Portsmouth City Council

Sustainable Development
Agenda 21

Energy Case Study – For Waste Management Incineration

Integrated Energy Policy
&
Energy Strategy

1995

Required for

Waste Management Incineration – Onyx Ltd

MSc. Environmental Engineering Thesis
Alan Brewer Portsmouth University

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Climate Change

The potential impact of climate change and the need to reduce emissions of carbon dioxide and other greenhouse gases are now clearly recognised as critical issues for business globally. With emerging policies and regulations controlling emissions, rising energy prices and increasing public and investor interest, no business can ignore the strategic and operational implications of climate change and the new carbon economy.

The impact of climate change, however, also offers organisations opportunities to improve competitiveness and enhance innovation. Whether as a stimulus to resource efficiency, environmental performance or the development of new technologies, forward thinking Councils like Portsmouth City Council and other organisations are looking to gain a competitive advantage from this Agenda 21 programme.

Executive Summary

Significant environmental impacts emanate from man's activity on the planet Earth. These impacts are threatening the life support systems Globally in terms of increases in atmospheric pollution levels, water pollution, deforestation all of which have resulted in environmental burdens such as Global Warming and the partial destruction of the ozone layer. The concept of "Sustainable Development" is criteria behind the European Union's Fifth Action programme on the environment and development and is one which Portsmouth City Council is seeking to achieve in the area of sustainable energy use, the Urban Regeneration and protection of its economic base. Sustainable energy use is one of the most complex issues in the Agenda 21 programme and the Portsmouth City Council must lead by example, for this reason it is proposed that eight working parties have be established to address the Agenda 21 issues. The City Council have already embarked upon several energy efficiency projects.

The City of Portsmouth occupies an area of 4042 hectares and is one of the most densely populated Cities in England, 43.4 people / ha. Some of the most serious local environmental problems are those pertaining to transportation, waste management, housing, affordable warmth and employment. The City of Portsmouth currently uses 600 GWh of electricity from the national grid supply within its boundary and 775 GWh in its greater boundary. Atmospheric emissions within the City amount to 1,505,380 tonne of carbon dioxide, 11,603 tonne of carbon monoxide, 11,080 tonne of sulphur dioxide, 5,475 tonne of nitrogen dioxide and 3,715tonne of methane. Much of these emissions emanate from the combustion of fossil fuels and the action plans contained within the "Integrated Energy Strategy" could reduce these levels by as much as 50%. A reduction in energy use could be set by the Energy Conservation Working party within the range of 33% and 50% by the year 2025 in a three phased approach; a 10% reduction is to be achieved by the year 2000, 20% by the year 2010 and finally the 33% to 50% reduction by 2025, this energy policy it is hoped will be endorsed in 2001. Agenda 21 is seen as the instrument that could enable advances to be made in reducing the environmental impacts of energy use and is backed by industry and commerce in Portsmouth City.

Introduction

Portsmouth City together with other English and European cities have to administer the complexities of twentieth century life which have resulted in significant environmental impacts emanating from man's activity on the planet Earth. Only too often these impacts are seen as threatening the life support systems on Earth in areas of ; Global Warming and the carbon dioxide greenhouse gas emissions, increasing use of energy as society develops resulting in land, water and atmospheric pollution levels rising and the continual use of resources all affect the careful balances of sustainability. Man's continuity on the planet Earth will require serious global action to combat the environmental problems that exist. The environmental burdens do not just emanate from sustaining present developments but also from man being able to seek and achieve continual growth and development.

Is Sustainable Development possible?, can complex socio-economic, industrial and agrarian cultures continue to grow and develop ad infinitum. This project will research the engineering possibilities of sustainability in the City of Portsmouth and determine the environmental impacts of energy use within the City. The problem of Sustainable Development was discussed at the United Nations Conference on Environment and Development in June 1992 at the Rio de Janeiro Earth Summit. (LGMB,1995 [1]) A very important Agenda was formulated at the Summit which encompasses the principles of Sustainable Development, Agenda 21, however it is felt that it can only be achieved through systematic, co-ordinated global corporate approach to the environmental problems that the Earth must contend. Agenda 21 is seen as the way forward to be considered by both the European Union Member States, both Central and Local Governments as a series of strategic environmental objective programmes to be followed to achieve Sustainable Development. Agenda 21 is the most thorough and ambitious attempt to specify what actions will be required throughout the world to reconcile development with environmental concerns. Following its adoption by all Member States represented at the Earth Summit, it will guide and drive action towards Sustainable Development for years to come. It will also be the key text for all concerned with sustainable policy, strategy and environmental best practice. Commitment and cooperation of Central and Local Government is viewed as being paramount in order for Agenda 21 programmes to be successfully implemented.

The road from Rio is not an easy road, for this reason the Local Government Management Board (LGMB) has produced for local governments such as Portsmouth City Council in England an Environmental Best Practice Guide which forms the first part of the United Kingdom Local Government's "Local Agenda 21" programme. Portsmouth City Council has a leading role to perform in the strategic approach to resource husbandry, energy efficiency, environmental health, education and training and also in minimising the City's environmental impacts. To meet the challenge eight working parties have could be formed incorporating professional staff from many disciplines to investigate the City's environmental problems, formulate policy and strategy which will be encompassed within their Agenda 21 Sustainable Development programme.

The first working party established should be the Energy Conservation Working Party. After a series of meetings, working parties and conferences to be arranged in 2001 in which the principles of Agenda 21 would be discussed and debated, an " Integrated Energy Policy" could be formulated. The policy would be the first Agenda 21 policy Portsmouth City Council could achieve. A review of the current environmental gains made by the City Council should be made and a general Environmental Charter should be formulated from which special projects could be initiated in such areas as energy from waste, recycling, combined heat and power, emissions monitoring, BS7750 (English equivalent) , environmental education, gas fired district heating and energy efficiency in Council housing stock.

An Integrated Energy Policy will facilitate Portsmouth in formulating Sustainable Development strategies and action plans. A deadline for the completion of the strategies should be set.

The implementation of sustainable strategies should commence in January 2002, just how the City will achieve the Agenda 21 aspirations will be investigated within the project.

Aims of the Environmental Engineering Project

The project was to be conducted for Portsmouth City Council in England, in conjunction with the University of Portsmouth by the secondment of Mr Alan John Brewer an MSc Environmental Engineering from Top Consult in England in order to establish a framework to be adopted in the Portsmouth City Urban Regeneration programme.

Aims: To help develop an Integrated Energy Policy for the City Council in their commitment to achieving "Sustainable Development" under Agenda 21 criteria. The scope of the project will encompass both the City Council as an operating unit and the environmental impact of energy use within the City of Portsmouth.

The project will focus on the following;

- An outline of the principles of Agenda 21 and the formation of partnerships with outside organisations

- Determination of objectives to be achieved by the Integrated Energy Policy and Strategic Action plans

- Identification of the criteria that the individual elements of the policy must meet; recovery of capital costs, reduced emissions and energy reduction targets

- Identification of how the City can achieve Sustainable Development in the next century in line with the changing legal frameworks on a National and European basis

The study will be integrated with other activities taking place on the Agenda 21 subject within the Portsmouth City Council. Particular attention will be given to the introduction of novel approaches and technologies and the views and comments of related industrial companies, both large and small.

Chapter 1

1.1 *United Nations Conference on Environment and Development Earth Summit (Agenda 21) Rio de Janeiro 1992*

The Earth Summit Conference on the Environment and Development held in Rio de Janeiro from the 3rd to the 14th June 1992 played host to the Worlds Leaders from 150 Nations. The Conference set out to reaffirm the Declaration of the United Nations Conference on the Human Environment which was adopted on the 16th June 1972. The objective of this Earth Summit was to build upon 1972 agreements with the goal of establishing new and equitable global partnerships through the creation of new levels of co-operation among Member States, key sectors of societies and the populous of each City and Country. International agreements were worked towards and formulated with respect to the interests of all and to protect the integrity of the global environmental and development system. The Earth Summit Conference recognised the integral and interdependent nature of the Earth and formulated the " Agenda 21 programme". Agenda 21 was the most significant environmental programme outcome of the United Nations Conference at Rio and is the most ambitious attempt yet to specify what actions will be needed throughout the World to reconcile development with environmental concerns.

Agenda 21 will drive action toward Sustainable Development for years to come, and will be the key text for all concerned with Sustainable Development Policy and Strategy. Over two thirds of the statements in Agenda 21 which have now been adopted by National Governments, including the United Kingdom, and soon England, cannot be delivered without the commitment and co-operation of Local Governments such as Portsmouth City Council. The integration of policies and strategies is seen as essential in solving the World's major social and environmental problems. The main development environmental problems are Global Warming, resource depletion, de-forestation, energy consumption, poverty, population growth, food production, education and habitation. The Rio Conference set out forty chapters to deal with the major issues, the most significant of these was Chapter 28, "Local Authority Initiatives in Support of Agenda 21". (L.3/Add28 [2]) . In 1987 the Brudtland Commission on Environment and Development defined Sustainable Development as "Development which meets the needs of the present without compromising the ability of future generations to meet their own needs"

1.2. Local Authority Agenda 21 (UK)

Portsmouth could benefit from the United Kingdom Government's " a framework for Local Sustainable Development" which has taken the main attributes of the Rio Earth Summit agreement and placed them into a Local City Authority level. The challenge for Portsmouth City Council and other Local Authorities is to meet the Agenda 21 aspirations. The Local Government Management Board (LGMB) were instructed by the Department of the Environment (DOE) to produce a series of guidelines and awareness training packages to be made available to Local Authorities in the United Kingdom to help them develop Sustainable Development policies and strategies. This series of publications is the first response to the European Union Agenda 21 programme by the United Kingdom Government and forms the basis for the first strategy for Sustainable Development. These could be used to aid Portsmouth.

The LGMB publication "A Framework for Local Sustainability " was produced which could enable Portsmouth City Council and other Local Authorities to embark upon their Agenda 21 programme thus meeting the requirements of the European Union's Fifth Action Programme on the environment out of Rio de Janeiro.

As a preamble to the Framework for Sustainability the LGMB also produced a "Step by Step Guide" to Local Agenda 21 called "Principles and Process". (LGMB.LG0116 [3])
The Local Agenda 21 is the process of developing local policies, such as the Integrated Energy policy for Sustainable Development and building partnerships between Local Authorities and other sectors to implement them, which is a crucial part of the move towards Sustainable Development.

Four key values have been identified within the Sustainable Development criteria;

Environmental Protection

Provision for the future

Quality of life

Fairness

Six Major key areas are associated with Sustainable Development;

1) **Safeguarding The Environment:** a precondition of development and is not to be seen as an obstacle to development and sustaining the economic growth and development of a City or Country. There exists an interdependency between development and safeguarding the environment.

2) **Physical Protection of the Environment :** the carrying capacity of the environment for man made pollutants such as nitrogen oxides, sulphur oxides, carbon dioxide and ozone imposes limitations to human development activities. Social communities such as Portsmouth City must live within these carrying capacities of its local and global environments so that they can continue to support the City population.

3) **Human Well-being** : this is an area of which has social, cultural, moral and spiritual dimensions as well as physical, material and environmental aspects. Development in the future under the Agenda 21 programme must be seen to encompass all of these attributes and not some at the expense of others.

4) **Development of All People**: each human must have the opportunity to develop independently which does not mean that everyone should follow the same path of development.

5) **Development and Economic Growth :** these are viewed as being distinctly different, it is possible however to have either without the other. For Portsmouth City Council it is important that the economic Sustainability of the City is made possible. Development must be made an important issue in the Agenda 21 policies, keeping in mind at all times the environmental impacts of each new development proposal, with a view of keeping the impacts to a minimum.

6) **Sustainable Indicators**: broader indicators are required other than those, which highlight economic growth, often used as a measure of development. Wise choices must be made in the formulation of these policies and their communication very important.

Each Local Authority will have to make careful choices about what can realistically be achieved in the short term. The particular short term areas to be addressed within the framework of Agenda 21 must be guided by local circumstances, needs and opportunities. Many components of the Sustainable Development programme already exist within Local Authorities and in the community, not all the concepts are new. The important key to recognise within the process of implementation is that the City of Portsmouth are aware that old and new measures can both be contained within the new Sustainability programme. By acting locally and thinking Globally then Local Agenda 21 can be the common ground where each can meet and be addressed.

Table 1. Step by Step Guide for Portsmouth City ;

Managing And Improving the Council's own environmental performance	**Integrating Sustainable Development aims into the Local Authority Policy and Strategy programme**
Corporate commitment	Green Housekeeping
Staff training and raising awareness	Land use planning
Environmental management systems	Transport policies and programmes
Environmental Budgeting	Economic development
Policy integration across all sectors	Tendering and purchase provider splits
	Housing Services
	Tourism integration / visitor strategies
	Health strategies
	Welfare, equal opportunities and Poverty
	Explicitly environmental services

Source :(LGMB.LG0116 [3])

Step by Step guide for Portsmouth City (Continued)

Awareness raising and education	**Consulting and involving the Public**
Support for environmental education	Public consultation process
Awareness raising events	Planning for real (Environmental)
Visits and Talks	Feedback mechanisms
Support for voluntary groups	Parish maps
Public and local information	Focus groups
Press releases	Foray
Initiatives to encourage behaviour change and practical action	
Measuring, Monitoring and reporting on progress towards Sustainability	**Partnerships**
Environmental monitoring	Meetings, workshops and conferences
Local State of the Environment report	Working groups and advisory groups
Sustainability Indicators	Round Tables
Targets	Environmental City model
Environmental Impact Assessment (EIA)	Partnership initiatives
Strategic Environmental assessment	Developing World partnerships/ support

Source :(LGMB.LG0116 [3])

1.3. Local Government management Board (LGMB) Recommendations

A series of publications have been produced by the LGMB as indicated in the earlier section relating to the Step by Step guidance for Local Authorities to follow for their Agenda 21 programmes. The Board have also produced specific "Environmental Practice in Local Government" and its purpose is to spread the environmental message even further throughout Local Government within the United Kingdom, in Europe and beyond in England. The prime objective is to enable the improvement of the environment within the respective Local Authority and to progress towards Sustainable Development. The particular area of interest are the sections relating to Energy, the recommendations made and guidelines to follow for Local Authorities. The environmental impact of burning fossil fuels to heat, light and power our buildings and vehicles is significant, especially in the areas of resource depletion, atmospheric pollution and Global Warming, the "Greenhouse effect". By using energy more efficiently and maximising the use of renewable energy resources such as solar, wind, geothermal, hydro and biomass the contribution that energy consumption makes to Global Warming can be significantly reduced.

Technologies exist that could reduce Local Authority energy consumption by between 33% and 50% by the year 2025. (EPLG,1992 [4])

Portsmouth and other Local Authorities can meet the challenge of this essential reduction target, however the identification of resources such as time, money, manpower and the development of environmental management structures are required in order to implement the technologies.
Many new approaches have been adopted for the improved energy management over the past decade and the following improvement recommendations are proposed by the Local Government management Board;

- **Information technology** : Advances in this sector have enabled energy management systems to be developed, which have been installed in many Local Government buildings. These systems enable temperatures, relative humidity, energy consumption and other variables to be read remotely and stored onto computer. After computer analysis the operation of the plant equipment is possible, which allows f
or more environmental control.

~ **Combined Heat and Power (CHP)** : Developments in small scale heat and power systems have resulted in the main from developments in information technology and the need to conserve energy and reduce pollution levels such as nitrogen oxides, sulphur oxides, particulates, volatile organic compounds and carbon dioxide emissions. The cost of maintenance of small scale gas fired engines that produce both electricity and useful heat has been significantly reduced with computer based monitoring and control systems. In the absence of more than one or two large scale City wide Combined Heat and Power plants in the United Kingdom, small scale CHP units are the most effective way of reducing carbon dioxide emissions. Using a CHP unit to provide electricity to buildings increases the efficiency of energy utilisation when compared to conventional power generation from the national grid system by approximately 30% to as much as 80%.

~ **Management Information** : Information technology improvements have also resulted in improvements and advances in management controls and information to building users. Energy managers can predict energy consumption based upon the previous year's consumption data. They can then estimate costs and so provide vital budgeting details to building managers.

~ **Efficiency Improvements** : The efficiency of lighting and heating appliances has improved. Lighting developed over the last decade includes the compact fluorescent lamps that use approximately 80% less energy than the conventional Tungsten filament lamps and last up to eight times as long. Also occupancy or daylight detectors are used significantly their function to switch on or off lights dependent on ambient light levels. High efficiency heating boilers have also been developed such as the Condensing boiler.

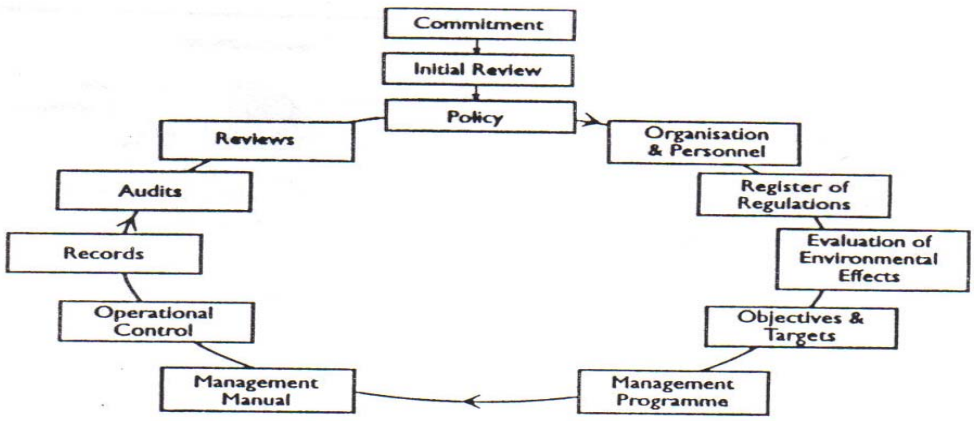
~ **Transport** : Improvements in the Transportation Sector have not been fully seen in this area. The energy efficiency of the fossil fuel petroleum or diesel engines has not improved significantly. However, Local Authorities could improve the energy efficiency of their own transport fleets.

1.4. Interfaces with BS7750 & EMS

BS7750 and EMS (Environmental Management System) are forms of environmental quality systems which can be used as a tool to control potential environmental impacts from an organisations activities. A consolidated approach to energy efficiency, pollution control and environmental management can all be linked to a quality system such as the British Standard Institute BS7750 system. Currently Portsmouth City Council have gained accreditation to the BS5750 system in the City Engineers Client and Consultancy services departments. This particular management system, although not an environmental one is designed to ensure that the specifications for a service or product is meet consistently. This system became synonymous with the International ISO9000 in 1987. BS5750 enables the Council to check its own system of management, or be assessed by external agencies and can be used to evaluate contractors, sub-contractors or suppliers before committing themselves to any contractual arrangement with one of the competing parties. The Engineers department gained full accreditation in June 1995 in all sections and only exhibited three minor non-conformances.

With reference to the aspirations of the Council to eventually gain accreditation to an environmental management system such as BS7750, the National Accreditation Council for Certification Bodies (NACCB) have indicated that this could be possible over a period of two years in the City Engineers sections and five years throughout the corporate Council as a whole. The BS7750 key elements can be seen in figure (i), appendix 1. The Eco Management and Audit Scheme (EMAS) system is designed by the Local Government Management Board and is a voluntary scheme to encourage Local Authorities such as Portsmouth City Council to manage their environmental impacts in a systematic and considered manner. The scheme came into operation in April 1995 and provides for the protection and enhancement of the environment, which is one prime issue concerning all Local Authorities, either in a local sense or at the same time in a wider global sense.

BS7750 Key Elements



The growth of environmental awareness and inter-generational dimensions, commonly addressed as the concept of "Sustainable Development" makes such a scheme worthy of merit. EMAS offers an important mechanism to help develop a more systematic approach to issues throughout the Local Authorities activities. It has been identified as a critical step in preparing for Local Agenda 21 policies, strategies and action plan implementation.

EMAS has been established for the evaluation and improvement of the environmental performance of the Local Authorities in all its activities, services and information releases to the public.

The objective of the scheme is to promote continuous improvements in the environmental performance of a Local Authority by ;

- the establishment and implementation of environmental policies, strategies and management systems by Local Authorities in relation to their Departments, Divisions, Sectors or other operational units.

- the systematic , objective and periodic evaluation of the performance of such elements

- the provision of information on the environmental performance to the public

The EMAS system is different from the BS7750 management system only in as much that it does not have to be introduced throughout the whole of the corporation at the same time. Each Department such as the Portsmouth City Engineers Section could introduce BS7750 when and if required. It should however be adopted as a whole corporate venture, which could take five years as a means of leading the Agenda 21 programme and demonstrating to the local community that the Council has its own house in order.

1.5. Summary

Environmental impacts of man's activities have resulted in problems associated with deforestation, Global Warming and general degradation of the planet Earth. The declaration made in 1972 at the United Nations Conference Earth Summit has established new levels of co-operation amongst Member States in the form of the Agenda 21 programme for Sustainable Development . The United Kingdom Local Agenda 21 programme has been launched and the Local Government Management Board have produced detailed documentation pointing the way forward for Local Authorities to achieve Sustainable Development. The main focus areas were indicated as being Environmental Protection, Provision for the Future, Quality of Life and Fairness. In order for Local Authorities to be effective in the implementation of the Agenda 21 programme they must first be seen as competent and leading by example. Awareness and satisfaction with Local Authorities has significantly increase in recent years according to the 1995 MORI survey on the subject. This factor should make the implementation of Agenda 21 policies , strategies and action plans easier to be accepted and adopted by the public, industry and commerce.

The environmental impacts of burning fossil fuels to heat, light and power our buildings and vehicles is significantly high which had promoted the Government to set up various Departments such as the Energy Efficiency Department of the DTI and ETSU in order to provide best available technological advise to achieve energy efficiency. The energy consumption reduction targets set by the LGMB over a thirty year period are realistic and in line with Member States targets, namely 30% to 50% reduction by 2025. This will, if achieved by Local Authorities help minimise the increasing levels of pollution and Global Warming emanating from countries such as India and China, which are seen as the countries which have the most significant environmental impacts in the future due to their development and population growth rates. Within the United Kingdom the BS5750/BS7750 and EMAS environmental management systems exist which could help Local Authorities, industry and commerce to achieve control and reductions in environmental impacts due to their actions. These systems will enable monitoring of emissions of CO_2 , NOx, SOx, CO and VOC's and the particulates to be made, the establishment of environmental policies, strategies which will work towards reducing energy use, emission levels and decrease the Global Warming affect of Portsmouth. Portsmouth City could implement BS7750 corporately over a period of five years.

Chapter 2

Major Environmental issues in Portsmouth

In order for the initial objective of the project to determine objectives to be achieved by the Integrated Energy Policy, strategy and action plans it was necessary to determine the local environmental issues associated with the City such as Transport, Housing, Pollution levels and Energy use by researching relevant data such as demographic, social, commercial, industrial, trends in energy use and transportation statistics. This Chapter is concerned with identification of these issues and to indicate areas of strength and weakness in order for the current situation to be assessed and proposals made for reducing the environmental impacts, energy use and CO_2 emission levels within the forthcoming Integrated Energy Policy.

2.1 Local Environmental issues in Portsmouth identified by City Marketing Department

Portsmouth as a City has much in common with other Cities, both in terms of development, infrastructure, activity and proposals for strategic action plans for the 21st Century. Each City has its own set of particular environmental concerns and issues it must address and for this reason no two Cities can be directly compared as being the same. Similarities do exist within the English Cities which have experienced common political policies which govern the mode of authority and areas of responsibility. Portsmouth City has a wide scope of environmental issues to be addressed, these will be made more significant in the Unitary reorganisation status the City has been granted in May 1995 to commence in 1997. The main long term environmental issues which exist according to the Councils head of Marketing in a 1995 report were;

- Scale, type and location of new development and re-development projects
- Waste and recycling, built environment and open space
- Pollution, contamination, litter & cleansing
- Ecological issues such as sites of special scientific interest
- Environmental health services, advice and help to improve diet /lifestyle
- Use of energy and renewable resources
- Traffic and congestion

Project identification of major environmental issues in Portsmouth relating to energy

Portsmouth City has the following project list of the major problems personally identified;

- **Transportation:** major problems with pollutants from vehicles, SOx, NOx, VOC, CO_2, fossil fuel energy use.
- **Waste Disposal:** landfill site exhausted at Paulsgrove to the North of the City, CH_4 gas emissions from the landfill
- **Energy Efficiency:** profile of environmental impacts of energy use is low
- **Housing profile**: raising the housing stock energy efficiency profile in line with the National Home Energy Rating Scheme
- **Energy production**: National grid supply could be improved upon in terms of efficiency, less pollutants if CHP adopted
- **Affordable warmth** energy poverty, residents not being able to provide for adequate heating
- **Building Regulation:** new developments such as the Renaissance of Portsmouth harbour project do not meet with the concept of Sustainable development
- **Lighting:** low wattage, high efficiency lighting and control systems
- **Renewables**: strategies required to meet Agenda 21 agreements on the promotion of alternative energy resources and in line with the Non-Fossil Fuel Obligation (NFFO)
- **Monitoring:** energy monitoring needs to be controlled and developed
- **Management**: profile of energy matters being explicit in management decision making must be encouraged
- **District Heating**: the district heating scheme - efficient use of energy from the incineration of MSW utilising CHP
- **Finance**: identification of European / United Kingdom grants

2.2. State of Portsmouth City: Environment Report 1992.

A detailed study of the "State of Portsmouth City's Environment (STOE [5]) was drafted in 1993, from this report the estimate for the amount of energy used in the City was determined. There is little specific data available which can be readily obtained from either the electricity companies or gas companies which service the City. The STOE report did however cross correlate data from the London Energy Study, published in September 1993 and the "Energy and the Environment Strategy for a major Urban City Centre" report for Newcastle and using conversion factors for population and per capita energy consumption, employment and income, an approximate energy consumption figure was obtained. The figures for the total energy usage for the City of Portsmouth must be regarded with caution as they are only estimated and each City is different from the other in terms of exact employment, energy trends, demographics and income levels. The transferred results of the calculation performed for Newcastle and Portsmouth's total energy / fuel consumption is indicated in Table 2.

