerations relating to building orientation are covered by neither the planning nor the building regulations, and establishing urban-scale CHP has been difficult.

At the wider urban scale it must be accepted that there will never be total certainty about the effects of particular policies on energy consumption because much depends on variables (such as the propensity to travel) which are inherently difficult to predict. The available evidence suggests that authorities responsible for land use planning in urban areas should:

* Make the efficient use of energy resources an explicit goal of land use development plans;

* Consider the energy implications of alternative policy options in plan preparation;

* Make energy efficiency an explicit consideration in urban planning policies. This is likely to mean:

  - mixing of land uses at a scale which provides a reasonable choice of jobs and services;

  - a positive attitude to higher densities in appropriate locations (for example, along public transport routes), subject to high standards of design;

  - avoidance of dispersed development;

  - avoidance of dormitory development in suburbs or new settlements, especially where these are unrelated to public transport facilities;

  - location of employment areas and service facilities where these are not dependent upon access by car, or likely to generate significant numbers of additional car-based trips;

  - provision of every facility to encourage walking and cycling, discriminating against cars wherever there is conflict;

* Adopt a positive attitude towards environmentally-benign energy sources, subject to full assessment of the environmental impact of any specific proposals;

* Engage in early discussion with energy suppliers with a view to achieving the optimum combination of supply facilities and efficiency measures in new development;

* Seek a better understanding of patterns of energy consumption within the urban area, and monitor the influence of energy-related policies in the urban plan;

* Co-ordinate transport investment priorities to achieve strategic objectives for increased energy efficiency.

2.9 The long term

In the long term the key objective must be the development of environmentally-sustainable patterns of urban development. To achieve this, it will be necessary to conduct environmental/energy assessment of urban plans and policies.

Greater integration is essential - integration of land use and transport planning, and integration of the planning of the built environment with that for energy supply and conservation. Institutional change is likely to be necessary in many urban areas to achieve genuine integration of energy considerations into the urban development process.

Finally, it must be remembered that energy-conscious land use planning, siting and building regulations are necessary but not sufficient conditions for the improvement of urban energy efficiency. They must be set within the context of urban, national and international policy frameworks employing the full range of policy instruments - public investment, information, fiscal measures and regulation. Policies need to be integrated both 'vertically' and 'horizontally' if they are to achieve the desired aims.

It is within this wider framework that land use planning, siting and building regulations have a significant role in urban energy management. But a policy package designed to achieve an environmentally-sustainable urban energy system in the longer term would be incomplete if urban planning proceeded to ignore the opportunities to reduce energy consumption for travel and within buildings. When a range of policies is employed to achieve the same objective, the whole is likely to be greater than the sum of the parts.

3. URBAN ENERGY MANAGEMENT CASE STUDIES

3.1 Mainz, Germany

3.2 Helsinki, Finland

3.3 Gothenborg, Sweden

3.4 Newcastle-Upon-Tyne, UK

3.5 Portland, Oregon, USA

3.6 Rennes, France

3.7 Schiedam, Netherlands

3.8 Torino, Italy

3.1 MAINZ, Germany

Mainz is in the Land (State) of Rheinland-Pfalz and in the planning region of Rheinhessen Nahe.

Building and zoning in Mainz is very expensive. High density is a necessity, which is positive in terms of ecological intentions and energy concepts. New zoning which borders existing housing areas is difficult to achieve. This means that new development happens a long way from the centre of town. Zoning plans and other strategies aim to increase ecological planning and development in addition to the reduction of energy-use in buildings.

Town Planning should remain flexible in order to respond to future change e.g. wider use of solar cells, 'wintergardens' on the south-side of the houses etc. However, there will be conflicts between a rational form of land use, solar gain and other town planning considerations.

Institutional framework

In Germany zoning plans are part of city law and are binding for everybody (e.g. Zoning plan B 50/1 in Mainz). These plans take account of climatic considerations, for example in regulating the orientation of buildings. The plans also take account of the loss of ecological value caused by development and hard surfaces. For the town centre there are detailed regulations for dealing with excess heat.

Fact file

Population and developed density

Area (1992)	97.75 km^2
Settled area (1992)	37.85 km^2
housing area (1985)	25.20 km^2
business area (1985)	7.80 km^2

Population (1987)	175.000
Households (1987)	90.500

There are about 50% single person households.

Housing

Dwelling-houses	25.070
Other Residences	86.980

Tenure:

Condominiums	23.9%
Rental apartments	76.1%

There is an average of 2.02 persons per unit.
660 new housing units were completed in 1990.

Employment

employment rate 1987	45.4%
Employed people	111.800

Jobs and employees in the retail business is slowly declining but are increasing in the service sector. Manufacturing represent about 11 per cent of employment, ’blue-collar’ services 34 per cent and ’white collar’ services 54 per cent.

Traffic data

Cars and caravans have increase by 31 per cent in 8 years. In 1990 there were 488 cars per 1 000 inhabitants in Mainz and there are 53 000 business commuters to Mainz each day (65 per cent increase in 17 years). The share of public transport is 21 per cent.

Total traffic volume per work-day is 500 000 journeys.

Climate

The climate in Mainz is characterised by warm summers and mild winters, prevailing winds are westerly and average rainfall of about 500 mm. The average annual mean temperature is about 10^{o} C. The climate of Mainz in comparison to its suburbs is marked by thermal- and hygro- anomalies. The usual ’heat island’ is found in the centre with a temperature about 1.4 per cent higher than the suburbs. The centre suffers from smog, humidity and harmful air pollution and in summer these factors together with heat, cause health problems. Micro-climatic problems are increased by its position on a river.

Energy and land use planning

Emissions

Due to the installation pollution control devices in industry and a reduction in the sulphur limits in heating oil, Mainz/Wiesbaden has experienced a reduction in harmful emissions, especially SO_x, NO_x fluoride, lead and dust. However about 25 per cent of CO_2 emissions are caused by traffic which is increasing.

Energy use

Space heating in Mainz uses 37 per cent of the total energy supply. Only 60 per cent of space heating is now provided by oil and coal, which lowered to 60 per cent in 1982. Mainz is shown with a thermal radiation of more than 23 W/m^2. In comparison, the surrounding area of Mainz shows an average of 1 W/m^2.

This unused energy is an economic problem. In Munich the year-round energy loss of thermal emissions is 125 million DM. Therefore, the expanded use of pipe-connected energies and the use of waste heat produced in the production of electricity are important in Mainz.

In all new zoning-plans, only pipe-connected energies, mostly community-heating and gas are considered acceptable. Through statutes, house owners can be forced to use these energies sources. At the outset of the development of the suburb Lerchenberg, this statute was enforced, and 80 per cent of the households were connected. The switch from oil to gas can create a noticeable reduction of emissions (example of statute B 50/11).

Energy supply

Since the mid 1970s Mainz has produced 94 per cent of its own energy demand. The proportion of pipe-connected energy supply increased from 17.5 per cent in 1974 to 39.9 per cent in 1982, with a resulting decrease of 4 700 t/a air pollution. It is hoped to increase this energy supply to 50 per cent in 1992 mainly through natural gas and community-heating.

The energy supply of Mainz in 1989:

Gas	3.232.7 GWh
Electricity	2.834.7 GWh

The natural gas network expanded twelve-fold between 1970 and 1985. Mainz is trying to achieve 9.9 per cent community-heating by 1992 which is low in comparison to other towns (e.g. Saarbrucken: existing 12 per cent, planned 24 per cent).

Transport policy

Mainz has a general programme for traffic including public transport (park and ride, cycle tracks etc.). A current project is considering the reduction of air pollution caused by traffic. This project involves research on legal possibilities for reducing cars and trucks when certain levels of pollution are exceeded (which happens from time to time).

Energy planning

An energy planning study group led by the town-planning bureau and including all relevant municipal departments studies energy efficient construction and brings all relevant experts together. The group has published a report concerning passive solar use, heat saving above that required by law, choice of building materials, building techniques and improvement of the micro-climate through planting.

District heating

The first goal is to increase the percentage of pipe supplied energy. In all newer zoning plans only pipe connected energy is considered (mostly gas or community heating). There are some areas where district heating is enforced. In one town, 80 per cent of households are connected with community-heating. Changing CHP plant from oil to gas has helped to reduce emissions.

Planted space

Almost 10 000 square meters of open space have been planted in Mainz to a high ecological value to make up for the harm done by 280 new dwellings.

Planning requirements indicate ways to arrange trees and bushes so that they do not hinder natural ventilation in buildings. The negative environmental effects of hard-surfacing can be counteracted by ensuring that there is protected and protective farmland and trees to the north of the development. The green area can be protected by the requirement for investors to buy a share of the green area, according to the size of his building site. This means that the protection of the micro-climate will eventually be in private, not public, hands. Many investors see the complicated regulations as too rigid, and these may be withdrawn on appeal. However, without these regulations this plan would never have passed through public and political discussion.

Geographic Information Systems

Mainz is using Geographic Information Systems (GIS) to evaluate qualitatively and quantitatively the results of zoning. The method uses EDV and air-photographs. Planning goals were defined through density readings of economic aspects. The system will make it possible to give greater weight to ecological and environmental aspects in new zoning plans, since calculation and use of characteristic values in this sector are possible. The characteristic values are defined by the relationship between negative environmental aspects (for example sealed or built-over areas) and the positive environmental aspects such as areas of vegetation. During the planning phase these characteristic values can be considered by prognoses (for example planned density, percentage of sealed areas, planted roofs and the volume of bushes and trees).

Housing developments

All houses, without exception, are orientated north-south (for better passive solar use). Landscaping and housing are linked together by building, noise pollution barriers and green structures. This is possible by building the house close to, and almost into, the noise pollution barrier. The scarp of the pollution barrier ends directly where the planted roofs of the houses start. Only deciduous trees are acceptable, so that in winter these trees do not block the sunlight, and in summer they give shade to the south exposed windows. A special statute regulates the duty to connect the whole area with district-heating. Sewage is disposed in a duo system. Two open, naturally designed ponds contain the harmless water from roofs. These ponds improve the micro climate.

No through-traffic is permitted.

Business developments

A recent design for a serviced business area took into account climatic aspects at the planning stage (in particular a cool air stream). Air-aisles and height restrictions in the new development were design tools used and energy supply is limited to district-heating. Offices have planting against walls and planted roofs in order to minimise the need for increased space heating caused by the cold air streams.