Table 2. Total energy consumption breakdown for the City of Portsmouth

Electricity	**775 GWh/Y**
Gas	**1544 GWh/Y**
Oil	**295 GWh/Y**
Petroleum	**560 GWh/Y**
Diesel	**232 GWh/Y**
Aviation fuel	**60 GWh/Y**
Refuse derived fuel (RDF)	**49 GWh/Y**
Coal derived solid fuel	**239 GWh/Y**
Total	**3808 GWh/Y**

The above values for energy use result from the use of energy by the population of Portsmouth which amounts to 187000 domestic inhabitants, 5695 industrial and commercial buildings and a population per hectare of 43.4 persons per ha. There is an unemployment level of 12.7% males and 7.29% females and 57000 in a need category. (After STOE [5])

Table 3. Southern Electric Regional Energy Consumption for the S/E.

Sector	1993 GWh	1994 GWh	1995 GWh	Growth %
Estimated				
Domestic	10,309	10,615	10,825	+ 2.0
Commercial	9,101	9,134	9,446	+3.4
Industrial	5,956	6,027	6,283	+4.2
Other	645	637	615	-3.5
Total	26,011	26,413	27,169	+2.9
Actual				
Domestic	10,298	10,641	10,574	-0.6
Commercial	9.097	9,143	9,354	+2.3
Industrial	5,956	6,029	6,265	+3.9
Other	645	637	615	-3.5
Total	25,996	26,450	26,808	+1.4

Source : (S.E.1995 [6])

The figures obtained in table 3 were supplied by Southern Electric for the S/E region as a whole for up to July 1995, with historic data for 1993 and 1994. The following figures relate to the STOE report for the City of Portsmouth with the assumption that Portsmouth has a similar structure in primary energy production as Newcastle. The primary energy supply for Portsmouth is 18% of electricity supplied from the burning of coal, 22% electricity generated by nuclear power stations (which is 20% of total energy),45% is accounted for by gas systems, 1% oil generation and 14% other.

The consequent atmospheric pollutants for Portsmouth would be ;

~	**Carbon dioxide**	**(CO_2)**	**1,505,308**	**tonne**
~	**Carbon monoxide**	**(CO)**	**11,603**	**tonne**
~	**Sulphur dioxide**	**(SO_2)**	**11,080**	**tonne**
~	**Nitrogen dioxide**	**(NOx)**	**5,475**	**tonne**
~	**Methane**	**(CH_4)**	**3,715**	**tonne**

Both the figures for energy use and atmospheric pollution levels were estimated against the total area of Portsmouth City which extends beyond Portsea Island.
(After STOE [5])

2.3. Strengths and Weakness of current Council Framework

In reviewing energy management within any Organisation it is paramount to determine the Organisational Profile to energy management. The profile can be easily obtained by using table 4, designed by the Energy Efficiency Office " The Energy Matrix".

Before viewing Table 4 a brief explanation of the use of the Matrix is required. There are six columns and five rows in the Matrix, each row has a level number associated with it in the range of 0 - 4. The lowest form of energy management has the level number 0 associated with it, the highest and most desired energy management profile has the number 4 associated with it. A profile can be drawn for the City Council by identifying were at the present moment in June 1995 the City Council is at each stage of the Matrix.

Table 4. Energy Management Matrix.Energy Workshop,Brighton 1995

Energy Policy	Organising	Motivation	Comms Systems	Marketing	Investment
Active commitment of top level management	Fully integrated into general management	All staff accept responsibility for saving energy	Detailed system, with effective management reporting	Extensive marketing within and outside organisations	Positive discrimination in favour of "green - Schemes"
Formal policy but no commitment from top	Clear delegation and accountability	Most major users motivated to save energy	Monthly monitoring and targeting for individual premises	Regular publicity campaigns	Same appraisal criteria used as for all other investment
Unadopted policy	Delegation but line management and authority unclear	Motivation patchy or spasmodic	Monthly monitoring and targeting by fuel type	Some adhoc staff awareness training	Investment with short term payback only
Unwritten set of guidelines	Informal part-time responsibility	Some staff awareness of importance of energy saving	Invoice checking	Informal contacts used to promote energy efficiency	Only low cost measures taken
No explicit policy	No delegation of energy management	No awareness of the need to save energy	No information system or accounting for consumption	No marketing or promotion	No investment in energy efficiency

Source : (Brecsu,1995 [7])

The energy profile line obtained above indicates an unbalanced approach to energy management within the Portsmouth City Council. The ideal profile line should be a horizontal line in level 4, as indicated above the line ranges from "Energy policy column , level 3" down to "Organisation column, level 2", to "Motivation column, level 2", up to "Comms Systems, level 3", then down to Marketing column, level 1" and finally up in "Investment column, level 2". When each respective box is linked together with a line then the line can be seen to be unbalanced and not a straight horizontal line, thus indicating an unbalanced energy management approach by the Council. In order for energy management to be more effective then the profile has to be slowly brought up to level 4 in all columns, ending up a straight horizontal line. Once the line has been raised and each weakness strengthened then the Council will have a balanced energy management profile.

In setting out to improve energy management in the Council the changes have to be consciously managed. As indicated, energy use has associated environmental impacts and if the Council is to minimise these impacts and reduce the Global Warming factor locally then this profile must be raised. It is important to identify the issues with the highest priority, a review of how well an energy manager is functioning and performing is required and it is essential to assess the quality and level of support which the Council is giving in the pursuit of energy management. The support could be in areas of manpower delegation, finances and time allocation. It remains important to determine what the Council are trying to achieve, what help is required and identification of the antagonism and resistance to the implementation of the Agenda 21 Integrated Energy Policy and action plans. Senior management teams within the Council have a limited time to hear the case for energy efficiency and have been made briefly aware of the economic gains and environmental gains to be made by Agenda 21 action plans. Awareness has been raised for the need to set up an "Energy Fund" where the economic savings on energy can be centrally pooled for corporate ventures. A case made to the management team was that reductions in energy use can reduce the environmental impacts associated with the Council's activities. On establishing the Integrated Energy Policy and adopting it, the Council has raised the profile in the Energy Policy column on the Matrix up to level 4.

Once the financial commitment has been gained, time and resources are made available then it will be possible for the Agenda 21 action plans to be put into practice. There needs to be a steady movement up the Matrix which is estimated at approximately two years. Numerous strengths in the field of engineering, planning control, waste management, environmental health and building services exist and commitment to energy management.

There are several areas of weakness however which may prevent the Council being effective under the Agenda 21 programme. Decades of local government cut-backs and re-organisation have left their mark. The Agenda 21 programme will not be achieved without increased levels of communication between Departments, financial allocations, time and manpower commitments.

A proactive approach is required to Agenda 21 and not a reactive approach in order to consolidate and facilitate positive actions. Local Authorities are severely restricted financially by Central Government. The City Council must pressurise Central Government into releasing financial assistance to enable the Agenda 21 program to be successful. The ambitious targets set within the Integrated Energy Policy and forth coming strategy are realistic and achievable and must be communicated both to senior management and staff across the Council Departments as a whole. The political benefits of a City embarking upon environmental management must be highlighted and given an eminent profile in the political arena and media. The identification of how this can transform the image of Portsmouth City as being an environmental action City has already been determined by the Marketing Department report earlier by Mr Martin Evans in a reply to the City manager. Global Warming , as an example can be minimised by Local Authority energy efficiency programmes and by each inhabitant of the City of Portsmouth.

European funding is currently being sought from the Thermie and Joule programmes for energy efficiency throughout industry and commerce by the City Council in September 1995, once obtained then significant environmental gains can be made, air quality improvements made and reductions in energy consumption made. The main areas in which the grants could be used is in the provision of affordable warmth for Council tenants by funding energy efficient projects such as cavity wall insulation, solar hot water system installation and efficient lighting, help with the transportation problems, by initially funding the Light Rapid Transit proposal and cycle ways. Another major area where help could be given is the recovery of energy form domestic waste by funding an incineration unit and recycling plant.

Another area of weakness has been identified in this report, that of the problems associated with Compulsory Competitive Tendering (CCT). A recent report from the Local Government Audit Commission indicated that CCT should be more actively encouraged, at present many contracts are let to single bidders CCT was introduced in 1988, since that time little effective competition exists in many areas of activity. Seven areas were investigated including, Sports and Leisure Management, Internal Catering, Other Catering, Vehicle maintenance, Building Cleaning, Other Cleaning, Ground Maintenance and Refuse Collection & Disposal. In the areas investigated within the Council, only 25% of Councils received a contract from inhouse teams. (LGMB Survey [8]

In order for the Council to reduce running costs they should encourage more competition by investigation into methods to encourage more companies to tender should be made with the possibility of the contracts being smaller. Contractors, at present withdraw bids due to complaints regarding specifications, paperwork, size and for company strategic reasons. The example of waste refuse tender drop-out rate is a good one, the rate being very high, environmental impacts could increase if the company winning the contract has not the "Best Available Technology" to deal with that waste. With increased competition then the technological choices for waste disposal or energy efficiency could be made , thus keeping to the Agenda 21 remit for Sustainable Development.

2.4 Summary

Portsmouth City covers an area of 4042 hectares and is the most densely populated City in England with a population density of 43.4 persons per ha. The number of residents amount to 187000 in domestic dwellings and a total of 5695 industrial and commercial buildings. The City is bound on three sides by water and has sites of special scientific interest and unique conservation areas in Portsmouth Harbour, Langstone Harbour and Farlington Marshes. The City also has close links with its neighbours Fareham, Gosport and Havant and will gain Unitary status, independency from Hampshire County council in 1997. The current unemployment rate for males is 12.7% and females 7.29% which will effect the disposable income levels, purchasing and transportation choices of this socio-economic group. The number of people employed by the Ministry of Defence in the City has fallen by 15% indicating the run down of Portsmouth as a whole. There exists in the City 57000 people in a need category and in the Portsea area in the south of the City there is a 5.5% level of unemployment. All of the above factors have a significant effect on energy use and affordable warmth criteria under the Agenda 21 program.

Benchmark data has been established for many buildings within the City for comparison for the effectiveness of the Agenda 21 program. Portsmouth has in the period 1981 to 1991 a 45% change in OUTGOING commuting from the City and 70% of all journeys in the City are undertaken by car and the level of tourism has grown to 82% day trippers, 50% came from the S/E region and over 75% had been before and 20% of all visitors were from abroad. The new Portsmouth Harbour development project will draw an estimated 1.6 million visitors to the City. There exists 1100 thousand square metres of empty industrial property in the City, 5000 square metres of vacant commercial office space and approximately 200 square metres of vacant shops. Long term illness in the City runs at 100 GB index, the highest throughout the region. Throughout the England as a whole there is a future requirement for a further 4.4 million one parent family homes by the year 2016 which will have a considerable effect on energy consumption in Local Authorities and Portsmouth City Council must make adequate development plans with energy efficiency measures contracted for in each new development.

The detailed study of the City in terms of the energy consumption has indicated electricity usage for the wider Portsmouth City Boundary an estimate of 775 GWh per annum and an estimate for the Portsea Island area being 600 GWh per annum. Gas consumption is 1544 GWh per annum, Oil 295 GWh per annum, Petroleum 560 GWh per annum, diesel 232 GWh per annum and Coal 293 GWh per annum. The emission levels for the City were estimated as 1,505,380 tonne of CO_2, 11,603 tonne of CO, 11,080 tonne of SO_2, 5,474 tonne of NOx and 3.715 tonne of CH_4, all values were obtained from the Agenda 21 report "Portsmouth - The State of the Environment-1993".

There exists an unbalanced approach to energy management throughout the Council, as highlighted by the Energy Management Matrix recommended by the Energy Efficiency Office. The main area which needs to be addressed is Marketing who should raise the level of energy efficiency within the City, both internally and externally. Motivation and investment is needed to help achieve the short, medium and long term energy consumption reductions of between 33% and 50% by the year 2025. Compulsory Competitive Tendering has hindered effective communication and positive co-operation between Council Departments and caused problems in the Tender drop out rate. All new projects within Portsmouth should have specific environmental clauses in them and major projects should consider the adoption of environmental impacts statements.

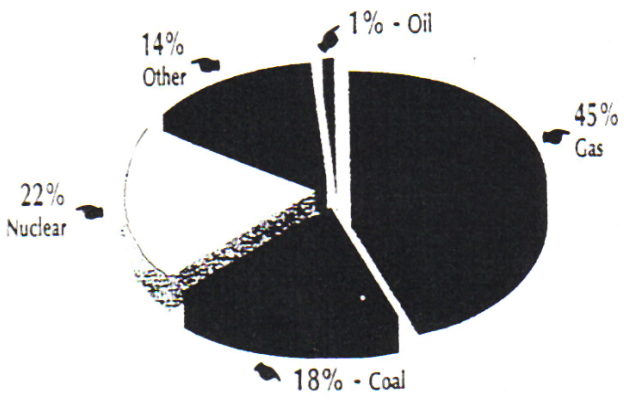
Chapter 3. Environmental impacts of energy use

This Chapter aims to determine the environmental impacts of energy use on a global level, energy production levels, indicating trends historically, current and future together with determining the global CO_2 emission levels in the United Kingdom for the year 1990. Identification of domestic, industrial, commercial, service sector and transportation energy models were examined which have enabled the Working party gain a more in depth knowledge of the environmental impacts of energy use and also as an aid to determining another objective of the project Report of methodology to be adopted in the Integrated Energy Policy.

3.1 Global energy use

One of the most challenging aspects of Sustainable Development is that of energy use. The Local Agenda 21 program for a City Authority such as Portsmouth to adopt poses some interesting concepts. These concepts include the development of policies and strategic action plans which will lead the City into an energy efficiency mode over the next thirty years and more. To bring relevance to those policies and strategies it is important to determine global use of energy, United Kingdom energy use and more importantly Portsmouth City's energy use, which was established earlier. One major result of energy production and consumption, as seen in fig 1 is the of the Greenhouse gas CO_2 produced as a result of the extraction and burning of fossil fuels.

Figure 1. European Energy per consumption



Source : (O'rierdan [9])

Tackling the problems of energy use is an extremely complex and enormous undertaking, since all developing and developed countries are dependent upon the use of fossil fuels within their industrial, commercial and agrarian societies. Many developing Countries have their own resource supplies of fossil fuels and many of those Countries are too far down the development line to even consider the energy efficiency technology which exists to minimise the environmental impacts such as Global Warming resulting from greenhouse gas emissions. All societies are dependent upon energy and the World commercial energy use for the period can be seen in figure 1. Global Warming will result in rising sea levels, flooding of low-lying coastal regions with devastating effects on agricultural land and fresh water supplies which may be contaminated by salt water and cause water shortages. The United Nations Intergovernmental Panel on Climatic Change (IPCC) indicated that over 300 of the World's leading climatologists stated in May 1990 that emissions from human activities are substantially increasing the concentration of greenhouse gases in the atmosphere which will enhance the greenhouse effect resulting in additional Global Warming. If emissions continue to grow at present rates the average temperature rise may be 1^0C higher by 2030 and 3^0C higher by the end of the 21st Century.

There has been a steady growth in energy use throughout the United Kingdom and the World in general, consequently an increased level of emissions of SOx, NOx, CO_2, volatile organics and particulates. Economic activity, development and energy use are intimately linked. It does not always follow that increased economic growth and activity result in increased use of fossil fuels and energy use, as seen in appendix 1, figure 2. In the more developed countries energy intensity has decreased, this has been mainly due to the improvements in material science and energy efficiency. The maximum energy intensity has progressively decreased over time and developing Countries can avoid the experience of developed industrial Countries by using energy in a more efficient manner and incorporate Agenda 21 policies and strategies within their Governmental programmes.

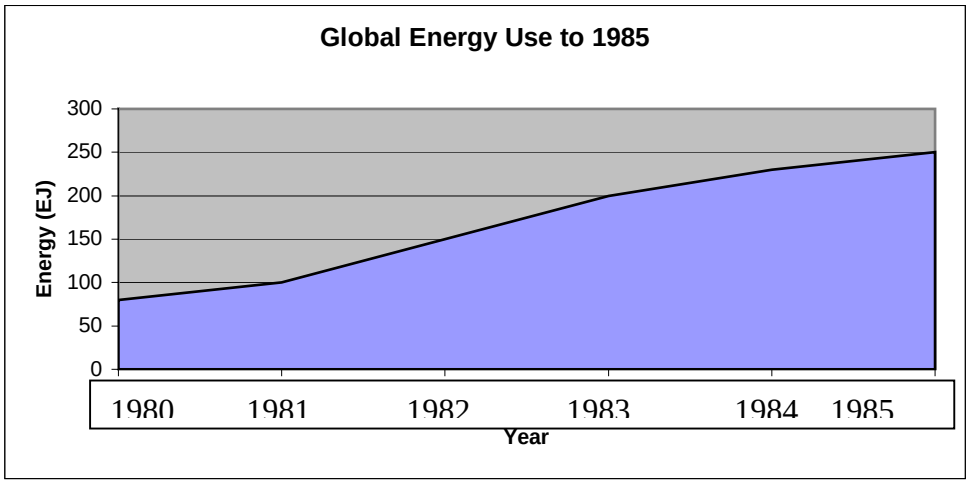
In 1994 the British Petroleum figure for total World primary energy consumption was estimated as 7804.3 million tonnes of oil equivalent. Source : (BP, Stats [10])

In order to determine the energy consumption problems within the European Union Member States it is essential to determine the trend in energy consumption and investigate how that consumption has changed in recent years and to try and estimate future consumption trends.

The European Union (EU) energy market place has changed fundamentally since the Second World War, which commenced in 1939 and ended in 1945. There has been a shift in primary energy consumption of 100% in the first three decades up to the early 1970's. Large scale displacement of the primary fossil fuel of coal to that of oil and natural gas resulted, oil had accounted for 10% of European energy requirements in the 1950's, this figure increased to 59% in 1973, nuclear power was utilised which then accounted for 14% of EU energy production, in 1990 it accounted for 22% of the energy production total.

As a result of the insecurity of energy supply the EU has attempted to conserve energy and moderate consumption to approximately 1,000 Mtoe per annum and also reduce the dependency on imported oil in order to achieve diversification in energy production, as indicated in figure 2.

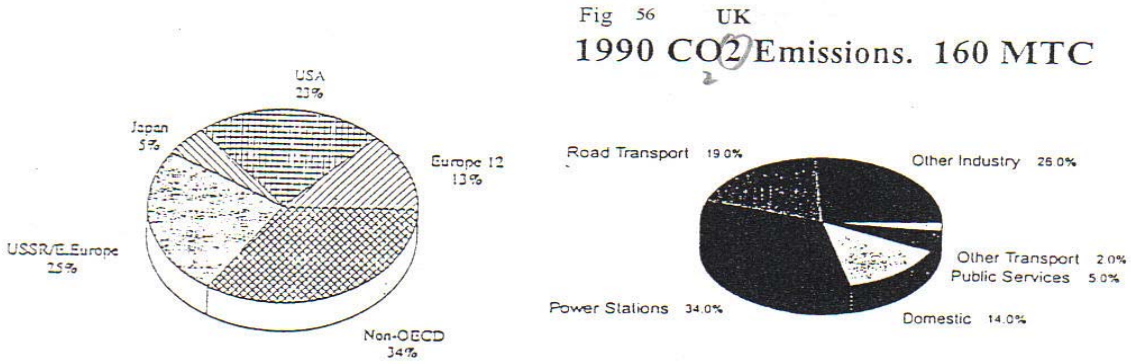
Figure 2. European Energy Consumption 1990



Source :(Thermie [11])

The 1990 energy consumption levels are important in terms of European and United Kingdom proposals to stabilise the consequential carbon dioxide emissions which emanate from the burning of fossil fuels. The UK Member State is attempting to stabilise the level of carbon dioxide at the 1990 level of 160 MTC, the sector breakdown of carbon dioxide emissions can be seen in figure 3.

Figure 3. World CO2 Emissions &. UK emission 160 MTC



Source 12

The total emissions by all Member states is indicated in Table 5.

Carbon dioxide contributes the largest proportion of EU pollutant emissions and accounts for half the Global Warming effect associated with greenhouse gas emissions.

Table 5. Total European Union Member States emission of five pollutants

Pollutant	**Total Emissions in Millions of Tonnes**
Carbon Dioxide (CO_2)	35,000
Sulphur Dioxide (SO_2)	12,225
Nitrogen Oxides (NOx)	10,452
Volatile Organic Compounds (VOC's)	5,234
Carbon Monoxide (CO)	33,009

Source : (Thermie [13])

The sector use of energy can be seen in appedix 1, figure 3, which indicate how energy is consumed within our societies which is an important factor to consider for future reduction target areas. Energy projections must be accounted for in order for Portsmouth City Council to target for reduction in future energy consumption within the proposed Agenda 21 Integrated Energy Policy. A recent publication from the Department of Trade and Industry in March 1995 called the "Energy Paper 65.Energy Projections for the UK" indicates energy use and related emissions of carbon dioxide in the UK for the period 1995 - 2020. The publication proposes six scenarios in its projection estimates as seen in Table 6 ;

Table 6. Energy Paper 65 scenarios [14]

~	**LL**	Low GDP growth	-	Low fuel prices
~	**LH**	Low GDP growth	-	High fuel prices
~	**CL**	Central GDP growth	-	Low fuel prices
~	**CH**	Central GDP growth	-	High fuel prices
~	**HL**	High GDP growth	-	Low fuel prices
~	**HH**	High GDP growth	-	High fuel prices

The estimates for both primary energy demand and carbon dioxide emissions for the period 1990 to 2020 can be seen in table 7 and table 8.

Table 7 Total United Kingdom Primary Energy Demand 1990 - 2020 in Mtoe (Temperature adjusted)

Scenario	1990	2000	2010	2020
LL	221	231	245	262
LH	221	226	237	253
CL	221	237	257	283
CH	221	232	249	273
HL	221	240	266	298
HH	221	235	258	289
Energy Paper 59 Range	221	216-245	237-311	256-381

Source : (EP65 [14])

Table 8 UK Carbon Dioxide Emissions 1990 -2020 in MtC (Not temperature adjusted)

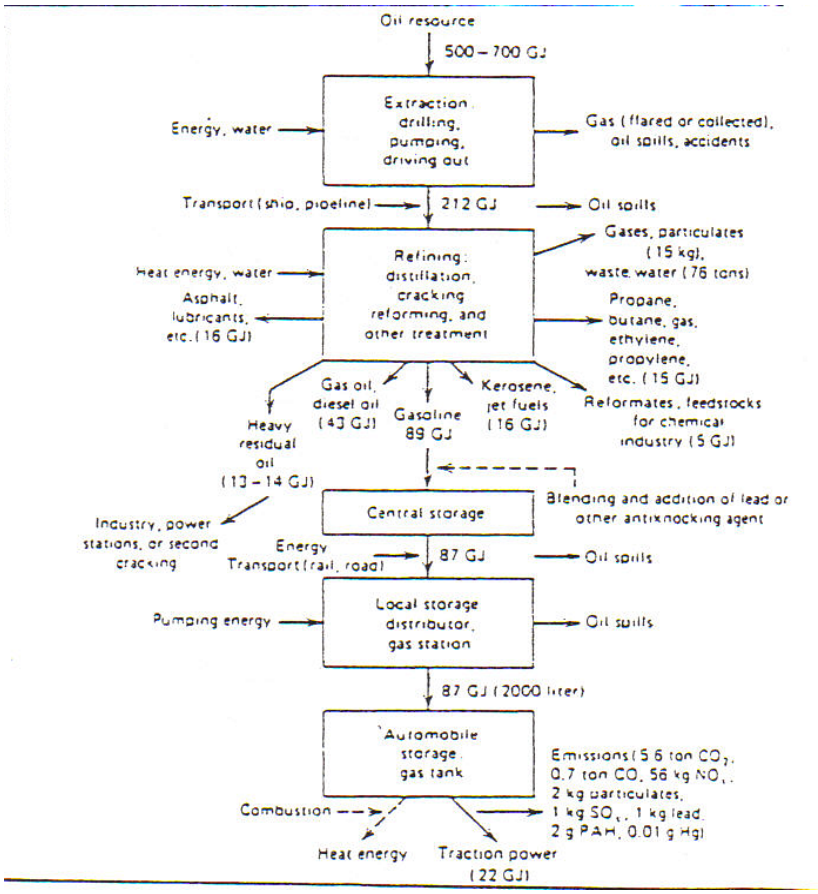
Scenario	1990	2000	2005	2010	2020
LL	158	147	157	155	171
LH	158	144	154	154	173
CL	158	150	162	162	184
CH	158	148	159	161	188
HL	158	152	165	167	193
HH	158	151	163	165	197
EP59 Range	158	156-178	165-200	172-227	186-283

Source : (EP65 [14])

3.2 Environmental Impacts of Energy use

The use of energy in the environment results in significant environmental impacts. For this reason the International Energy Agency (IEA) organised an expert workshop in May 1992 which focused on the area of Life Cycle Analysis (LCA) of energy systems. The objective of the workshop was to determine a methodology for the LCA which enabled the impacts on the environment to be determined for specific energy resources such as natural gas, oil and uranium. Recommendations for the choice of energy to be used by the Portsmouth City Council and contractors can be specified in design specifications and contractors terms of reference, in terms of "the least environmental impact" is best. The following three figures will indicate the LCA for three energy resources; oil, natural gas and uranium , used in nuclear energy power stations.

Figure 4. Life Cycle Analysis of the resource Oil as used in an automobile consuming 2000 litres of gasoline (typical annual load).