Energy efficiency and buildings

With respect to design, Mainz’ planning system includes many regulations except relating to the construction of dwellings, where there are some regulations relating to the conservation of heat and power. The planner can only give good advice, show positive examples in terms of planting, energy considerations and volume of the building. CO_2 emissions in a well-planned low energy house can be reduce one fifth compared to an average oil heated building.

Planted roofs will soon however be strictly enforced by regulations for new or refurbished roofs larger than 20 square meters up to 15 degrees. This helps to prevent energy waste as well as having a positive influence on the micro - climate and noise pollution. Soil on those roofs has to be between 6 to 12 cm. Methods are explained in the regulations and can be clarified by the planner.

Continuing Vocational Education

Seminars for architects and developers can have an impact on energy saving, despite the limited power of planning in this field.

3.2 HELSINKI, Finland

Institutional framework

Local master plans and detailed plans are prepared by four municipalities. The plans are approved by the municipal councils. Plans need to be sanctioned by the Ministry of Environment. Transport operators and energy supply utilities give statements to authorities. Building standards are given by the state authorities.

Fact file

Population and housing

	Helsinki	HMA*
Population	490 872	820 755
Households	239 449	366 408
Average household size	2.05	2.24
Dwellings	250 000	370 000
Tenure		
- owner-occupied	53%	58%
- rented & other	47%	42%
New units p.a.	4 500	8 000

***** HMA: Helsinki Metropolitan Area

In Helsinki the population has increased by 1.5 per cent and in the Helsinki Metropolitan Area by 8.8 per cent during the past 10 years. There will be growing immigration from Russia, Sweden and other countries to the Helsinki Metropolitan Area.

Employment

	Helsinki	HMA*
Economically active	370 000	526 000
Manufacturing	12%	14%
'blue collar' services	38%	39%
'white collar' services	48%	47%

The growth sectors have been services and finance, insurance etc.. Employment in manufacturing has declined while construction, trade, hotels, restaurants, transports and communications employment has remained more or less the same.

Transport

In 1990 there were 315 cars per 1000 inhabitants in the Helsinki Metropolitan Area. The total number of trips per day is 1.8 million in the Helsinki Metropolitan Area. 39 per cent of trips are made by public transport and 61.8 per cent by car. The share of public transport has been constantly declining.

Climate

Helsinki is situated on the Baltic Sea at 60 degrees N latitude. The mean temperature in February is -6.2 degrees centigrade and 5.2 degrees centigrade annually. Because of the Gulf Stream the climate in Scandinavia is warmer than elsewhere at these latitudes.

Energy management and land use planning

Urban planning and design solutions can be used to minimise energy costs and related emissions. Overall density of urban areas and location of housing relative to work affects solutions for infrastructure including public transport. The trend in Helsinki is to infill urban areas instead of creating new settlements. Thus longer journeys to work can be avoided and also the associated emissions.

Energy use & emissions

Energy represent about 40 per cent of all urban costs in Nordic conditions and in Finland almost 60 per cent more energy is consumed per inhabitant than in the UK, France or Switzerland

Fuel	***Consumption (*)***
Coal	*1 849 000 tonnes*
Light oil	*147 000 tonnes*
Heavy oil	*87 000 tonnes*
Natural gas	*14 863 000* m^3
Bio-gas	*461 000* m^3
	(*) Transport excluded

Sector	***GWh***	***%***
Residential	*8 451*	*38.0*
Commercial	*4 947*	*22.0*
Industrial	*1 696*	*8.0*
Transport	*6 923*	*32.0*
Total	*22 017*	*100.00*

Emissions in the Helsinki Metropolitan Area

Emission	SO_x tonnes (%)	NO_x tonnes (%)	Particles tonnes (%)
Source			
Energy production	18 900 (86)	17 500 (56)	2 000 (62)
Other point sources	1 900 (9)	500 (1)	200 (5)
Area sources	500 (2)	n.a.(-)	n.a. (-)
Traffic	650 (3)	13 200 (42)	1 100 (33)
Total	21 950 (100)	31 200 (100)	3 300 (100)

n.a. - not available

Carbon dioxide emissions from cars in the Helsinki Metropolitan Area represent 50% of all transport-related CO_2 emissions.

Opportunities and barriers

Public transport is favoured by traffic planners. The number of public parking places in the Central Business District area has been reduced. Otherwise, consumer choice is not restricted.

The environmental office continuously measures impurities in the air at fixed measuring stations and at mobile units in the Helsinki Metropolitan Area. The latest technology is used for detailed analyses.

The share of public transport has declined. Growing traffic generates more pollution and noise. The air quality in Helsinki is getting worse and Helsinki is not moving toward sustainable development.

The Helsinki City Planning Office has suggested road tolls, streets for trams and buses, lower downtown speed limits, pedestrian streets, and other measures to change the modal split. However, local politicians do not agree. Some politicians do not fully comprehend the magnitude of these problems so they vote against them in city councils.

Utilities have a lot of expertise but their targets differ from society’s targets. What is good for the power industry is not necessarily good for society.

Too many parties in The Helsinki Metropolitan Area are involved in the planning process. For example the following have an active role: the four cities, the Roads and Waterways Administration, The Regional Planning Authority, The Ministry of the Environment, The State Railways, and The National Board of Civil Aviation. Private land-ownership guides land use in a way that is not always beneficial to society.

All critical decision making should be concentrated in one organisation that would decide about all land use and planning in The Helsinki Metropolitan Area.

New initiatives in transportation modelling and policy

Because of the problems outlined above, the Helsinki Metropolitan Area Transportation System Plan (TSP) has been devised to improve the quality of life, stimulate economic life in the Helsinki Metropolitan Area and to further the development of Helsinki as the capital of Finland.

The outcome of the TSP will be a plan that covers all modes of travel. All parties, the state and the four cities in the Helsinki Metropolitan Area, are broadly in agreement with the plan which includes a list of all the investments made in main streets and in the transit system and a list of other possible measures (road tolls, taxes related to traffic etc.) that affect the whole transportation system. Though the TSP covers only the Helsinki Metropolitan Area, external traffic will be taken into account too. The plan covers the period from the present to the year 2020.

In 1992 a specific project will introduce a plan for the transportation system. The plan will be approved in the beginning of 1994. The budget of this project is 700 000 ECU.

The planning project involves consultation as part of the process The project is divided into four sub-projects of which the "transportation system 2020" is the main project and will be complemented by the results of the other three sub-projects. The aim of the project "Vision 2020" is to study the interaction of land use and traffic and to criticise, strengthen and guide the land use set in the Master Plans. The third project "Decision Making" aims to improve the decision making concerning the regional traffic investments. The fourth project "Finance" is set to secure the financing of those investments.

Planning scenarios

Four scenarios have been produced of land use and transportation system in the Helsinki Metropolitan Area in 2020. Two common factors in all scenarios were the growth in the regional centres and the higher costs of driving a car in the year 2020. Otherwise the four were all different regarding land use, population and GNP growth, etc.

The first scenario was called "The Free Market Economy". The population increase was assumed to be 100 000 inhabitants and the increase in the number of jobs 50 000. Some of the new inhabitants would reside in the cities surrounding the Helsinki Metropolitan Area. Open space and countryside would be developed. Only the Master Plans would control land use and detailed plans would no longer be prepared by the municipalities. The motto in this vision was "You can live anywhere you like to choose any mode of travel you like, as long as you can pay for it". The state and the city would not regulate the free market economy in any way.

The second scenario concerns rail transport. It was assumed that the population increase will be 230 000 and the increase in the number of jobs will be only 16 000. There will be a growing immigration from Russia and other countries to the Helsinki Metropolitan Area. This will lead to very high unemployment. New housing will be developed along railway corridors. The main mode of transport as far as the newcomers are concerned is public transport.

The third scenario was ’Zero Growth’ based on assumptions that the population and the number of jobs would remain at present level. The structure of the population would change because the number of pensioners will increase by more than 50 per cent. There would be few resources for investments in traffic and building. The principal objective of this scenario was to accomplish sustainable development by having a balance between jobs and dwellings so that vehicle mileage would be minimised. The existing city structure would be developed. Main modes of travel would be public transport and non-vehicular modes.

The fourth scenario was "The Pro-environmental Alternative" with the objective of sustainable growth. The population would increase by 100 000 - 200 000 and the number of jobs by 100 000 - 200 000. New jobs and services would be located near within walking distance of railway stations. Heavy investments would be made on the transportation system.

The population was divided into different categories according to the different steps of the modelling. The most important categorisation was the division according to a person's access to a car. Destination choice models included 117 alternative destinations to obtain the number of trips by mode of travel and by class etc.

Analysis

First the data on the transportation system of each scenario was analysed by the program EMME/2. The land use data was put in a form used by the traffic models.

Traffic forecasts were then made using the traffic models. Sophisticated models were developed based on the data gathered in the Helsinki Metropolitan Area Traffic Survey of 1988.

The model structure was basically a four step model with feedback between the last three steps. Trip generation was calculated using production and attraction rates.

Trips were divided into four categories according to trip purpose (home-based work trips, home-based school trips, other home-based trips and non-home-based trips). Four alternative modes were included in the mode choice models. The transit mode was divided into tram and heavy rail.

The traffic forecasts were first analysed by traffic planners at the Helsinki Metropolitan Area Council. Then the environmental effects of traffic and traffic safety were analysed by a consultant. The thorough studies done previously by the Technical Research Centre of Finland and the National Road Administration formed the theoretical basis for this analysis.

A fully computerised analysis was then made using the results of the EMME/2 assignments (speed, traffic volumes, etc.) and additional information (the percentage of vehicles equipped with catalysts, the share of heavy traffic, saturation, etc.). As results data was obtained on, for example, the number of dead and injured people in traffic accidents, emissions (CO, organic compounds, NO_X, CO_2), noise zones, energy consumption, level of service, operating costs, etc.

3.3 GOTHENBORG, Sweden

During the last two decades the demand for fuel oil in Gothenburg has been reduced considerably and the district heating and natural gas systems have expanded. Industrial waste heat, large heat pumps, waste incineration and natural gas have replaced fuel oil in the district heating production mix. Many single family houses have also changed from heating based on oil to electrical heating. The overall specific energy demand for heating has been reduced as a result of energy conservation measures. As a result of these changes the emissions from the energy sector in Gothenburg have been reduced drastically. Emissions from traffic have however remained on a high level.