Source : (LCA [15])

Figure 5. Natural Gas usage chain for production of low-temperature heat or hot water to a building environment indicating environmental impacts

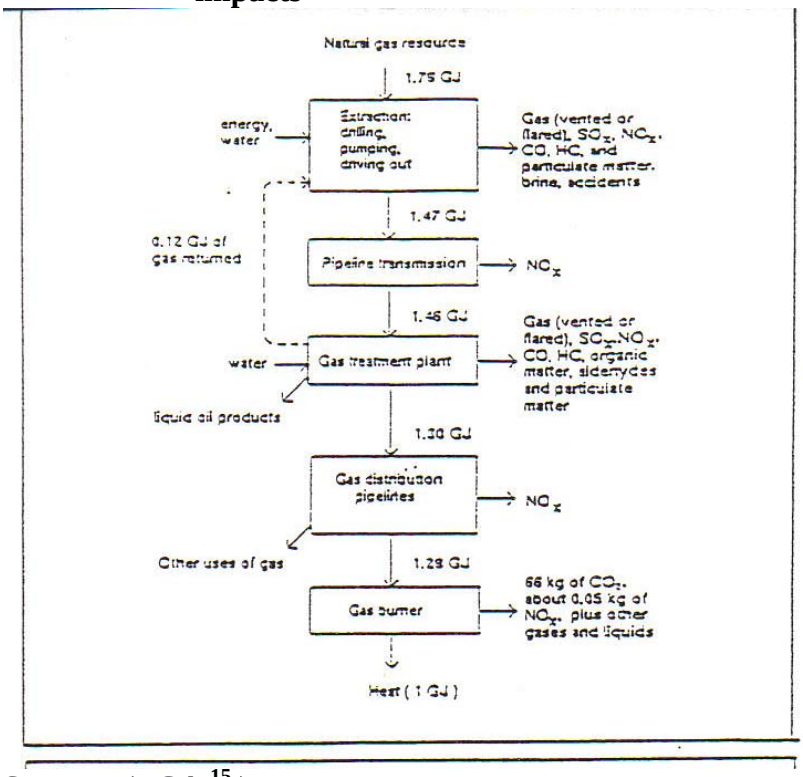


Fig 8 Natural Gas usage chain for production of low-temperature heat or hot water to a building environment .

Source : (LCA [15])

Figure 6. Nuclear power usage chain with indication of environmental impacts

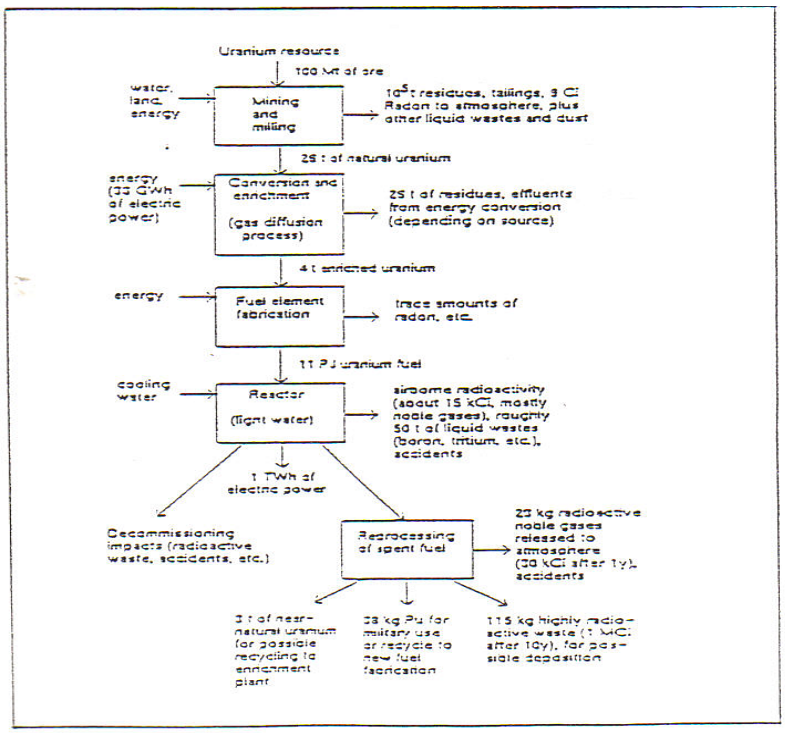


Fig 9 Nuclear power usage chain with indication of some environmental impacts.

Source : IEA (24) The LCA data was abstracted from the use of the TEMIS software (Total Emissions Model for Integra

Source :(LCA [15])

Other environmental problems associated with respective pollutants and quantities can be seen in table 9.

Table 9. Other major environmental impacts of energy use

Problem	Environmental Significance	Main pollutant	Quantity released UK World
Greenhouse effect	**Stratospheric accumulation of some gases may be changing Earth's energy balance, leading to climate change**	**Carbon dioxide** **Methane** **Nitrous oxide** **CFC's, NO_2, CO**	**160 MteC 7000** **3 Mte 250-500** **0.6 MteN 33-9**
Stratospheric ozone depletion	**Degradation products of CFC'S which react and destroy stratospheric ozone**	**Chlorofluoro-carbons** **-CFC11** **-CFC12** **-CFC113** **Halons**	 **31 Kte 350** **21 Kte 480**
Acid rain	**Reactions of acidic ions with water in atmosphere, acidifies precipitation resulting in acidification of receiving waters**	**Sulphur dioxide** **Nitrogen oxides** **Hydrogen-chloride** **Hydrogen fluorides**	**3.9 Mte 110** **2.3 Mte NO_2 69**
Waste management	**Extent of air/water/soil pollution problems caused by waste disposal make this a problem area in its own right**	**Household** **Industrial-effluent** **Hazardous - special waste** **Agricultural** **Mines/quarries-Construction** **Power stations** **Sewage Sludge** **Clinical**	**25 Mte 370** **2000 Mte** **3.9 Mte** **250 Mte** **133 Mte** **14 Mte** **11 Mte** **0.15 Mte**

Source: (Purvis & Culaba [16])

3.3. Carbon dioxide (CO_2) Equivalents for different fuels (1990) levels

The approximate energy consumption figure has been determined for the City of Portsmouth at 3808 GWh per annum and the carbon dioxide emission levels determined as 1,505,380 tonnes per annum. An understanding is required of how the carbon dioxide levels from various fossil fuels are estimated. In Table 10 the CO_2 equivalents at 1990 levels can be seen for different fossil fuels.

Table 10. CO_2 Equivalents at 1990 Levels

Fuel Type	Kg CO_2 / KWh	Kg Carbon / KWh
Coal	**0.31**	**0.09**
Coke	**0.44**	**0.12**
Other solid fuel	**0.48**	**0.13**
Gas	**0.21**	**0.06**
Oil	**0.30**	**0.08**
Electricity	**0.73**	**0.20**

1 tonne of carbon (C) is equivalent to 3.67 tonnes of carbon dioxide (CO_2)

Source:(Warren springs [17])

Electricity consumption from the National Grid system which is supplied in the main from power stations produces more carbon dioxide from the burning of fossil fuels than alternative forms of electricity production such as Combined Heat and Power (CHP). This remains an important factor for Portsmouth City Council to consider when setting energy reduction and carbon dioxide reduction targets in the future. Often, as indicated in the coming chapter on CHP, the energy efficiency of production of electricity when using a CHP system is approximately 40% more efficient than the conventional fossil fuel power station generation, due to the CHP utilising the waste energy. The gas fired CHP systems also emit less pollutants as a result of less sulphur content of the gas when compared with coal, which has significantly higher proportions of sulphur. It is the sulphur content which when in combination with the combustion product of oxygen results in Acid rain.

3.4 Environmental benefits of energy efficiency

The environmental benefits of energy use must be made aware in order for the City Council to determine advantages to the City of Portsmouth. The environmental benefits do to some extent depend on where the energy efficiency measures are implemented. For example, appliance efficiency measures would save particularly on all those emissions associated with the electricity supply industries including nuclear waste, CO_2, acidic emissions, heavy metals such as mercury.

Improved insulation however would show less reduction in emissions of the electricity supply since a relatively small percentage of space heating is provided by electricity. In general the environmental improvements are greater for each unit of electricity saved than they are for unit savings in other delivered fuels because of the increased quantities of primary fuels required to provide one unit of delivered electricity. The European Union has proposed a Community Action plan for improving the efficiency of electrical consumption. The effect of this action plan can be seen in table 11.

Table 11. European Union Community Action plan based on a 20% reduction in electricity consumption

Carbon dioxide emission reductions	**40 Million tonnes**	**7%**
Sulphur dioxide emission reductions	**540,000 tonnes**	**14%**
Nitrogen oxides emission reductions	**150,000 tonnes**	**6%**
Radioactive waste reductions	**6,500 cubic metres**	**20%**
Mercury emission reduction	**8 tonnes**	**15%**

Source:(Christie [18])

Table 11 indicates the emission reduction targets proposed by the European Union Community Action plan with the percentage reduction based on current levels.
It is clear from table 11 that a 20% reduction in electricity consumption would produce a pro-rata improvement only in the reduction of nuclear waste. Reductions in CO_2 and acidic emissions of NOx and SOx would be dependent upon, to some extent the efficiency improvements being made with respect to all delivered fossil fuels.

The proposed energy efficiency reduction of 20% was the target when the Energy Efficiency Office was first started in 1990. The environmental benefits of 20% energy consumption are illustrated in Table 12.

Table 12. Pollution emission reductions due to European Union Community Action plan for 20% energy consumption reduction.

Carbon dioxide emission reductions	**110 Million tonnes**
Sulphur dioxide emission reduction	**740,000 tonnes**
Nitrogen oxides emission reductions	**440,000 tonnes**
Radioactive waste reductions	**6,500 cubic metres**
Mercury emission reductions	**10 tonnes**

Source: (Christie [18])

3.5. Environmental Impacts of renewable energy

During 1991 - 1992 a technical assessment of each renewable energy resource was carried out by the Energy Technology Support Unit (ETSU) on behalf of the Department of Trade and Industry. The findings provided an expert perspective of how, under various views of the future renewables might contribute to the UK energy supply. Figure 7 to figure 9 were abstracted from the Energy Paper No.60 from the DTi in November 1992.

The assessment of each renewable energy source covered the state of its technical development, the scope for further improvements, the size of the UK energy resource and its potential usefulness in economic and environmental terms. There exists a wide range of contributions to the UK energy supply from the use of renewable energy resources. The ranged indicated was approximately 15 - 130 Terawatt hours per annum (TWh/Y) by the year 2025. In 1992 the electricity supply to the UK was estimated at 300 TWh/Y.

The range indicated of between 15 -130 TWh/Y is very wide and is an indication of the uncertainty in the renewable estimates. The assessment of heat producing renewables, such as passive solar design, photovoltaic cells and bio fuel technologies offer problems in estimating their contribution to supply. It remains however very substantial and offers considerable environmental and economic gain. The term accessible potential is often used in the renewable energy resource field and is the amount of renewable energy which would be technically possible to be derived, taking into account only basic constraints, which can be seen in figure 7.

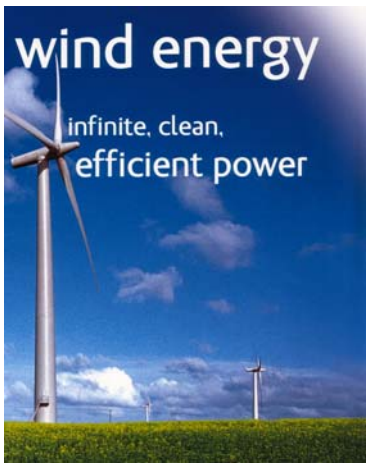
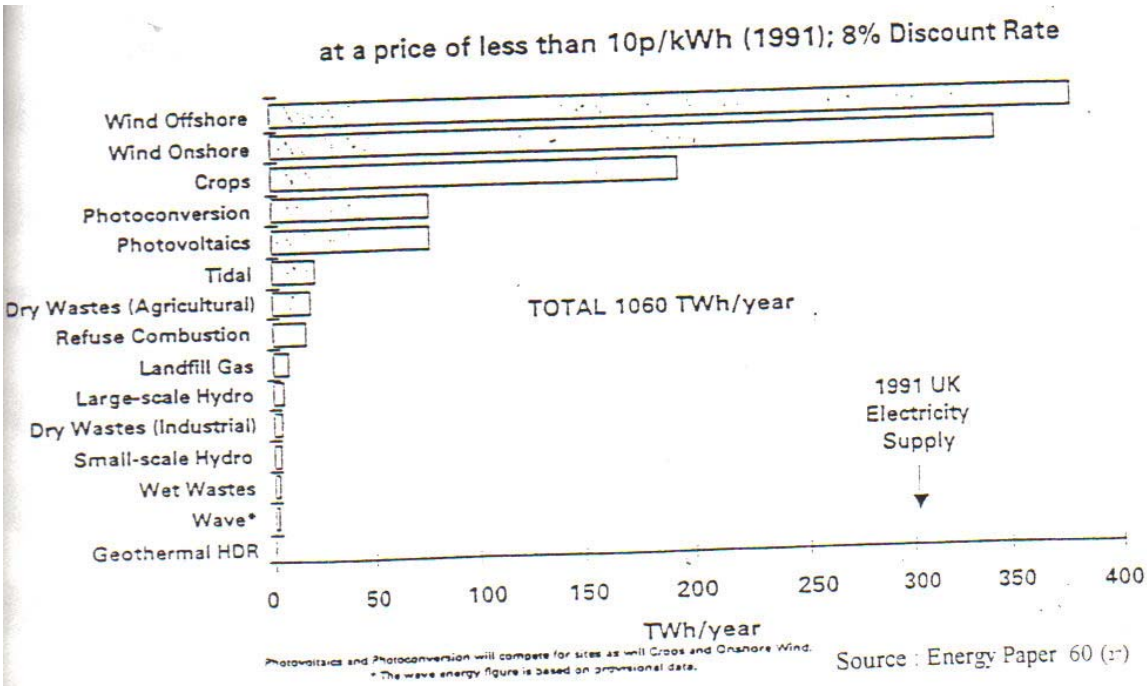


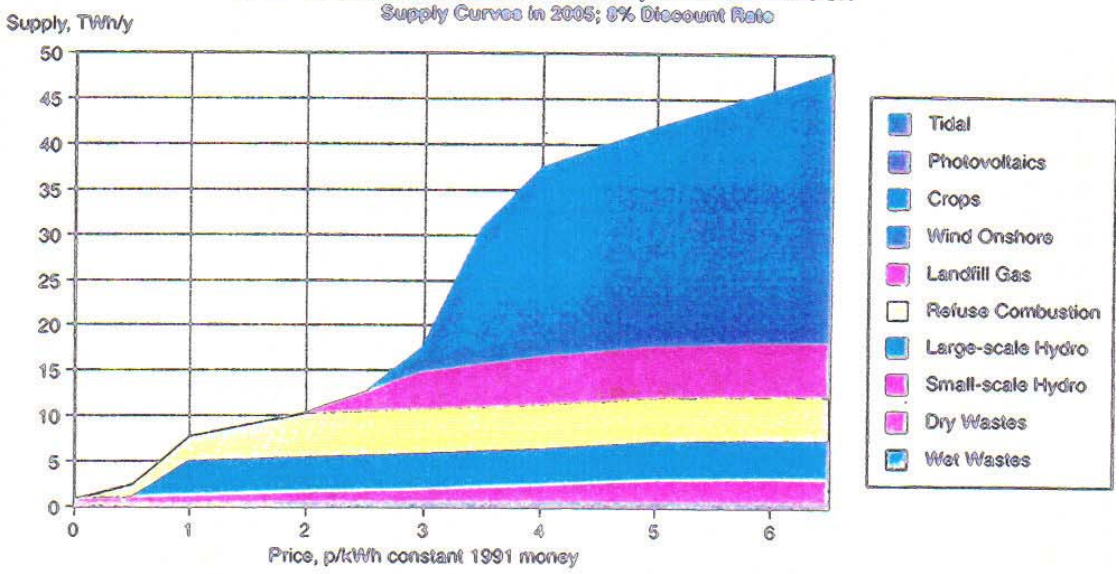
Figure 7.



Source:(EP60 [19])

Figure 8

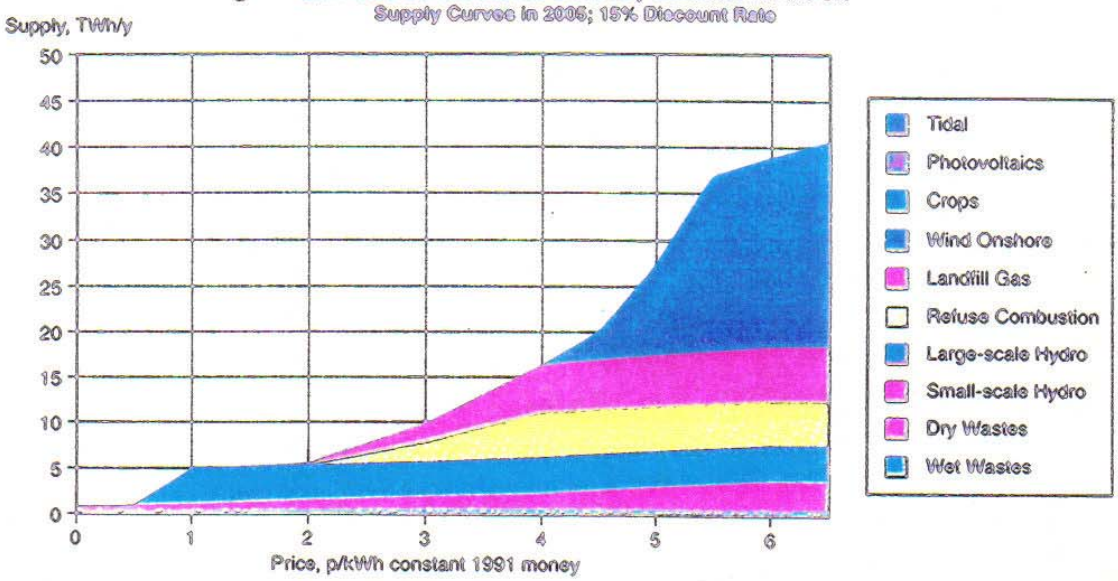
Fig 14 Estimated Contribution to Electricity Generation in the UK
Supply Curves in 2005; 8% Discount Rate



Note: Wave Energy is currently being reviewed and figures from estimated contribution are not yet available.
There is uncertainty surrounding the contribution from crops as the assessment is at a preliminary stage.
The contribution from Geothermal HDR, Offshore Wind and Photoconversion is not expected to be significant within the ranges shown.

Source : Energy paper 60 (27).

Fig 15 Estimated Contribution to Electricity Generation in the UK
Supply Curves in 2005; 15% Discount Rate



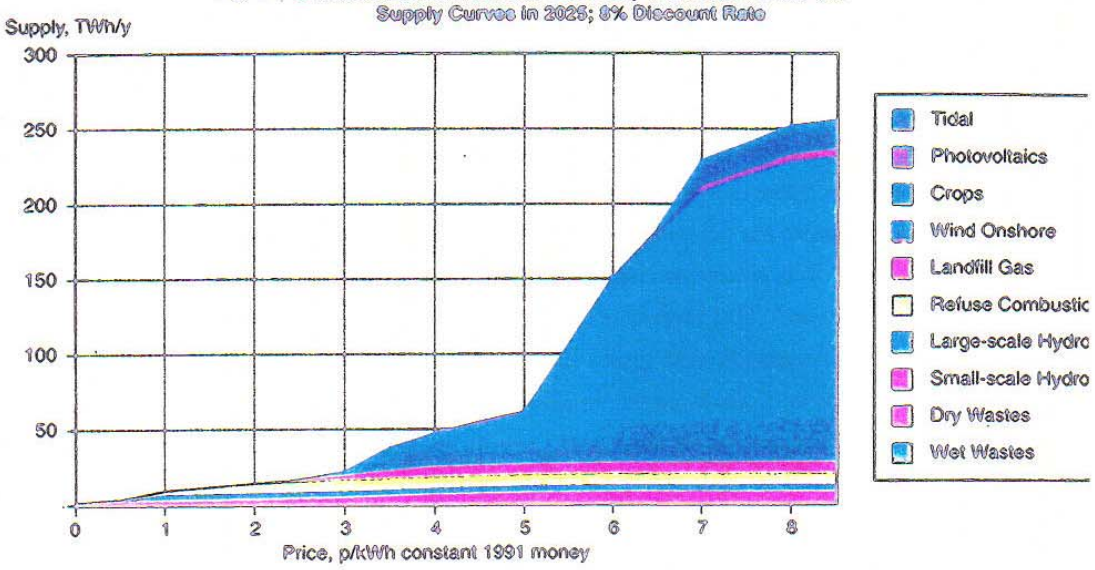
Note: Wave Energy is currently being reviewed and figures from estimated contribution are not yet available.
There is uncertainty surrounding the contribution from crops as the assessment is at a preliminary stage.
The contribution from Geothermal HDR, Offshore Wind and Photoconversion is not expected to be significant within the ranges shown.

Source : Energy paper 60 (27)

Source: (EP60 [19])

Figure 20 and 21 indicate that in time the technological advances will be made and the contribution which crops can make to the electricity generation capacity of the UK increases to a level second only to tidal power potential.

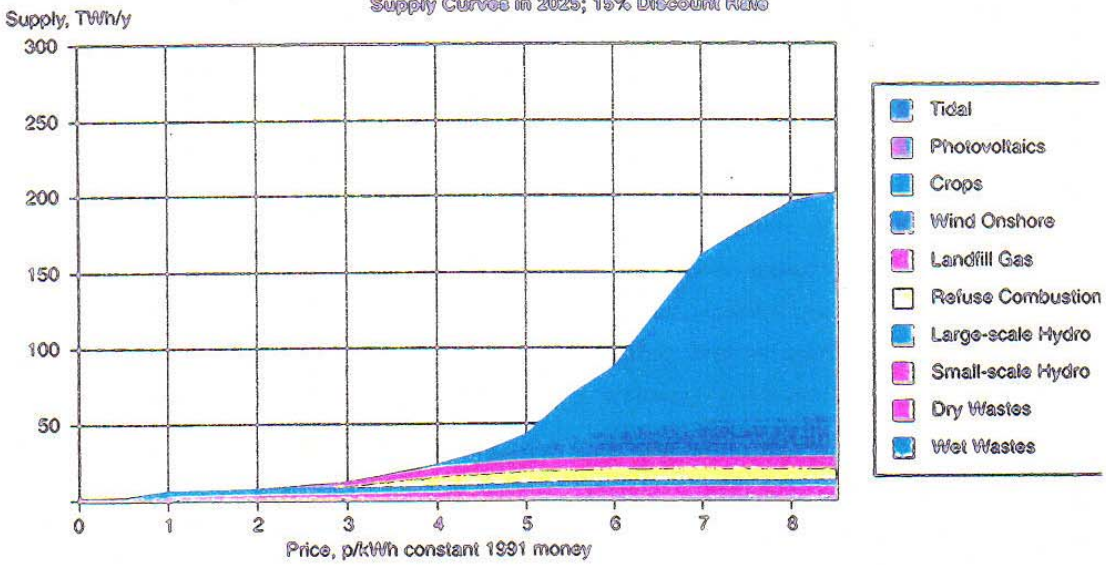
Fig 16 Estimated Contribution to Electricity Generation in the UK
Supply Curves in 2025; 8% Discount Rate



Note: Wave Energy is currently being reviewed and figures from estimated contribution are not yet available.
There is uncertainty surrounding the contribution from crops as the assessment is at a preliminary stage.
The contribution from Geothermal HDR, Offshore Wind and Photoconversion is not expected to be significant within the ranges shown.

Source : Energy paper 60 (27)

Fig 17 Estimated Contribution to Electricity Generation in the UK
Supply Curves in 2025; 15% Discount Rate



Note: Wave Energy is currently being reviewed and figures from estimated contribution are not yet available.
There is uncertainty surrounding the contribution from crops as the assessment is at a preliminary stage.

Source : (EP60 [19])

With the implementation of policies of energy conservation and renewable energy use then significant amounts of emissions of carbon dioxide can be reduced. The renewable energy potential for the UK can also be seen in figure 7 above, which reveals, in the S/E region that Portsmouth City could take advantage of the Solar Energy range of 2.8 - 3.0 KWh/m^2/day.

The costs associated with the use of various renewable energy resources can also be investigated, which often remain competitive eight renewable energy resources with costs per KWh.

Photovoltaic (PV) cells generate electrical power when exposed to sunlight and research and development in manufacturing techniques over recent years have reduced the cost and improved performance of the systems. A review of the technology was undertaken by the DTi Renewable Energy Programme which concluded that large scale centralised generation of electricity for the National Grid system by means of PV cells is unlikely to be economically attractive in the UK in the foreseeable future. Small scale distribution systems may be possible and were seen to be the more favourable alternative. PV systems which are integrated into buildings could offer a generation cost competitive with other renewable sources.

The average domestic electricity demand in the UK is approximately 4.6 MWh per annum, with future developments in the PV technology the projected scale of output is estimated at 5 MWh per year and 6.5 MWh per year. A significant fraction of the domestic electricity demand could be met by using the photovoltaic systems. In terms of the proposals for energy conservation in the City of Portsmouth then the full use of renewable energy should be made, in line with Agenda 21 criteria for Sustainable Development.

3.6 Summary

One of the most challenging aspects of Agenda 21 and Sustainable Development is that of sustainable energy consumption. Historically the use of energy has increased due to man's inhabitation on the planet Earth and consequential social development trends. The World total for primary energy consumption is 7804.3 million tonnes of oil equivalent. With the use of fossil fuel energy carbon dioxide and other pollutant levels increase, for carbon dioxide the UK 1990 figure was 160 MtC. The UK 1990 CO_2 figure remains important as the Uk is trying to stabilise CO_2 emission levels to combat Global Warming, reduce the sea level rise and counteract the growth in energy use by India and China, who are the fastest developing Countries. If the emissions of greenhouse gases continue to grow at present rates then the average temperature rise may be 1^oC higher than present by the year 2030. The major European energy consumed is gas, which accounts for 45% of the total primary energy demand.