In this case study we will focus on the municipal planning process which deals with physical planning in parallel with energy planning, with the aim of the two being complementary.

Institutional framework

The smallest political unit in Sweden is the municipality. Compared with corresponding units in many other countries it has an important position in community planning. This is related to its right to taxation and its monopoly in terms of physical planning, thus controlling the location of settlements.

Through the Planning and Building Act (PBA), the Municipal Energy Planning Act (MPA) and the Natural Resources Act (NRA), municipalities have become responsible for the maintenance and improvement of the built and natural environment. An important factor in addition is the decision by the Swedish government to phase out nuclear power by the year 2010.

Fact file

Population & housing

	Gothenburg	Conurbation
Population	433,000	731 000
Households	210,000	
No. of dwellings	227,000	
Tenure:		
-owner occupied	30%	
-municipal rented	30%	
-other rented	40%	

The current building rate is 1,500 new units per year. Gothenburg is still the national centre of transportation and wholesale trade. Private services related to the manufacturing industry have expanded substantially since 1980. Changes in the industrial structure have "re-moddeled" the development of the city. Central and semi-central areas have been developed or re-developed for services.

Climate

Gothenburg is a coastal municipality situated at the mouth of a river. Its climate is northern temperate.

Energy and land use planning

The Gothenburg energy plan

In Gothenburg the municipal energy planning has been organized by a committee, "The Energy Group", with representatives from different municipal administrations responsible for energy related issues. The municipality-owned utility Goteborg Energi AB and the real estate board have been responsible for the majority of the analysis and considerations forming the basis for the energy plan, which includes:

* the present situation.

a fairly detailed analysis of the present use of energy in different areas, and data about emissions

* the energy future.

future trends and changes in systems

* goals.

for the future energy system and emissions

* means

legal instruments, advisory service, tariffs and actions in controlled by the municipality.

*action programme

physical planning, efficient use of energy, supply of electricity, reliable energy supply and district heating production, for example: physical planning and district heating production.

Energy use and emissions

The estimated energy demand in Gothenburg is shown in the following table

Category	GWh/yr	%
Heating (R & C)	5 200	35.0
Industry	6 000	38.0
Electrical appliances	1 800	12.0
Transport	3 000	17.0

***** R & C = residential and commercial

In addition to national goals for SO_x and CO_2, the municipal council of Gothenburg has decided that NOx emissions from traffic shall be reduced by 55 per cent from 1980 to 2010.

	EMISSION		
	Sulphur	**Nox**	**Co2**
Sector	**%**	**%**	**%**
R&C*	**46.0**	**18.0**	**25.0**
Industry	**50.0**	**16.0**	**39.0**
Transport	**4.0**	**66.0**	**36.0**
Total	**100.0**	**100.0**	**100.0**

***** R & C = residential & commercial

The environment and health protection office in Gothenburg has installed a computerized air quality surveillance system to monitor air quality. The Gothenburg ’Airviro System’ is, or will be, used for:

planning purposes. It is important for city planners to have answers to questions like eg. What will be the consequence for local air quality and emissions if we build a new through road or change the traffic situation?

follow-up. The system is used for follow-up i.e. validating the actions that have been taken to improve air quality in the region.

air quality surveillance. General air quality surveillance is made, including special applications as tracking pollution from specific and large polluters.

general knowledge. The system is used for raising the level of education and knowledge concerning air pollution problems.

short term forecast. Predictions of air quality will be made for 12-24 hours. This information will be used for warnings and recommendations to the public.

Energy planning tools

The city planning authority has developed energy planning tools. Although the need for such tools decreased due to reduced intensity in development, they will regain importance if the intensity of development is increased. The "energy index" and the "central vs peripheral" tools are described here.

Energy index

This makes it possible to calculate energy demand as a function of where the building is situated (by the sea, in a valley, in the city centre, on a hill etc). The energy index is a number varying with energy demand. The reference number 100 corresponds to the conditions in the central part of Gothenburg. The divergence from this number shows how much more or less energy for heating is needed for a house situated elsewhere. The index is based on an average of how a number of key factors affect energy demand in seven different types of houses. The energy index is 100 for the central part of the city and varies between 100 and 135 throughout the city and it is clear that exposure to the wind creates a higher energy demand, all other factors being equal.

City structure - central or peripheral -

This deals with both dwellings and offices/industry, and total demand for travelling (not only commuting). Four development scenarios were calculated; central or peripheral dwellings combined with central of peripheral offices/industry. All scenarios were based on an average 10 year development volume.

Dwellings and places of work should be located in an "energy efficient" way. An unsuccessful localization pattern causes longer travel times and larger energy consumption. However, different factors have a tendency of equalizing the differences. A difference of 5-10 per cent in energy demand can be the result of structure alternatives.

The most central localization of both dwellings and offices/industries is preferable. The important thing is not how to use the central parts of the city, but that they are used. If there is a choice, dwellings should be given priority at the available central sites.

In general, land use policies should:

- localize buildings in a way that simplifies supply of energy
- aim at placing buildings at climatically protected sites
- test new energy technology
- prepare for alternative forms of heating e.g. CHP

Regional co-operation will be investigated and new municipal sector programmes, e.g. the housing programme, are important pre-requisites for energy planning.

District heating

New energy sources were introduced, e.g. industrial waste heat from one of the refineries and large heat pumps using cleaned sewage as heat source. Natural gas and coal were also introduced as supplementary fuels, largely as a consequence of the changed district heating production mix. Emissions from heating production in the city were drastically reduced, by about 80 per cent between 1973 and 1989. Taxes on fossil fuels have increased steadily, which has made for example biomass more competitive. A conversion of heating plants from coal to biomass has been tested.

Efficient use of energy

Efficient use of energy, both national and in Gothenburg, was initially concentrated on heating, and especially reduction of the use of oil. The responsibility for this was held by special energy conservation staff within the real estate department of Swedish cities.

Goteborg Energi AB is carrying out a number of studies in cooperation with Stockholm and Malmoe to increase knowledge, to create prototypes of new practice technical solutions and to market their services to potential customers. The following are examples of projects:

schools: the technical and economical potential for energy efficiency improvements will be identified.

multi-family houses: this project is concentrated on improving the knowledge of efficient use of electricity in multi-family houses. The study comprises 800 flats owned by a municipal housing organization.

energy advice: an energy advisory process connected to the building permit procedure is investigated together with the city planning authority.

quality assurance: a standard plan will be promoted on how to achieve all important qualities related to energy use, e.g. indoor climate and lighting.

efficient exhaust air heat pumps: improvements in heat pumps associated with mechanical ventilation installations will be developed and recommendations made to users.

efficient use of electricity in office buildings:

"The St Jorgen Environment Project". A number of areas of the municipality will be investigated to consider rational use of natural resources and giving priority to the use of renewables.

Municipal garbage

Municipal garbage has been incinerated in a large plant in Gothenburg since 1972. This plant uses garbage from 9 communities in the Greater Gothenburg region. This reduces the volume of waste going to landfill and utilises the energy content of the waste. 20 per cent of the Gothenburg district heating production comes from this source. Stricter emissions standards have led to large investments in flue gas cleaning.

The capacity of the waste incineration plant will now be increased by 30 per cent since waste volumes are increasing every year. Incineration is also an attractive alternative for landfill disposal of combustible building waste which can be stored for incineration at peak demand times.

Waste heat/renewables:

Two of the four main oil refineries in Sweden are situated in Gothenburg. From one of these, large qualtities of waste heat is used for district heating. This was introduced to decrease the use of oil for heating and to lower emissions in the city.

Heat pumps using cleaned sewage as heat source are common in Swedish district heating systems. This has been possible as a consequence of the low electricity prices in Sweden. Large heat pumps are also used in Gothenburg, producing 20 per cent of the district heating. If electricity prices increase as expected, these will be used less in the future. Individual heat pumps using other heat source, e.g. exhaust air and ambient air, have also been introduced.

Wind energy is produced by a 750 kW wind turbine in the Gothenburg harbour area. A decision has recently been taken to build a wind farm consisting of smaller wind turbines in the community.

Transport Policy

In Gothenburg there are 380 cars per 1000 in habitants, which is below the national average. The average traffic movements per day are estimated at 11.5 million person kilometres, of which 80 per cent relate to private transportation and 20 per cent to public transportation. Using 1960 as a base, the number of trips by public transportation is approximately constant, while the number of trips by private cars have increased by 200 per cent.

The main goals for transportation planning in Gothenburg are mobility and accessibility. Of the factors limiting the possibilities to fully reach these goals, the following priority order has been established:

1. Safety 2. Emissions 3. Resource conservation

Large investments in public transportation have been discussed for some time, and different systems are being evaluated, but no major decisions have yet been made. Gothenburg has a goal of 10 000 electric cars in the city in the year 2000.

Episodes of inversion occur in Gothenburg, especially during autumn and winter. This, in combination with emissions leads to "smog". An important part of the emissions comes from traffic. As a method to reduce the risk for "smog", it has been suggested that all private traffic in the city should be banned. Swedish communities have been given the right to do this, but none have implemented it to date.

3.4 NEWCASTLE UPON TYNE, UK

Institutional framework

In the UK at present, land use and transportation planning is a discrete activity which has no formal connection with any form of energy and environment planning. The Government has begun to recognise the connections between the topics in its publications "This Common Heritage" 1990, and "Transport and the Environment" 1992. Having set the target of stabilising CO_2 emissions by the year 2000, a range of actions needs to be taken to achieve, or to better this. Recent advice to UK local authorities states that energy should be a relevant issue when strategic land use and transportation plans are being prepared.

In general the energy supply utilities are in competition with one another and each seeks to stimulate the market in its favour. Public transport operators are also privately rather than municipally owned and are in competition with each other and especially with the car.

As private companies, the electricity and gas supply utilities are in competition for market share and seek to achieve a good return for their shareholders. They are also subject to regulatory control and are obliged to pursue ever greater efficiency, and safeguard the environment. There are potential conflicts within these obligations, particularly for private companies who in normal situations would want to increase sales.