The European energy market place has changed since the Second World War, it has risen by 100% over three decades and is concentrating on exploiting natural gas. This figure can be questioned in light of the BP statistical information, from which indicates oil as the main energy consumed, which in 1993 stood at a figure of over 700 million tonnes of oil equivalent. Industry, power station and transportation systems result in the highest contributions of carbon dioxide in the UK, these figures are respectively 26%,34% and 19% of the total 160 MtC. The expectancy for the life of energy resources has been estimated as oil being 30 years, coal 350 years and gas being 40 years, at current consumption rates. As the Gross Domestic Product (GDP) increases so does the energy consumption rate per capita. The current World energy consumption average figure stands at 50 GJ per person. Production of oil, gas and electricity is increasing whilst coal is decreasing as seen in figure , appendix 3. Total energy use within the Urban environment can be estimated by using the models for its determination as seen in appendix 3, figure . There exists a careful balance between ecosystems and energy use in the environment, imported energy into the environment results in an increased environmental burden. The Life Cycle Analysis (LCA) models indicated in figures to figure . reveal how significantly damaging oil, gas, coal and nuclear fuels are to the environment.

Each LCA model indicates the inputs and outputs to the environment, natural gas has the lowest carbon dioxide emissions; 0.21Kg CO_2 /KWh as opposed to electricity generation 0.73 Kg CO_2 /KWh. The generation of electricity by using CHP systems is considered less an environmental burden due to the less polluting fossil fuel and the use of waste heat. Stratospheric accumulation of some gases are changing the Earth's energy balance and leading to climatic change. The nitrogen and sulphur oxide emissions from the combustion of fossil fuels are resulting in acid rain.

The largest effect of the domestic sector on the emissions of carbon dioxide in the atmosphere was determined as the emissions emanating from space heating, some 52.3% as seen in figure . The proposed European Union Community Action plan for Energy Efficiency of electrical use indicated that a reduction in electricity consumption of 20% would have the environmental benefit of the following reductions in emissions; CO_2 reduced by 40 million tonnes (7%), SO_2 reduced by 540,000 tonnes (14%), NO_2 reduced by 150,000 tonnes (6%), radioactive waste reductions by 6,500 cubic metres (20%) and reductions in mercury emissions of 8 tonnes (15%). Having reduced electricity reduction then a 20% reduction in energy would result in the following emission reductions; CO_2 reduced by 110 million tonnes, SO_2 reduced by 740,000 tonnes, NO_2 reduced by 440,000 tonnes, radio active waste reduced by 6,500 cubic metres and mercury emissions by 10 tonnes. This remains a very significant case for Countries and Local Governments like Portsmouth City Council to produce energy policies, strategies and action plans which will ensure that reductions will be made over a period to help minimise the environmental burden of energy use and electrical generation.

The impacts on the environment associated with renewable energy sources are significantly lower than those related to fossil fuel use. The assessment made by ETSU in 1992 indicated a range of between 15 - 130 Terawatt hours per year by the year 2025. The largest potential of energy exploitation from renewables were found to be from offshore wind, onshore winds, bio-crops, photo-conversion and photovoltaic cells. The contribution that bio-crops and wave energy can make to potential energy resources are currently being fully assessed. In the year 2005 tidal power was found to have the largest renewable energy potential and crops still not fully exploited.

Changes will occur by the year 2025 with the estimates made that bio-crops will have the highest renewable energy potential which is in line with the NFFO development obligations of funding projects for energy from waste and baffle research. There remains significant energy savings and reductions in consumption which, through energy efficient programmes could reduce energy use from the 1990 level of 220 million tonnes of oil equivalent to 120 million tonnes of oil equivalent in the year 2030. The UK Government have stated an intension of working towards the target of 1,500 MW of new electricity being produced by renewable energy sources as a whole by the year 2000. The current UK energy figure for installed domestic solar hot water systems is 36 GWh/year and for swimming pools 29 GWh/year. The average carbon dioxide emission values achieved when using solar hot water systems for an average household was determined as 443 Kg. The projections made for savings in emissions from the solar energy aided district heating systems for an average system supplying 231 homes was estimated as 676,000 Kg CO_2 per year.

Renewable energy costs per unit KWh remain very competitive, when considering the 8% and 15% discount rate for small 5MW installations, bio-crops, poultry, scrap tyre, landfill gas and wet wastes all indicate a price of between 2-4 pence per KW of electricity production. For larger installations of approximately 2000 MW, such as wind farms the cost is between 6 and 8 pence. Portsmouth City Council will produce their Agenda 21 Integrated Energy Policy which will try and set targets for energy reduction and also recommend alternative forms of energy production such as renewable energy sources. With the information now determined on the exact environmental impacts associated with energy use the following Chapter will investigate the formulation of that Integrated Energy Policy.

Chapter 4. Integration of Energy policy and strategy

This Chapter is concerned with the Portsmouth City Council formulation of the Integrated energy policy and proposed strategic action plans.

4.1 Background to the Integrated Energy Strategy

Energy use and, as was earlier indicated the environmental degradation associated with its use are expected to increase in developing countries such as India and China as well as being a significant issue in the already developed western World. Degradation will increase into the 21st Century with adverse ramifications on Sustainable development programmes worldwide. Due to the environmental impacts indicated, in the earlier Chapter, of energy use, reductions in both energy and pollution emanating from the use of fossil fuels for energy production and consumption is a major factor in the Agenda 21 programme. In order to combat the Developing Countries environmental impacts on Global Warming and resource depletion then Western Member States of the EU have set targets for their energy reduction throughout the World.

The "Friends of the Earth's" climate resolution proposes to reduce CO_2 levels by 30% by the year 2010. This is a level set by them in order to lead the way to Sustainable Development and also to have a long-term target reduction of 60% by the year 2025. These targets will, if achieved by Member States help to limit levels of pollutants to 1990 levels and off-set the increased contributions of emissions from China and India. The term "Sustainable Development" has come to indicate a process by which development occurs without harmful side effects to the environment. The use of energy poses a basic dilemma in achieving Sustainable Development in both Developing and Developed Countries. The use of energy is necessary for economic growth, however increased energy use is not always to be expected for economic growth to occur.

The use of energy is then a requirement for economic growth but with increased energy efficiency and the use of renewable energy then the consumption of energy can be reduced still further allowing for economic growth to continue. In 1991 the total use of hydrocarbon energy resources accounted for 91% of total commercial energy consumed Worldwide and 95% of that used in Developing Countries.

This energy consumption results in major localised and Global environmental pollution and the energy policies in both Developing and Developed Countries must be properly thought out to achieve Sustainable Development. The energy policies must not just be made to enhance the economic growth of a City or country but also consider the environmental impacts of energy use. (EPSD,Abdalla [20])

The Agenda 21 Earth Summit program is being addressed by Portsmouth City Council in all major sectors of the City Council's areas of responsibility. Eight Working Parties were formed within the Portsmouth City Council to formulate the Agenda 21 Sustainable Development policies for the City. The first Working Party set up was the Energy Conservation Working Party, which was formed in April 1995, they had to formulate an Integrated Energy policy by June 1995 and then a Strategy by September 1995.

The Energy Conservation Working Party revived the Agenda 21 Earth Summit documentation, Local Government Management Board recommendations, Friends of the Earth Climate Resolution and other City energy and environmental policies. On completion of the review it was possible for the party to formulate appropriate target setting and policy statements. Table 13 is an indication of the reduction target setting made by other Countries in order to reduce the environmental impacts of energy use and the greenhouse effect.

Table 13. Announced Targets for Reducing Greenhouse Gases (GHG)

Country	Goal
Australia	**Reduce GHG'S by 20% by 2005**
Austria	**Reduce CO_2 by 20% by 2002**
Canada	**Freeze CO_2 at 1990 level by 2000**
Denmark	**Reduce CO_2 by 20% by 2005;30% by 2020-2040**
France	**Freeze CO_2 near 1990 per capita level**
Germany	**Reduce CO_2 by 25 % by 2005**
Netherlands	**Freeze CO_2 at 1990 level by 1995 then reduce further**
New Zealand	**Freeze CO_2 by 20% by 2005**
Norway	**Freeze CO_2 at 1989 level by 2000**
Sweden	**Freeze CO_2 at 1988 level by 2000**
Switzerland	**Reduce CO_2 by 10% by 2000**
Japan	**Freeze CO_2 at 1990 level by 2000**
United Kingdom	**Freeze CO_2 at 1990 level by 2005**

Source :(Flavin [21])

After the review of other Country reduction targets, City's within the United Kingdom were reviewed together with the LGMB, DTI and Labour Party policies for comparisons of their reductions, the findings to be found in Table 14 .

Key to table 14

City 1 = Hull City 2 = Birmingham / City 7 = East Hants District Council / City 3 = Thames mead /City 4 = Nottingham / City 8 = Glasgow City 5 = Leicester / City 6 = Labour Party

Table 14. Comparison of Energy / CO_2 reduction actions in the UK City's

Factor	City 1	2	3	4	5	6	7	8
Reduce energy consumption by 10% by the year 2000	*			*	*	*		*
Improve energy efficiency of housing stock						*		*
Increase refurbishment priority for estates with low energy rating (NHER)	*					*		*
Reduce carbon dioxide levels by 20% by the year 2005	*				*	*		*
Reduce the use of fossil fuels	*							
Increase maintenance of combustion plants		*						
Reduce the use of electricity		*						
Use only energy efficient products		*						
Monitor performance, tariffs and set targets for reduction		*	*	*		*		*
Reduce energy bills	*	*	*	*	*	*	*	*
Communicate best practice to Council staff and customers, educate and train	*	*	*	*	*	*	*	*
Priority for investigation and implementation of alternative energy sources				*	*	*		*
Exploit CHP systems in the City								
Improve transportation efficiency, less emissions and less energy use						*		
Integrate energy management issues into decision making				*		*		*
Incorporate energy efficiency into new developments	*				*	*		

Source : (Strategy [22])

The matrix in table 14 indicates the particular action favoured by the respective City as shown by (*) in appropriate squares. On review of the tabulated results from Table 14 it was possible to determine the main reduction targets for CO_2 was 20% by 2005 and also to freeze CO_2 at 1990 levels by the year 2000. The particular target reduction proposed for the Integrated Energy Policy were 33% - 50% reduction in CO_2 emissions by 2025, which was in line with the LGMB recommendations and the Friends of the Earth climate resolution aspirations and the full Policy can be seen in section 4.2. Integrated Energy Policy.

4.2. Integrated Energy Policy for Portsmouth

This policy was formulated in consultation with Council Officers and represents a proposal for the energy consumption reductions and minimising carbon dioxide emissions.

1. The City Council has a responsibility to its Community to Sustain the City's economic base and ensure that development of the City is undertaken in a Sustainable manner. This can be defined as "Development that meets the needs of the present without compromising the ability of future generations to meet their own needs" This responsibility is enshrined in "Local Agenda 21" (Earth Summit 1992) which exhorts Local Authorities to consult with and forge partnerships with its community to examine issues which influence "Sustainability"

2. The City Council seeks to address the issue of energy efficiency across the whole community, including the business sector. This Policy Statement represents the first step towards a fully integrated energy strategy. It sets out the City Council's goals for achieving energy efficiency, sustainable power generation and reductions in CO_2 emissions and represents the basis upon which a detailed strategy will be prepared.

3. The policy statement and the emerging strategy focus on the major areas of energy production and energy usage and will be concerned with the following issues;

- **Heating**
- **Lighting**
- **Transport**
- **Power Generation**

4. By using fossil fuel energy more efficiently and maximising the use of renewable energy sources (e.g. wind, solar, wave, hydro, energy from waste, geothermal and biomass) significant economic and environmental benefits can be gained. Additionally, the more efficient use of heating and lighting supplies within buildings will lead to lower operational costs for the business sector and more affordable energy for all sectors of society.

City Council Aims

A) **The City Council will seek to maximise the efficiency of energy production and consumption within the City of Portsmouth in order to Sustain and enhance its economic base.**

5. The reduction in the demand for different types of energy and the promotion of more efficient forms of energy will, in the long term, lead to a more cost effective society and economic base. The implementation of alternative energy systems should also be to the benefit to the environment. The generation of affordable energy which is not detrimental to the environment by way of pollution or wastage of natural resources will result in a more environmentally pleasing City in which to live and work whilst the reduction of energy costs would benefit both residential and commercial sectors of society. Specific aims would include the reduction of energy costs for business and reduce energy bills for the disadvantaged sectors of society.

B) **The City Council will continue to improve the energy efficiency of its own housing stock and provide affordable warmth to all tenants. It will also seek to encourage and influence private sector residents to improve the energy efficiency of their homes.**

C) **The City Council seek to minimise its own energy requirements for existing and future Council properties.**

6. The City Council can demonstrate by example a more effective approach to energy consumption within all Council owned properties.

D) The Council will seek to improve the use of energy by all sectors of society by encouraging the industrial, commercial and residential sectors to use all forms of energy, including transport, in a more efficient manner.

7. Awareness of the energy efficiency issues throughout society can only be achieved through education, consultation and partnership with relevant groups.

E) The City Council will consider alternative and renewable forms of energy production and will liase or form partnerships with other sectors to ascertain the appropriateness of adopting new energy systems.

8. A number of opportunities exist within the City for the generation of power by alternative means. The provision of an "Energy from Waste" plant would provide the option for combined heat and power whilst further emerging technologies, such as solar energy production, may also have a considerable role to play in the future.

F) The City Council will seek to reduce CO_2 emissions by significant levels through the more efficient production and consumption of energy. This should also involve the encouragement of alternative forms of transport.

9. Alternative forms of energy production would have to be judged in terms of the need to meet energy and emission reductions targets, the possible effect upon the built and natural environments and human health as well as cost implications for the business sector and the public.

G) The City Council will seek to reduce energy usage in Portsmouth by 50% by the year 2025 and specifically to reduce energy usage in Portsmouth by 10% by the year 2005.

10. The Local Government Board have stated that a reduction in energy consumption for Local Authorities of between 33% and 50% is achievable by 2025 with an appropriate management structure to implement new technologies. It would be reasonable to assume that energy consumption for the whole of Portsmouth can be suitably reduced. The aims of the strategy will be ;

(i) to promote an image of Portsmouth as an energy conscious / efficient City working in partnership with others.

(ii) to identify criteria to enable the monitoring of improvements to energy efficiency throughout the City of Portsmouth.

(iii) identify areas within the City Council properties where energy use can be made more efficient without constraining operational effectiveness.

(iv) to identify means of improving energy efficiency within the City Council's own housing stock.

(v) to consult with business to identify the potential for reduction of energy costs throughout the commercial sector.

(vi) to liase with the business sector and the public to quantify the reduction in energy demand and to target priority sectors of society.

(vii) to promote energy issues and the best practice techniques through education and training schemes.

(viii) to establish means for more Sustainable energy generation.

(ix) to develop initiatives, partnerships with others where necessary to promote economic and Sustainable energy use within the City.

(x) to set targets and performance measures for these objectives and for individual City Council service plans.

4.3. Portsmouth City Council Proposal for an Energy Strategy

This section on the Strategy for an Integrated Energy Strategy was not formulated by the Energy Conservation Working Party but proposed after discussion with the environmental coordinator of the City Council, after research into other City strategies. The proposal for the Energy Strategy was put forward to the Working party as a means for discussion and debate.

Organisational Change

In line with the Energy Efficiency Office recommendations on identifying the current energy management profile of the Council the following has been noted from that matrix and will be used within this section for the development of the Strategy.

The Council have many energy efficiency programmes running which have made inroads into the reductions of energy consumption and the greenhouse gas CO_2. As a reminder in the energy matrix in the earlier section, there exists however an unbalanced approach to energy management across the corporate Council. The Council is seen as being above average in the areas of monthly monitoring and targeting to individual premises and adopts the same appraisal criteria for all new investment programmes. It has recently adopted an energy policy leading the way to the strategy. The Council is however weak in the area of clear delegation and centralised accountability for energy efficiency within the City and the major users of energy are not motivated to save energy, motivation is patchy and spasmodic, informal contacts are used to promote energy efficiency.

The Council is above average in energy monitoring but needs to develop clear delegation and accountability and to increase motivation and marketing.

The proposed Integrated Energy Strategy can now be investigated and its structure can be seen in Table 15.

Table 15. Proposed Integrated Energy Strategy (To be considered only)

Subject	Responsible Agency and timescale	Action Required	Comment
1) Large Scale CHP	UK government		
	a) short term	Required to seek support to encourage CHP programmes to be adopted by industry	CHP is currently running at about 80% efficiency as opposed to 30%-40% environmentally sound, less environmental impacts.
	b) medium term	(i) give City Council new powers to plan CHP introduction in the City	
		(ii) Encourage district heating program in the City	This is currently being investigated by the City Heat company and is compatible with CHP linkage when installed
	Portsmouth City Council c) long term	Over thirty year period, in a phased approach, introduce CHP into all suitable Council properties saving 70% on energy bills and 69% CO_2	Significant environmental impact reductions
2) Renewable Energy	UK government. Portsmouth City Council a) short term	Seek UK and EU funding for local Solar hot water systems to be installed in development projects in both Council and private housing stock. Investigate the use of Photovoltaic cells in developments.	Promote the Non-Fossil-Fuel Obligation (NFFO) program to encourage less polluting forms of energy production.
	b) medium / long term	Increase take up factor for Solar and encourage wind turbine feasibility study for Portsdown hill.	This has long term potential for energy consumption reduction and may generate a cultural change
3) Energy Efficiency	UK government Portsmouth City Council a) short term	Consider the Energy Centre being established to promote and encourage energy efficiency within the City	Best practice advice can be given to industry/ commerce and the public, also free energy audits can be made available
	b) medium term	Encourage the grants to be made available for Solar hot water systems and other renewables for private and Council tenants, plus the possibility of short term payback.	This will actively promote take up of the new technologies in Solar heating through reducing energy and CO_2 emissions

Source :(AB,1995 [23] **)**

Table 15. Proposed Integrated Energy Strategy (Continued)

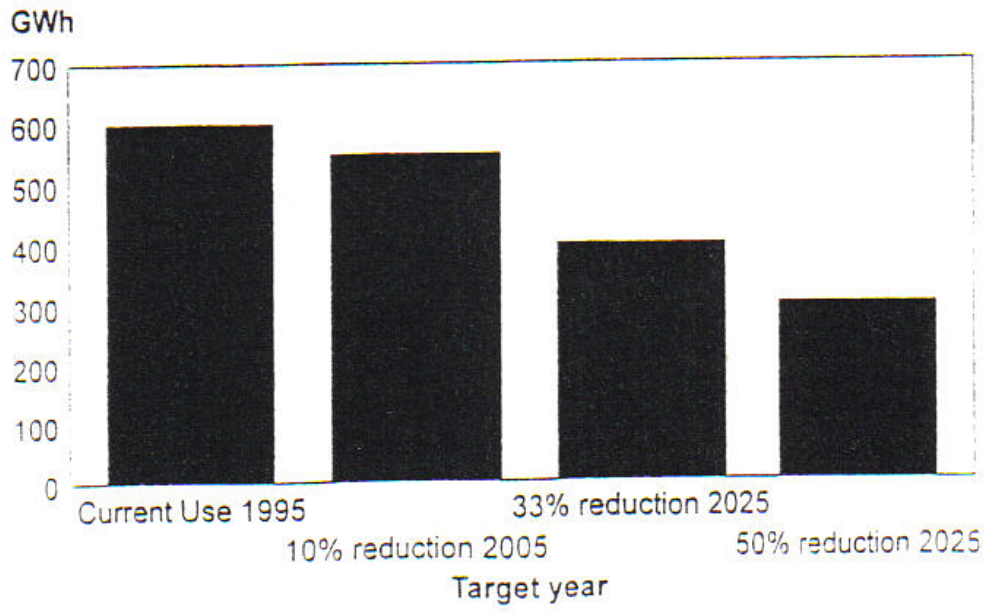
Subject	Responsible Agency and timescale	Action Required	Comment
3) continued Energy Efficiency	Portsmouth City Council c) medium term	a) Introduce measures to enable the energy savings made within the City Council building stock to be invested into a central energy fund	This can generate further energy efficiency projects to be established throughout the City
	Portsmouth City Council	b) Update the building regulations and planning guidelines to encompass increased energy efficiency in the City	This will further increase the reduction in energy use and CO_2 emission production
	Portsmouth City Council	c) Seek energy utility companies to make funds available to encourage energy efficiency in the City	A percentage of turn over could be given to Agenda 21 programmes
	Portsmouth City Council	d) Encourage the promotion of "Best practice" and "Best available Technology" to be used in all new developments within the City	The new Millennium Renaissance Harbour project is currently investigating the use of renewable energy and energy efficiency throughout the development.
4) Transport	UK Government A) short term	a) Increase funding for selective subsidy of public transport schemes and charges	The Light Rapid Transit link (LRT) could be part funded from UK/EU /City funds
		b)Increase City funding for projects that can demonstrate energy efficiency measures	Less environmental pollutants of NOx, SOx, CO_2. etc.
		C) Seek to give LRT a high profile within the City	Encourages the public to use when running
	b) Medium term	Introduce controls a) Introduce "Polluter pays" taxation	This will penalise poor performance/ high level pollution
		b) Give Local Authorities more power to encourage LRT	
	Portsmouth City Council Short/Medium term	a) Bus priority on major routes. b) park and ride should be given serious thought and the use of gas powered buses	This will help reduce the increased effect of tourism on the City and reduce pollution and energy use.
		C) Incentives for car pooling	Encourages public transport use and car sharing, less pollution and energy use
		d) Encourage cycling, make a priority issue for the funding of new safe cycle routes.	Less environmental impacts due to less energy and emissions

Source : (AB,1995 [23])

The above strategy proposal can be considered action plans and may be used by the Integrated Energy Policy Working Party to formulate the specific actions for the City Council to adopt in Sustainable Development in the 21st Century. The main areas to be addressed by the strategy are transportation, power generation, affordable warmth and housing. The proposed LRT is viewed as a positive step forward together with park and ride schemes in reducing energy use and emissions. The introduction of a Carbon tax is viewed once more as positive and will result in the population being forced into serious consideration of environmental burdens associated with their chosen forms of transportation.

With the implementation of the Integrated Energy Policy and the forth coming strategic action plane then the reduction target of energy use, as seen in Table 16 will be achieved.

Table 16 put in diag from page 51 of report



Source 24

4.4 Summary

Increasing energy use in developed and developing Countries has given rise to global concern over resource depletion, deforestation and Global Warming. There is a growing commitment throughout the World to the Agenda 21 program and its aspirations. The problems associated with energy use and environmental burden are viewed with seriousness and to this end many Governments, including the United Kingdom are setting actions plans in place to try and reduce the Global Warming and sea level rise threats. The Friends Of the Earth's climate resolution has indicated carbon dioxide levels should be reduced by 30% by the year 2010.

The Integrated Energy Working Party was formed consisting of eight members from different departments of the Portsmouth City Council. They commenced work in April 1995 to investigate all the UK Governments policies on energy use and the environment together with proposed action to achieve energy efficiency and carbon dioxide reductions together with detailed studies of all other Countries targets and UK City target reductions. The Policy has to be produced by July 1995 and the Strategy by November 1995. After careful investigation the Working Party decided upon several main strategic objectives in the Policy in order to reduce energy consumption by 10% by the year 2000, reduce carbon dioxide levels by 20% by 2005, monitor performance (bench mark) buildings in their control, communicate best practice advice to industry, commerce and the public in terms of energy efficiency. It was regarded that four main areas should be contained within the policy; heating, lighting, transport and power generation. By maximising efficiency of energy production, Sustainable Development within the City would be helped together with protecting its economic base. The City will embark upon energy efficiency programmes throughout all sectors, especially in the area of affordable warmth for its tenants. Energy consumption in the City owned housing stock and other buildings will be investigated and action plans will be developed in the future, such as raising the NHER of the properties and also to exploit the relatively untapped renewable energy resources. The main target which has been set by the City is that relating to energy use and reductions of between 33% and 50% by the year 2025, with a short term target of 10% reduction by 2005.

The current energy management profile for the City remains unbalanced, however the City does have many current energy efficiency projects running in Departments such as Building Services, Council Housing, Environmental health Energy Audits and City Engineers proposed District Heating plans. The new Millennium Harbour project ,it is hoped will have in the design specifications Agenda 21 Sustainable Development criteria. A different approach is required when looking at the investment criteria for the capital equipment, it should be costed for by using externality environmental criteria and Net Present Value discount rates.

The Integrated Energy Strategic proposals put forward were done so in order to raise the energy management profile of the city Council. Short, medium and long term action plans were developed for inclusion into the Strategy in order to meet the Agenda 21 criteria for Sustainable Development. Long-term environmental considerations must be taken into account in all decision making within City Council management for all future developments and plans. The Action Plans within the Strategy will enable the City to meet full Sustainable Development only if funding and resources are made available from UK Central and Local Governments. No set Strategy has been formally adopted by the City Council so the Strategy framework proposal still has to be endorsed. All the Integrated Energy Policy objectives were endorsed at the Frontline Services Committee in July 1995 with no exceptions and the Friends of the Earth's (FOE) Climate Resolution was endorsed in June 1996 by the City.

In general the Policy and forthcoming Strategy will, on paper be a good one which will lay the foundation for Sustainable Development within the City of Portsmouth to be achieved in the future and hopefully enable future generations to reap the benefits of a far less environmentally burdened City.