In the UK there is no restriction on consumers who may choose never to use public transport or to use one or a mixture of fuels for energy supply. There is no formal relationship between regulations for the conservation of heat and power through, for example, insulation in the UK. Building regulations and planning legislation are entirely separate. Detailed orientation of buildings is a matter of aesthetics and access, passive solar gain is not a consideration in planning control.

Fact file

Newcastle is part of the wider Tyne & Wear Conurbation

Population & Housing

	Newcastle	Tyne & Wear
population	280 000	1,100,000
households	110 500	440,000
(1990 data)		

The population is static and falling and there is an increase in older age-groups partly due to an out-migration of younger people. There is an increasing number of small households.

There are 118 000 dwellings in the city of Newcastle, with the following types of tenure:

Owner occupied	50%
Local Authority owner	37%
Other rented	13%

The building rate is 450 new units annually, predominantly in the private sector. Housing clearance is minimal. The overall residential density is about 40 dwellings per hectare.

Employment

	Newcastle	Tyne & Wear
Manufacturing:	13%	25%
"Blue collar" Services	29%	30%
"White collar" Services	58%	45%

Manufacturing employment in Newcastle has declined over a lengthy period; shipbuilding and engineering in particular have suffered heavy job losses. Newcastle acts as the Regional Capital for Business, Retail and Government services; this sector has grown steadily and is expected to continue to do so over the next decade.

Transport

In Newcastle there are 250 cars per 1000 inhabitants, well below the national average of 350 cars per 1000 inhabitants. Car use is increasing at a rate of between 3 to 4 per cent per annum. Public transport use declined during the 1980's. It is estimated that a total of 2.7 million vehicle kilometres of traffic movement took place within Newcastle on a typical day in 1990.

Climate

Maritime - Northern Temperate zone

Energy Planning

A Study of Energy and the Environment in Newcastle was completed in April 1992.

Energy use & emissions 1990

Fuel	GWh
Gas	2368
Electricity	1189
Refuse derived fuel	75
Coal derived fuel	450
Oil derived fuel	1760

Sector	GWh
Domestic	2379
Commercial	934
Industrial	1202
Transport -	
- petrol	859
- diesel	356
- aviation fuel	92
- electrical	20

Pollutant	Tonnes ('000)
CO_2	2310
CO	18
SO_2	17
NO_X	8
Methane	6

A number of new initiatives have been proposed to reduce CO_2 emissions from energy used in Newcastle by up to 45%, and emissions of SO_2, CO and NO_x by 89 per cent, 82 per cent and 76 per cent respectively. The proposed initiatives include:

gas fired combined cycle CHP (the Forth Energy Project), which could supply most of Newcastle's electricity requirements, and provide heat to major consumers in the City centre;

traffic restraint, going beyond what is possible by means of local traffic management and including nationally led taxation policies;

energy efficiency, a new drive to radically improve efficiency in all sectors; and

'Renewables', the use of photovoltaic cells mounted on buildings to supply electricity, and the continued use of energy from refuse at the Byker reclamation and CHP plant.

Not all the initiatives considered in the Newcastle energy and the Environment Study have a direct relationship with land use and transport planning. Those that do are now considered.

City Centre Combined Heat and Power: the Forth Energy Project

The City Council's Unitary Development Plan (UDP) specifically encourages this project and refers to a site for the power station. The Plan does not, however, safeguard the route of the District Heating (DH) mains, or provide an overall strategy for the development of DH cells. As a first step the UDP could identify the main DH pipe routes and impose policies which prevent their obstruction, in the same way as highway improvement lines are safeguarded. This may in theory give rise to claims for compensation where redevelopment potential is reduced. However in practice the pipe network has been designed to minimise such conflict.

There is currently no precedent in UK planning practice for safeguarding future DH pipe networks. Neither is there any precedent for including the development of district heating cells, as part of a City-wide CHP strategy. An extension of planning practice to embrace CHP development could be helpful. In the case of Newcastle, CHP offers the single most significant reduction in CO_2 emissions, this is because of the characteristics of the Forth Energy Project, and the mix of fuels used in electricity generation at present.

Traffic Policy

The City Council's UDP contains policies which will restrain car access to the City Centre, thereby encouraging public transport and cycling, and allowing for essential service vehicle access. These policies will improve the environment for pedestrians and businesses, but it is by no means certain that they will reduce the amount of energy used for transportation. Newcastle is part of the wider Tyneside conurbation and recent years have witnessed a steady decentralisation, firstly, of population and housing, and more recently of economic activity and retailing. If car access is made more difficult in one part of the conurbation, there is a strong possibility that over time further decentralisation of activity will take place. This is likely to increase journey lengths and the use of energy in transport.

The absence of a county or regional level of planning means that there is no way of ensuring that traffic restraint in one part of the conurbation does not give rise to more energy being used in transport, as described above.

The use of fiscal measures such as energy or carbon taxation, road pricing, and vehicle tax could be used as a tool to reduce energy consumption in private transport and help to encourage a move back to public transport in association with a programme of improvements in public transport infrastructure.

Renewable energy

Some sources of renewable energy are relevant to the region, but not to the City, for example, hydro power, wind power, hot-dry rock geo-thermal energy. Other forms are more relevant to the city.

- Combined Heat and Power (CHP) from garbage incineration

Currently, half of the City's garbage (approx. 55,000 tonnes p.a.) is processed at Byker. The plant separates out non-combustible waste and concentrates the combustible material, principally paper and card, into fuel pellets. These pellets are used to provide heat to an adjacent district heating scheme and to housing blocks and public buildings elsewhere in the City.

An increase in fuel pellet production from 1992 will be used to generate about 26 GWh of electricity p.a. This expansion of the Byker operation will give the City its first significant increment of CHP/DH.

The use of garbage for CHP and Direct Heating raises a number of planning issues:

the siting of the plant must be convenient for the supply of garbage preferably avoiding any double handling. At the same time the plant must be located and operated so as to avoid nuisance to nearby housing;

as fuel pellets are easily transported, the plant does not have to be located near to the district heating plant, although this can be an advantage;

processing garbage to produce fuel pellets reduces the overall need for landfill, and avoids some of the problems involved in tipping of untreated or unsorted garbage.

- Passive Solar Gain

There are currently no planning requirements to consider passive solar gain, and it would be impossible to enforce requirements to this end under UK planning law. However, a great deal could be achieved by encouragement and the provision of information and guidelines to architects and developers. It is estimated that even 1000 dwellings designed and sited to enhance passive solar gain could save 2 GWh of gas consumption p.a.

- Photovoltaics

A demonstration study into the cost effectiveness of electricity generation from photovoltaics will be carried out in Newcastle during 1992/93. It is proposed the photovoltaic modules be installed on the roofs of certain Local Authority owned dwellings and as wall cladding on certain University buildings.

The introduction of photovoltaic modules raises certain planning issues, concerning the appearance of buildings. Planning Guidelines are not currently available, but would be helpful, and could be prepared in the light of the proposed demonstration study.

Land use transport and energy planning

In common with other UK Cities, Newcastle is currently preparing a Unitary Development Plan (UDP) which will guide the physical development of the City over the next 15 years. The plan is concerned with the following matters:

> Allocation of land for economic and housing development and for recreational purposes;
>
> Retailing policy;
>
> Environmental protection - historic buildings, landscape etc.;
>
> Green Belt designation;
>
> Highway construction, and management of the priorities given to public and private transport.

A great deal of the future planning framework is in fact already in place, and the UDP will act as a review and update mechanism. The matters which have a bearing on energy use include the following:

> The amount of new development, number of houses, commercial floorspace etc.;
>
> The location of new development, and the number of additional journeys likely to be generated;
>
> Any significant change in the structure of the City, new shopping or commercial centres etc.; and
>
> The balance between private and public transport.

No specific analysis has been attempted to examine, for example, whether new development in one location would give rise to more journeys and therefore greater energy use than an alternative location. Equally no energy use calculations have yet been made with regard to specific transport proposals.

This is because Newcastle has a Green Belt which currently prohibits development outside the built up area. The majority of new housing will take place on infill sites and redeveloped areas within the built up areas.

The exception to this may be some limited housing, and more significant economic development on the City's periphery, if the Green Belt boundary can be modified. The compact nature of the City will be maintained.

The use of energy attributable to the new development anticipated over the next 15 years is a relatively small proportion of current energy use, and the lack of specific analytical tools was also a problem at the outset of plan preparation.

The relatively modest scale of new development proposed, and its location with, or on the periphery of the built up area still suggests that analysis of its energy implications and comparison of alternatives is unlikely to yield significant information. In contrast, examination of the UDP's proposals for traffic restraint in the City Centre, together with greater priority being given to public transport, will be the subject of a specific energy and environment study to be grant aided by the European Commission. This will be undertaken during the next 18 months using the TEMIS model as the main tool for energy analysis. (See also chapter 4.)

Energy supply

The energy supply utilities (private companies) are consulted during the course of preparing strategic plans. They are aware of locations for new housing and economic development and take them into account in planning their own supply systems.

Barriers

Barriers to integration lie with policy formulation and experience. They are not primarily to do with technology or even with the lack of direct public sector investment, although there are not enough analytical tools available. A lack of overview, or regulation can be dealt with by the government.

Environmental effects of energy use: methods and targets

In Newcastle we have used the TEMIS model developed by the ÖKÖ Institüt, Darmstadt. Generally, as the principal accounting framework for the Energy and Environment Study, the model provides detailed information on the environmental impact of energy use, and allows comparisons to be readily made between alternative scenarios.

Specific targets for reducing either energy or atmospheric emissions have not been set although the Government has set certain targets for the UK as a whole. The Newcastle Energy and Environment Study shows that by adopting certain strategies, and developing new infrastructure such as CHP, environmental improvement in excess of UK targets can be achieved.

3.5 PORTLAND, Oregon, USA

The Portland area's biggest challenge today concerns not its centre, which has been renewed with greater attention to developed density, access to public transportation and pedestrian/bicycle friendliness, but its suburbs. Policy initiatives like the LUTRAQ study and the Transportation Planning Rule hold out hope that the revolution of the central city can be exported to the suburbs.