Chapter 5. Portsmouth City Environmental Initiatives

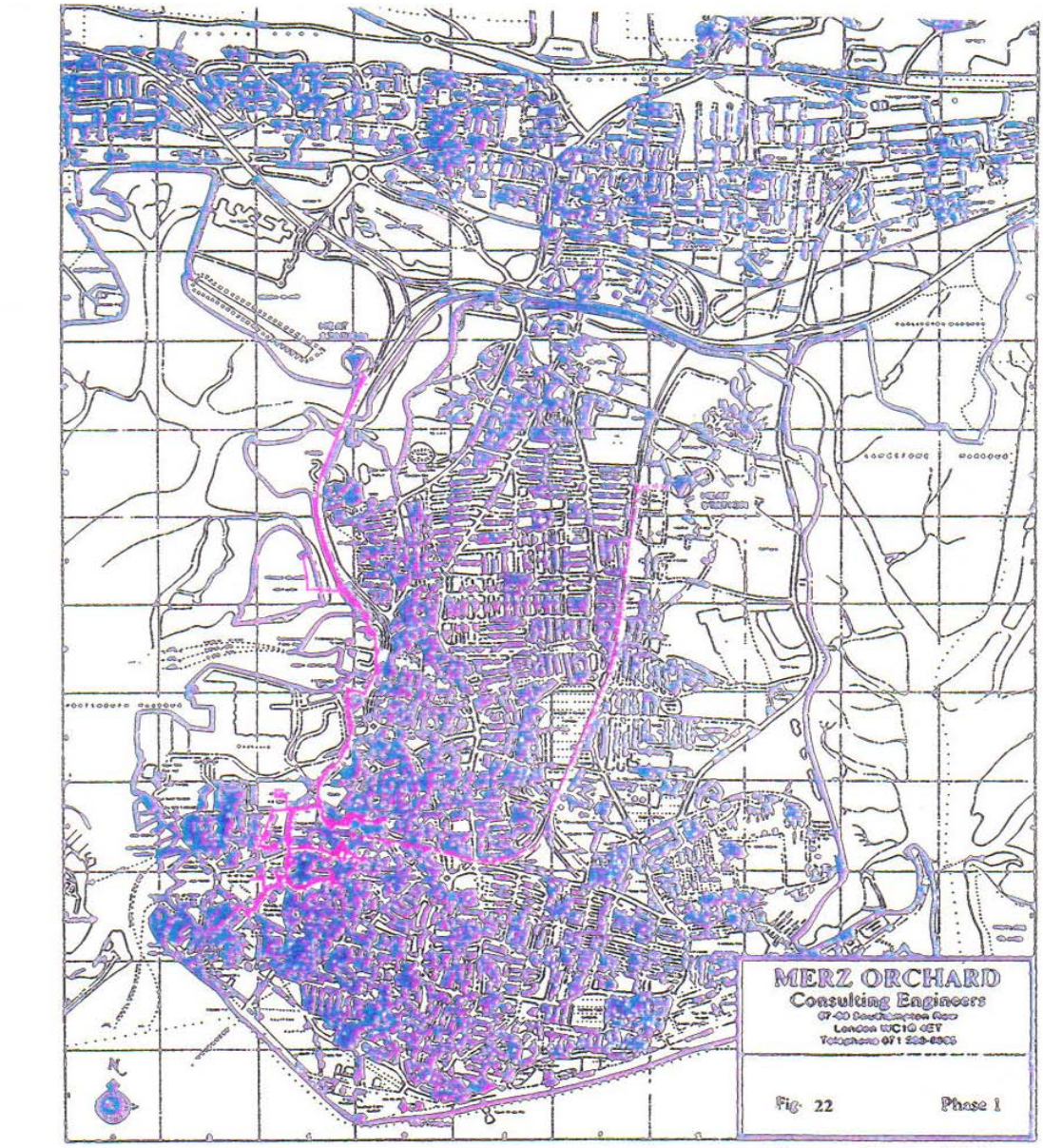
With the principles of Agenda 21 firmly identified, consolidated and understood, the Policy endorsed and Action plans to follow, this Chapter will be concerned with how the Portsmouth City Council can meet some of the objectives and move into a Sustainable Development mode in the area of energy efficiency. The current and future initiatives will help towards the emission reduction of carbon dioxide and project energy consumption reduction of 33% - 50% over a thirty year period and FOE reduction of 30% by 2005.

5.1 CHP , Incineration (energy from waste) and District Heating

Combined Heat and Power and Incineration can be used to provide District Heating to a City such as Portsmouth. Community heating can be reliable and provide a high quality of heating systems which will deliver heat that is affordable to the Community. One of the Integrated Energy Policy objectives for Agenda 21 Sustainable Development within the City was to offer affordable warmth to all tenants and the population within the City as a whole, inclusive of business, industry and commerce. Community Heating plays an important role in the total heat supply for much of Europe.

The aim of the European Union is to supply 35% of all heating requirements by district heating systems, the current UK situation is only 1%-2% of the housing stock are heated in this manner. Technological advances in the Community Heating distribution network piping and consumer controls have made District Heating a distinct possibility. The schemes will be cost effective to the consumer, help the City of Portsmouth meet its CO_2 reduction targets due to their energy efficiency. Braithwaite Environmental and the consultants Merz Orchard have undertaken a feasibility study of the opportunities for utilising District Heating in the City of Portsmouth. The initial phase of construction for the system can be seen in figure 10 . The map of the system shows the houses in blue and the proposed District Heating pipes in pink. The heat stations are indicated at the end of the pipe line, one being the Old incinerator, the other the Landfill site at Paulsgrove.

Figure 10. Proposal for District Heating for the City of Portsmouth.



Source : Bramwell (40)

5.1 CHP and District Heating

Combined heat and power systems (CHP) can be used to provide district heating to a City such as Portsmouth. Community heating can be reliable, high quality heating systems which will deliver heat that is affordable to the community. One of the policy objectives of the Agenda 21 integrated energy policy Portsmouth has adopted is to provide affordable warmth to all its tenants and population within the City as a whole, inclusive of business and commerce. Community heating plays an important role in the total heat supply for much of Europe.

Source :(Bramwell [25])

A survey of the City's heat loads was completed which identified 125 MW of load in 174 buildings. After assessment of these loads (magnitude, intensity of heat demand and relative locations) a phase network was identified which would supply 33MW of heat mix of public and private sector loads in and around the centre of the City which included 31 connections.

The study assumed that the Integrated Waste Disposal Facility (IWF) under consideration by Hampshire County Council will be the heat source for the network. The total District Heating scheme will be established in a four phased approach. Phase one was to be the City centre comprising the larger institutional buildings and commercial buildings including the Civic Offices, Naval Establishments, retail and commercial buildings together with the University buildings.

The loads from all phase one buildings will take 25% of the heat load market surveyed. Phase two is a proposed extension of the first phase to the South of the City as far as the Pyramids Leisure Centre together with the connection of smaller loads in the City centre, also a new network in the North of the City comprising the industrial estates, I.B.M. and Mariott hotel. Phase three will be a progressive connection of the lower density housing and commercial properties in the Central areas of the City. Phase four will be the final connection stage for the City, by which time the heat load would be of such a size to justify the supply of heat from a major power station which could be many miles away, such as Southampton.

The heat production plants constructed for the earlier phases would be retained for peak duty or standby plants. The initial feasibility study was performed by the City Heat company, sterling Energy company and Merz Orchard, who were the main contractors for the development. Details of the heat loads and peak heat demand can be seen in Table 17.

Table 17. Estimated annual heat use and peak heat demand for the District Heating

Sector	No. of Sites	Estimated annual heat use (MWh)[1]	Estimated Peak Heat Demand (MW)[2]
Housing Public Sector only	29	14,940	5.7
Educational sites	83	41,010	31.2
Sports centres/ Libraries	10	6,820	2.2
Hospitals	2	43,610	12.4
Other Public Sector	31	16,840	6.7
Offices Shops	9	11,300	6.5
Industrial Commercial	4	3,390	1.9
Hotels	1	2,000	0.7
Naval Buildings	5	172,790	56.4
Total	174	312,700	125.0

Source:(Bramwell [25])

1. Annual heat used is delivered from fuel data assuming a boiler efficiency of 80%
2. Peak heat demand calculated using estimated load factors

The emission reductions for the District Heating Phase one can be seen in Table 18.

Table 18. Emission reductions for phase one of the District Heating Scheme

Pollutant	SO_2	NOx	CO_2
Annual Emissions (tonnes)	91	21	19,114

Source: (Bramwell [25])

5.2 Energy from Waste (EFW)

This section is concerned with the potential use of energy from waste which is of considerable environmental importance and an extremely important issue for Portsmouth City to resolve.

With the problems associated with the landfill site at Paulsgrove being full in 1998 and the reluctance to incineration proposals the City has a waste disposal problem to resolve when it gains Unitary status in 1997. This Chapter will also look at the disposal routs, hierarchy of waste options, the energy content in waste streams and also make proposals for best practice technologies to be adopted within the area of waste management.

European, National and Local Government policies recognise the important role that "Energy from Waste" (EFW) has in the management of waste and the development of Sustainable Development programme. Waste minimisation and recycling policies will not on their own significantly reduce the need for final waste disposal waste treatment and disposal initiatives. Energy recovery from waste in suitably sited plants, which are designed to meet the new emission standards for pollutants such as Dioxin represent an environmentally acceptable form of waste treatment. Legislative changes introduced since 1990 have transformed the way in which waste management functions in Great Britain. The main change occurred with the introduction of the Environmental protection Act (EPA) of 1990 which requires waste disposal Authorities such as Hampshire County Council, at present to seek competitive tenders and contract arrangements for municipal solid waste disposal (MSW). With the pressure from landfill sites being full within three years in the Portsmouth area, diversion of wastes from this mode of disposal to alternative treatment processes of material and energy recovery are being formulated. In 1989, as a result of the privatisation of the electricity supply industry, the Non-Fossil-Fuel-Obligation (NFFO) was introduced into England and Wales. The NFFO obliges the twelve regional Electricity Companies (REC'S) to secure a specified capacity of their electricity supply from non-fossil-fuel sources. The chief objective is to promote the renewable energy sources which include "Energy from Waste". A guaranteed market has been provided for this new energy supply under NFFO which will enable EFW technologies to be fully exploited.

Ultimate Analysis of Municipal Solid Waste

In order to determine the energy content of municipal waste then an investigation into the analysis of waste is required. The constituents of this waste stream can be seen in Table 19 which indicates the Ultimate Analysis of solid municipal waste.

Table 19. Ultimate Analysis of Solid Municipal Waste

Substance	Average Weight (% by weight)
Carbon	**26.80**
Hydrogen	**3.58**
Oxygen	**19.35**
Nitrogen	**0.53**
Chlorine	**0.56**
Sulphur	**0.17**
Moisture	**25.55**
Inorganics	**23.44**

Source :(Winchester [26])

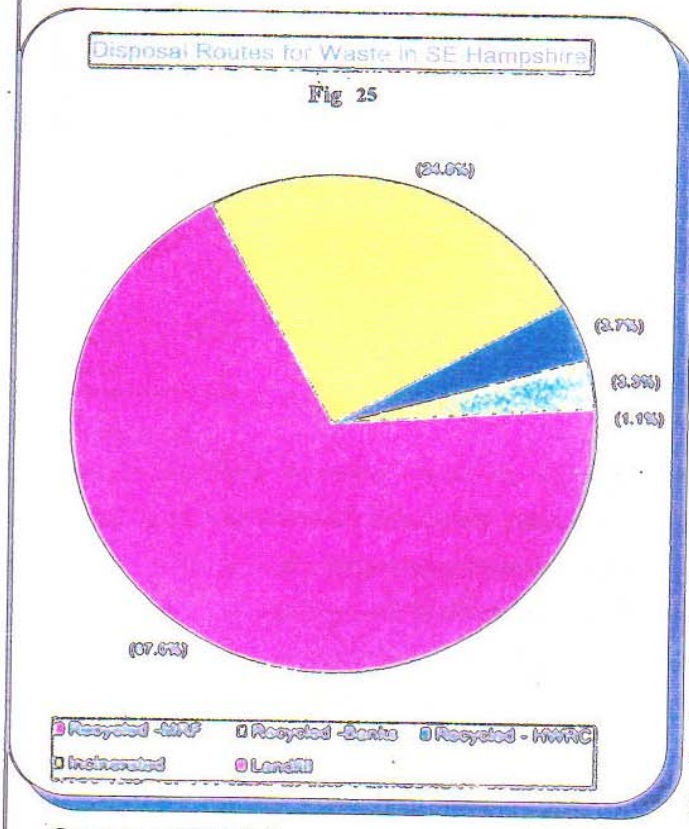
The EFW opportunity has resulted from the development of major, capital intensive infrastructures evolving which require new commitment and planning. The balance between the various waste management options will vary from region to region but consideration must be given to the nature of the waste, availability of sites, economic viability, environmental impact assessments and a desire to provide a local solution to the waste management problems.

The current situation with waste in Portsmouth City can be seen in figure 11. The main waste streams are considered to be household, Commercial and Clinical Grey wastes. The disposal routs for this waste can be seen in figure 12, the main disposal rout being landfill which accounts for 67.0% of the total waste arisings.

Figure 11. Current situation with waste in Portsmouth City Fig(25)

Current situation with Waste in Portsmouth City

An indication of the current situation regarding waste within the City will now be made and suggested directions forward within the Agenda 21 framework for utilising the "Energy" from waste potential.



Source : comport (45)

The main waste streams for the City of Portsmouth are Household, Commercial, Clinical Grey wastes. The disposal routes for this waste are indicated in fig 25 . Comport (45).

Currently the waste authority who have a statutory duty for the disposal of that waste is Hampshire County Council. In 1997 Portsmouth City Council will revert to Unitory status and all waste streams will be disposed of by the appointed contractors via Portsmouth City council. The main disposal route of waste in the S/E region is by landfill, some 67% at present. Detailed plans have yet to be formulated as to the ratio of that waste being sent to landfill , recycling, reuse or incineration. The proposed Badcock incinerator for Portsmouth City in 1992 was designed to take in waste from other districts and had a running capacity of 430,000 tonnes per annum. In 1993 / 1994, waste figures indicate that there is a total waste stream of 260,700 tonnes per annum of waste arisings in the S/E region.

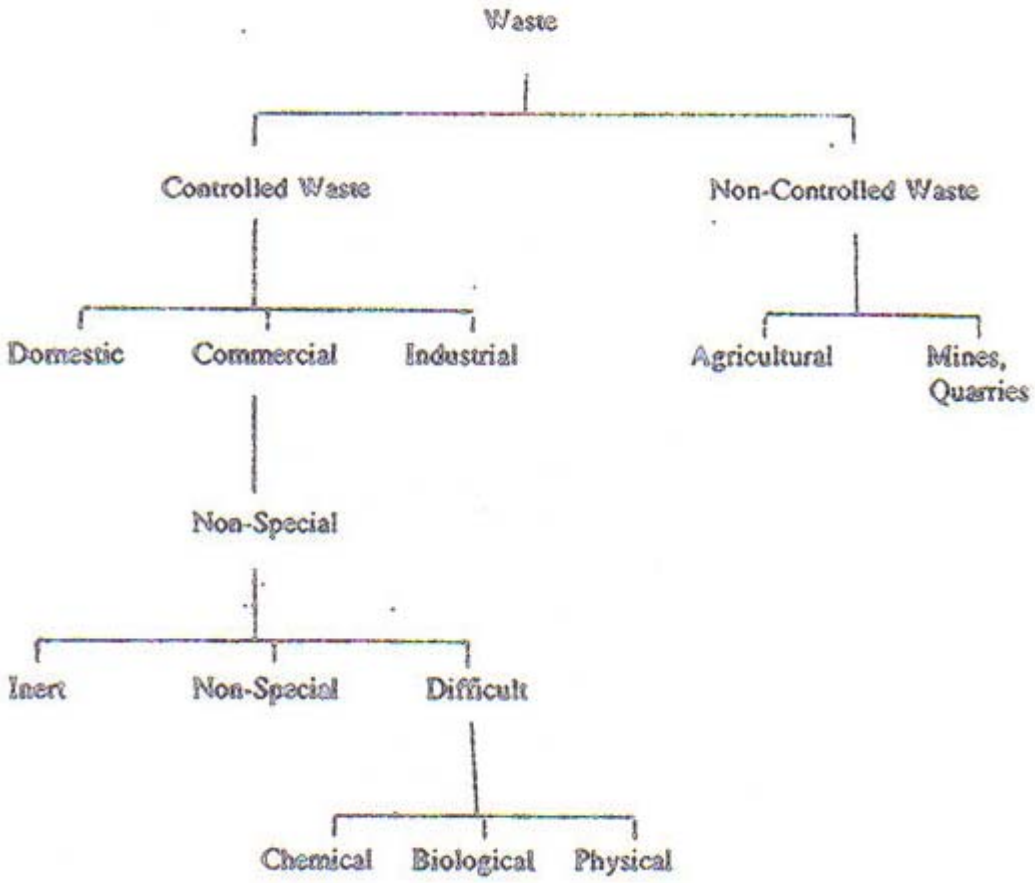
In light of proposed changes in the disposal of waste and the increased recycling ratio the initial incineration proposal was not granted planning permission, together with other environmental impacts as dioxin levels too high and general air quality concerns.

Source: (Comport [27])

The current Waste Disposal Authority is Hampshire County Council, however, as stated earlier the City of Portsmouth will become a Unitary Authority in 1997 and will then become the Waste Disposal Authority. Detailed plans have yet to be formulated for the disposal of that waste, however Hampshire Waste Services have proposed their "Project Integra" plans for this disposal which is currently under public consultation.

The waste stream classification can be seen in figure 13, which can be used not only for Portsmouth City Council but for any Local Authority use.

Figure 13. Classification System for Wastes



Source : (Nowell [28])

Once the waste has been classified and collected then the appropriate disposal rout must be determined it is for this reason that Hampshire Waste Services have produced "Project Integra" a thirty year plan for disposing of waste in Hampshire, including Portsmouth.

Project Integra

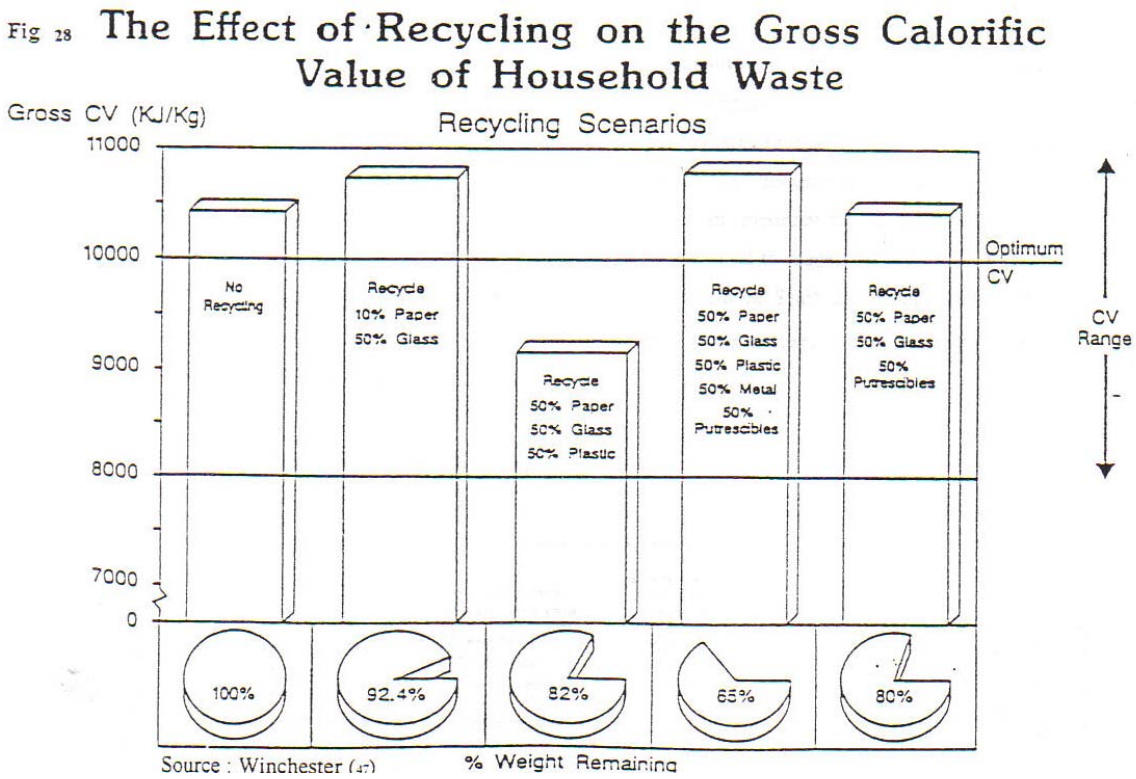
The Project Integra proposed by Hampshire Waste is a phased approach to the waste disposal problem for Hampshire. It has been shown that waste can be separated into two main types; controlled waste and non-controlled waste streams. The largest controlled waste stream is the domestic sector waste which accounted for 172,500 tonnes of the total waste arisings of 310,000 tonnes per annum for the S/E region. Portsmouth City has a waste stream total of 78,000 tonnes per annum. The present Hampshire Waste Services proposal "Project Integra" puts forward two disposal scenarios, the first an incineration approach the second a non-incineration scenario for the disposal of waste. Three phases will exist for the disposal over a period, phase one will commence in January 1996 to December 1996, when the incinerators at Otterbourne, Havant and Marchwood are due to close owing to increased pressure from European legislation on emission levels.

The second phase will commence on the 1st December and is planed to last for a six year period and will focus on the areas of recycling and landfill as waste disposal options.
Phase three will continue for a period of twenty years and will focus on incineration (EFW), and concentrate on the "5 R's of dealing with the waste ;

- **Reduce**
- **Recycle**
- **Reuse**
- **Resources Recovery**
- **Residual Waste Disposal**

By the Adoption of the 5 R's principal of waste disposal then the Agenda 21 criteria of Sustainable Development waste disposal will be met, this will enable Portsmouth City Council to embark upon a long term Sustainable waste disposal program. The benefits in recycling of waste can be seen from figure 14 in which an indication of the effect of recycling waste has on the final calorific value of the end waste fraction.

Figure 14.



Source : (Winchester [26])

Recycling and EFW are not mutually exclusive options and the European experience has demonstrated that EFW can underpin recycling initiatives which are particularly prone to fluctuations in market conditions. Recycling may reduce the amount of waste to be disposed of, as seen in figure 15, however the calorific value (CV) of the waste to be disposed of is usually little changed. In certain circumstances the recycling and processing may be deliberately extended to produce an enhanced fuel Refuse Derived Fuel (RDF) for energy recovery, thus giving a higher CV than before. From the recycling and incineration scenarios there are energy gains, (RDF), environmental gains to be made from the three phase approach by Hampshire Waste Services.

The environmental gains are the RDF, decreased use of landfill sites, decreased possibilities of land and water pollution from the leachate from the landfill sites, and

the main Sustainable Development criteria of Agenda 21 will at least be more enhanced. There are significant problems to overcome regarding waste disposal, political sensitivity of environmental issues and waste incineration within the City of Portsmouth have resulted in incineration being regarded as unacceptable.

Examples of the most common forms of energy from waste , Landfill, mass burn, RDF and biogas can be seen in many reports made to Portsmouth City Council by myself in earlier reports.

The emissions from current incinerators in the S/E region can be seen in table , appendix with the SELCHP emissions (Best Practice Incineration Technology) are indicated in table , appendix .

Research into the environmental software "TEMIS" (Total Emissions Model for Integrated Systems) has indicated analysis of various resources. Seven resources have been listed in figure 10, appendix 1, which indicate the lower and higher heating values associated with each resource. This data could enable long term actions plans to be instigated, taking full advantage of the energy in the resources identified.

In September 1995 the City Council Head of the Councillors banned once more the concept of incineration within the City. This situation is still in a state of flux due to the pressure being experienced by the Agenda 21 program which is forcing Local politicians to take a long term view of the problems in line with Sustainable Development criteria.

The "Best Practice" energy from waste plant is considered by the DTi to be the South East London Combined Heat and Power (SELCHP) incinerator. SELCHP is based upon the principle of recycling the municipal waste into usable energy. The example demonstrated by SELCHP is one which Portsmouth City Council should investigate and remains a distinct choice for the disposal of waste in the City. The particular SELCHP design enables 400,000 tonnes of refuse to be burnt per annum which generates a total of 32MW of electricity and could provide heat for a total of 7,500 homes through the district heating scheme. Magnetic separation also recovers residual ash and ferrous metals which are then recycled. The details of the SELCHP plant can be seen in Table 20.

Table 20. SELCHP Plant Details

Refuse throughput	**420,000 tonnes per annum in 2x29 tonnes per hour refuse burning streams.**
Storage capacity	**4 days of full plant capacity- 5,000 tonnes.**
Number of tippings	**11**
Steam output	**144 tonnes of steam per hour at 395^{o}C and 46 bar with refuse heating value of 8,500 KJ/Kg.**
Flue gas treatment	**Each stream fitted with CNIM semi-dry lime scrubbers followed by high performance Bag House type filters, ejecting into double flue 100m chimney.**
Availability	**Guaranteed 85% each refuse burning stream.**
Operating staff	**55 persons**
Site area	**5.5 acres**
Design & construction cost	**£85 million (1992 basis)**

Source :(SCELCHP [29])

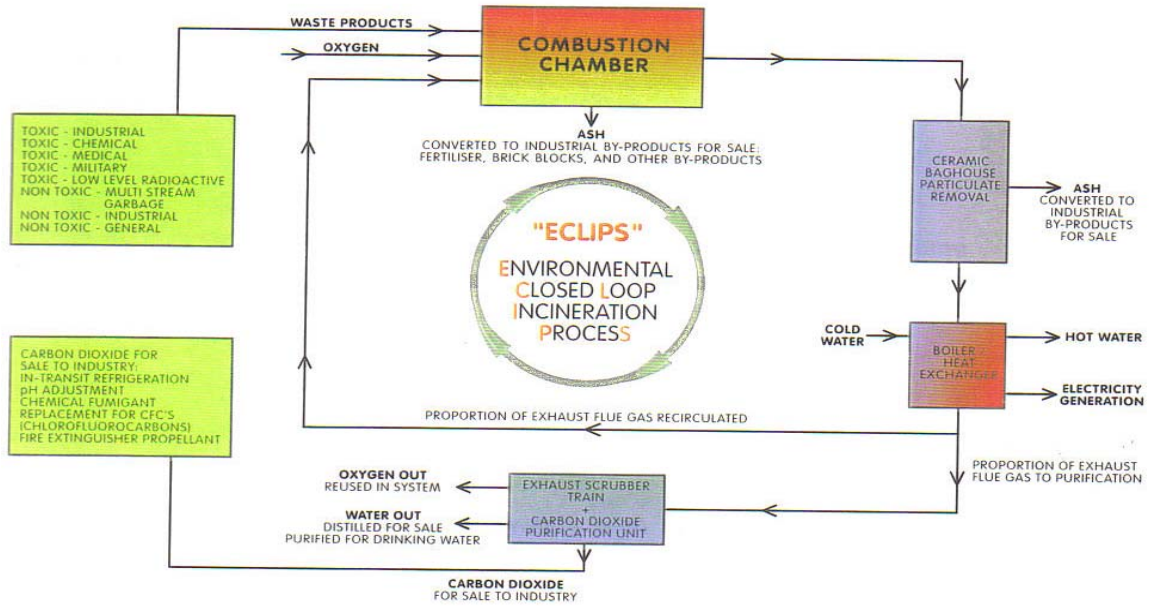
Table 21 Energy Produced at SELCHP

Electricity	**Maximum export capacity 32 MW, self generated in-plants consumption - 3.5MW**
District Heating	**Export capacity 50MW thermal for 7,500 homes**

Source : (SELCHP [29])

SELCHP does not have to be the only option, other more environmentally beneficial forms of waste exist. The City Council were given details, as a result of this project, of a new "Closed Loop" Incineration process produced by the American company Eclipse which could process all the cities waste, produce recycled end products and combined heat and power outputs if required without atmospheric emissions. The English company Environmental Reclamation International (ERI) have produced a series of recycle modules which can achieve a recycle rate of up to 80% of municipal waste which surpasses the UK current target for recycling of waste of 40% by the year 2005 and the construction can be funded by the ERI company at a cost of £22,000,000:00. Table 22 indicates the Eclipse Closed Loop System and Table 23 is a summary of the ERI recycle system.