Institutional Framework

Until the early 1970's land use planning in Oregon was not really planning at all, but a series of local governments issuing development permits under zoning and subdivision ordinances. This resulted in uncontrolled development. New planning and development legislation: the Oregon Land Conservation and Development Act, commonly referred to a Senate Bill 100, was enacted to set state-wide planning goals. It contains powers and sanctions to ensure that plans are produced that comply with the goals. The 277 cities together with counties and state agencies have to draw up comprehensive land use plans with regard to natural resources, transportation, energy conservation and urbanisation. A Land Conservation and Development Commission was set up to oversee all land use plans and ensure that they complied with the goals of the Act.

Fact File

Climate

Portland is located at 45.5 degrees north latitude, approx. 60 miles from the Pacific Ocean. This ocean proximity provides a mild climate, with average winter temperatures ranging between 1.2 and 6.7 degrees Celsius, and average summer temperatures ranging between 13.3 and 26.7 degrees. Due in part to the presence of the Cascade Mountain Range immediately to the east of the city, Portland receives an annual rainfall of 935 mm. Most of the rain occurs during the winter months, leaving the summers relatively dry.

Population and Housing

The City of Portland is part of a greater metropolitan area covering portions of two states (Oregon and Washington), and consisting of 25 cities and 4 counties. The entire region covers approx. 1000 square kilometres and has a population of approx. 1.4 million.

	Portland	Metro area
Population	478 815	1 365 683
Households	210 394	548 702
Av. household size	2.27	2.49

Since 1985, however, both population and household growth have been approx. double the U.S. annual average. These high growth rates are expected to continue for at least the next twenty years. Most of the growth, however, is projected to occur in suburban jurisdictions, outside Portland's city limits.

Housing

	Portland	Metro area
No. of dwellings	198 368	605 513
Single Family (owner-occupied*)	63%	69%
Multi-family (rented*)	37%	31%
units/ha	36.9	33.6

* on the whole
(1990 data)

Less than 1 per cent is public sector rented. The average number of new units per year between 1981 and 1990 was 6,894, the anticipated annual average to 2010 is 10,000. Virtually all will be in the private sector.

Employment

Portland is still a major transportation, wholesale, and distribution centre and is the state's centre of financial, insurance, legal and health services; it is also the centre of publishing, media and advertising. Federal government offices are located here, as are the largest air and water ports in Oregon. Suburban economies are more heavily based in manufacturing, technology, and retail trade. In Portland, the average size of the top 50 private sector employer is only 2,000, and almost 50 per cent of the city's employment is with firms with less than 100 workers.

Employment

Portland	331 932
Metro area	639 928

It is expected that past trends away from manufacturing jobs and towards service, information, and professional sectors will continue.

Energy, land use and transportation planning

During the 1960s and early 1970s, Portland's central city was suffering from the same urban flight pressures of other U.S. downtown areas. Jobs and households were moving to the suburbs in droves, leaving empty buildings, under-utilised lands, and myriad social problems.

A programme of urban regeneration in the late 1970s and 1980s has almost completely reversed the city's trend towards deterioration. As well as new park land and leisure facilities, the city's redevelopment agency facilitated the construction of high density housing downtown, substantially increasing residential use of the downtown. The city's transportation department instituted a parking limitation in the downtown area, averaging no more than 1 parking space per 100 square metres of gross floor area.

The city used land use policy as a method of encouraging alternative transportation use. The city's policy has been to "locate the highest densities in the downtown and along potential and existing transit corridors" in the central city. This policy is reflected on the city's zoning maps, which indicate a 15:1 floor area ratio (FAR) in the downtown area and 12:1 to 9:1 FARs along central city transit trunk routes.

The city has also developed an integrated program to provide a pedestrian friendly environment downtown. This program includes a series of design guidelines that emphasise pedestrian orientation. Of particular importance is the limitation on the amount of ground level blank wall allowed on downtown structures and a 60 metre by 60 metre downtown block structure. In addition, the city code requires the provision of retail establishments at the ground level of all new and renovated structures (even parking garages) in substantial portions of the downtown.

The cumulative result of these actions are:

> Since 1972, more than 30,000 jobs have been added to the downtown without appreciable increase in the numbers of parking spaces or vehicle trips into the down town.
>
> Transit trips to the downtown increased by more than 50 per cent; transit now accounts for 43 per cent of the work trips to the downtown (compared with some US cities with a 10 per cent share).
>
> The light rail line currently has more than 24,000 weekday boardings. More than $800 million in development has occurred along the light rail right-of way, partly due to the accessibility provided by the light rail service; another $400 million in development is planned.
>
> The number of violations of U.S. carbon monoxide standards have gone from more than 100 per year to zero.

The city has taken a number of recent actions to capitalise on these successes. In the area of transportation the city has adopted a policy banning the construction of new freeways within the city limits, and is actively pursuing new public mass transit systems.

On land use issues, the city is starting to take actions to implement a 1977 study of the city's energy demands. The study, produced by the U.S. Department of Housing and Urban Development, analysed the energy impacts of alternative land use scenarios, looking particularly at the effects of concentrating development along transit lines. The report concluded that by increasing residential densities from 7 units per hectare to 19 units per hectare along major transit corridors, households in those corridors would, through increased transit use, save 33 per cent of the energy they would otherwise spend on transportation.

The city is now embarked on an ambitious programme that would focus virtually all future development in the city along transit service routes. Through infill, light rail station, and transit corridor development, the city hopes to increase substantially densities in transit served areas.

Energy use and related emissions

Energy consumption in the metropolitan area for 1987/8 is shown in the following tables.

Fuel	GWh (%)
Gas	3 770 (16)
Electricity	5 682 (24)
Coal	0
Oil*	14 496 (61)

* pro-rata on population from State data

Sector

	GWh	(%)
Domestic	4 546	(19)
Commercial	4 156	(17)
Industrial	2 856	(12)
Transportation	12 561	(52)

Emissions related to energy use

Pollutant	1000 metric tonnes (1987)
CO_2	4637
CO	237
NO_X	32
SO_X	11
VOC**	39

** volatile organic compounds

The LUTRAQ project

A wide-ranging research project on land use, transportation and air quality has been initiated.

Phase One was to identify the state-of-the-art for integrated land use/transportation computer modelling, and base line land use conditions.

Phase Two of the study seeks to implement a series of improvements to the computer model in use in the study area, and to develop an integrated land use/transit/transportation demand management alternative to the Western Bypass.

Phase Three will quantify the alternative by subjecting it to the improved computer model and making other ancillary calculations.

Phase Four will develop a series of implementing strategies.

The Oregon Transportation Planning Rule (TPR)

This has not yet been implemented by the state's various jurisdictions and the effectiveness of any policy initiative is largely dependent on the implementation of that policy. Nevertheless, the contents of the TPR indicates a strong desire by the State of Oregon to foster efficient urban forms that will provide a substantial reduction in the state's reliance on the automobile.

The average weekday Vehicle Kilometres travelled in 1988 was 35,680,000 and average weekday vehicle trips was 3.6 million

Mode split of all vehicle trips:
96% automobile (car)
4% transit

Mode split of vehicles trips Suburbs to Central Business District
74% automobile
26% transit

Annual increase in auto trips 1985-2005

* Metropolitan area 1.86%
* City of Portland 0.19%

Car ownership per person

* Metropolitan area 0.7
* City of Portland 0.68
* Central Business. District. 0.39

Parking Management Plan

The rule's requirement for a parking management plan dictates that each of the state's metropolitan areas achieve a 10 per cent reduction in the number of off-street parking spaces per capita over 20 years. This decrease may be achieved by restricting the amount of parking allowed in new developments, redeveloping existing parking areas to new uses, or a combination of the two.

Implementing Policies, Regulations, and Ordinances

To implement the Transport system plan (TSP), the rule requires each local government to adopt or amend land use or subdivision ordinances that require:

> bicycle parking facilities in all new retail, office, institutional, and multi-family residential developments, and transit transfer stations;
>
> facilities providing safe, convenient, and direct pedestrian and bicycle access within and from new subdivisions, shopping centres and industrial parks to nearby residential areas, transit stops, and neighbourhood activity centres;
>
> internal pedestrian circulation in new office parks and commercial developments through clustering of buildings and the construction of pedestrian ways;
>
> new retail, office and institutional buildings at or near existing or planned transit stops to provide preferential access to transit;
>
> in existing or planned transit corridors, the designation of types and densities of land uses adequate to support transit.

Although land use and transport planning is successful in the urban centre of Portland, it is less successful in its satellite cities, where 'urban sprawl' is much in evidence. This is due in part to the failure of ordinances to include provisions to carry out many of the plan's policies.

Many of the provisions that are included in the ordinances work *against* the intent of the policy document. For example:

promotion of public transport (which needs high density) in an ordinance with a low stated development density;

amount of parking provision.

Evaluation and Selection of Transportation System Alternatives

In evaluating alternative methods to meet identified needs, responsible planning agencies must consider a range of options:

increasing residential densities and establishing minimum residential densities within one quarter mile of transit lines, major regional employment areas and major regional retail shopping areas;

increasing densities (i.e. minimum floor area ratios) in new commercial office and retail developments;

designating lands for neighbourhood shopping centres within convenient walking and cycling distance of residential areas;

designating land uses to provide a better balance between jobs and housing considering:

(a) the total number of jobs and total number of housing units expected in the area or sub-area;
(b) the availability of affordable housing in the area or sub-area;
(c) provision of housing opportunities in close proximity to employment areas.
(d) Establishing maximum parking limits for office and institutional developments which reduce the amount of parking available at such developments.

The options selected must :

be consistent with state and federal standards for the protection of air, land, and water quality;

minimise adverse economic, social, environmental, and energy consequences;

minimise conflicts and facilitate connections between modes of transportation;

reduce reliance on the automobile by:-

* reducing Vehicle Miles Travelled per capita;

* increasing non-automobile mode shares;

* increasing average automobile occupancy;

* decreasing the number of overall trips.

3.6 RENNES, France

Cities account for over 70 per cent of France's total consumption of energy. Major cities in particular require large amounts of energy for use by households, transport and business and community activities.

There are four ways in which large cities are directly involved in energy issues:

1. as consumers of energy, used to provide facilities and services;

2. by having responsibility for town planning and the design of transport systems;

3. by supplying their inhabitants with energy;

4. as pace-setters and poles of attraction.

For these reasons the authorities in Rennes have made energy a priority issue; their achievements have made Rennes one of the leading 'energy cities' in France.

Institutional framework

City authorities are able to exercise close control over the production and distribution of heat for district heating, either through the municipal board or the operating utility, but they have little say in the planning of electricity and gas distribution networks, which remain under the control of nationalised companies whose primary concern is to implement government policy.

Although rights were conferred on town councils to act as licensing authorities under the 1946 law on the nationalisation of gas and electricity utilities, as well as in recent legislation on the devolution of power to local authorities, no licensing agreement on electricity distribution has ever been signed in France.

This has a direct impact on municipal town planning activities where future distribution networks, and particularly the cost of their installation, have to be negotiated with the utilities. Indeed, the impact of energy costs on local inhabitants, and the subsequent operating costs for individual communities, are hard to take into account and difficult to control.

The lack of energy balances and accounts at community level already provides some indication of the difficulties that municipal authorities face in energy planning.

Energy, land use and transportation planning

Energy use

Energy use takes from 6 to 15 per cent of French town's annual operational budget. In Rennes it was less than 3 per cent in 1989. In 1990, the city of Rennes spent FF 55 million on energy. This works out to some FF 270 per inhabitant per year. Approximately 40 per cent is used in the supply of heat and power to buildings, 27 per cent in providing bus services, 12 per cent on street lighting and the remainder on the collection and disposal of household refuse, the municipal vehicle fleet, water, sewage treatment, abattoirs, greenhouses etc. The following actions have contributed to Rennes' efficient performance in energy use.

Development planning

The development plans for Rennes and its conurbation pay particularly close attention to projected energy expenditure on housing, transport, water distribution, sewage treatment, etc. The needs of every new residential area are carefully thought out in terms of energy demand, climatic constraints, appropriate heating, transport, street lighting, existing energy distribution networks, public information desks, public advisory services. Furthermore, as much account as possible is taken of weather conditions in the design of municipal buildings

Energy action

The authorities have made a typological study of housing in the Rennes area. This study, based on a representative sample of building styles, allowed the authorities to identify the type of work that needs to be carried out on buildings and the installation of equipment to improve heat retention and thus lower heating costs.

A special "Energy" working party was set up by the Council to monitor progress. One of the town councillors was given special responsibility for energy and, in addition, entrusted with the task of co-ordinating the municipality's energy policy with policies in other areas such as town planning, transport, etc.

Departments are asked to suggest ways in which they might use energy more efficiently and then to implement their proposals and monitor results. To do this, they use an accounting system to measure energy expenditure and regularly issue energy balances for the sector for which they are responsible.

The Public Housing Department has one employee with special responsibility for energy issues. The Engineering Department keeps an overall record of the work performed and results achieved. It also checks that Council polices are properly implemented and monitors other departments; in some cases it may even provide technical assistance or advise on procedure.

It does this by setting up systems to monitor energy consumption. This has now been expanded into a full-scale energy management system for which microcomputer software is currently being developed.

The Mayor of Rennes, who at the time was Deputy Minister for Energy asked the General Manager of the city's Engineering Department to set up a number of working parties on Energy comprising officials from the city's Engineering Department and representatives of public, semi-public and private organisations.

Eleven such working parties were set up, taking eight months to complete their task:

- town planning and development
- sewage and water
- district heating and household garbage
- abattoirs and refrigerated warehouses
- greenhouses
- vehicle centres and workshops
- public transport
- architecture and building
- energy in the suburbs (peripheral communities)
- raising awareness in schools
- new and older housing, building permits

The municipal engineering department had in fact been drawing up annual energy balances for a number of years. This meant that it could submit proposals as soon as the Energy working parties were instituted in 1981.

The working parties were asked to analyse the way in which the city used energy, as well as the technical, financial and legal problems involved. They were also instructed to set objectives and to determine the scope of future studies so that annual action plans might subsequently be submitted to the Council.

The project was finally drawn up in June 1982 and provided a basis on which contracts could be negotiated with the central government.

Besides this, the working parties also resulted in a highly productive exchange of information between all the parties involved. The whole experience allowed new links to be forged, and existing links strengthened, between technicians from different organisations.

Transport policy

Over the last twenty years, the number of passengers carried by the public transport network has risen from 9 million to over 35 million. Rennes' decision to invest in public transport was motivated by social considerations and protection of the fabric of the city - the centre in particular.

Thus access for cars to the city centre is restricted and space required for roads and parking has been reduced, along with transport energy use and related pollution.

The city has met its objectives by developing public transport supply. It has extended the network, increased the frequency of buses, optimised routes, improved passenger comfort and increased seating capacity.

As a result of a sustained drive by the municipal authorities, **over a third of all trips** to the city centre are now made by bus, making the town centre a lively and attractive place to visit.

Energy efficiency in the public sector

In the field of public buildings, the actions taken (renovation of heating systems, energy management, solar panels for heating shower water at a camp site, recycling of air in some swimming pools...) have made possible a 50 per cent reduction in energy expenditure, without detracting from user comfort.

The steps taken to improve the management of the city's vehicle fleet, which consists of over 700 vehicles and plant of all kind ranging from Renault 4s to bulldozers, were as follows:

- rigorous management of the vehicle fleet using a computer system to monitor fuel consumption and outlets;
- conversion to LPG: 60 vehicles and plant machines have been converted to run on LPG;
- more efficient use of vehicles;
- regular checks on tyre pressures;
- inspection of vehicles;
- installation of fuel economisers;
- driver training;
- Electrically- and bio-fuel-powered vehicles are being investigated.

Savings have been made on street lighting and traffic signals by:

- replacing incandescent lamps with sodium-vapour lamps;
- installing voltage regulators;
- rigorous maintenance programme (note that street lights are left on all night for safety reasons).

The savings achieved in 1990 amounted to FF. 500 000 (approximately 100 000 USD).

Energy is also saved by recycling, especially glass.

Energy efficiency in housing

The housing sector (a total stock of 710 000 square metres of habitable space or more than 8 800 dwelling units) is one area in which a few simple improvements can produce spectacular results:

- insulation
- control devices,
- reconditioning of boilers,
- replacement of light bulbs by strip lighting,
- strict management procedures.

Over the last few years, energy consumption in the housing sector has been reduced by over 50 per cent as a result of a series of annual improvement programmes costing around FF. 3 million (approximately 600 000 USD).

The National Housing Improvement Agency (ANAH) has helped the authorities by publishing and distributing a consumers' guide to heating systems.

A programme of installation of remote sensing of controls on district heating plants installations assists with the rational use of energy. In addition a programme of training of operators will complement the sensing activities; this involves a programme of co-operation between the various public and private sector partners involved.

Energy efficiency advice and information

The town of Rennes makes an effort to make its inhabitants sensitive to energy problems by the use of information days and a permanent exhibition in the Municipal Housing Office. These inform owners and tenants about techniques for energy use and savings, and on payment and energy audits. A Regional Show for Energy Savings provides an opportunity for professionals and the inhabitants of Rennes to take stock every two years.

A major achievement was the OEACH programme, to improve energy conservation in the home, which ran from 1984 to 1987. Covering three residential areas south of the city centre consisting of around 20 000 homes, the programme was designed to encourage homeowners and tenants to make their homes more energy-efficient or simply to improve their heating systems, regardless of whether they lived in individual houses or blocks of flats.

Advice was given to homeowners and tenants on how to save energy: preliminary studies to help identify problems, proposal of suitable schemes, evaluation of the cost of the work, estimates of potential savings and the time needed for the work to pay for itself.

Energy supply: incineration

Energy is generated from incineration of garbage to supply hot water and heating for the inhabitants. Over time, extension of the incineration plan will make it possible to produce both electricity and heating. Over 7000 tonnes of fuel oil has been saved since 1968 and over one third of the population of Rennes uses one of the city's two district heating systems.

The following work has been in progress under a pluriannual programme introduced several years ago:

upgrading and interconnection of networks;
preliminary studies for a second incineration services to new residential areas;

Methane produced in sewage sludge digestors is used to generate enough electricity to meet the half of the plant's power requirements; the heat generated by the digestors is also recovered. The cost of generating electricity from methane works is about 60 per cent that charged by the national electricity generator.

Energy supply: solar power

The use of solar power has allowed savings of 50 MW to be made on supplies of hot water to several municipal buildings.

Key lessons

In the energy sector, responsibilities are shared between local government, national authorities and nationalised industries. Energy is an issue that concerns all municipal departments, and thus any attempt to draw up an energy programme must take account of efforts already in progress or under consideration in other sectors. Energy planning should complement town planning for transport, urban development and infrastructure.

3.7 SCHIEDAM, Netherlands

In improving urban energy management in Schiedam, planners did not work to environmental targets but based their decisions on best practice principles with respect to traffic management, natural landscape, building design and the application of technology.

Schiedam's traffic and transport policy has for several years been geared towards the optimal efficiency of public transport.

In addition attention to the importance of green, planted areas, especially trees is also taken into account in land use planning and linked back to open space outside towns. Furthermore, the cleansing and water-balancing effect of vegetation is also deployed to redress the need for drainage caused by asphalted and paved areas, important in a polder area (reclaimed from the sea).

Eco policies and actions

Policies and actions about energy use, water balance and pollution reduction.

Vegetation and green space

The importance of open space planning is clearly recognised in the Netherlands, though not always with the knowledge that plants produce oxygen and therefore (partly) reverse air pollution. Trees in particular, are excellent dust filters. New residential areas should therefore contain green space. In the case of Spaland a minimum of asphalted and paved areas was planned, to create the best conditions for plant growth. Since the natural environment and the range of plants are enhanced when the minimum space requirements for each type are exceeded, a splitting up of green belts is avoided as much as possible. By linking open spaces with the large urban green structures (which elsewhere are also linked as far as possible), the cleansing potential is even further enhanced.

Schiedam considers the cleansing effect of trees so vital that in the fallow area of Spaland, where it will be some years before construction takes place, a forest has been planted for the interim period. Thus the area now contributes to purifying the atmosphere, whilst an important basic material -wood- is formed.

Once construction is commenced in that part of the area, all the wood will be removed for use.

The minimising of asphalted and paved areas does not only mean having more space for plant growth, with all the resultant positive effects. The quantity of asphalted space also greatly affects the water balance, certainly in the polder landscape, since the rain water has to be drained away again. The larger the asphalted areas, the faster the water flows away, which increases the need for drainage capacity.