Table 22. Eclipse Closed Loop Incineration system



Source: (Eclipse [30])

ERI Recycling System

The ERI consortium have been able to source separate all glass, paper and plastic fractions of domestic waste. ERI have brought together the best tried and tested technology from all parts of the world in order to create a unique industry capable of separating all municipal domestic waste from any commercial or domestic zone. The system can be supplied to Portsmouth without capital expenditure to a value of £22,000,000:00 with the cost per tonne of £12:00 over a thirty year contract period. The system is totally enclosed and causes minimal pollution, below current emission levels,, noise levels below average traffic noise and odours imperceptible. The minimum size for a plant is 100,000 tonnes per year of MSW. The system is self running due to the electrical power generating system, CHP . The system has a vitrification plant for processing the ash from incineration which forms the ash into usable products, such as building blocks. Table 23 indicates the products from the recycling system.

Table 23. ERI Recycle Plant

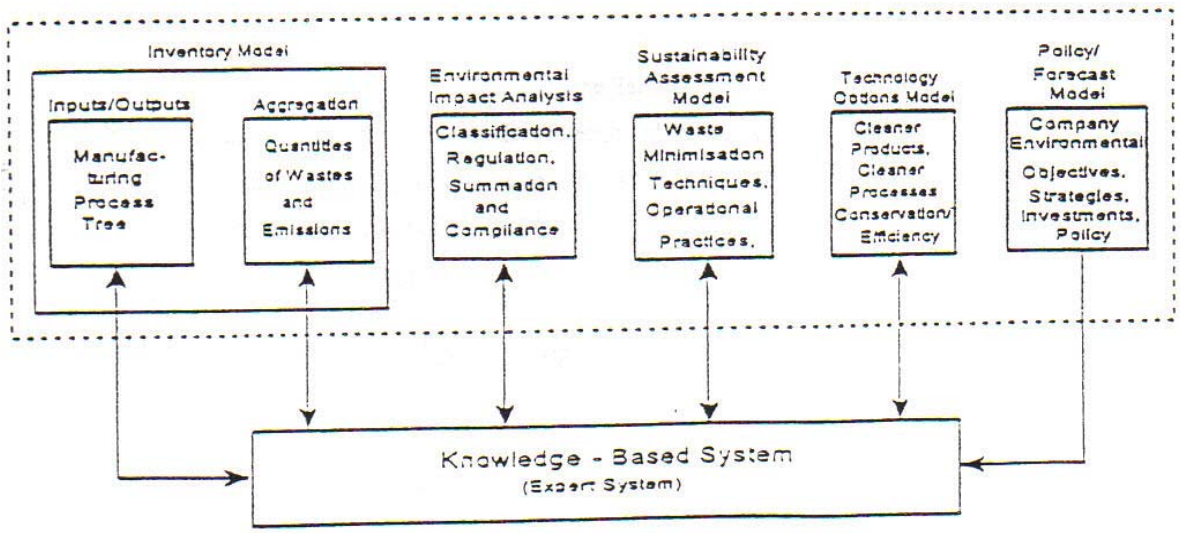
Electricity
Hot Water .... could be used in a district heating scheme
Soil improver
Ethanol
Methane
Ferrous metal
Non-ferrous metal
Recovered plastic polymers such as PVC, PE, PET
Plastic building blocks
Plastic inert material
Mineral wool

Source : (West [31])

5.3 Sustainability in Manufacturing

I order for Portsmouth City to be sustainable the problem of dealing with current waste streams is, as was indicated in section 5.2 an important issue. Recent research programmes in the Department of Mechanical Engineering at the University of Portsmouth have developed sustainability models for manufacturing. A recent report submitted by a Culaba and M Purvis.1995 discusses the sustainability concept within the manufacturing sector of society. The concept is an important one in which waste arisings from manufacturing activity is examined and models formulated to suggest Sustainable development within this sector, which can be seen in figure 15.

Figure 15. Sustainability in Manufacturing



Model Structure

,Sustainability in Manufacturing

Source : (Purvis & Culaba [32])

Environmental Management Systems (EMS) are increasingly being adopted by companies to promote and demonstrate positive, sound environmental practice. Sustainable Development within the City of Portsmouth must be concerned with how the industrial and commercial sector take up the environmental challenge. Sustainable Development will require manufacturing to be sustainable.

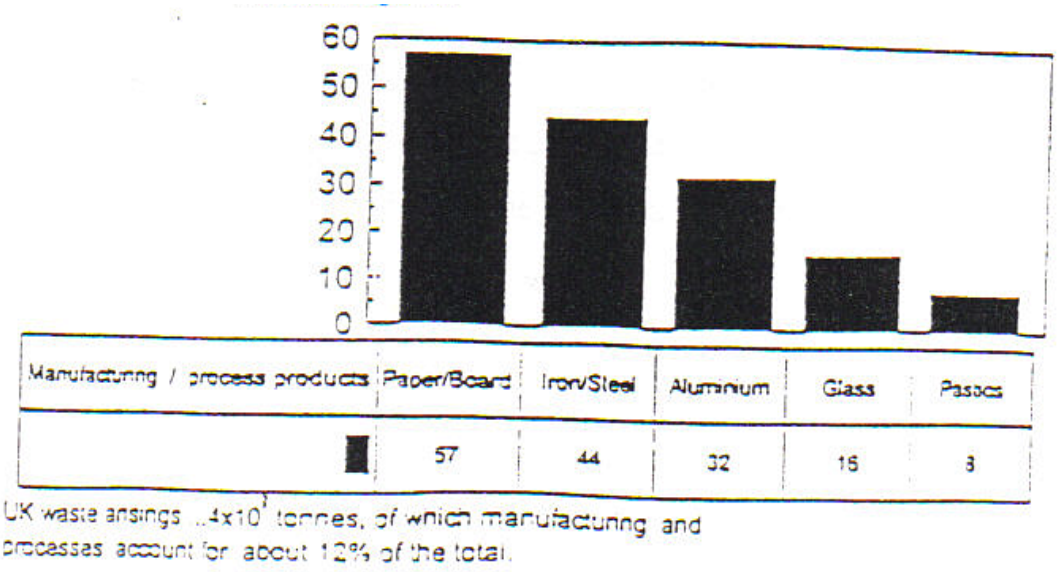
Manufacturing does provide for economic growth, this however must not be at the expense of rapid resource depletion. The reservoir of raw materials is finite, the flow of substances through many stages of manufacturing processes, consumption and use should be managed to encourage optimum reuse and recycling. If this is achieved then wastage and prevention of resource depletion of the natural resource stock would be avoided. Whilst resources are conserved then the economic base will benefit and the environmental impacts from manufacturing process streams will be minimised. Industry is one of the main target areas for the Agenda 21 Sustainable Development program; priority actions are ;

- **Sustainable management of resources**
- **Integrated pollution control**
- **Waste prevention**
- **Reduction in the use of non-renewable energy sources**
- **Public health issues**

The Common Inheritance Report (1992) is the UK response to the Earth Summit Agenda 21 programme and recognises the key role of business and industry have in the protection of the environment. The main UK legislation which has been adopted to facilitate a positive approach to the cleaner and cost effective technologies is the Environmental Protection Act of 1990 (EPA 1990). In this EPA waste minimisation and clean technologies are given a high profile. Opportunity for growth results from industrial activity, however this growth should not be at the expense of resource depletion which is not sustainable. Resources are finite and the flow of material substances through the stages of processing, consumption, use and disposal should be managed as not to cause environmental burden.

In order to minimise the environmental burden of industry then the City Council needs to encourage optimum reuse, recycling and recovery of resources. The UK manufacturing and process industry recycle values can be seen in figure 16.

Figure 16. The UK manufacturing and process industry recycling values (%)



Source : (Purvis & Culaba [32])

Total waste arisings in the UK have been estimated at 4 x 10^8 tonnes of which 17% are attributed to industry. Manufacturing and processing account for 12% of the total arisings. The current recycling rate in the UK by industry is 57% paper, 44% of iron and steel, 32% aluminium, 16% glass and 8% plastic. (Source; waste management Paper No.1,1992). The modelling for manufacturing sectors is based upon the incorporation of Life Cycle Analysis methodology (Culaba & Purvis,1995), which enables the environmental impacts to be determined.

5.4 Sustainable Transportation Systems

Transportation problems in the City of Portsmouth are high on the environmental agenda. Sustainable transportation within the City is a requirement of Agenda 21, for this reason Portsmouth City Council have embarked upon several transportation programmes to meet the challenge of sustainability. The programmes include proposals for a Light Rapid Transit link, Park and Ride, Traffic Calming,Cycle routes and Bus Priority routes throughout the City.

In general terms results from the 1991 Census suggest that the number of persons travelling out of the City of Portsmouth to work has risen by 50% compared with the 1981 Census. This is the highest rate of increase out of any of the Big 11 Districts. Recent modal split surveys indicate that there has been little peak hour growth in traffic on the major roads in the City. The number of persons travelling into the City have averaged 27,000 per day for the last 3 years and the mode of transport has remained at 70% by car.

Portsmouth Modal Split Survey details for October 1994 for the Inner Cordon of Portsmouth reveal for the period 1986 - 1994 there has been an approximate shift of 3% in modal choice from public transport to private vehicle in the peak periods. Rail has lost a greater share of its market whilst buses have maintained approximately 11% of all person trips at the peak times, as have the ferries. The long term decline in cycle usage appears to have stabilised at approximately 4% of peak hour journeys and 3% off peak, this figure is expected to rise significantly with the introduction of safe cycle routes throughout the City. The private vehicle remains the most dominant mode of travel which can be seen in Table 24 indicating inbound movement for the period 0700 - 0900 hours.

Table 24. Portsmouth Central Area Inbound Movement Only

Mode	1986	1988	1990	1992	1993	1994
Bus	11.0 % (3154)	10.8% (3286)	10.0% (2957)	10.2% (2869)	9.2% (2499)	11.3% (3251)
Train	7.0% (2149)	6.3% (1935)	5.8% (1730)	4.8% (1368)	4.8% (1307)	3.8% (1094)
Ferry	11.0% (3363)	12.2% (3736)	10.8% (3198)	11.4% (3213)	11.2% (3022)	11.2% (3219)
Public Transport Total	29.0% (8666)	29.3% (8957)	26.6% (7885)	26.4% (7450)	25.2% (6828)	26.3% (7564)
Private Vehicles	64.0% (18678)	65.3 % (19949)	68.4% (20268)	69.6% (19575)	70.9% (19191)	69.7% (20067)
Total person trips by motor vehicle	27344	28906	28153	27025	26019	27631
Pedal Cycles	7.0% (1955)	5.4% (1644)	5.0% (1467)	4.0% (1115)	3.9% (1037)	4.0% (1154)

Source : (Modal [33])
(Figures in brackets are person trips)

The total number of person trips made for the period 0700-0900 hours inbound including cycles can be seen from Table 25.

Table 25. Total person trips 0700-0900 hours Inbound

Total person trips	29299	30550	29260	28140	27056	28785

Source : (Modal [33])

A summary of the Modal Split Survey 1994 details for morning, midday and afternoon person trips and mode of transport can be seen in Table 26.

Table 26. Portsmouth Modal Split Survey Summary 1994 Person Trips

Inner cordon							Total
Direction	**Time**	**Private Vehicle**	**Bus**	**Train**	**Pedal Cycle**	**Ferry**	
In	**am peak 0700-0900**	**20067 69.7%**	**3251 11.3%**	**1094 3.8%**	**1154 4.0%**	**3219 11.2%**	**28785 100%**
Out	**midday 1100-1300**	**16386 79.0%**	**2073 10.0%**	**403 1.9%**	**652 3.2%**	**1231 5.9%**	**20745 100%**
Out	**pm peak 1600-1800**	**25215 73.2%**	**3835 11.2%**	**1205 3.5%**	**1389 4.0%**	**2780 8.1%**	**34424 100%**

Source : (Modal [33])

From Table 26 it can be seen that the private vehicle accounts for the majority mode of travel. Incoming private vehicles accounted for 69.7 % of the total numbers for the morning period and 73.2% for the afternoon vehicles numbers. In view of the significant environmental problems associated with private vehicles then a shift in this trend is a requirement for a sustainable transportation system. In order for sustainable transportation systems to be achieved within the Agenda 21 Sustainable Development program there has to exist scenarios where renewable resources are used for that mode of transport. Transportation systems throughout the World, the UK and more importantly Portsmouth City account for significant use of energy. The concept of a completely sustainable transportation system may be one which, in time could be achieved, however is must be viewed as being a very long term objective due to our current demographic, social and economic structure. In the short to medium term the more realistic targets to be achieved are those which encompass resource efficiency. Using the TEMIS software data of emissions the following indicates the pollution levels which emanate from 20067 private vehicles entering Portsmouth City:

Diesel Car (new)			**Gasoline Car (new)**		
SO_2	-	0.158717 g/Km	SO_2	-	0.029876 g/Km
CO_2	-	148.1046 g/Km	CO_2	-	148.104600 g/Km
NO_x	-	0.6000 g/Km	NO_x	-	0.370000 g/Km
Particulates	-	0.0800 g.Km	Particulates	-	0.010000 g/Km
CO	-	0.4800 g/Km	CO	-	4.800000 g/Km
N_2O	-	$4x10^{-3}$ g/Km	N_2O	-	0.015000 g/Km

Total value of CO_2 emissions for the 20067 vehicles is as follows;
20067 x 148.1046 g/Km = 2972015.008 g/Km = 2972.015008 Kg/Km
The total Global Warming factor (CO_2) emissions for the 20067 incoming vehicles to Portsmouth is therefore 2.972015008 Tonne /Km/day = 1084.785470 Tonne/Km/year.

It remains important to make less trips, make shorter trips and use the most efficient mode of transport. There has been an increase on average in the number of trips being made and for an increase in the length of each journey. This trend has to be reversed in accordance with the new Planning Policy Guideline (PPG) No.13 which recognises the inter-relationship between land use, transport and significant environmental impacts. The future developments within the City will seek to encourage development to occur in locations where good public transport networks already exist or can be achieved concurrent with development. Developments submitted which increase car usage will be discouraged. There is an increased responsibility by both Central and Local Governments to positively promote Sustainable Development modes of transport. The Department of Transport now require Local Authorities to give full consideration to how transportation policies and programmes for transportation improvements will contribute to an integrated transport system, rather than each proposal being assessed in isolation, the wider environmental impacts are increasingly important.

In 1992 the County Council and the Borough Councils of Fareham, Gosport and Portsmouth commissioned an environmental impact assessment of the proposed LRT system which indicated that this new mode of transport would reduce traffic congestion, noise and air pollution. Unless the LRT was introduced then the traffic movements would be frustrated, environmental pollution would increase and economic growth and development would be discouraged. The LRT is a proposal which complements the Integrated Energy Policy and Strategy for the City in line with Agenda 21.

The LRT proposal would be more energy efficient, using modern trams which are quiet, emit zero pollutants in their operation and will travel at 80 Kilometres per hour. The total journey length for the initial proposal route will be a distance of nine miles from Portsmouth to Fareham vis Gosport and will take a journey time of thirty minutes. Shorter journey times and increased comfort for the commuters will be experienced which will enable the development of tourism and encourage economic growth together with significant reductions in environmental impacts. The cost of the system is approximately £100 million for the Portsmouth / Fareham link. Much of the development work still has to be completed and also funding sources identified in time for Unitary status in 1997.

5.5. Sustainable Housing and Energy Efficiency

Another initiative the City Council has developed over many years is the energy efficiency program of its housing stock. A major aspect of Agenda 21 is that Council's provide for affordable warmth for all their tenants in Council owned properties. The Housing Department has in place the National Home Energy Rating scheme (NHER) which is enabling the Council to raise the energy efficiency of its housing stock according to the NHER system. The full profile of the current numbers of houses in Council ownership and the ratings achieved can be seen from figure 11, appendix 1. Housing is a very important area for the Council to consider in its Integrated Energy policy. Domestic dwelling account for considerable environmental burdens in terms of energy use and carbon dioxide emissions. Many measures such as roof insulation, dry lining, double glazing, cavity wall insulation and general refurbishment work has been a priority policy issue.

In September 1992 the Housing Department made a formal commitment to adopt an energy policy and are now committed to provide affordable warmth, eradicate condensation and mould growth from the housing stock and reduce the City Council's contribution to Global Warming. Future proposals to be adopted by Housing Services include the following action plans;

- **Raise the NHER of the housing stock to at least 5.5**
- **Prepare energy audits with costed programmes for improvements**
- **Review and set energy ratings, condensation risk and CO_2 reduction**
- **Train energy surveyors to provide advice to tenants**
- **Co-ordinate the Housing energy policy with the Integrated Energy Policy of Portsmouth City Council**
- **Investigate the potential for CHP and alternative energy resources**
- **Monitor Housing stock improvements and the effect on the NHER.**

5.6. Technological options for Combined Heat and Power (CHP)

It has been established from the Integrated Energy Policy that there exists several energy efficiency objectives. The Council seek to not only minimise their own energy use but also encourage industry and commerce to adopt CHP in the City. After detailed investigation into CHP the Building Services Department of the City Council have proposed to install a CHP system into the main Civic Office in Portsmouth and also to recommend its adoption , where suitable within the City as a whole.

The main principles of CHP

The environmental problem could be considered as an energy problem. Energy is neither created or destroyed, it simply changes from one state to another. Energy is normally used in its converted form, the general pattern being to buy fuel and convert it on site into steam or hot water and to buy electricity separately from the National Grid supply. The conversion of fossil fuel to electricity in conventional power stations produces large quantities of waste heat which cannot be used and is therefore rejected to the atmosphere via cooling towers or to a water course. Power stations are also the largest producers of NOx and SOx pollutants and therefore the overall environmental impact of this method of electricity generation is significant. Only one third of the calorific value of the fuel is then used in useful work, electricity is produced, however waste heat energy is rejected and lost to the environment. Indicated in the earlier Chapter on energy use it was noted that the energy supply industry uses 29% of all energy in the UK. Energy savings of between 20%-40% are achievable if the power generation is located where the waste heat produced can also be used, as in the case of a CHP installation. The output from this then represents $^{4}/_{5}$ of the original calorific value of the fuel and the combined cost of heat and electricity is lower than buying separately. Typical Thermal efficiency of power stations is 38%, the thermal efficiency of the CHP electricity generation is 40% with a 67% efficiency of waste heat recovery. (After :Easthop & Croft [34])

The TEMIS software obtained from the OKO institute in Germany has enabled the comparison of the LCA and composition of fuels to be possible. The example in the software is based upon German natural gas, the fuel to be used in the Portsmouth City Council CHP system is English natural gas. The TEMIS software will enable Portsmouth City Council eventually build up a total City wide emission model and predict total energy use. In this case the TEMIS software was used to compare heating values and emissions from the combustion of the natural gas, as seen in Table 27.

Table 27. Characteristics of Natural Gas

GERMANY NATURAL GAS and ENGLISH NATURAL NORTHSEA GAS

CH_4	**83.3**	**(Vol-%)**	**CH_4**	**95**	**(Vol-%)**
C_2H_6	**1.2**	**(Vol-%)**	**C_2H_6**	**2.9**	**(Vol-%)**
C_3H_8	**0.1**	**(Vol-%)**	**C_3H_8**	**0.5**	**(Vol-%)**
C_4Hgn+1	**0.1**	**(Vol-%)**	**C_4Hgn+1**	**0.2**	**(Vol-%)**
CO_2	**1.3**	**(Vol-%)**	**CO_2**	**-**	**(Vol-%)**
N_2	**14**	**(Vol-%)**	**N_2**	**1.2**	**(Vol-%)**
H_2N	**$4x10^{-4}$**	**(Vol-%)**	**H_2S**	**-**	**(Vol-%)**
Lower Heating Value	**30.88**	**(MJm^{-3})**	**Lower Heating Value**	**35.3**	**(MJm^{-3})**
Higher Heating Value	**34.25**	**(MJm^{-3})**	**Higher Heating Value**	**39.2**	**(MJm^{-3})**

Source :(Temis [35]) **Source :(Purvis [36])**

The calorific value of the English Natural Gas is higher than the Germany natural gas by 4.95 MJ^{-3} at the higher heating value and 4.42 MJ^{-3} at the lower heating value as seen in table 25. The main reason for this is the higher CH_4 value in the English gas which is 95% CH_4 in the English and 83.3% in the German gas. The nitrogen content is only 1.2% in the English and 14% in the German natural gas which would result in the German natural gas resulting in more NOx and acid rain production.

When considering selection of a CHP system the fuel used to power the prime mover is an important environmental consideration. Table 28 indicates the carbon dioxide emissions and energy available energy generated from specific fuels which result in global warming due to the greenhouse effect.

Table 28. Carbon dioxide emissions and carbon fuel heat in fuels

Fuel	**Typical % of carbon in fuel**	**Tonnes of CO_2 produced / tonne of fuel**	**Kg of CO_2 /GJ of available energy (GCV)**	**Kg of Co_2 per MWh of available energy (GCV)**
Coal	87	3.2	91	327.6
Heavy fuel oil	86	3.1	74	266.4
Gas-oil	86	3.1	69	248.4
Natural gas	73	2.8	50	180

Source : (EEO [37])

Carbon dioxide is the gas which is produced in the greatest quantity by the combustion processes. By combustion of the fuel the available carbon is converted to CO_2 in order to release the available energy. From the above table 26 it is considered the environmental gain is highest when the choice of fuel is natural gas which if adopted within industry and commerce in the City of Portsmouth would help significantly meet the criteria of sustainable development. Table 29 indicates the sulphur dioxide content in fuels, which leads to acid rain.

Table 29. Sulphur dioxide emissions and sulphur content in fuels

Fuel	**Typical % Sulphur in fuel**	**Kg of SO_2 / tonne of fuel**	**Kg of SO_2 / GJ of available energy (GCV)**	**Kg of SO2 / MWh of available energy (GCV)**
Coal	2.0	40	1.15	4.14
Heavy fuel oil	2.5	50	1.17	4.21
Gas-oil	0.3	6	0.13	0.47
Natural gas	nil	nil	nil	nil

Source : (EEO [37])

The choice made to install the CHP system in the Portsmouth Civic Offices was made in line with the new Integrated Energy policy and Agenda 21 policy which the Council has adopted. The choice of fuel for the system being natural gas enables the City Council to lead by example and minimise its own environmental impacts within the Civic Offices Building. Natural gas has a gross calorific value of 38.60 MJ^{-3} and a net calorific value of 34.90 MJ^{-3} . The characteristics of the fuel also indicate a high proportion of CH_4 some 83.3% and is low in H_2S and is the least polluting fossil fuel when compared to coal or oil. The environmental impacts are significantly reduced which makes it highly desirable for use in electricity and heat generation.

The estimated energy cost savings for the CHP installation is £90,000 per annum with a four year payback period and an estimated 3000 tonnes CO_2 reduction per year.

The current Benchmark costs per metre for the Civic Offices can be seen in figure 17 which outline the Benchmarks for maintenance, utilities, cleaning and overheads for the offices. These Benchmarks are important for future energy efficiency measures to be introduced which will enable Portsmouth City reduce the CO_2 emissions from their building stock within the City boundary.

Energy delivered to the Portsmouth Civic Office site can be seen in Table 30 for the period 1994 - 1995 for the electricity and gas consumption.

Table 30. Energy Delivered to the Portsmouth Civic Offices (Electricity and Gas)

Month	Electricity Demand KWh	Natural Gas demand KWh	Electricity Costs per month (£)	Natural Gas Costs per month (£)
March	**607200**	**694928**	**36009.98**	**7863.29**
April	**667500**	**653200**	**31288.91**	**7391.11**
May	**612800**	**399435**	**28653.33**	**4519.71**
June	**640000**	**297731**	**30046.34**	**3368.90**
July	**703000**	**33710**	**33141.99**	**370.74**
August	**832000**	**106306**	**38774.89**	**1169.15**
September	**786300**	**111378**	**31653.30**	**1042.50**
October	**649800**	**343666**	**26556.31**	**3216.71**
November	**645750**	**431844**	**28684.75**	**4042.10**
December	**645750**	**431844**	**28684.75**	**4042.10**
January	**647100**	**898336**	**57636.74**	**10164.89**
February	**614900**	**773708**	**51040.20**	**8754.70**
Totals	**8052100**	**4410043**	**422,171.49**	**456,113.80**

Source : (Dutt [39])

The tariff is an interruptible tariff for the electricity and gas supply which has been estimated at 3.76 pence per kilowatt electricity and 0.88 pence per kilowatt for gas and the CHP power factor is 0.95. The CHP system will produce a financial saving of £90,000:00 for a cost of £300,000:00.

The CHP installation will incorporate four chillers and one absorption chiller each with a 800 KW capacity and 750 KW capacity respectively. The CHP system is to provide both electrical and heating loads for the building, which covers a total of 24,000 sq metres. There are a total of 1,100 people who occupy the building and there is a variance to the base load figures due to individual fans in the summer months and fires in the winter months. The values for the variance to base loads are 25% in the winter and 15% in the summer. No cost benefit analysis calculations were performed using discounted cash-flow techniques only a simple payback calculation with a 10% discount rate for long-term capital repayment. The CHP system was chosen on the grounds of offering cheaper electricity and heat generation, increase in total energy efficiency, free use of waste heat, more economical and more environmentally friendly technology, resulting in less environmental impacts. The specific calculation used to determine the CO_2 was calculated from the operational load details of 750 KWh for 5000 hours of operation and CO_2 savings factor of 0.8Kg/KWh;

CO_2 Emission Reduction Estimate

750 KWh x 0.8 Kg (CO_2)/KWh x 5000 h per year = 3000 tonne CO_2 reduction/year

The adverse aspects of the CHP system are the high capital costs, noise and maintenance costs. Maintenance is very expensive each year and has been estimated at £30,000:00 per year which equates to 0.75 pence per KWh. The project intension was to do a full investigation into the particular CHP system installation in the Civic Offices, however due to the delay in the installation being completed this was not possible.

5.7 Summary

Portsmouth City energy efficiency initiatives are varied, one of the most ambitious is the proposed District Heating Scheme which proposes a four phased approach. Identification of a heat load for 174 buildings was determined as 125MW with an initial heat load of 33MW for 31 connections. The site selected for the transmission heat main was the landfill site at Paulsgrove, along the M275. CO_2 reductions were estimated at 19,114 tonnes per annum, SO_2 reductions of 91 tonnes and NO_2 reductions of 21 tonnes per year. The Building Services department had a Clean Green Budget between 1992-1993 totalling £27,000:00 which was used to reduce energy consumption in the Civic Offices by installing Power Factor Correcting equipment and speed controls fitted to the ventilation fans. The 1994 -1995 budget was £171311:00 to be used on energy efficiency projects which have an average payback period of 2.3 years. The full list can be seen in table 1, appendix 1. The CO_2 reductions experienced per household in Portsmouth due to the Housing Departments energy efficiency programme are as follows; careful use of lights in the home could save 190-500 Kg CO_2, insulation of hot water systems saving 125-190Kg CO_2, cavity wall insulation saving 750-880 Kg CO_2 per annum. The total waste arisings in the UK amount to $4x10^8$ tonnes per annum. The existing landfill site at Paulsgrove is due to close by the end of the Century, the incinerator at Quatermain Road has closed and the existing S/E incinerators are all due to close due to not meeting the new European Union emission standards. The Problems Portsmouth City Council will face when they become the Disposal Authority in 1997 are significant. The waste services company Hampshire Waste services have put forward the long term Integra waste disposal programme for S/E Hants which includes recycling, resource recovery, reuse and incineration (energy from waste). The capacity in the UK for energy from waste totals 4.5 Mtpa and for mass burn 7.0 Mtpa. The current disposal routes for waste in Portsmouth are as follow; 67% landfill, 24% incineration at Havant, 3.7% recycled at the Hampshire Waste Recycling Centre, 3.3% recycled at recycling banks and 1.1% recycled at the Municipal Recovery Facility in Portsmouth. The City has gained high level status for their recycling initiatives and are at present sixth in the Country. The number of households connected to the Kerbside collection system at present is 3000. The total domestic waste arising in the S/E region is 172,000 tonnes per annum. The Council will achieve a reduction of 3,000 tonne of CO_2 per annum and reduce the fuel bill by £90,000 per year.

Chapter 6.1 Discussion

The Sustainable Development Agenda 21 programme should achieve new levels of environmental co-operation amongst European Union Member States. The United Kingdom Local Agenda 21 programme has been launched following the 1992 Earth Summit. The Local Government Management Board (LGMB) has established effective guidance notes for a City such as Portsmouth to follow to achieve Sustainable Development within the United Kingdom. The essential inclusion of this Agenda 21 programme was energy reduction targets. The 30%-50% energy reduction targets set by the LGMB over the period 1995-2025 is in line with Sustainable Development criteria and is realistic when reviewing the CHP, Energy From Waste Incineration and renewable energy technology advances being made in areas of solar energy, crop, wind and tidal power and their increased use. Increasingly CHP systems and energy from domestic waste plants are used as a means of enhancing the energy reductions and emissions from conventional fossil fuels, in the case of CHP an increase in efficiency of 40%-50% can be achieved. If 50% of the electricity consumed within the City was generated by CHP then the annual savings of CO_2 would be 0.8Kg x 300 GWh = **240,000 tonnes CO_2** [1] . This reduction in energy use will result in CO_2 emission reductions in the United Kingdom and Globally which will minimise the increasing pollution and Global Warming from countries such as India and China. The electricity consumption of the City of Portsmouth has been estimated as 775 GWh per annum and for the Portsea area 600 GWh.

The EMAS and BS7750 environmental management systems which will help Portsmouth City reduce their environmental impacts could be fully incorporated into the City Council management structure within five years. Each new building development within the City should be subject to a full environmental impact assessment. The City of Portsmouth covers 4042 hectares and is the most densely populated City in England. The population density is 43.4 persons per hectare and the City has 18700 domestic dwellings. The current unemployment rates of 12.7% male and 7.29% female will effect the disposable incomes for energy efficiency purchasing, affordable warmth and transport choices.

In the period from 1981 to 1991 there has been an increase of 45% in transport out of the City and 70% of all journeys are now by car. This trend in expected to increase in line with Kondratiev cycle predictions unless a Carbon Tax is brought into discourage car use. The data from the Modal Split Transport Survey indicated that there were a total of 20067 inbound private cars and the emissions of CO_2 on a daily basis was estimated as **1084.78 tonnes/KM/year** [2]. The Light Rapid Transit link when established will hopefully reduce car transportation, only if the system is financially attractive to commuters, is safe and efficient. Throughout the United Kingdom there is a future requirement for a further 4.4 million one parent family homes by the year 2016. These homes should be built to the highest energy efficiency rating and incorporating passive solar design, solar hot water systems, photo-voltaic's, cavity wall insulation and double glazing.

The solar gain in the S/E of England is 3.1 KWh/M^2 and should be utilised in new build houses. The projections made for savings of emissions of CO_2 from solar energy aided district heating for 231 homes was estimated as 676,000 Kg CO_2 per year. The ETSU assessment made in 1992 on renewable energy sources indicated that between 15-130 Terawatt hours of electricity per year by the year 2025 would be generated. The largest potential within the ETSU assessment was off shore wind, onshore winds, bio-crops then photo-conversion. In the year 2005, tidal power was found to be the largest renewable resource, crops not yet fully exploited.

Changes will occur by the year 2025 with bio-crops having the highest potential, however this will only occur if grants from the European Union are provided and the UK Central Government allocate funding to respective Councils. The Government intend to work towards a target of 1,500 MW of new electricity being provided by renewables by the year 2000. If the renewable power,solar district heating was extended to all the present 18700 homes within the Portsmouth area then the **CO_2 reductions per annum would be 54723 tonnes** [3] per annum, which is very significant.

Portsmouth's energy efficiency programme indicates that a further reduction in CO_2 emissions can be made in the following areas; careful use of lights in the home could save 190-500 Kg CO2, hot water insulation saving 125-190 Kg CO_2, cavity wall insulation saving 750-880 Kg Co2 per year. Taking the figure of 18700 homes in Portsmouth then the total CO_2 reduction would be between **19,915.5 tonnes** [4]-29,359 tonnes **CO_2 per annum.**

The single largest contributor of CO_2 emissions in the domestic sector was space heating, which accounted for 52.3%. If energy efficiency measures are vigorously undertaken then the European Union Community Action Plan for energy efficiency of electrical use indicated that a 20% reduction in consumption would result in a CO_2 reduction of 40 million tonnes**,** 540,000 tonne reduction in SO_2 , NO_2 reduced by 440,000 tonnes and radio active waste reduced by 6,500 cubic metres.

This is a very strong case for Portsmouth to produce a strategy to minimise the environmental impacts of energy use within the City. As seen from the Energy Management Matrix in Chapter 2 Portsmouth City Council has an unbalanced approach to energy management. Energy efficiency within the City should be raised. Motivation of the management should be giving serious consideration in order to instil the importance of energy efficiency within management decisions within the Council. The World total energy consumption is 7804 million tonnes of oil equivalent, per capita average energy use is 50 GJ and the primary fuel used in Europe is gas which accounts for 45% of total fossil fuel use. The emissions of CO_2 within the UK is between 158 and 160 Mtc. Energy must be conserved and its use within Portsmouth, Europe and the World must be made more efficient due to the depletion rates for gas being 40 years, oil-30 years and coal- 350 years. The fossil fuel Gas has the lowest CO_2 emission factor and amounts to 0.21 Kg CO_2 /KWh and if the energy reduction targets set in Agenda 21 and the FOE Climate Resolution are to be achieved over the thirty year period gas should be used in conjunction with CHP electricity production within Portsmouth City and Europe. In approximately 40 years the gas resource will be severely depleted and a transition to another fuel will be required, care must be taken when planning for the future fuel choice in line with Life Cycle Analysis.

The Council are involved in numerous energy efficiency initiatives, one of the most ambitious is the proposal for a District Heating scheme. The heat energy is to be supplied by the combustion of domestic waste. Energy from waste is a very important environmental factor and is to be encouraged. A heat load factor of 125 MW was determined for 174 buildings within the City. The first phase was to connect 31 buildings with a heat load of 33MW. The annual reduction in **CO_2 emissions was 19,114 tonnes** [5], SOx reductions of 91 tonnes and NOx emission reduction of 21 tonnes. The concept of energy from waste is both environmentally and economically attractive and of the total UK waste arisings of $4x10^8$ tonnes, incineration accounts for 4.5 Mtpa energy from waste (EFW) and 7.0 Mtpa mass burn.

Trends within the waste sector indicate an increase in both incineration and mass burn EFW. With the restriction on movement of waste from one County to another, the prohibition of dumping at sea and the landfill sites being exhausted then the Project Integra programme, which includes incineration, recycling and landfill is a step in the right direction for a waste scenario. Both the Eclipse Closed Loop atmospheric emission free incineration and the ERI 80% recycle systems should be incorporated within any future waste disposal programme, recycling remains the best environmental option.

The TEMIS software model has been used within this project to estimate the greatest potential for energy utilisation from different fuels. The highest heating value with the lowest environmental burden should be chosen as a fuel for incineration. The model indicated that residential waste has an upper heating value of 2.68 MWh/t, straw has 3.47 MWh/t and gas 5.38 MWh/t. There is a clear environmental gain to obtain the energy from domestic waste and also to encourage the use of straw and other bio-crops such as rape seed as a fuel in incineration systems for Portsmouth and Hampshire. Of the total S/E regional wastes of 178,000 tonnes Portsmouth has a waste stream of 78,000 tonnes per annum with a potential for electrical generation of 209 MWh/year. If normal incineration systems are used the emission levels of **CO_2 from the process is estimated as 100,000 Kg/TJ or 20,900 tonnes per annum [6].** If the Closed Loop Incineration process was adopted the system freezes the CO_2 which is then recycled, thus reducing the Global Warming Factor.

With the nitrogen and sulphur oxide emissions from the combustion of fossil fuels resulting in Acid Rain and the CO_2 and other Stratospheric accumulations of gases changing the Earth's energy balance and leading to climatic change, Global Warming. Each of the LCA models indicated the inputs and outputs to the environment, natural gas having the lowest carbon dioxide emissions causing Global Warming then the less polluting fossil fuel used for the generation of electricity is considered having the lowest environmental impact. Gas has 0.21 Kg CO_2/KWh as opposed to conventional electricity generation having 0.73 Kg CO_2 / KWh. The generation of electricity by using gas in a CHP system is considered less polluting and more efficient. The CHP plant proposed for the City Council will reduce **CO_2 emissions by 3000 tonnes per annum** [7] and save £90,000 per year on fuel bills and a pay back of 3-4 years, which is very favourable.

Portsmouth City Council decided in 1995 to investigate the process of Agenda 21 and formed eight working parties. The Integrated Energy working party formulated the Policy which was formally excepted by the Front Line Service committee and the Environmental Forum later in that same year. There was a commitment to a reduction in CO_2 levels of 10% by 2000 and by the year 2005 a 20% reduction. The council will also work towards the 33%-50% LGMB reduction target by 2025. The City intended to sign up to the FOE Climate Resolution which states that the City will achieve by the year 2005 a 30% reduction in CO_2 and undertake to develop a detailed strategy to achieve this target within 12 months of it's adoption.

Unfortunately limited resources of finance, time and manpower together with a general apathy towards such issues the City has not achieved that strategy within the time period. A serious effort of educating the officers and general public to the importance of such a resolution is required and ensuring that each Councillor of the Council understands fully it's implications. It will be possible to meet the reduction targets if solar energy hot water systems are placed on the 18700 Council owned homes, this will be possible by a serious of bridging loans between banks and a financial cash back arrangement over five years which is available, if energy from the tide is obtained by the use of water turbines between Gosport and Portsmouth, Energy From Waste, wind generators are placed upon Portsdown hill and out to sea, together with the CHP City wide and general energy efficiency measures.

Companies exist now who can finance fully the £22 million recycling plant, offer free 100,000 low energy lights to the City and the European Thermie grant scheme together with the Energy Efficiency grants of 50% to 100% installation costs for CHP systems and the Non Fossil Fuel obligation of fixed term low cost per KW of electricity generated from renewable sources.. The project I believe has indicate the complexity of energy efficiency within a City and has made a positive Integrated Energy Policy, sound strategic action plans and high lighted the areas of weakness, strength and proposed "Best Environmental Technologies" to aid the target reductions for CO_2 and energy consumption. My allocation of time was important within the project and I found that too much time was devoted to preparing and giving a total of six presentations to City Officers and Councillors and helping the environmental coordinator research into Agenda 21 issues. Due to the complexity of energy efficiency I found it difficult to limit the project to 100 pages and felt that a more in-depth study is required.

The City of Portsmouth now has as a result of the Integrated Energy Policy formed Links with major employers in the City and had a 65% positive response to an energy survey they sent out to Industry and Commerce in the City. Companies such as Paul Europe, Johnson&Johnson, IBM and 62 other major companies expressed more information on how best to help Portsmouth achieve the Agenda 21 energy reduction targets. As a result of the project the City offered me the energy Strategy Officer's position, however had no funds available. The City of Portsmouth is now in a position to embark upon it's Sustainable Development programme by instigating the first Integrated Energy Policy and the FOE Climate Resolution.

Taking each of the high-lighted figures in the discussion [1-7] for CO_2 reduction the total CO_2 emission reduction indicated in the project amount to 358,736 tonnes per annum.

The road from Rio is not easy, however Portsmouth can go forward with Agenda 21.

6.2. Recommendations

This section is concerned with the personal recommendations made to the Energy Conservation Working Party and Council Executive in order to promote and facilitate effective Agenda 21 implementations.

6.2.1. Recommendation for Chapter 1. European and UK Agenda 21 Programme

(i) Portsmouth City Council should lead by example in the aspirations of the United Nations Agenda 21 "Sustainable Development " programme.

(ii) Increased levels of satisfaction and service should be actively encouraged by the City Council in order to be effective in the "Local Agenda21" programme.

(iii) The City Council should endorse the Friends of the Earth's Climate resolution of a 30% reduction in carbon dioxide emissions by the year 2010 and comply with the LGMB and DTi recommendations of a 33% -50% energy consumption target by the year 2025.

(iv) The City Council should work towards full environmental management accreditation under the EMAS scheme, initially in the City Engineer's Department and then corporately across all Departments.

6.2.2 Recommendations for Chapter 2. Portsmouth City Major Environmental Issues

(i) The Council should reduce energy consumption within the City of Portsmouth by 300 GWh by the year 2025 also commence training programmes in Best Practice Technology in energy efficiency and CHP in relation to the Agenda 21 program.

(ii) The City Council should reduce the current 70% car journey rate in the City by actively promoting the LRT, Bus and Cycle priority routes.

(iii) A full Environmental Impact Assessment (EIA) is required for the Millennium Renaissance Harbour development and recommendations proposed for "Sustainable Development" full use of Alternative Renewable Energy Resources in the project.

(iv) The City needs to reduce unemployment levels and establish a sound industrial and commercial base which will help minimise transportation problems of" OUTGOING" from the City.

(v) Local contractors and where possible materials should be used for all development and construction work within the City.

(vi) In order to project the Council from an "Unbalanced" approach to energy management the City should promote formal contacts for energy efficiency, staff motivation and make a clear delegation for energy responsibility for the City. The marketing Department should increase the profile given to energy efficiency and Agenda 21 programmes.

(vii) Promote non- costed budget control for Council officers to attend meetings and communication to aid Agenda 21.

6.2.3. Recommendations for Chapter 3. Environmental Impacts of Energy Use

(i) CHP power generation must be given a high profile for selective use in new developments and current building stock within the City.

(ii) The TEMIS software package should be used by City Council Departments such as Purchasing, City Engineers sections, specifically Waste and Special projects Sections, Environmental health in order to make professional judgements for material choices, waste minimisation and energy efficiency.

(iii) The domestic sector of the City's energy efficiency programme should concentrate on the 53.3% space heating losses experienced in the UK from this sector. cavity wall and all other forms of insulation needs active promotion.

(iv) In line with the European United Nations Community Action Plan for energy efficiency of electrical use a 20% minimum reduction is recommended.

(v) Promotion of all solar technologies for heating and electrical production supply should be made in the City which will enable full advantage to be made of the solar resource in the area of between 2.8 and 3.0 KWh/sq m/day.

(vi) Energy from waste programmes are encouraged and a recommendation is made for the closed loop incineration (energy from waste) be investigated as a possible way of alleviating the public fears of atmospheric emission levels from waste disposal.

6.2.4. Recommendation for Chapter 4.Integration of Environmental Energy Policy and Strategy.

(i) Reduce energy consumption in the City by 33%-50% by the year 2025, in a phased approach; 1st phase 10% reduction by 2000, 2nd phase 20% reduction by 2005 and the final 3rd phase of 50% by the year 2025.

(ii) Monitor all buildings in Council control for energy efficiency and performance. Target those which have a Benchmark above the average for electricity and gas use.

(iii) Communicate Best Practice advice to all sectors of society and City Council staff in general.

(iv) Establish an Energy Advice Centre in the City of Portsmouth, make energy and environmental issues a key role in management decision making.

(v) Continue with the affordable warmth programme and private housing energy efficiency initiatives in line with the NHER scheme.

(vi) Develop short term, medium term and long term action plans for the ongoing development of CHP in the City.

(vii) Establish an energy fund where all energy cost savings can be channelled into the central fund for the promotion of other energy efficiency projects.

(viii) Consider new development projects exceeding the Building regulation requirements in term of energy efficiency and consider environmental clauses to be in the specifications for all development in the City.

(ix) Increase the funding for selective public transport programmes such as the LRT.

(x) Introduce car pooling into the Civic Offices and offer financial incentives to staff not to use the car as their mode of transport to and fro from work.

(xi) Restrict access to the City Centre by private vehicles.

(xii) Increase car parking charges to promote less use of the car and limit the maximum number of car parks and spaces.

6.2.5.Recommendation - Chapter 5. Portsmouth Environmental Initiatives

(i) In consideration of the proposals for the District heating Scheme for Portsmouth City, investigate the potential of using biogas, biocrops as a secondary incineration fuel resource.

(ii) When designing the new development sites for the Renaissance Harbour project install underground heat transmission pipes which can be linked into the proposed District heating scheme.

(iii) Develop the ERI recycling scheme throughout the City of Portsmouth.

(iv) Investigate the possible reuse of the landfill wastes as a source of fuel for incineration.

(v) Make full investigations into the Closed Loop Incineration system.

(vi) Develop the TEMIS software for waste management scenarios and energy from waste projections.

(vii) Make fully available Park and Ride areas for use by "Incoming" traffic

(viii) Do not transfer out of the City any waste for disposal.

(ix) The introduction of low level emission monitors linked to traffic control lights is recommended. When atmospheric emission are high the lights will remain green in order to facilitate a faster traffic flow which will minimise idling of engines and emission build up.

(x) Increase public transport bus numbers on routes with the highest number of commuters in and out of the City.

(xi) Investigate the possibility of providing grants for solar hot water systems in domestic, commercial and industrial sectors.

(xii) Place on the proposed Millennium Tower photovoltaic cells for electricity.

(xiii) Consider the use of Tidal Power and Wind generation of electricity together with CHP for use in the Millennium Harbour Project.

(xiv) Photo-voltaic panels are not financial viable at present, the approximate cost of £1,000 per square meter does not lend it's self to large scale use. It is recommended that the Council make the Civic Offices a demonstration model of this technology by obtaining grants from the European Thermie Energy Funds.

(x) Transport into Fratton used Tyres to be combusted for the production of electricity.

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Benchmark [38] Building Energy Benchmark data compiled for Portsmouth City Council owned property in Portsmouth, Services section, Portsmouth City Council.

Dutt [39] department,K.Dutt, Combined Heat and Power tender documentation,August 1995, Building Services Portsmouth City Council consultant.

Appendix 1.

Figure 1. BS7750 Environmental Quality System Key Elements

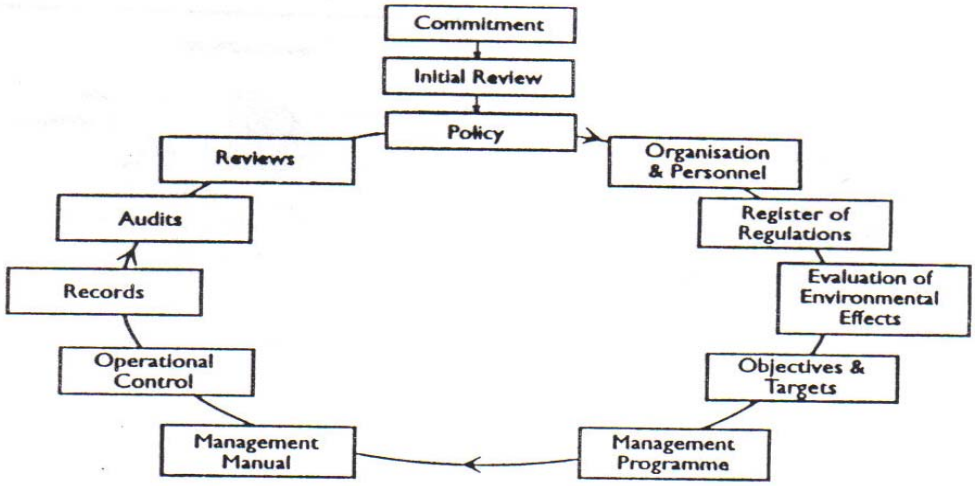
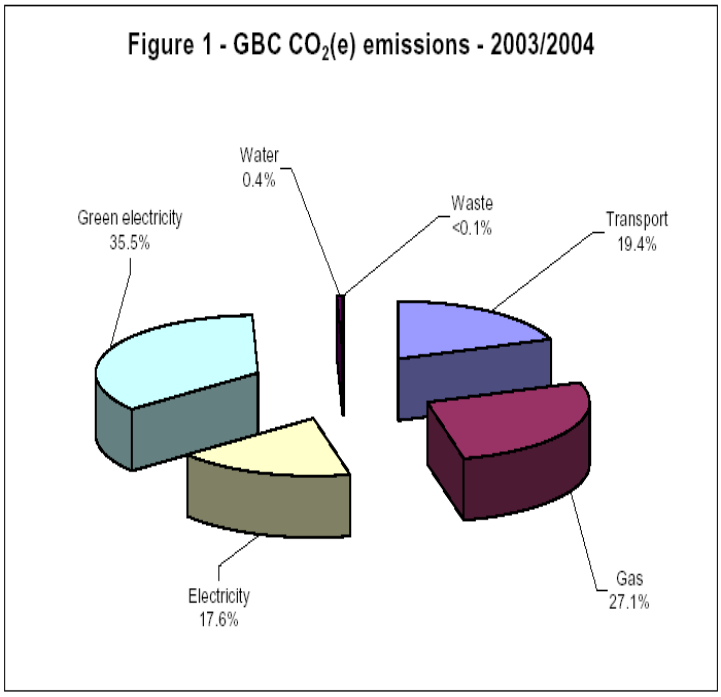
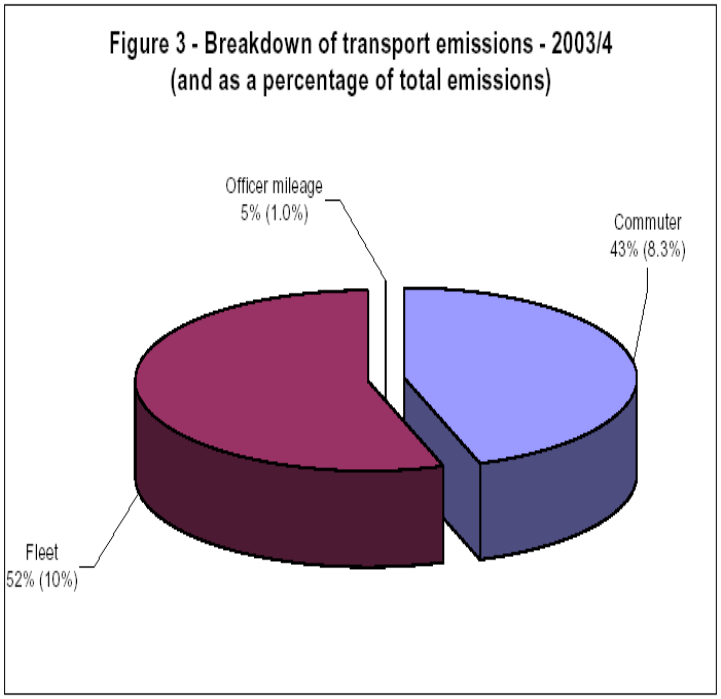