It is far preferable to have the water balance regulated by vegetation by retaining the water and allowing it to evaporate slowly. This also has a positive effect on the micro-climate. Some German towns offer subsidies to property owners who grow roof gardens, since this can reduce the required sewerage capacity. Schiedam is trying to find clients in Spaland who are willing to build houses with roof vegetation and there is a growing interest in this.

Harbour soil for preparing future residential areas in Schiedam for construction was found to be polluted and was thus further treated so as to allow future residents to grow and consume their own produce without any restraints. The current method of preparing the area for construction will make it suitable for farming.

Energy Conscious Design

Initially, energy conscious design was encouraged but no defined targets were given. Whilst the national average amount of fuel used during a heating season was 2500/3000 m^3 natural gas, Schiedam's first energy conscious design projects used an average of about 1400 m^3.

The use of targets

A research project showed that with extra investment, it proved possible to require as little as 300 $m^3$of gas for a family house during a heating season (with a slightly higher electricity bill). This led to the definition of the first performance standard. Planners asked developers to design for less than 1000 m^3 of gas for one heating season. As experience has grown this standard has become as low as 700 m^3 and some designs perform even better at below 600 m^3 with no extra construction costs.

Passive solar design

In addition to targets for energy-conscious design, Schiedam is encouraging passive solar design for new dwellings. In planning the Spaland area, the municipality aims to have as many blocks of houses facing south as is practical, so that conditions for utilising solar energy are optimal and shadow effects minimal. In addition, requirements are set for maximum energy consumption for space heating. It is in principle left to the client and architect to decide how this is done. This working approach is thought to enhance creativity and prevent monotony of design. Recently, designers have been required to pay extra attention to daylight utilisation, so as to reduce the need for artificial light.

The basic principles of passive solar energy are to maximise opportunities for free (solar) energy and to conserve as much as possible within the building. These principles result in a more or less south orientation with large windows on the solar side and much small windows to the north. There are high insulation levels and in many cases forced ventilation with an air-to-air heat exchanger. But energy bills form a simple performance check.

The computer output of energy bills has been monitored for some years. Until now every project has met or out-performed its design standard. If a project has an average energy use of 100, the best occupant reaches 50 and the worst uses 150.

In the beginning, it was difficult to obtain the technical installations that were needed, so sometimes these were custom-made. This makes it more vulnerable to technical problems. Nowadays, everything needed can be obtained from stock and maintenance is easier.

Retrofit insulation

A programme of retrofit insulation and controlled ventilation in existing dwellings is being carried out so that the lowest possible amount of fossil fuel is needed.

It is clear that the great majority of homes that will be in use in the year 2000 already exist. Thus energy efficiency improvements had to be made in all existing homes. 11 000 homes in Schiedam (a third of the total) are municipally owned. The municipality started a large retrofit insulation programme using mainly exterior insulation where possible. The municipal insulation programme exceeded the national programme that was running at the same time.

Energy Efficient Technology

Solar water heating

Some years ago, an average new home needed about 3000 m^3 of natural gas during a heating season. People were not inclined to worry about the proportion of fuel used for domestic hot water which was less than 10 per cent of the space heating requirement. By new energy conscious design and retrofit insulation, space heating fuel requirements were reduced to 700/800 m^3 or less while there was a trend towards increasing use of hot water of up to 500 m^3 of gas. Thus the impact of solar-assisted water heating became more viable and planners are requiring developers to install solar assisted domestic hot water system in new housing. These can save 200-300 m^3 of gas per year per household.

Combined heat and power

Building complexes may be more suitable for Combined Heat and Power (CHP) when they can obtain both power and heat from the same installation. In traditional power generation, much of the energy in the fuel is lost to the atmosphere or to waterways as heat producing negative environmental effects. CHP reduces fuel consumption and pollution and in addition there are social advantages in spreading the generation of electricity over a series of small power stations rather than a few large ones.

Because transportation of electricity is much easier than transportation of heat, small electricity plants were constructed in places where this heat can be used. Schiedam's utility company started offering a heating service. This service was based on contracts where they offered to provide the owner of a building (homes, factories, offices, hospital etc.) with heat from a CHP unit installed in or near the building to be heated. The customer only had to pay for the heat delivered. The CHP unit was operated and paid for by the utility. The 'waste' heat heats the building, whilst the electricity goes into the grid.

There are 10 installations (totalling 15 engines) in operation now and the system is still expanding. The main reason for starting these projects was the need to reduce pollution. This has proved to be successful. The systems are operated under break-even conditions and might in the longer term even make a slight profit.

Biomass for domestic space heating

Further reductions in fossil fuel can be made by the use of wood from gardens or specially planted forest.

Environmentally-conscious buying

A great deal of environmental pollution or even a destruction of nature derives from the extraction and processing of raw materials, their usage and finally their disposal as waste.

Schiedam's purchasing policy demands a concise report on the environmental influence of each selected product over its entire life. This is complex and time-consuming.

In the construction of new dwellings, Schiedam discourages the use of tropical hardwood and encourages the use of paint which is more environmentally friendly than the usual products. Schiedam is also discouraging the use of PVC by developers.

Transport policy

The view was taken that pedestrians and cyclists are the less polluting participants in traffic and must be protected and encouraged. Similarly good public transport systems have also been developed. As a result, a network of bicycle paths were constructed through the town, so that it is currently possible to reach many destinations in Schiedam via these bicycle paths. These are maintained in winter by deploying snow-clearing teams.

New traffic priorities were designed in residential areas. Residential areas were designed with '*woonerfs*' which is where pedestrians and cyclists have equal rights to the car. Such areas are no longer attractive to through-traffic. At the same time, a grid of separate cycle lanes was constructed and improved, making cycling more attractive. Finally, a tramway was constructed linking a new development area of 5500 homes.

A temporary bus service was brought into use after 200 houses had been constructed. The tramway system was brought into operation after 800 were finished. It was important to avoid the situation where people became dependent on their cars as the only was of getting around.

There are no figures about the environmental consequences of our traffic policy. Schiedam's planners have relied on 'common sense' such as: the best forms of transport are walking and cycling, thereafter comes public transport, first rail, then buses, and finally, cars.

3.8 TORINO, Italy

Institutional framework

There is competition between natural gas and hot water district heating options in the space heating sector for large urban area; even though the firms and the utilities working in the field all belong directly or indirectly to the Government, this has not led, until recently, to a more precise national strategy in this sector;

there is a low activity level in the residential construction sector; that does not permit a suitable penetration of innovative technologies in heating plant -building systems;

there is a complex structure of political and administrative decisions to obtain permission for infrastructure projects in large urban areas, especially if several Authorities are involved.

Fact file

	Torino city	TMA (*)
population 1989	1 002 000	1 776 888
households	420 000	700 000
area	130 km^2	

(*) Torino greater metropolitan area (TMA)

TMA consists of Torino city plus 52 municipalities: 23 inner and 29 outer. Torino is the chief town of Piemonte Region, of Italy (735,000 industrial jobs in 1988, 9.2 per cent of Italy), while 7.6 per cent of the Italian population is located in this Region.

Industry is mainly engineering and particularly in vehicle production (the majority of FIAT plants and the management of the firm are located in TMA). In particular, little less than half (69 million m^3 of the covered area in Torino City, excluding the hill districts), is devoted to industrial activities.

From 1980-90, there has been considerable changes in the specialisation of the area: trading and service jobs now represent 51 per cent of total jobs in the metropolitan area, an increase of over 16 per cent. Industrial jobs now represent 41 per cent, a decline of 20 per cent. As a result, the social structure and dynamics of the area are deeply changing as well: Torino City population is continuously decreasing; although owing to smaller families and single person households, the number of households has grown by 16 per cent in 30 years: thus residential energy demand at about 90 million m^3 gas in Torino and 150 million m^3 in the whole Metropolitan Area, is still high.

Energy, land use and transportation planning

Land use planning

The **Local Master Plan** 1959 has recently been re-drafted and approved; energy management and environmental policies are now included within the land use planning system. For example:

no new residential districts will be sited in the City limits, in order to prevent an increasing in land occupation and in housing, heating, transportation demand;

no new industrial district will be sited in the City limits in order to prevent air pollution and heavy traffic increasing;

very few and small industrial plants, moving from old industrial areas in rehabilitation, will be accepted in some industrial districts in the City, where reorganisation of industrial texture is promoted;

the inner City will be renewed, will change their use mainly to trading or business activities and partially to housing: In Torino City about 2 million m^2 of industrial areas are empty because of economic down-turn and because of the transfer of several small and middle size plants to the surrounding municipalities, mainly within the Metropolitan Area. This almost continuous belt of rehabilitated old industrial has been named "Central Bone" (in Italian "Spina Centrale").

Energy supply and use and related pollution

From the mid 1970s, the share of solid and liquid fossil fuels started to decrease: coal use practically disappeared, gas-oil first replaced oil, then natural gas network developed very fast, acquiring a growing share of the energy market, mainly in space heating sector. Liquid fuels were used only in large centralised heating plants.

Because of the concentration of industry and population in the Region especially in the Torino Metropolitan Area there is a high demand for energy in both industry and housing.

The climate has continental characteristics, which requires a household space heating demand for 6 months a year, with an energy consumption quite similar to Central European Countries (with 2570 degree-days).

The only domestic energy source of the Region is the electricity produced in hydro plants; and an increasing quantity of electrical energy has to be imported, mainly from the nearest Italian Regions (Liguria and Valle d'Aosta) and from Switzerland and France.

Individual building heating plants, together with car emissions and industrial pollution are the cause of the bad air quality in the area. Owing to the very poor dispersion capability of atmospheric circulation for long periods during the year, the pollutant concentrations are very often higher in the central part of the City than in the external rings; especially during week-days between 8.00-10.00 a.m. and around 6.00 p.m. when thousands of heating plants are running and adding their emissions to those of several thousand of vehicles flowing in the Central Business District. There has been some improvement by the increasing use of natural gas in heating plants, better maintenance and control of central heating boilers' and improvements in pollutant industries' emissions have improved air quality in relation to measurements taken in the early 1970s. However, the air quality, mainly in central narrow streets, is still bad.

Immigration from Third World, family fragmentation and higher quality of life will probably lead to a higher energy demand for domestic uses, even in a weak demographic area.