Figure 2. Sector Energy Use Example Guildford Borough Council





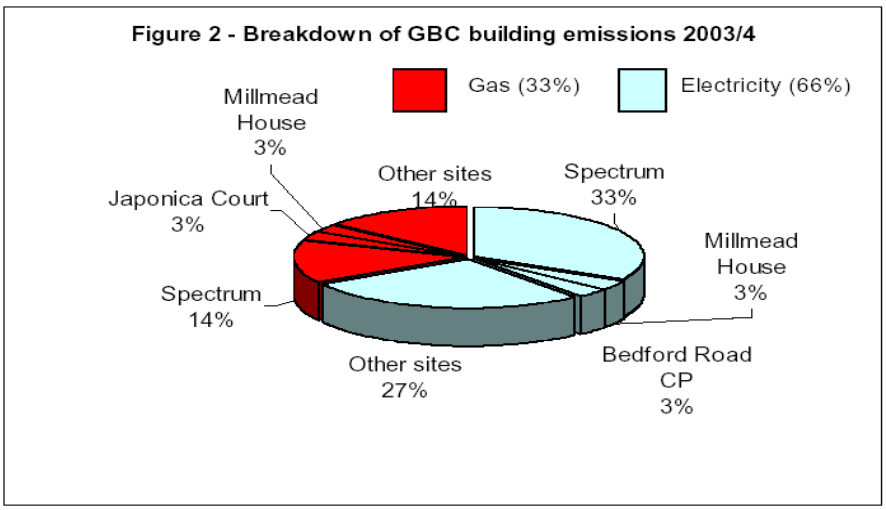
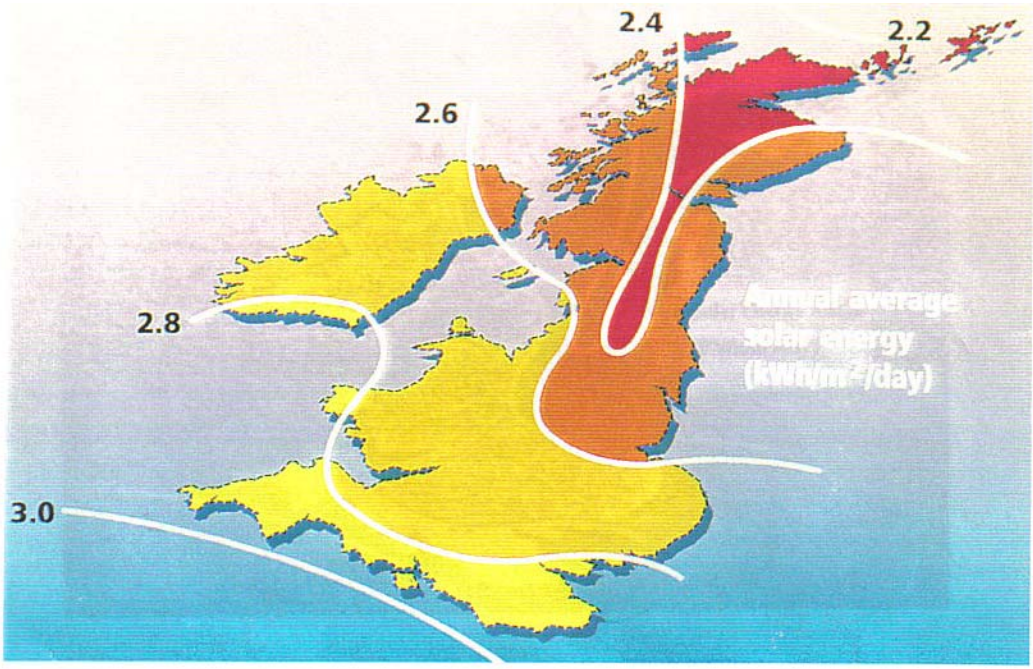
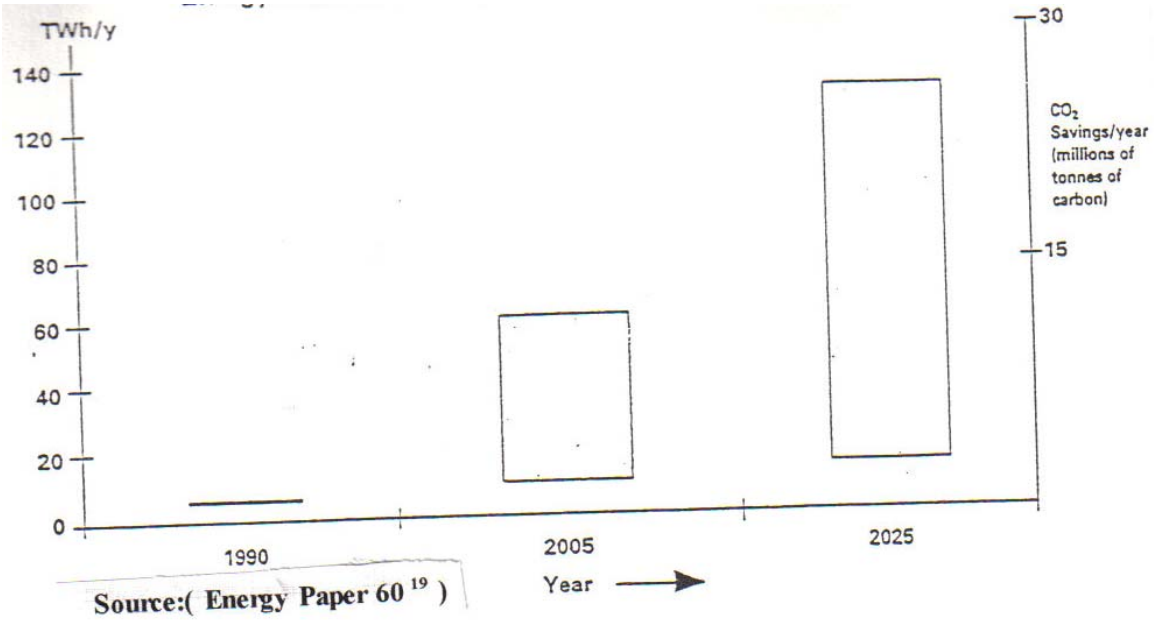


Figure 3. Solar Energy Map



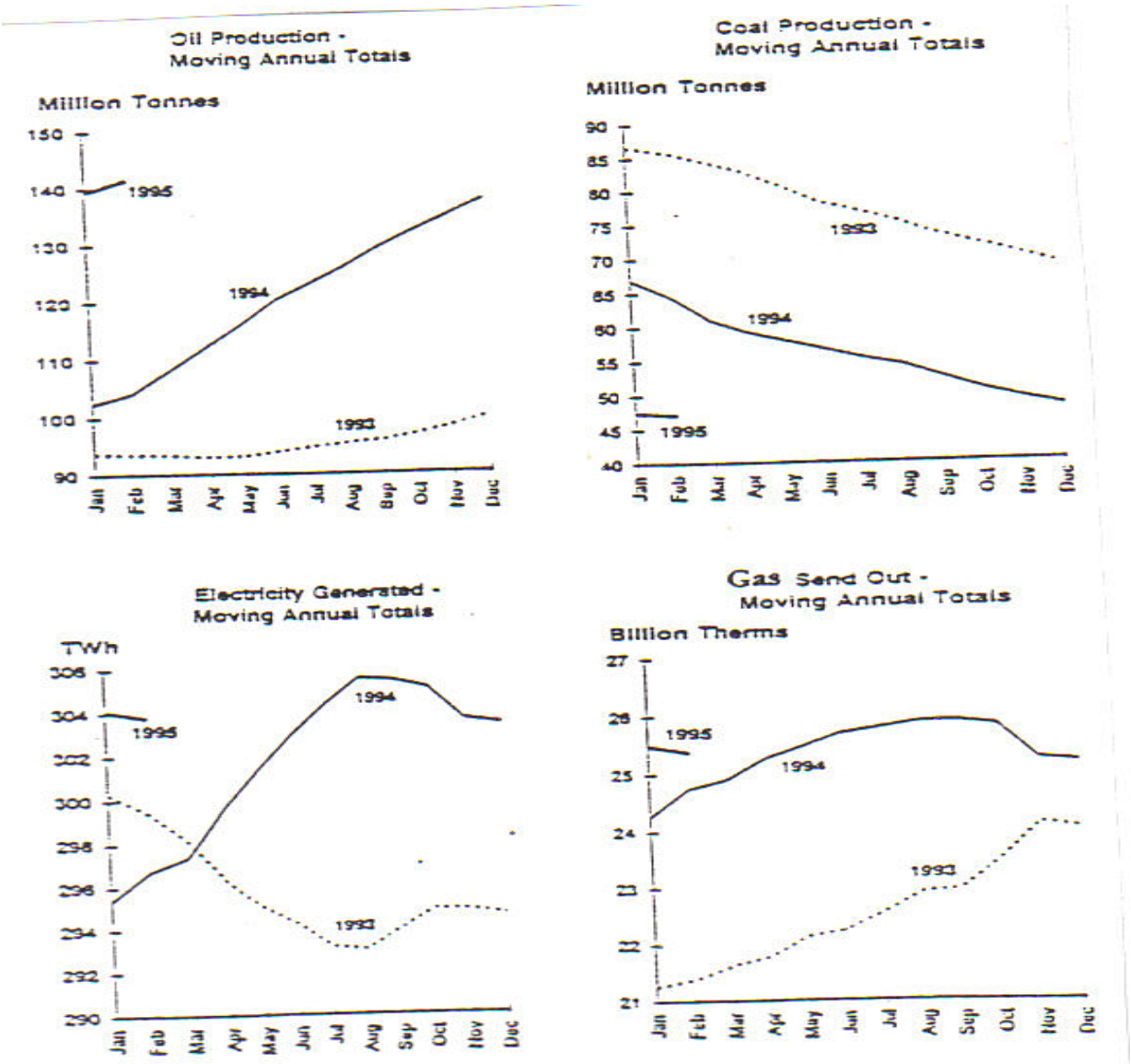
Source:(An Assessment of renewable energy for the UK, ETSU,1994)

Figure 5 Range of Estimated Contributions Supplied from Renewable Energy Sources and Equivalent CO2 Savings.



Source:(Energy Paper 60 [19])

Figure 6. Production of Coal, Oil and Gas



Energy Production 1993-1994

Figure 7. Total Energy use in the Urban Environment

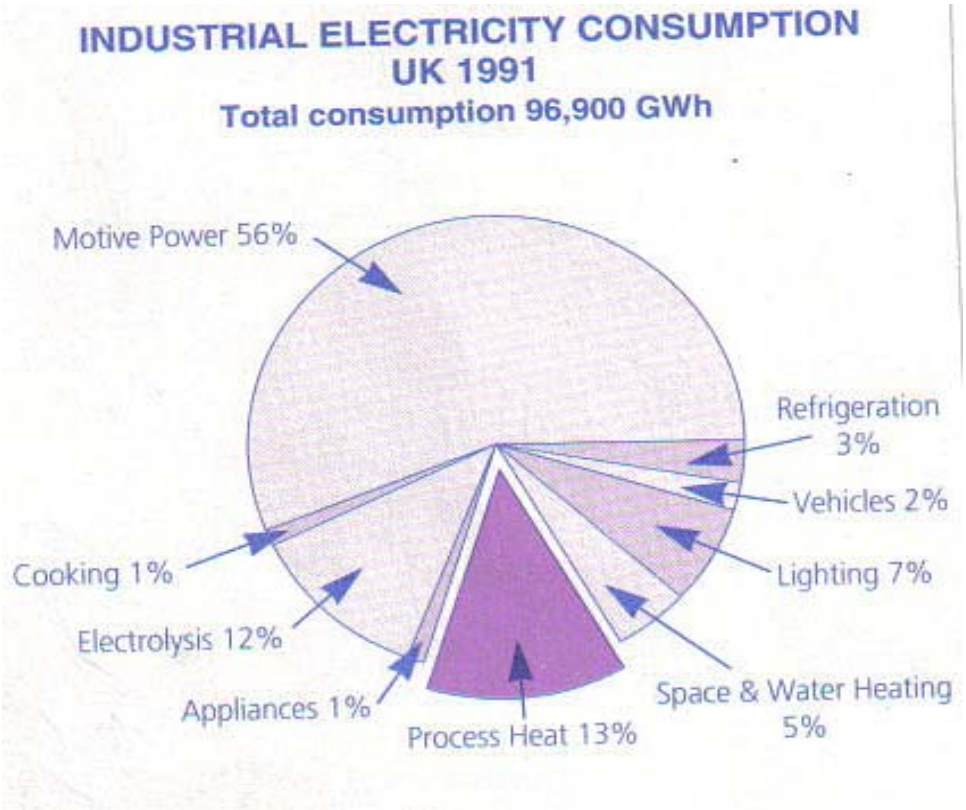
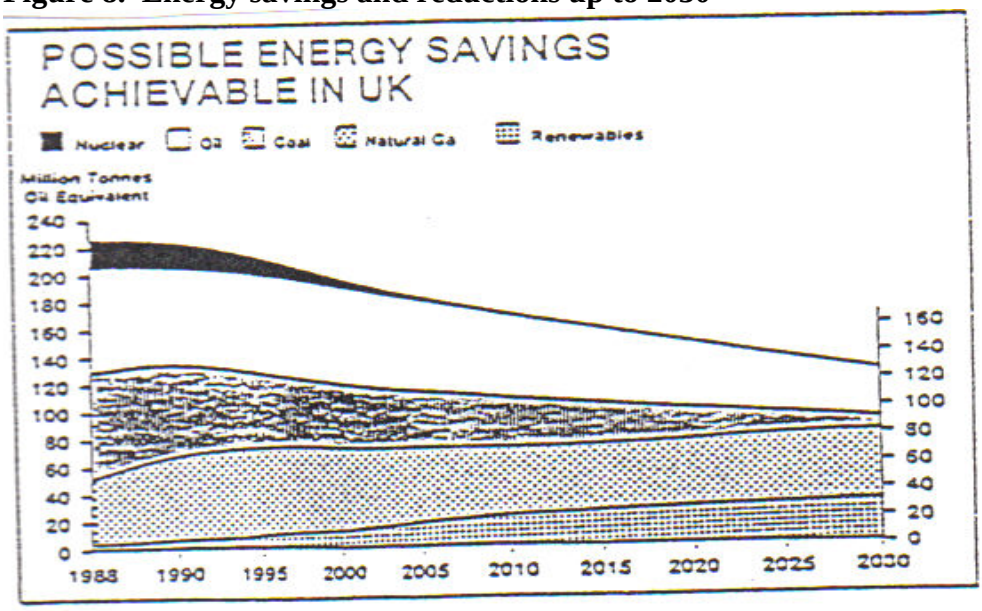


Figure 8. Energy savings and reductions up to 2030



based on information derived from "Energy and the Environment", by Mike Grubb, in 2Energy Policies and The Greenhouse Effect, This assumes a modest slow down in economic activity

Figure 9. Energy from waste Landfill, Biogas

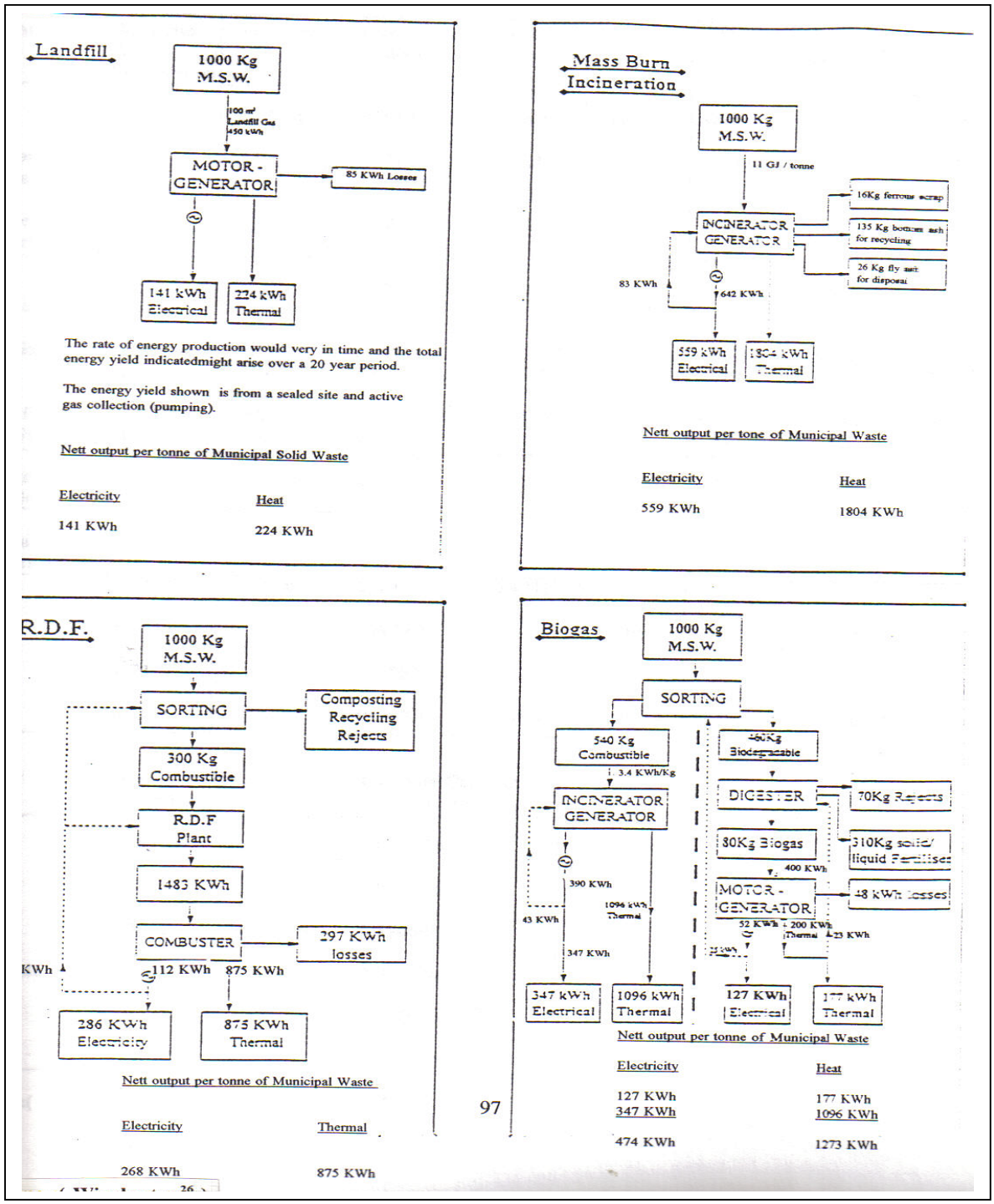
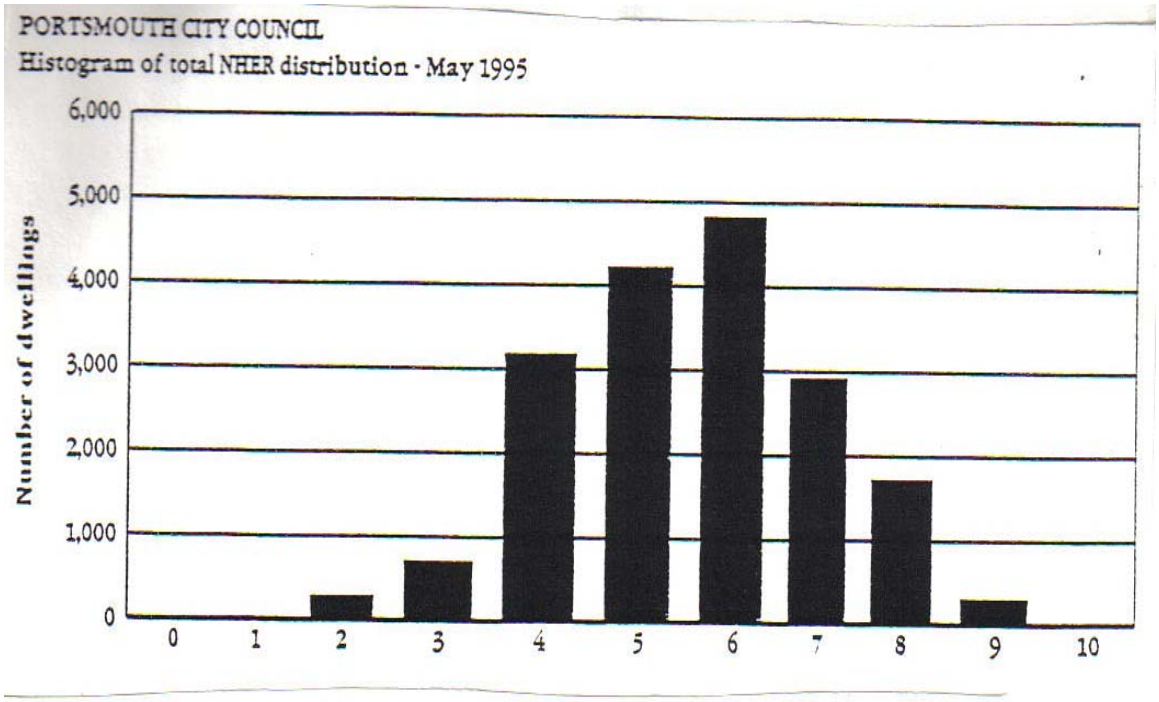


Figure 10. Temis seven tables

Factor	Domestic Waste-Incineration	Gasoline	Power Plant Hardcoal	Natural Gas	Straw	Diesel Fuel	N/S Crude Oil	Bio Gas Manure
	MWh/t	MWh/t	MWh/t	KWh/m^3	MWh/t	MWh/t	MWh/t	KWh/m^3
Lower Heat Value	2.33	11.89	8.71	9.39	3.47	11.89	11.11	6.47
Higher Heat Value	2.68	12.61	8.50	10.41	3.47	12.64	11.32	7.18
Air Demand	m^3/Kg 2.355	m^3/Kg 11.18	m^3/Kg 7.612	m^3/m^3 8.993	m^3/Kg 3.252	m^3/Kg 11.23	m^3/Kg 10.39	m^3/m^3 6.21
Flu Gas Rate	m^3/Kg 2.295	m^3/Kg 10.44	m^3/Kg 7.428	m^3/KWh 8.109	m^3/Kg 3.261	m^3/Kg 10.48	m^3/Kg 9.814	m^3/m^3 5.906
Specific Flu Gas Rate	m^3/KWh 0.98	m^3/KWh 0.88	m^3/KWh 0.91	m^3/KWh 0.86	m^3/KWh 0.94	m^3/KWh 0.88	m^3/KWh 0.88	m^3/KWh 0.91
CO_2 in Dry Flu Gas	18.58%	15.35%	18.70%	11.63%	21.06%	15.29%	16.15%	16.90%
Emission Factors (Kg/TJ)								
SO_2	951.413	14.938	611.622	0.4278	140.657	79.358	499.492	248.256
HCl	355.054		69.962		72.406			
HF	12.5364		3.582					
CO_2	100000	74052	93347.1	55154.4	$1.09x10^5$	74052.3	78320.0	84682.7

Factor	Diesel Car - new (g/Km)	Gasoline Car - new (g/Km)
SO_2	0.158717	0.029876
CO_2	148.1046	148.1046
NOx	0.60000	0.370000
Particulates	0.08000	0.010000
CO	0.48000	4.800000
N_2O	0.00400	0.015000

Figure 11. NHER housing graph



Source:(Portsmouth City Council, Housing Maintenance Department, 1995)

Table 1 Portsmouth City Council Energy Conservation Measures 1994 - 1995.

PORTSMOUTH CITY COUNCIL, BUILDING SERVICES

ENERGY CONSERVATION MEASURES PROPOSED 1994 - 1995

Scheme	Total Annual Energy Cost (£)	Annual Savings (£)	Implementation Cost (£)	Payback Period (Years)	Remarks
Victoria Swimming Centre, Anglesea Road, Portsmouth.					
i) Combined Heat and Power System	57,598.00	15,551.00	75,000.00	4.80	
ii) Power Factor Correction		470.00	800.00	1.80	*
Mountbatten Centre, Alexandra Park, Twyford Avenue, Portsmouth.					
i) Lighting Control Gear	63,943.00	3964.00	10,000.00	2.52	*
Central Depot, Eastern Road, Portsmouth.					
i) Lighting Control Gear	46,826.00	2840.00	7900.00	2.78	*

Scheme	Total Annual Energy Cost (£)	Annual Savings (£)	Implementation Cost (£)	Payback Period (Years)	Remarks
Paulsgrove Area Housing Office, 221 Allaway Avenue, Portsmouth.					
i) Heating System	5615.00	1800.00	225.00	0.12	Implementation of energy saving measures to be carried out in two phases. Completion of two phases will achieve a saving of 60% per annum with a payback perio of less than two years.
Tweed Court, Leigh Park, Portsmouth.					
i) Heating System	7940.00	3220.00	386.00	0.12	Report is in two parts, part II to be published with further energy conservation measures.
City Museum, Portsmouth.					
i) Lighting Control Gear	15,120.00	745.00	2000.00	2.69	*
Civic Offices, Guildhall Square, Portsmouth.					
i) Power Factor Correction		2268.00	5000.00	2.21	*
ii) Lighting Replacement	344,487.00	120,000.00	354000.00	2.95	See report for further details
Civic Offices, 3rd Floor, Guildhall Square, Portsmouth.					
i) Lighting Replacement	60,000.00 (apprx)	18,000.00	70,000.00	3.89	See report for further details

*These Schemes submitted for bids in 1993-94 did not receive necessary funding and were transferred to 1994-95

Source:(Building Services Department, Portsmouth City Council, k.Dutt,1995)

END