Therefore, a successful policy in energy saving was seen to be the only way to reduce energy consumption. It was this belief that moved the Local Energy Agency and the Municipality to the implementation of some relevant projects in the district heating sector.

Torino Municipality owns more than 8 million m^3 of property, with more than 800 heating plants and a yearly consumption of about 50,000 toe. More than 80 per cent are supplied by liquid fuel, and less than 3 per cent are presently connected to local district heating networks. An heated volume of 22,000,000 m3 (200,000 inhabitants) on the city area of 12,000 km^2 will be served by the proposed District heating system.

Energy use

sectors	energy delivered	energy demand
	Ktoe/y	Ktoe/y
residential	487	
transportation	330	
industrial	942	

The volume of natural gas supplied almost doubled in the years 1982-1989. The market penetration of natural gas reached the actual value of 50 per cent of the total energy consumption for buildings.

Electrical per capita energy consumption in the industrial sector is generally assumed as an index of industrial productivity. In 1988 it was about 2 500 kWh per capita, almost equivalent to the regional value. These values are some 40 per cent and 23 per cent higher than the average Italian and EC quantities, respectively.

Electricity supplied in the urban area (1989)

Sector	%
industrial & commercial	67.7
residential	24.2
street lighting	2.5
other small electric uses & for internal use	5.6

total electricity: 3.3 billion kWh

The National Energy Plan

The National Energy Plan (PEN), adopted by the Government on August 1989, but not yet approved by Parliament, assumed five priority tasks, according to the EC's objectives in this field:

* energy saving as a virtual energy source;
* environmental protection as an internal objective of the energy policy;
* development of national resources;
* diversification of the energy sources and of geo-political area of production ; and
* competitiveness of the national productive system.

According to this Plan, the energy demand of about 180 Mtoe, estimated for the year 2000, will be satisfied through a consistent increase of natural gas and coal uses, coupled with a reduction of the oil share.

Combined heat and power generation, both in the industrial sector and for space heating purposes at urban level, must contribute a consistent amount (up to 3 Mtoe) to the total saving (from 17 to 20 Mtoe) expected by 2000, even with large investments and long payback times.

A significant role can be played by the Municipal Utilities, which can invest about 10,000 billion Lire (over 66 billion ECU) by 2000 in the energy sector, and specially in cogeneration and renewable sources plants.

The TEST project

Starting from the results of several studies (available on request) carried out by the Energy Planning Team of the Politecnico di Torino, an ad-hoc Working Group was asked to formulate energy planning proposals to be included in the Master Plan structure. The main project was the Torino Energy and Environmental Strategy -TEST.

Activities have included:

* A general procedure for the analysis of sites suitable for the installation of plants and subsidiaries for the TMA district heating scheme and with respect to the main feeders of the natural gas network.

* A detailed analysis of six locations, showing the highest values of indexes based on suitable parameters which include user pattern and distribution, and site size and characteristics.

* A design proposal for an underground CHP Plant to be located in a green area belonging to the new urban campus of the Engineering and Architecture Faculties of the Politecnico di Torino; the solution adopted for this very central location allowed the Municipality to evaluate this project as a Pilot Design for other CHP plants in central Districts.

* The plant is intended to be a Combined Cycle Gas Steam Turbine Unit and a Peak Boiler, located some 20 metres below the ground level, with a layout area of about 4,000 m^2 providing 25 MW of thermal power and with 25 MW of electricity. A connection of the plant with the main district heating network is also planned, in order to extend the area of the city which is supplied by the thermal grid.

* the potential energy utilisation by electrically driven heat pumps, which recover heat power from the water flow at a reasonable Coefficient of Performance, of five old canals (at present completely culverted) which cross the central City. The principal objective is to contribute to a substantial reduction of the pollution resulting from the utilisation of fossil fuelled heating plants, mainly in the central districts, where particularly bad air quality still persists.

Objectives include:

to evaluate the energy and environmental implications of the urban development strategies carried out by the new City Plan;

to harmonise the energy and environmental goals of the City with the objectives of the European Communities for 1995;

to improve the urban management system, providing new ways for energy efficiency planning for the Technical Services of the City;

to define programmes and actions to put the energy and environmental "issues" into "policy".

Specific objectives are to produce reference data in each demand sector and the related environmental effects:

Reference Energy System: this will allow energy sources to relate to end uses of each demand sector (residential, transportation, industrial).

Reference Environmental System: this provides the ground to develop the analysis of the actual changes in dynamics and to plan future and expected changes.

Methodology addresses classification and the production of decision aids in the transport, industrial and building sectors.

Some difficulties have been encountered with municipal administration and more public consultation is thought to be needed.

Enabling legislation for the National Energy Plan

In order to implement the national Energy plan, a specific Act (308/82 Act), which defined types and amount of financial supports for different energy saving undertakings was passed. Such grants have been confirmed through new financial appropriations (in 1987 and 1989); Regional Governments have been required to implement particular Acts and Regulations for the actual use of the financial resources.

The production and distribution of thermal and mechanical energies are free from institutional constraints but **electrical** energy has been strictly controlled: since 1962 -when the National Electricity Board (ENEL) was constituted and charged of the management of the whole electrical system, all over the Country - the production, transport, and distribution of electricity have been centralised.

In 1900/91 a new Act (1142-90) concerning Local Authority Autonomy and two Energy Acts (9-91 and 10-91 Acts) modified the general conditions by which Municipal Utilities and private owners may reduce dependence on national utilities, generate their own power and sell surpluses to the utilities, from cogeneration (CHP) or renewable energy plants. These Acts changed very remarkably the profitability of district heating and, as a consequence, the interest in the installation of combined heat-and-power plant and, more in general, the market conditions for oil natural gas and hot water utilisation for space heating systems in large urban area.

The new scenario determined by the two new Acts (9-91 and 10-91) involves:

- new regulations for electrical energy production;
- energy and land use planning at regional and metropolitan level;
- new regulations concerning energy use in buildings with particular conditions given to public owned buildings.

Since 1991, Municipalities and Local Energy Agencies may produce, transport, distribute and sell electricity to private or public users by an agreement with ENEL according to conditions fixed in a general national agreement on this subject. These must be licensed by the Industry and Trade Ministry unless they produce less than 0.5 MW installed power.

Even more favourable conditions are offered if renewable energies are used; the use of such energy sources is considered of public interest and the works have to be given urgent priority.

Renewable energy

As far as energy planning is concerned, Regional Governments have to set up a **Renewable Energy Regional Plan** which includes:

the Regional Energy Balance, with the definition of local energy basis, coming from zoning criteria mainly based upon the availability of renewable sources;

the siting of district heating plants;

the financial scheme for supporting new energy plants, with priority criteria based on the amount of energy savings;

the rules for siting, designing and licensing power plants for industrial users.

Cities with more than 50,000 inhabitants are requested to include in their Master Plan a **Specific Plan for the Improvement of Renewable Energy Sources Utilisation**. Renewable energies include solar, wind geo-thermal and hydro but also include municipal garbage incineration and energy efficiency measures such as retrofitting of space heating and lighting. These sources are considered as true renewable energies - with same regulations and financial supports.

Energy conscious design and design targets

The Acts establish that the design of new buildings must include suitable solutions for energy savings; in the purchase of flats or buildings, the owner is requested to exhibit to the buyer an energy assessment, issued by experts charged of this check by Local Administrations.

Energy Efficiency

Public Institutions started to pay more attention, for financial and environmental reasons, to energy efficiency by promoting and directing these modifications; the regional government promoted some innovative collaborations with local Scientific Institutions, in particular with the Politecnico di Torino and started to establish co-operation with the principal National Energy Institutions (ENEA, ENI, ENEL).

The main successful projects in the field of urban energy policy have been developed in the 1980s:

district heating systems;
proving the natural gas supply network;
the improvement of the Electricity Distribution Network in Torino Metropolitan Area;
improvement of the Street Lighting System.

District Heating

The District Heating Programme, in addition to some re-powering of the two existing networks of "Le Vallette" and "Mirafiori Nord" districts has added a new network of "Torino Sud" (more than 22 million m^3 of building, including also a large Hospital District), supplied through a large feeder carrying hot water from the nearby Moncalieri CHP Plant.

Transport

The urban public transportation system consists of a network of 447,995 km:
a) 97,060 km of electric tram lines
b) 350,935 km of bus lines

Private vehicles are the most used mode even within the inner ring of the city: in 1988 circulating automobiles were 565,000 and the average commercial speed was less than 25 km per hour.

4. MONITORING AND TARGETTING

The energy use of developments implemented before the year 2000 will have a major influence over the success of international agreements to reduce the emission of greenhouse gases. Energy use in urban areas will be a major determinant of environmnetal performance at both local and global level.

However, effective urban energy management will require wide acceptance of a standard procedure for assessing the energy performance of a development area and its direct and indirect environmental effects. It will also be required to project the likely effects of alternative development options and monitor progress in practice.

Without internationally agreed means for assessing changes in key performance indicators and setting targets for local performance then national targets will remain untested aspirations and international agreements will not command respect. With this in mind IEA

Annex 22 committee is evaluating a number of systems. However, two particular systems had been used in connection with the case studies presented at the Newcastle-Upon-Tyne workshop.

4.1 TEMIS

TEMIS (Total Emissions Model for Integrated Systems) is an assessment technique to help abate the environmental effects of energy use attributable to development options. It starts with an estimate of the environmental burdens from each of the fuel cycles involved in the option.

The model has been developed by the OKO Institute in Darmstadt in collaboration with the Environmental Systems Research Group at the University of Kassel. The TEMIS database covers most standard energy systems which can be used for calculation purposes. As these systems can differ in efficiency, emission control, fuel, etc., each TEMIS user needs to be able to modify such protypical systems as required. Once these plants, or processes, have been defined then they can be logically connected together to form complete fuel cycles or energy systems.

4.2 EMICUS

Emicus, developed by the Technical Research Centre of Finland, Laboratory of Urban Planning and Building Design, is a model for estimating the total energy consumption and emission consequences of an urban structure. It takes into account the energy demand and emissions of construction, starting with the production of materials, as well as the annual energy demand and emissions of heating, electricity consumption and transportation. The demand of primary energy and emissions of complete production chains of different energy forms are also included in the estimations. It is possible to use the model at different planning levels from the roughest of sketch phases to the final plans or, for example, from general plan level to even building design level.